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The primary strategies for overcoming challenges in mastering secondary school mathematics: remedial teaching

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Abstract*. Introduction.* Mathematical concepts play a crucial role in the educational field by providing a structured framework for analysing and solving various everyday life problems. The standard pedagogical methods employed to teach these concepts can be challenging and may not always enable students to fully master the material. *Aim.* The *aim* of this study is to identify the challenges faced by Moroccan secondary school students in acquiring mathematical knowledge, to determine the primary reasons for these deficiencies, and to analyse effective strategies to help overcome these issues. *Methodology and research methods.* In the course of the study, we examined strategies for mastering mathematics in high school, considering the principles of a systematic approach. A survey was conducted with the voluntary participation of 220 Moroccan secondary school students. The questionnaire comprised three sections featuring closed and multiple-choice questions, which facilitated the analysis of the primary difficulties encountered in learning mathematics. *Results.* The analysis of the results highlighted the common difficulties encountered in teaching mathematics at the high school level and proposed the most effective strategies to help overcome these challenges. *Practical significance.* The study proposes measures to enhance the teaching of mathematics, assisting teachers in overcoming emerging challenges. Additionally, it aims to guide curriculum developers and textbook authors in making the subject more accessible to secondary school students.

Keywords: pedagogical tools, learning difficulties, mathematics learning, remedial teaching

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Основные стратегии преодоления трудностей в освоении курса математики в средней школе: корректирующее обучение

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Аннотация. *Введение.* Математические концепции играют решающую роль в сфере образования, предоставляя структурированную основу для анализа и решения различных повседневных жизненных проблем. Стандартные педагогические методы, используемые для обучения, не всегда могут помочь учащимся освоить материал в полном объеме. *Цель* данного исследования – выявление трудностей, с которыми сталкиваются марокканские учащиеся средних школ при получении математических знаний, определение основных причин этих недоработок и анализ эффективных стратегий, помогающих преодолеть эти проблемы. *Методология, методы и методики.* В ходе исследования с учетом положений системного подхода изучались стратегии освоения математики в средней школе. Был проведен опрос, в котором приняли добровольное участие 220 марокканских учащихся средних школ, с использованием анкеты, состоящей из трех разделов с закрытыми и многовариантными вопросами, и проанализированы основные трудности при изучении курса математики. *Результаты.* Анализ результатов позволил выделить часто встречающиеся трудности в обучении математике в средней школе, и предложить наиболее успешные стратегии, помогающих преодолеть эти проблемы. *Практическая значимость.* В исследовании предложены меры по улучшению преподавания математики, которые способны помочь учителям преодолеть возникающие затруднения, а разработчикам учебных программ и авторам учебников – сделать предмет более доступным для учащихся средней школы.

Ключевые слова: педагогические инструменты, трудности в обучении, изучение математики, коррекционное обучение

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Introduction

Mathematics commonly occupies a position as a fundamental discipline that delves into structures, shapes, quantities, and abstract relationships. Often described as the science of patterns and orders, they are of crucial importance in various sectors such as science, engineering, computer science, economics, and other fields [1].

The teaching of mathematics is faced with increasingly complex problems that take on new and unpredictable forms, according to B. Nachit et al. [2]. It is highly unlikely that we will ever be able to enumerate them all, as every difficulty is merely the result of a set of other difficulties. In the Moroccan context, the mathematical knowledge and skills of most students are not satisfactory; reference can be made to the TIMSS (Trends in International Mathematics and Science Study) results from the ISC (International Study Center) and PISA (Programme for International Student Assessment) [2].

Symbolic algebra, conceptualised by Viète in the 17th century, goes beyond the traditional approach by using letters not only as unknowns but also to symbolise data. I. Demonty announces that this development marks a significant conceptual transition, paving the way for the emergence of innovative language and the adoption of new cognitive methods [3]. Unfortunately, the unequal distribution of students from late primary to early secondary remains one of the difficulties encountered during the progression of mathematical learning, particularly concerning problem-solving, according to C. Allard, J. Horoks, D. Jeannotte et al. [4].

Secondary school students often face challenges in mathematics. Studies such as TIMSS and NAEP indicate that mathematical skills have been consistently low at both primary and secondary levels since 1999, adversely affecting the performance of secondary school students.

It is essential to master fundamental mathematical concepts such as numbers, fractions, and equations. Furthermore, understanding depends on the level of cognitive development of the problem-solving model that the individual employs, according to J.-F. Maheux and J. Proulx [5]. It is equally crucial to correctly apply formulas, mathematical methods, and to understand mathematical notations and representations.

Geometric concepts can be difficult for some students, as they need certain logical reasoning skills, which can be harder to acquire than other mathematical skills. To help these students, remedial classes and extra help are essential, as they give them the support they need to succeed. When students have difficulty with a subject or skill, they may feel frustrated and feel they cannot keep up [6].

The problematic and the previous research of our article have led us to address some hypotheses, from an epistemological point of view, which characterise the field of study that interests us here: students lack basic mathematical knowledge during the period of distance learning due to COVID-19 confinement measures, and they are required to acquire knowledge following the approval of the emergency programme by the ministry. Despite the efforts made to implement the distance learning programme, several constraints and factors of inefficiency still confront the officials responsible for this programme at the ministry level, and urgent and appropriate solutions must be provided [7], language difficulties disrupt the mathematical activity of migrant students [8], the preparation of students for the lesson was unsatisfactory and irrelevant to the lesson's proceedings; the reasons explaining the lack of preparation in mathematical problem-solving were investigated [9], as the respective weights of different factors influencing students' learning have not yet been accurately assessed [10].

As a result, the inquiry prompts us to explore the difficulties students face in this valuable domain, as well as to understand the reasons behind them based on the analysis of studies [7, 8, 9, 10]. The challenge remains: What causes these obstacles to students' learning of basic concepts in algebra and geometry? How can remedial teaching improve students' understanding of mathematical concepts? How can teachers adapt and select programmes and teaching methods to help students develop basic skills and remedy their gaps?

Literature Review

Students face persistent obstacles in mathematics, particularly in applying formulas and properties, understanding exercises, as well as linguistic difficulties related to the language of instruction. In response to these challenges, research in mathematics education has focused on these sources of difficulty. The aim is to identify the origin and nature of these hindrances within the framework of studies, with a view to proposing solutions to overcome them.

Mathematics learning difficulties are intimately linked to the student's relationship with knowledge, involving the cognitive processes deployed during learning, as well as epistemological obstacles and the specific language of mathematical instruction. These difficulties can stem from various factors, such as the complexity of concepts, the accumulation of learning difficulties, inadequate preparation of lessons at home, and reasoning problems. These obstacles can lead to the formation of misconceptions and persistent gaps throughout the school journey. The experience of teaching elementary and secondary school students involves not only understanding how students think about mathematics but also what they feel about a subject that often appears as a simple set of facts and rules to master [11]. M. Bray and M. N. Kobakhidze argue that more students with low mathematical abilities exist than students with high mathematical abilities [12].

However, it is emphasised that nearly half of the students encounter difficulties in successfully completing exercises involving calculation, placing a number on a number line, and problem-solving [13].

Students may resort to numerical calculations and mathematical formulas to solve exercises, and the numerical representation of mathematical or physical objects is also of great importance [14]. Furthermore, the use of heuristic strategies, a computational method aiming to provide a quick solution proves crucial. This involves a rule to reduce the number of mental operations (or information processing steps) required to solve a problem [15].

Most students fail to interpret the instructions correctly and/or are unable to formulate a response that considers the relationship between the three objects, whether from a visual, material, or verbal perspective [16].

Table 1 presents examples of current research on mathematical difficulties.

Table 1

Examples of current research on mathematical difficulties

Examples of current research on mathematical difficulties	Bibliographical sources
Studies on learning difficulties in mathematics have revealed that cognitive difficulties are one of the main contributing factors.	[17]
In Ms. Rolland's class, students find the demonstrations and challenging exercises the least enjoyable aspects of the lessons.	[8]
Different standards are used to define learning difficulties, and focusing solely on academic delay oversimplifies the problem.	[18]
When educating students with learning difficulties, it is essential to take into account their academic background and experiences, as demonstrated by the many studies presented in this text.	[19]
Students are frequently confronted with situations where they need to use and understand graphs representing functions. However, despite the importance of these concepts, research shows that students at different levels continue to have difficulty understanding functions.	[20]
Second-year students do not use the expression "tends towards" in their everyday speech. They have difficulty providing examples of sentences that include it.	[21]
To improve students' ability to apply mathematical concepts in physics, it is essential to regularly offer them a variety of physics problems in math and physics classes. This variety will reduce the challenges they face when tackling real physics problems.	[22]
Research suggests that effective teaching of problem-solving involves introducing the whole process holistically, rather than focusing separately on individual strategies (heuristics).	[23]

The various quotations converge on an analysis of the challenges encountered in learning mathematics and approaches to overcoming them [17] and R. Najar and E. F. Brahim [20] both highlight the cognitive difficulties associated with learning mathematics. K. Millon-Faure [8], S. Krstic and M. Papotto [22] discuss the importance of the variety of exercises and problems exposed during lessons to enhance learning. L. DeBlois and J. Giroux [18], V. Hanin and C. Van Nieuwenhoven [23] examine the criteria used to assess learning difficulties and propose more holistic approaches to addressing them. G. Lemoyne and G. Lessard [19] draw attention to the importance of considering the school history of students with learning difficulties to better adapt teaching methods. Finally, B. Cornu [21] highlights students' linguistic shortcomings in mathematical language, which can hinder their understanding of concepts.

Methods

Characteristics of the Sample

The targeted respondents for this study were students belonging to the provincial direction of the Regional Academy of Education and Training in the Casablanca-Settat region of Morocco, attending a school in an urban environment. In total, 220 students out of the total population participated in the survey questionnaire. The sample was selected using simple random sampling and included 113 students from the 1st year of secondary school (51%) and 107 students from the 2nd year of secondary school (49%). All students were aged between 15 and 19 years at the beginning of the study.

Table 2 presents the distribution of students according to types of learning difficulties in mathematics.

Table 2

Distribution of students by type of learning difficulty in mathematics: frequency of problems encountered by students in different categories

Types of mathematical learning difficulties	1st year		2nd year		Total	
	Percentage	N	Percentage	N	Percentage	N
Difficulty in applying formulas and properties	31,86%	36	42,06%	45	36,82%	81
Difficulty in grasping the fundamentals of mathematical material	44,25%	50	47,66%	51	45,91%	101
Language-related difficulty (language of instruction)	34,51%	39	27,10%	29	30,91%	68
Difficulty in understanding exercise questions	16,81%	19	19,63%	21	18,18%	40

The observations highlighted by the data demonstrate that students face several challenges throughout their learning journey in mathematics. Approximately 36,82% encounter obstacles in applying formulas and properties. The highest percentage, estimated at 45,91%, reveals fundamental difficulties, suggesting that many students grapple with challenges inherent in understanding basic mathematical concepts. Additionally, 30,91% of students face language barriers related to the language used for instruction. Finally, 18.18% of learners report difficulties in understanding exercise prompts, shedding light on an additional challenge associated with question formulation. These findings underscore the imperative need to innovate pedagogical approaches to overcome this array of obstacles impeding mathematics learning.

Prior to the experiment, students generally had difficulty with mathematical skills and concepts, according to L. S. Calucag [24]. Unfortunately, the results of the study conducted by T. M. A. M. Khair, A. Z. Khairani and T. A. Elrofai indicate that students continue to perform poorly in mathematics [25].

In addition, A. Ibourk, K. El Aynaoui and T. Ghazi conducted a close examination of student evaluations against educational performance standards could shed light on the factors that contributed to students' poor overall performance [26].

The Research Process and Data Analysis

To collect data relevant to this research, we used data measurement instruments that assess the following parameters:

Learning difficulties: Assess the level and types of learning difficulties among students in mathematics in relation to the final learning objectives through a test prior to the remedial teaching. This involves a particular focus on the areas of algebra and geometry, with an interpretation of the results obtained before and after the remedial teaching.

Skills acquired during remedial teaching: Assess students' effectiveness and efficiency in learning mathematics, with a focus on algebra and geometry, from affective, cognitive, and metacognitive perspectives, in a variety of contexts. This assessment encompasses the skills acquired during the remedial teaching identified in the mathematics remedial teaching programme, intended to be developed in the students, with an interpretative analysis of the results before and after the remedial teaching courses.

Table 3 presents the results of the Cronbach's alpha reliability test on the scale measuring skills acquired during remedial teaching courses in the field of mathematics. The results indicate that the 17 items are highly correlated, as the Cronbach's alpha correlation value of 0.730 is higher than the value of 0.700, often considered to indicate a strong correlation.

Table 3

Cronbach's alpha reliability tests for the soft skills scale

Cronbach's alpha	Cronbach's alpha based on standardised items	Number of items
.730	.722	17

Measurement Instrument

This research was conducted using a quantitative approach. To address the research questions, an anonymous electronic questionnaire composed of three distinct sections was employed.

In the first section, titled "Analysis of the Distribution of Learning Difficulties in Mathematics by Types and Classes, with a Focus on Levels of Understanding of Geometry Concepts", the aim was to enhance the quality of mathematics education, particularly in the field of geometry. The objective was to understand and specifically address the learning difficulties encountered by students. Three questions were included in this section. The first question focused on the distribution of students based on types of learning difficulties in mathematics, assessing the frequency of problems encountered by students across different categories. Participants were asked to select the type(s) of difficulty they found challenging to learn. The second question addressed the level of difficulties in mathematics by class, where students were asked to categorise their experiences using the following options: "Yes, frequently", "Yes, sometimes", "Rarely", "No, never". The goal was to gather information about the frequency of difficulties encountered in mathematics learning.

In the second section, titled "Analysis of the Distribution of Students Based on Their Difficulties in Interpreting Graphs and Tables in Mathematics, and Learning Preferences", our objective was to improve the quality of mathematics education by identifying specific obstacles faced by students. We adjusted teaching methods accordingly and promoted a more personalised educational approach, taking into account individual learning preferences. In this analysis, we examined the distribution of students based on their difficulties in interpreting and using graphs and tables in mathematics. Students' responses were categorised as "Yes, frequently", "Yes, sometimes", "Rarely", "No, never". Additionally, multiple-choice questions (MCQs) were included to explore learning preferences in mathematics, including preferred choices among concrete examples, problem-solving, theoretical explanations, etc., as well as the didactic tools and methods used to understand mathematical concepts.

In the third section, titled "Study of Strategies to Address Obstacles in Mathematics: Distribution of Solutions, Student Preferences, and the Impact of Remedial courses on Exam Performance", we aimed to gather proposals for solutions to difficulties related to mathematical learning and other associated concepts. We presented suggestions to overcome learning challenges, emphasising the improvement of mathematics education. We identified solutions, developed suitable strategies, and considered students' preferences. Our research concluded with three exam assessments, analysing the impact of pre- and post-teaching remedial courses to maximise exam performance.

Finally, we have set up a three-month remedial teaching course for pupils to help them overcome learning difficulties in mathematics.

Ethical Considerations: Measures were taken at the beginning of the second semester. Moreover, all students were informed that their participation in this study was voluntary, and they could decide to withdraw at any time.

Instrument Validation: The questionnaire was pre-examined and approved by three experts in the field of education: two Moroccan university teachers from a public university in Morocco, a doctor in education, and two mathematics teachers in qualifying secondary education. This validation process led to the rewording of certain elements to make them more understandable for qualifying secondary school students and more scientifically accurate. The experts deemed the final version of the questionnaire as valid. Before being used as a data collection instrument, it is important to note that the questionnaire was tested with 5 participants with characteristics similar to those of the students studied.

Data Analysis Process: Quantitative data collected through questionnaires were analysed using descriptive analysis (averages) with Microsoft Office Excel 365. Regarding the remedial courses, we developed remediation sessions for learning difficulties based on the responses collected in the questionnaire, parallel to normal student sessions. This intervention lasted 2 hours for each school level over three months, starting at the beginning of the second semester. Each month, an exam was administered to track the progress and evolution of students.

Experimentation

As part of the experiment, the teacher first taught students in the first and second years of secondary school throughout the first semester. At this point, the teacher was able to identify specific learning gaps for each student, focusing in particular on those with a below-average grade. An observation grid was designed for this purpose, which revealed that these students were having difficulty with basic math concepts.

The greatest difficulties observed concerned factoring, development, addition and subtraction of whole numbers, trigonometric calculations, arithmetic in the set N, as well as understanding the sets N, D, Z, Q and R. More importantly, students struggled with the properties of Thales's theorem and vector calculus, which are very important for the development of courses in numerical functions and scalar product in the first year of secondary school, and courses in function limits, differentiation, function investigation and analytic geometry in the second year.

Faced with these problems, the teacher oriented his teaching method during the experiment, trying to adapt teaching to fill these gaps while meeting the requirements of the programme. As a result, the teacher and the school management also organised extra remedial courses for students in difficulty. It was agreed that a classroom would be made available for this purpose, and the students' timetable was adapted for three months. Two hours of remedial teaching per week were allocated to each grade level.

These sessions were a follow-up to given mathematical exercises where students were experiencing difficulties, with reminders of essential operations provided from time to time. The teachers' task was not only to encourage the students to get on with the exercises, but also to raise their awareness of the importance of making mistakes. The teachers tried to motivate them to come to the blackboard to write and explain their solutions.

The teacher began with algebra lessons, which were necessary and fundamental in the first lessons of the second semester. One month after remediation, a first exam was organised to test the skills acquired during remediation. However, the result was not satisfactory, as the students were still making the same mistakes with their representations.

The teachers then continued the exercise sessions and introduced other new geometry subjects in the second month. After another test, it was found that the class average had increased significantly and that almost all the problems related to algebraic foundations had been solved. Encouraged by these results, he chose to continue the study in the third month.

At the last moment, a final exam was taken, the results of which showed that the class average was good, confirming the success of the remedial courses and the students' hard work.

Limitations

The study sample focuses solely on the Casablanca-Settat region of Morocco, which limits the possibility of extrapolating results to other regions or contexts. The study focuses on students aged 15 to 19, which may not be representative of the learning challenges experienced by younger or older students. Although the questionnaire is validated, it does not capture all the subtleties and particularities of students' mathematical learning problems. The support course lasted three months, with sessions lasting two hours a month, a duration and intensity that may not be adequate to effectively address the students' learning difficulties. This may not accurately reflect the opinion of the target population.

Results

The statistical results presented in the table provide an analysis of learning difficulties in mathematics. Student averages were examined using a pivot table. It can be seen that the highest percentage, estimated at 44.55%, concerns students who frequently encounter gaps in their learning. On the other hand, 22.27% said they sometimes encountered difficulties, 19.55% rarely, and 13.64% said they never encountered difficulties (Table 4).

Table 4

Difficulties in mathematics by class

Class	Difficulties in mathematics by class							
	Yes, frequently		Yes, sometimes		Rarely		Never	
	N	%	N	%	N	%	N	%
2nd year	55	51,40%	28	26,17%	14	13,08%	10	9,35%
1st year	43	38,05%	21	18,58%	29	25,66%	20	17,70%
Total	98	44,55%	49	22,27%	43	19,55%	30	13,64%

Certain difficulties are sometimes associated with the increasing complexity of mathematical concepts such as linear, periodic or second-degree functions as the student progresses through the course. In addition, 44.55% of students lack certain mathematical basics such as factoring, development or trigonometric calculations, which makes it more difficult to understand new ideas, particularly those related to polynomials, square roots or arithmetic in the set of natural numbers. The European Commission's report on Lifelong Learning [28] states that these gaps in students' knowledge, from the inability to solve systems of linear equations to the correct application of the theorems of Pythagoras and Thales, are the result of an accumulation over the years of schooling and the widening gap between the minimum results required to continue studies. C. L. Giles, K. D. Bollacker and S. Lawrence pointed out that whether adding fractions, factoring polynomials, or simplifying a quotient of algebraic expressions, students have significant gaps in basic skills essential to mastering advanced mathematics [29].

Table 5 presents the analysis of students' ability to grasp the concepts of angles, triangles, circles, etc. according to the frequency with which they encounter difficulties in assimilating these concepts. We can see that, for first-year students, 47.79% claim to assimilate these concepts frequently, 39.82% occasionally, 8.85% rarely and 3.54% never. Similarly, for second-year students, the results show that 71.96% claim to assimilate these concepts frequently, 23.36% occasionally, 3.74% rarely and 0.93% never (Table 5).

Table 5

Levels of difficulty in understanding geometric concepts: distribution of students according to their ability to assimilate the notions of angles, triangles, circles, etc.

Class	Students have difficulty assimilating the concepts of angles, triangles, circles, etc.							
	Yes, frequently		Yes, sometimes		Rarely		Never	
	N	%	N	%	N	%	N	%
2nd year	77	71,96%	25	23,36%	4	3,74%	1	0,93%
1st year	54	47,79%	45	39,82%	10	8,85%	4	3,54%
Total	131	59,55%	70	31,82%	14	6,36%	5	2,27%

Table 5 highlights the frequency with which students manage to assimilate specific geometric concepts. Overall, 59.55% of students claim to do so frequently. However, the proportion of students claiming to assimilate these concepts frequently varies between the two classes, with a slight predominance among 2nd graders. The results suggest that, although the majority of students assimilate these notions regularly, there are significant variations in the frequency of this assimilation between the two classes. This information could guide pedagogical efforts aimed at improving understanding of specific geometric concepts.

These obstacles may relate to spatial visualisation or to the understanding of abstract concepts. The nature of geometry often requires a shift in perspective from other areas of mathematics, which can make learning more difficult for some students. Certain obstacles were identified by students in the course of learning geometric concepts. These difficulties were mainly due to the way the sub-themes were presented in the textbooks published by UNESCO, as well as to teachers' lack of familiarity with these new concepts. The second phase of the project, focusing on vector geometry, was implemented in 1972 [29]. The study conducted by S. Mrabet shows that the transition to vector geometry around Thales's theorem is accompanied by difficulties for students [30].

Table 6 appears to represent responses to a survey on the challenges faced by students in interpreting and using graphs and tables in mathematics. The data is broken down by class (2nd year and 1st year), and the possible responses are grouped into four categories: "Yes, frequently", "Yes, sometimes", "Rarely", and "No, never". For the second year, 53,27% of students frequently report difficulties, while this percentage is slightly lower at 32,74% for the first year. Regarding occasional difficulties, 27,10% of second-year students encounter them, while this figure is higher at 38,94% for the first year. Obstacles are less frequent, with rates of 10,28% for the second year and 23,89% for the first year. These data suggest that most students only face difficulties occasionally or rarely. Percentages reveal that a small proportion of students, namely 9,35% for the second year and 4,42% for the first year, never experience difficulties. Overall, the results show that, in both classes, most students encounter difficulties at least occasionally in interpreting and using graphs and tables in mathematics. The first-year class seems to experience more frequent difficulties compared to the second year. These data could serve as a basis for developing teaching strategies aimed at improving the understanding and use of graphs and tables in these specific classes.

Table 6

Analysis of the distribution of pupils according to their difficulties in interpreting and using graphs and tables in mathematics

Class	Distribution of pupils by their difficulties in interpreting and using graphs and tables in mathematics							
	Yes, frequently		Yes, sometimes		Rarely		Never	
	N	%	N	%	N	%	N	%
2nd year	57	53,27%	29	27,10%	11	10,28%	10	9,35%
1st year	37	32,74%	44	38,94%	27	23,89%	5	4,42%
Total	94	42,73%	73	33,18%	38	17,27%	15	6,82%

Additionally, accurately interpreting the data depicted in graphs or tables necessitates a specific proficiency in visually analysing relationships and trends, a task that can pose challenges for certain students. According to F. Hitt-Espinosa, students encounter difficulties stemming from two distinct types of obstacles [31]. On one hand, external hurdles are linked to the methods of function instruction in secondary education; while, on the other hand, internal obstacles arise from students' inconsistent utilisation of diverse function representation methods [32].

This table highlights students' learning preferences, particularly regarding their choices among different teaching methods. Second-year students appear to exhibit a slight preference for learning through concrete examples, accounting for 53,27%, compared to 36,28% for first-year students. On average, approximately 44,55% of students favor this approach. These results underscore that applying definitions and properties makes concepts more tangible, facilitating understanding. The use of real examples or practical applications in mathematics allows students to visualise how these concepts are relevant in the real world, reinforcing their understanding of the utility of mathematics in various everyday life contexts or other disciplines (Table 7).

Table 7

Learning preferences in mathematics: distribution of students according to their preferred choice between concrete examples, problem solving, theoretical explanations, etc.

Class	Preferred methods for learning mathematics (concrete examples, problem-solving, theoretical explanations, etc.)									
	Yes, I learn better through concrete examples.		Yes, problem-solving helps me understand better.		Yes, I need theoretical explanations to assimilate concepts well.		I have no particular preference		It depends on the subject or concept being learned.	
	N	%	N	%	N	%	N	%	N	%
2nd year	57	53,27%	3	2,80%	20	18,69%	6	5,61%	21	19,63%
1st year	41	36,28%	11	9,73%	24	21,24%	21	18,58%	16	14,16%
Total	98	44,55%	14	6,36%	44	20,00%	27	12,27%	37	16,82%

It is essential to note that problem-solving is not the preferred method for the majority of students, obtaining only 6,36% overall preference. However, the first year of qualifying secondary school seems to show a higher preference (9,73%) compared to the second year (2,80%). Many students admit not enjoying problem-solving due to their difficulties and uncertainty about how to solve them [33].

Regarding theoretical explanations, first-year secondary school students appear to have a marked preference, with 21,24% compared to 18,69% for the second year. On average, 20,00% of students prefer this method. The importance of providing theoretical explanations is emphasised, but this requires an advanced mastery of the learning environment, according to [34].

The preference for not having a specific preference is more pronounced among first-year secondary school students (18,58%), while the second year shows a lesser preference for this category (5,61%). Approximately 16,82% of students believe their choice depends on the subject or concept to be learned, with equivalent percentages for both years.

In conclusion, the table suggests variations in learning preferences between the two years, with notable differences in the choices of teaching methods. The first year seems to exhibit a stronger preference for theoretical explanations, while the second year has a slight preference for concrete examples. Problem-solving is not the preferred method overall. Some students have no specific preference, while others feel their choice depends on the subject or concept being learned.

Table 8 provides a thorough analysis of students' preferences regarding solutions aimed at overcoming difficulties in learning mathematics. These preferences are differentiated between students in the 1st and 2nd years of the qualifying secondary cycle, and the overall total is also considered.

Table 8

Analysis of needs to overcome mathematical difficulties: distribution of solutions and student preferences

Allocation of solutions and student preferences	1st year		2nd year		Total	
	Percentage	N	Percentage	N	Percentage	N
Offer remedial teaching or tutoring sessions to help students understand difficult concepts	38,94%	44	41,12%	44	40,00%	88
Provide progressively challenging exercises to better absorb the rules	48,67%	55	49,53%	53	49,09%	108
Homework preparation and review of exercises	27,43%	31	18,69%	20	23,18%	51
Introduce more practical examples to illustrate concepts	29,20%	33	30,84%	33	30,00%	66
Allocate more time in class for problem-solving	33,63%	38	35,51%	38	34,55%	76

The option of offering remedial courses or tutoring sessions stands out as a preferred solution, garnering relatively equal support from students in both years, totalling 40.0%. This approach, indicative of a commitment to personalised learning, is thus significantly endorsed.

Students express a clear preference for the approach of providing progressively more difficult exercises to improve their understanding of mathematical rules. This solution receives substantial support, reaching a total of 49.1%. The emphasis on gradual progression seems to be particularly well received by students.

However, the idea of preparing and revising exercises at home seems less popular among Year 2 students, although the overall rate reaches 23.2%. This approach, requiring individual investment at home, attracts relatively less interest.

Another option explored is the introduction of practical examples to illustrate mathematical concepts. This approach, which aims to contextualise and make lessons tangible, scored a total of 30.0%, indicating significant interest on the part of students in both years.

Finally, students clearly express an increased desire to devote class time to problem solving, showing a consistent preference between the two years, with a total of 34.5%. The importance given to this option underlines the perceived importance of active, interactive practice in learning mathematics.

A literature review by J. P. Meehan [35] convincingly reinforced the existence of underlying processes for successful learning.

Overall, the gathered data reveal a positive inclination of students in both years of the qualifying secondary cycle towards the proposed solutions for overcoming learning difficulties in mathematics. The favoured approach of the majority remains that of "progressively challenging exercises". However, remedial teaching, the use of practical examples, and an increased focus on problem-solving in class are also options viewed favorably. This information is valuable for guiding the development of teaching strategies and educational interventions tailored to students' preferences.

Table 9 presents the average of the significance test conducted and compares the mean ranks of students' grades before, during, and after algebra and geometry remedial courses in high school. We observed that before the remedial teaching; students' rankings were insufficient, falling below the average, indicating more severe mathematical difficulties. The summative evaluation targets achievements of low academic performance and is characterised, according to TIMSS, by performances below the international average [27].

Table 9

Influence of remedial courses on exam averages

Grade	Exam 1. Average before remedial teaching	Exam 2. Average during remedial teaching	Exam 3. Average after remedial teaching
1st year of qualifying secondary cycle	9,96/20	10,35/20	13,68/20
2nd year of qualifying secondary cycle	7,22/20	9,49/20	14,47/20

Following this evaluation, we developed a relevant and robust programme based on the gaps and shortcomings identified during the test, including factorisation, development, equation solving, powers, notable identities, numerical functions, drawing curves, and their geometric interpretations. It is emphasised that teachers start by identifying each student's difficulties through an assessment based on results. If the goal is to help students become effective problem solvers, the teaching of mathematical problem-solving must also be addressed [24].

Following this preparatory phase, we began providing remedial teaching, followed by a second examination aimed at assessing students' progress. We found that the class average was higher than after the first examination, which was encouraging. We continued with the remedial teaching, focusing on the new gaps identified during the second test, aiming to further improve the class performance. Finally, we organised the last examination at the end of the second semester and observed fairly satisfactory results.

Discussion

First, it should be said that this work aims to explore the difficulties that Moroccan secondary school students encounter in learning mathematical concepts, their origins and the strategies that teachers should adopt to overcome these difficulties. Thus, the study revealed that students experience several types of obstacles, notably concerning the very foundations of algebra and geometry. According to the report on national and international assessments [36], many elementary school students have not yet mastered the required mathematical knowledge and skills. These difficulties are due to various factors, depending on the teacher, and can be didactic, pedagogical or student related.

To overcome these obstacles, we can draw the conclusion that the organisation of remediation sessions, by adding two hours per week and revising the timetable, is an essential measure. These adjustments are made according to the identified needs of the students, which may also include their preference for additional help. The orientation of instructional content also seems to be based on particular difficulties noted in students; for example, the choice to start with algebra lessons to alleviate problems related to factoring and then development reveals such pro-activity aimed at meeting students' requirements [28].

The teachers formed a database by identifying challenges, and made several important decisions, such as designing observation grids to diagnose deficiencies, adjusting teaching methods, organising remediation sessions and collaborating with the administration to adjust student schedules. Additionally, teachers appear to have used their own observations and analyses to modify their teaching practices. As a result, it can be said that ongoing reflection on teaching practices and adaptation based on the results obtained are an essential part of their professional growth [27].

In addition, participation in training sessions focusing on diagnostic assessment techniques enables teachers to quickly become aware of students' shortcomings at the start of the semester. During these training sessions, they learn how to develop effective observation grids and interpret the results in order to adapt their teaching materials to the specific needs of secondary school students [37].

Understanding the teaching of mathematics is heavily dependent on the themes of algebra, geometry and linguistics. Language difficulties are a major obstacle to schoolwork and social and professional integration [38]. The problem seems to be more linguistic than mathematical, as the students have not chosen to take mathematics courses in French; rather, it is an imposition by Moroccan institutions aimed at raising the level of students to the detriment of their simple learning abilities. Educators in this field try to enhance the acquisition of a second language while simultaneously developing subject knowledge. However, this proves "cognitively complex" for them [39]. Low achievement in mathematics hampers logical reasoning, as students are unable to pass compulsory mathematics exams because they do not have a good mastery of the French language [40].

The minimum requirements for conducting secondary instruction are not being satisfied, and problems continue to exist in date and heuristics, obstructing learning. According to C. Corriveau, teachers have reported that students need to be grounded in algebra, including equation solving, factoring, highlighting, simplification and polynomial division [28]. This prerequisite is as valid for all NYA classes as it is for this NYC class. In fact, P. Barrouillet and V. Camos allude to a major difficulty for students, which is problem solving [41].

As a result, the proper foundations of algebra, geometry and linguistics are of great importance for the incorporation of many mathematical concepts particularly in secondary school. Given this, statistics from the PISA 2012 survey show that 23% of 15-year-old students in the OECD face very serious or even major problems in mathematics [42].

An analysis of the results revealed difficulties and gaps in students' knowledge of algebra, geometry and linguistics. It was found that many students encounter problems when it comes to applying formulas and properties, mastering the basics of mathematical subject matter, overcoming language of instruction barriers or understanding exercise statements. This trend is also found throughout the country, as revealed by the Ministry of the Federation [43], according to which 40% of students in the second grade lack fundamental mathematical skills. In addition, the transition from concrete mathematics to its more abstract forms, as well as abstract thinking, presents certain problems, particularly at the algebraic, numerical and heuristic levels. Teachers insist on the need to reorient the programme around the fundamentals of calculus and linear algebra [28].

Students' language difficulties can also be distinguished from those of struggling students in terms of the value they attach to school subjects. It is also worth noting that the inability to solve math exercises increases as students move from one grade level to another. These findings are in line with previous research indicating the possibility of dividing this group of students into two distinct segments:

around 30% start to experience delays only in secondary school, while almost 50% start to accumulate delays from elementary school onwards [44].

The study reveals that many students have misconceptions about the basis of mathematics. Many didactic researchers say that errors and obstacles lead to teaching and learning difficulties for students [45]. Some geometric integrations do not function this well, even though their interpretations are hard. For these students, understanding the results that come from movement is really lacking. First, they sometimes fail to see the phenomena mathematically as the teacher has advocated, as some other research has shown [46]. In addition, it is crucial for students to deepen their qualifications in the use of geometric instruments [47] and to change the way they see geometric figures [48]. This will make it easier to understand how various elements of figure understanding interact with each other [49].

As a result, we need to establish a good grasp of the various sources of error that apply to mathematical constructs, and which often lead young people to adopt misconceptions. This could be due to a few factors related to the very nature of the learning that has taken place, such as waste in teaching. We realise that students enrolled in mathematics courses may have incomplete skills and knowledge and face a variety of obstacles in the way of solutions. In addition, this situation is linked to a lack of basic knowledge in this discipline during the transition to college level, intensified by the results of distance learning introduced in response to the COVID-19 pandemic. Moreover, this problem is also fuelled by other difficulties encountered by students in distance learning courses, such as nanny attendance. These results are in line with those reported earlier by [37], who reported a lack of concentration and poor comprehension of lessons due to a lack of interaction between teacher and students.

On the other hand, other results depend on the context of the study, such as reducing class size to ensure better follow-up of students in difficulty, increasing the time devoted to exercises and setting up remedial courses to help students overcome obstacles to teaching and learning basic mathematical foundations. We also need to take into consideration the time devoted to the mathematics programme and learning-related aspects such as the lack of pedagogical tools for understanding graphs and mathematical figures. From a pedagogical point of view, overcrowded classrooms can lead to a shortage of the tools needed for a thorough understanding of mathematics. In other words, some students may not fully grasp lessons, creating cumulative challenges throughout secondary education which, if appropriate solutions are not sought, can compromise their understanding at more advanced levels. It is therefore essential to take these factors into consideration to improve the teaching and understanding of fundamental concepts concerning the mathematical subject.

Given these data and the proposals made by students to overcome barriers to learning, it is important to emphasise that most students need effective and relevant exercises to understand mathematical rules and properties and consolidate their knowledge. This is illustrated by the words of A. Antibi and G. Brousseau [50], who state: "adapting or replacing an old conception (leading to inadequate or erroneous answers) requires a complete overhaul of definitions, habits and formulations, which may inhibit previous transpositions". However, the Ministry should prioritise teachers to provide tailor-made remedial classes that will meet the individual needs of each student. A remedial class is simply intended to bridge the gap between what a child knows and what he or she is expected to know at that age, focusing on basic skills [26].

Based on relevant student solutions, we have created customised remedial teaching for these classes, based on the mathematical gaps identified in the learners' performance. Our in-depth evaluation confirms the vital importance of remedial math classes for school days, as they improve students' unaided levels. These personalised interventions, tailored to meet students' specific needs, are proving to be effective tools for overcoming challenges and reinforcing their understanding of fundamental mathematical concepts. It is therefore suggested that these remedial courses continue to be integrated into the curriculum to enhance students' academic success.

All research has certain limitations that should be emphasised. Firstly, it is based solely on students' perceptions. Secondly, it is limited to public school students. Finally, given that the sample size was only 220 students, further studies are needed to support the findings and discover how student effectiveness and efficiency influence the teaching process. In addition, it will enable teachers to accurately identify the sources of difficulties and the appropriate strategies for overcoming them.

Conclusion

This study highlights the significant difficulties and gaps encountered by Moroccan secondary school students in learning mathematics, particularly with regard to language barriers and didactic challenges. These results clearly show that no single method or pedagogy is sufficient to overcome these difficulties; targeted adjustments tailored to the different needs of students are required. Interventions such as remedial classes, the addition of two extra hours of teaching per week and the revision of the school calendar have proved promising, but it is essential to continue to seek more comprehensive and personalised solutions.

Based on current adjustments, specific developmental and evaluative multilingual teaching methods should be synthesised. Future research could examine whether pedagogical procedures integrating language support into mathematics teaching are effective. In this way, it will be easier to find out how students can overcome language barriers and strengthen their mathematical foundations. Relevant data could be collected on educational practices through a strict methodology including specific interventions such as intensive remedial classes and continuous assessment of students' progress.

This study has several strong points. Firstly, it tackles a crucial issue by addressing the specific challenges of teaching mathematics in multilingual environments and thus proposing solutions that meet students' needs. An integrated approach, combining mathematics teaching with language support, gives a holistic view of how to deal with learning difficulties. Secondly, a careful methodology involving the organisation of remediation sessions and adjustment of the school calendar ensures reliable data on the impact of teaching methods, thus reinforcing the validity of the results.

The results of this research provide teachers with concrete tools and strategies that can be directly applied to improve mathematics teaching in multilingual contexts. The methodologies and findings of this study can also serve as a model for similar research in other educational contexts, enabling the generalisation and adaptation of interventions to diverse environments.

Ultimately, the integration of teaching methods adapted to the specific linguistic and mathematical needs of students, such as remedial sessions and flexible lesson times, represents a significant step forward in improving academic success in mathematics. Further research in this field is essential to refine educational practices and tackle the complex problems of mathematics teaching.

References

1. Kandel N., Koeltz J., Guyon F., Girard R., Bartolini D. Study of the socio-economic impact of mathematics in France. *Synthesis*. 2015. Accessed January 25, 2025. https://www.agence-maths-entreprises.fr/public/docs/faits-marquants/eisem/20150527_Study_of_socioeconomical_Impact_of_mathematics_in_France_Synthesis_v1.4.pdf
2. Nachit B. Innovation en éducation et enseignement des mathématiques au lycée marocain. *Portail des Revues Scientifiques Marocaines*. 2021;4(1):9–20. (In French) Accessed January 25, 2025. https://revues.imist.ma/index.php/MASSALEK/article/download/25211/13803
3. Demonty I. La transition entre l'arithmétique et l'algèbre élémentaire dans le contexte de la résolution de problèmes arithmétiques. In: *Enseignement et Apprentissage des Mathématiques*. De Boeck Supérieur; 2008:225–246. (In French) doi:10.3917/dbu.craha.2008.01.0225
4. Allard C., Horoks J., Jeannotte D., Pilet J. Résolution de problèmes déconnectés de partage inéquitable par des élèves français de fin de primaire et de début de secondaire et lien avec l'enseignement reçu. In: *Actes du Huitième Colloque de l'Espace Mathématique Francophone – EMF 2022*. 2023. (In French) Accessed January 25, 2025. https://bibnum.publimath.fr/ACF/ACF24050.pdf
5. Maheux J.F., Proulx J. De résoudre un problème à problématiser mathématiquement. *Éducation Et Francophonie*. 2014;42(2):24–43. (In French) doi:10.7202/1027904ar
6. Somani G. Remedial classes and remedial education – a complete guide. *MasterSoft*. 2023. Accessed January 25, 2025. https://www.iitms.co.in/blog/remedial-classes-and-remedial-education-guide.html
7. Zaouaq M. Le service public de l'éducation à l'épreuve du Coronavirus. *Bulletin de l'Observatoire Marocain de l'Administration.* 2020;37–9. (In French) Accessed January 25, 2025. https://hal.science/hal-02883198/document
8. Millon-Faure K. Les répercussions des difficultés langagières des élèves sur l'activité mathématique en classe : le cas des élèves migrants. *Education. AMU – Aix Marseille Université*. 2011. (In French) Accessed January 25, 2025. https://shs.hal.science/tel-00941904/
9. Yaméogo S.M., N'do A.S. Absence De Préparation De La Résolution De problèmes Mathématiques : Négligence Ou méconnaissance De La Part Des Enseignants. *LIENS, Nouvelle Série: Revue Franco-*

phone Internationale. 2022;1. (In French) Accessed January 25, 2025. https://liens.ucad.sn/index.php/liens/article/view/23

10. Bautier É., Goigoux R. Difficultés d'apprentissage, processus de secondarisation et pratiques enseignantes: une hypothèse relationnelle. *Revue Française De Pédagogie*. 2004;148:89–100. (In French) Accessed January 25, 2025. https://www.persee.fr/doc/rfp_0556-7807_2004_num_148_1_3252
11. Wells D. *Motivating Mathematics: Engaging Teachers and Engaged Students.* Imperial College Press; 2015; Accessed January 25, 2025. https://openlibrary.org/books/OL30396276M/Motivating_mathematics
12. Bray M., Kobakhidze M.N. Measurement issues in research on shadow education: challenges and pitfalls encountered in TIMSS and PISA. *Comparative Education Review*. 2014;58(4):590–620. doi:10.1086/677907
13. Bec M. *Que Ressentent les Elèves Face aux Mathématiques?* UGA INSPE Grenoble – Université Grenoble Alpes - Institut national supérieur du professorat et de l'éducation; 2022. (In French) Accessed January 25, 2025. https://dumas.ccsd.cnrs.fr/dumas-03797239
14. Sénéchal D. *Méthodes Numériques et Simulations.* Savoirs UdeS; 2020. (In French) Accessed January 25, 2025. https://savoirs.usherbrooke.ca/handle/11143/17055
15. Gray P.O. *Psychology*. Institute of Electrical & Electronics Engineers (IEEE); 1994. 684 p.
16. Barrier T., Chesnais A., Hache C. Décrire les activités des élèves en géométrie et leur articulation avec celle de l'enseignant. *Revue de Recherches en Éducation.* 2014;54:175–193. (In French) Accessed January 25, 2025. https://hal.science/hal-01646985
17. Torkia-Lagacé M. *La Pensée Formelle Chez les Etudiants de Collège I : Objectif ou Réalité?* Cégep de Limoilou; 1981. 238 p. (In French)
18. DeBlois L., Giroux J. État d'avancement de la connaissance. In: *Adaptation Scolaire et Sociale de Langue Française*. Canada: Université Laval, Québec; 1998. (In French) Accessed January 25, 2025. http://adapt-scol-franco.educ.infinit.net/themes/dima/presdima.htm
19. Lemoyne G., Lessard G. Les rencontres singulières entre les élèves présentant des difficultés d'apprentissage en mathématiques et leurs enseignants. *Éducation Et Francophonie*. 2021;31(2):13–44. (In French) doi:10.7202/1079586ar
20. Najar R., Brahim E.L. Développement de la pensée fonctionnelle dans un contexte STEM au primaire. In: *Développement de la Pensée Algébrique au Travers Différentes Activités Numériques et Algébriques, de L'école à L'université*; October 25–27, 2022; Paris-Est Créteil, France. (In French) Accessed January 25, 2025. https://www.oipa.education/colloque-de-loipa-7
21. Cornu B. Apprentissage de la notion de limite: Modèles spontanés et modèles propres. *Proccedings PME (Psychology of Mathematics Education)*. 1981;322–326. (In French) Accessed January 25, 2025. https://www.hitt.uqam.ca/mat7191_fich/Cornu_1981.pdf
22. Krstić S., Papotto M. *Frictions Entre les Mathématiques et la Physique: Quelles Difficultés Mathématiques Rencontrent les Gymnasiens Dans le Problème du Plan Incliné ?* Haute Ecole Pédagogique du canton de Vaud; 2020. (In French) Accessed January 25, 2025. https://patrinum.ch/record/294157/files/mp8983_ms2_p44741_p45743_2020.pdf
23. Hanin V., Van Nieuwenhoven C. Rôle des régulations interactives entre pairs dans le développement d'une expertise adaptative en résolution de problèmes : une étude de cas. *Journal International De Recherche En Éducation Et Formation*. 2024;5(1). (In French) Accessed January 25, 2025. https://journal.admee.org/index.php/ejiref/article/view/115
24. Calucag L.S. Divergence of scientific heuristic method and direct algebraic instruction. *Journal of Education and Practice*. 2016;7(3):131–135. Accessed January 25, 2025. https://files.eric.ed.gov/fulltext/EJ1089794.pdf

25. Khair T.M.A.M., Khairani A.Z., Elrofai T.A. Level of students' achievement in mathematics at the end of elementary education in Yemen. *US-China Education Review*. 2012;2(6):588–593. Accessed January 25, 2025. http://www.cqvip.com/QK/88583A/201206/42957465.html

26. Ibourk A., El Aynaoui K., Ghazi T. *TaRL Maroc: Des Débuts Prometteurs Pour un Soutien Scolaire Innovant.* Policy Center for the New South; 2023. (In French) Accessed January 25, 2025. https://www.policycenter.ma/sites/default/files/2023-07/PP_12-23_Aomar%20Ibourk%20Karim%20El%20Aynaoui%20Tayeb%20Ghazi_0.pdf

27. Ourahay M. Effets de l'évaluation sommative sur la pratique pédagogique des enseignants cas de l'enseignement des mathématiques au baccalauréat. *Évaluation Et Management Des Systèmes D'éducation Et De Formation*. 2021;(5):406–419. (In French) doi:10.48423/imist.prsm/rmere-v0i5.25635

28. Corriveau C. Comment aménager le cours mathématique 536 du secondaire en vue de mieux préparer les élèves aux cours de mathématiques du cégep. *ENVOL*. 2003;132:25–28. (In French)

29. Giles C.L., Bollacker K.D., Lawrence S. CiteSeer. In: *DL '98: Proceedings of the Third ACM Conference on Digital Libraries*. New York, NY, USA: Association for Computing Machinery; 1998:89–98. doi:10.1145/276675.276685

30. Mrabet S. Le changement d'axiomatique dans l'enseignement de la géométrie. In: *ITM Web of Conferences*. 2021;39:01005. (In French) doi:10.1051/itmconf/20213901005

31. Hitt-Espinosa F. Annales de didactique et de sciences cognitives: Système sémiotiques de représentation lié au concept de fonction. In: *Publication des travaux du séminaire de Didactique des Mathématiques de Strasbourg.* 1998. (In French) Accessed January 25, 2025. https://bibnum.publimath.fr/IST/IST98011.pdf

32. Nouhou A.M., Sagayar M.M. *Introduire le Logiciel de la Géométrie Dynamique Pour Améliorer L'apprentissage des Fonctions Numériques au Lycée.* Université Abdou Moumouni (Niger); 2023. Accessed January 25, 2025. https://hal.science/hal-04239888/document

33. Houdement C. Résolution de problèmes arithmétiques à l'école. *Grand N*. 2018;100:59–78. (In French) Accessed January 25, 2025. https://hal.science/hal-01902810/document

34. Trouche L. From artifact to instrument: mathematics teaching mediated by symbolic calculators. *Interacting with Computers*. 2003;15(6):783–800. doi:10.1016/j.intcom.2003.09.004

35. Meehan J.P. *Educationem Sacram Pragmaticam? Une Philosophie Pragmatiste de L'éducation à L'aune du Tournant Pragmatique en Sciences Cognitives.* Université du Québec À Montréal; 2021. (In French) Accessed January 25, 2025. https://archipel.uqam.ca/15970/1/M17122.pdf

36. Challenges in basic mathematics education. In: *International Group of Experts on Science and Mathematics Education Policies*. Paris: UNESCO; 2009. 114 p. Accessed January 25, 2025. https://unesdoc.unesco.org/ark:/48223/pf0000191776_eng

37. Menai K., Manadi A. *L'usage des TICES en Classe de FLE et son Impact sur L'enseignement-Apprentissage durant la Période du Confinement : cas des Apprenants de L'école Privée Arc-En-Ciel de la Ville de Tizi-Ouzou.* Université Mouloud Mammeri Tizi-Ouzou; 2021. (In French) Accessed January 25, 2025. https://dspace.ummto.dz/items/d11d1cdc-f32a-41e7-901d-7e221c8a3db5

38. Messaoudi L. Plurilinguisme et pouvoir économique au Maroc. Quelle place pour la langue française. In: *Les Locuteurs et les Langues: Pouvoirs, non Pouvoirs et Contre-Pouvoirs.* Limoges: Lambert-Lucas; 2012. (In French) Accessed January 25, 2025. https://www.academia.edu/32426626/Plurilinguisme_et_pouvoir_%C3%A9conomique_au_Maroc_Quelle_place_pour_la_langue_fran%C3%A7aise

39. El-Mekaoui B., Régnier J.C., eds. L'alternance linguistique: un outil pour diversifier les langues d'enseignement? De la neutralité des choix et les difficultés d'application. In: *Penser la Complexité: Quelles Approches et Quels Outils en Contexte Pluriel ou Plurilingue?* France; 2021. (In French) Accessed January 25, 2025. https://hal.science/hal-03381667/

40. Noyau C., Vellard D. Construction de connaissances mathématiques dans la scolarisation en français langue seconde. In: *Pratiques Et Représentations Langagières Dans La Construction Et La Transmission Des Connaissances*. 2002:57–76. (In French)
41. Barrouillet P., Camos V. Savoirs, savoir-faire arithmétiques et leurs déficiences. Chapitre 7. In: *Les Sciences Cognitives et L'école*. Presses Universitaires de France; 2003: 305–51. (In French) doi:10.3917/puf.coll.2003.01.0305
42. OECD. *PISA 2009 Results: What Students Know and Can Do*. In: *Student Performance in Reading, Mathematics and Science (Volume I). PISA*. 2010. Accessed January 25, 2025. https://www.oecd.org/en/publications/pisa-2009-results-what-students-know-and-can-do_9789264091450-en.html
43. Ministry of the Wallonia-Brussels Federation. *Les Epreuves du CE1D de Mathématiques*. Le Portail De L'enseignement En Fédération Wallonie-Bruxelles; 2024. (In French) Accessed January 25, 2025. http://www.enseignement.be/public/docs/r-sultats-ce1d-math-matiques-2024-.pdf
44. Bissonnette S., Richard M., Gauthier C., Bouchard C. Quelles sont les stratégies d'enseignement efficaces favorisant les apprentissages fondamentaux auprès des élèves en difficulté de niveau élémentaire? résultats d'une mégaanalyse. *Revue De Recherche Appliquée Sur L'apprentissage*. 2010;3(1). (In French) Accessed January 25, 2025.https://www.treaq.ca/wp-content/uploads/2019/05/Article3_steeve_bissonn_2010.pdf
45. Adihou A. Enseignement-apprentissage des mathématiques et souffrance à l'école. *Les Collectifs Du Cirp*. 2010;2:90–102. (In French) Accessed January 25, 2025. https://www.cirp.uqam.ca/documents%20pdf/collectifs/10_Adihou_A.pdf
46. Restrepo A.M. *Genese Instrumentale du Deplacementen Geometrie Dynamique Chez des Eleves de 6eme*. Université Joseph-Fourier; 2008. (In French) Accessed January 25, 2025. https://tel.archives-ouvertes.fr/tel-00334253
47. Offre B., Perrin-Glorian M.J., Verbaere O.V. Usage des instruments et des proprietes geometriques en fin de CM2. *Petit X*. 2006;72:6–39. (In French) Accessed January 25, 2025. https://bibnum.publimath.fr/IPX/IGR06003.pdf
48. Duval R., Godin M. Les changements de regard nécessaires sur les figures. *Grand N*. 2005;76:7–27. (In French) Accessed January 25, 2025. https://irem.univ-grenoble-alpes.fr/medias/fichier/76n2_1554801689010-pdf
49. Braconne-Michoux A. *Étude Exploratoire de la Description et de la Reproduction de Figures Géométriques Chez des Elèves du 2e Cycle du Primaire*. PhD thesis. 2018. (In French) doi:1866/21335
50. Antibi A., Brousseau G. La dé-transposition de connaissances scolaires. *Recherches En Didactique Des Mathématiques*. 2000;20(1):7–40. (In French) Accessed January 25, 2025. https://revue-rdm.com/2000/la-de-transposition-de/

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