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Handbooks and the Use of Contexts

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Abstract: In this work, we focus on using contexts in some French and the Moroccan handbooks to reveal how the contextualization is used in learning situations and if it is to reach the skills and objectives fixed by the official guidelines. For this aim, we will proceed in two major steps. Firstly, the theoretical part analyzes the pertinence of contextualization to issue an interpretation. Secondly, an experimental part consists in putting into practice all the conclusions and the interpretations from the first part. We will rely on a data collection grid that allows us to measure several criteria and obtain some indicators about using the contexts in the French and Moroccan textbooks. We conclude that the Moroccan textbooks "do not contextualize enough" but stand out by varying the time distribution of the proposed activities. On the contrary, the French textbooks offer a sufficient number of real contexts. However, an effort should be made in their time distribution. This can help textbook writers to improve or think about the mathematics teaching methods.

Keywords: mathematics education, contexts, textbook analysis, algebra.

手册和上下文的使用

摘要：在这项工作中，我们专注于使用一些法语和摩洛哥手册中的语境来揭示语境化是如何在学习情境中使用的，以及它是否要达到官方指南规定的技能和目标。为此，我们将分两个主要步骤进行。首先，理论部分分析了语境化的针对性，提出了解释。其次，实验部分包括将第一部分的所有结论和解释付诸实践。我们将依赖一个数据收集网格，它允许我们衡量几个标准并获得一些关于使用法语和摩洛哥教科书中上下文的指标。我们得出结论，摩洛哥教科书“没有足够的背景化”，而是通过改变拟议活动的时间分布而脱颖而出。相反，法语教科书提供了足够多的真实语境。但是，应该在他们的时间分配上做出努力。这可以帮助教科书作者改进或思考数学教学方法。

关键词：数学教育、语境、教科书分析、代数。

1. Introduction

Given the growing interest of international standards in the development of school mathematics that will enable students to solve problems and understand real phenomena, it is essential to comprehend how they engage in learning atmospheres resembling genuinely realistic context situations.

We consider contextualization in mathematics as incorporating knowledge use contexts into teaching, linked to the learner's real world, which have been fundamental for humanity.

This place of the textbook in the learner's school career leads educational decision-makers to reflect on the choice of textbook to adopt. However, of course, this choice varies from one country to another. Sometimes in the same country, the textbook adopted varies from one region, town, or school to another or even from one class to another in the same school.

For example, in the USA, the teacher is responsible for choosing the most appropriate textbook for his or her class [1]. In the United Kingdom, the school chooses and even purchases textbooks [2]. In the French-speaking part of Switzerland, the MER

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(Moyens d'enseignement romand) are responsible for constructing the teacher's book, which describes the didactic and pedagogical choices. However, the teacher has the choice of dealing with the content parts while respecting the objectives and learning progressions of the study plans. In France, the school council decides on constructing MERs in such a way as to favor differentiated teaching, whereas in Morocco, the Ministry makes the decision.

In PISA, the term *context* was defined broadly as "a specific situation which includes all detailed elements used to formulate the problem [3]. In the current study, contextual tasks refer to tasks that are presented with illustrations such as pictures, representations, or real-life situations, and non-contextual tasks refer to tasks that are presented purely mathematically. It is important to note that although Van den Heuvel-Panhuizen [4] argued that there is a big difference between word problems and context problems, in the current study, these two types of problems were considered synonymous [5].

Contexts are important tools for teaching and learning mathematics since they provide different opportunities for students to learn [6]. Students' experiences with context help them understand the mathematical topics conceptually [7].

A learning situation or an activity will be meaningful if it touches the students' center of interest and poses challenges within their reach while allowing the usefulness of their knowledge to be highlighted. The scientific community is also unanimous on the importance of using contexts in teaching and learning mathematics [8-10]. It is also pointed out that much mathematical knowledge is learned but not subsequently used by students [11]. Sometimes, contexts allow students to develop new knowledge [10].

Our analysis aims to determine how the textbook authors operationalized this institutional injunction to contextualize mathematics learning in Moroccan and French schools.

Much research has been done on contextualization in textbooks which compares two teaching systems about a given object of knowledge using textbooks. For example, Cabassut [12] compares French and German textbooks about proof. Choi et al. [13] compare textbooks from Korea and Singapore on measurement and geometry, characterizing them by similarities and differences: "The two kinds of textbooks were compared and contrasted to determine the main characteristics, including similarities and differences."

This analysis will be based on two textbooks (Moroccan and French) from two contexts and open the door to other possible research questions, one of which would be: what correlation exists between the ranks of a certain educational system in different international educational and pedagogical evaluations?

To measure the degree of the textbook authors' awareness of the importance of using contexts, we will carry out a quantitative analysis of two textbooks (Moroccan and French). Analyzing the data collected will enable us to draw interpretations and conclusions about the relevance of contextualization in these two textbooks. We distinguish two approaches to textbook analysis, namely anthropological [14] and comparative [15, 16]. The comparison consists of surveying two textbooks (Moroccan and French) for contextualization.

Our interest in the two textbooks will be in the algebra chapters as part of a general reflection on teaching the latter and, more precisely, on using contexts to introduce algebraic thinking in different educational systems. Indeed, the omnipresence of Algebra chapters in middle school textbooks (the 7^{th} graders). [17] raises questions about the use of context and contextualization in algebra learning. This choice is also justified by the enormous difficulties encountered by students at this level in algebra as a new and difficult subject, which is taught more symbolically compared to other concepts, hence the usefulness of the use of contexts in this mathematical field more precisely [8-10].

Another study analyzed geometry problems in four sets of middle school mathematics textbooks from Taiwan, Singapore, Finland, and the United States, while exploring students' expectations for learning these problems [18].

For learning more about using contexts in the mathematics classroom and the types of contexts offered, the textbook is an inevitable source of information and, at the same time, allows us to measure the degree of conviction of textbook authors in the use of contexts. Our analysis attempts to answer questions such as:

What types of contextualized situations or contexts do textbooks recommend? How and by what means? Our analysis is based on a data collection grid used in [19], where she was interested in describing the use of contexts in the most widely used textbooks from 1960 to the present day, as well as in listing the different types of contexts used in these textbooks.

However, our analysis is different; we are interested in two textbooks from two different educational contexts but taught at identical times and to pupils of the same age. Therefore, as working samples, we will use the French textbook 'Sésamath' and the Moroccan textbook 'Almoufid,' the most widely used in both countries.

Our article is presented as follows: First, we present a theoretical framework. Next, we justify the choice of the problem and the research methodology adopted. Then, we analyze and discuss different terminologies used throughout the study. Finally, we make a general conclusion.

2. Theoretical Framework

2.1. The Contextualization

The contextualization of a mathematical problem is generally defined as the way (symbolic, verbal, pictorial, or manipulation) of presenting a learning situation [20, 21]. The proposed activities are generally inspired by the learner's daily life; they can be presented in stories with characters, places, and actions [22].

Caldwell [20] and Webb [21] are the first ones to distinguish the notion of the "context" from that of the "content." For the three authors, the "context" includes the non-mathematical part of the learning activity and should be presented in three successive stages:

- The presentation;
- The verbal context;
- The context of the task.

According to Webb [21], the "content" of mathematical activity is its mathematical aspect and may be presented in four main forms:

- The mathematical subject;
- The information describing the fields of application;
- The information describing the semantic content;
- The information describing the elements of the mathematical problem (find, build, prove).

Cotnoir [19] gives an organized representation of both contexts and contents as follows:

Table 1 The organization of the context

Nature	Description
Presentation	Symbolic, verbal, pictorial
Verbal context	Organization of characters, place, and dates
Task context	Necessary elements for the resolution, indications

Table 2 The organization of the content

Nature	Description
Math subject	Arithmetic, geometry, algebra
Scope	Chemistry, biology
Semantic content	Keywords, vocabulary
Problem elements	Relationships, the goal

2.2. The Contexts' Functions

The researchers have assigned different functions to the contexts. For example, they lead the students smoothly toward the appropriate solution by inspiring them to activate their prior knowledge [23, 24]. Other authors [7, 25, 26] consider the contexts as a didactic tool that helps the students fix and organize their knowledge. For others [25, 27], the contextualization of a mathematical problem promotes the auto-learning by the students themselves. Other authors [28] agree that the context makes it possible to give meaning to the concepts, procedures [29], numbers [24], and relationships between concepts and procedures [25].

The contexts (if numerous and varied from the learner's daily life) facilitate the application of their newly acquired knowledge [23, 30] and give meaning and sense to what they learn in the classroom.

2.3. The Types of Contexts

Cotnoir [19] has classified the types of contexts into four categories:

The real contexts: These are situations extracted from the daily life of the students and that can be realized as a classroom activity. For example, "Find the area of the classroom in order to install a carpet." In this context, the students find themselves engaged in the task and motivated to perform it [31].

The realistic contexts: These are situations inspired by the daily life of the students and that cannot be realized as a classroom activity. It is a simulation that arises from the students' social, cultural, or economic reality. For example, "Find the swimming pool area" is a real context.

The imaginative contexts: Generally proposed in the form of an analogy with the daily real life of the students, it can be theoretically simulated without realizing it. For example, we ask the students to create a house plan with a triangular room.

The purely mathematical contexts: They are generally proposed as a mathematical statement and refer to purely mathematical objects like numbers, relationships, and arithmetic operations, without any allusion to a real, realistic, or even imaginary situation. For example, solve the equation $x^2 + 3x - 2 = 0$.

2.4. Mathematical Activities

These types of contexts are always used in mathematical activities. Among these activities offered by real or imaginary contexts, two subtypes can be distinguished:

- *Natural activities:* These are activities that occur in nature or evoke it;
- *Human activities:* These are activities which can be realized by a human such as sports or music.

2.5. The Tasks Linked to Activities

The use of contexts in activities helps to motivate students to complete the tasks, which can be classified into three types:

- *Artificial task:* when the attached task has no link with the type of context chosen previously;
- *Authentic fictitious task:* when it conforms to what is required in the real activity, whether human or natural;
- *Real task:* when the student takes action and performs the task.

2.6. Degree of Relevance

Functions attributable to contexts relate to the actual contexts used, especially to the distribution of relevance, and are divided into three types according to the degree of relevance:

- *Essential:* when the student has to consider the context of the activity, and reasoning is only possible in this context;

- *Relevant:* when the student has to use the context elements in the elaboration of the answer;

- *Irrelevant:* when the student can solve the activity without regard to the context.

2.7. Moment of the Sequence

In order to solve a mathematical problem, it is necessary to classify the types of real context according to the moments of the sequence, which can be divided into three parts:

- *Preparation phase:* in the form of a reminder activity;

- *Realization phase:* during the realization of the activity (application exercises);

- *Integration phase:* training exercises.

3. Problem and Methodology

As mentioned earlier in the introduction, our problem is three-dimensional: contexts-manuals-algebra. Our motivation for these three lines of research was widely argued in the introduction. Our research aims to quantify using contexts in the chapters of middle school algebra in two textbooks (Moroccan and French). We decided to analyze the French textbook "Sésamath" for its remarkable notoriety.

Our objective is to quantify the proportions of the types of contextualized situations these textbooks use, how, and by what means.

The data collection focused on the Moroccan textbook 'Almofid,' the most widely adopted by Moroccan middle schools. However, for comparison, we opted for parallel analysis of another French textbook, 'Sesamath.' The choice of this textbook is justified above all by the almost identical nature of the two education systems: number of years of schooling, school curriculum, and courses of study offered.

For our analysis of these two textbooks, we used the grid model proposed by Cotnoir [19]. The data collection grid (see Appendix) includes several pieces of information on the textbook, the chapter, the title of the activity or the problem number, and the type of context proposed (real, imaginary, or purely mathematical). This allows us to qualify and quantify the contexts used by the authors of both textbooks. Another section of the grid, dedicated solely to real contexts and therefore not to imaginary and purely mathematical contexts, focuses on the corresponding type of reality. Its purpose is to specify the real contexts selected in the previous section. Then a section "Task attached to the proposed activity," also dedicated only to the activities stemming from contexts qualified as real, questions whether the task attached to the activity is a task emanating from the type of reality selected upstream (human activity or natural domain). In the section "Relevance of the context for reasoning," which is also dedicated to activities from contexts described as real, the question is raised about how well the proposed context supports the students in finding solutions. In the section "Algebraic content," we are interested in the teaching and learning of algebra, specifying the algebraic content addressed in the proposed activity. Finally, the last section contains excerpts from the teacher's guide or manual that could shed light on the choices made by the author(s) on the use of contexts in the sample chapter. In particular, a "sequence moment" section is integrated into the grid to qualify and quantify the moments when contexts are proposed during a sequence.

4. Data Analysis

4.1. Data Collection

Sésamath is a group founded in 1988 before becoming a non-profit association in 2001, based on the law of July 1901 set up by Waldeck Rousseau (President of the Council and Minister of the Interior and Cults). The main goal of Sésamath remains the development of exchanges between mathematics teachers through the use of information and communication technologies (ICT) for education. The association distributes free online educational resources and professional tools for teaching mathematics.

We are interested in the content of the 7th graders' textbook (for the Moroccan and French versions). Almofid is a textbook constructed by the Moroccan Ministry of Education.

The table below gives the distribution of the Algebra chapters in the two textbooks.

Table 3 Distribution of algebra chapters in the two textbooks

	Manuals	
Chapters	**Sésamath**	**Almofid**
Chapter 1	Whole numbers 1	Operation on the whole and relative numbers
Chapter 2	Whole numbers 2	Fractional writing and comparison
Chapter 3	Fractions 1	Operations on fractions
Chapter 4	Decimal Numbers	Decimal Numbers
Chapter 5	Decimal Number Operations	Decimal Number Operations: Multiplication and Division
Chapter 6	Fractions 2	Operations with Decimal Numbers: Addition and Subtraction

Subsequently, the figures below show the distribution of context types used in the two textbooks.

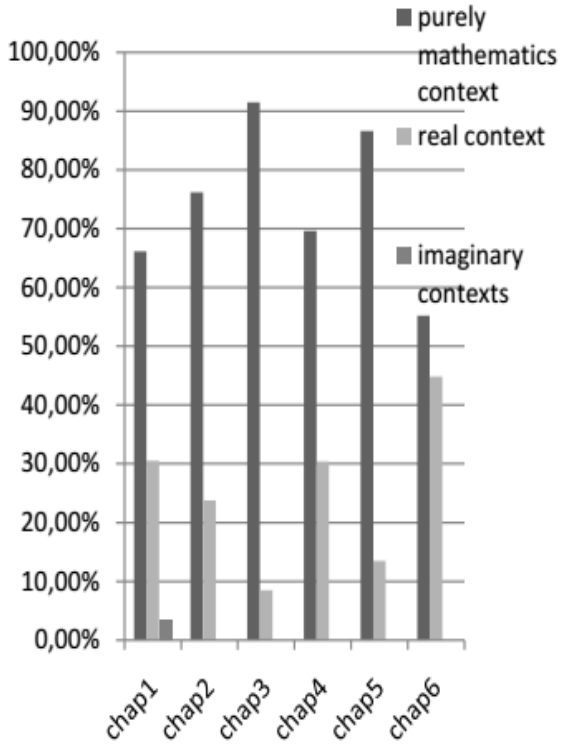

Fig. 1 Context type in the Sésamath manual

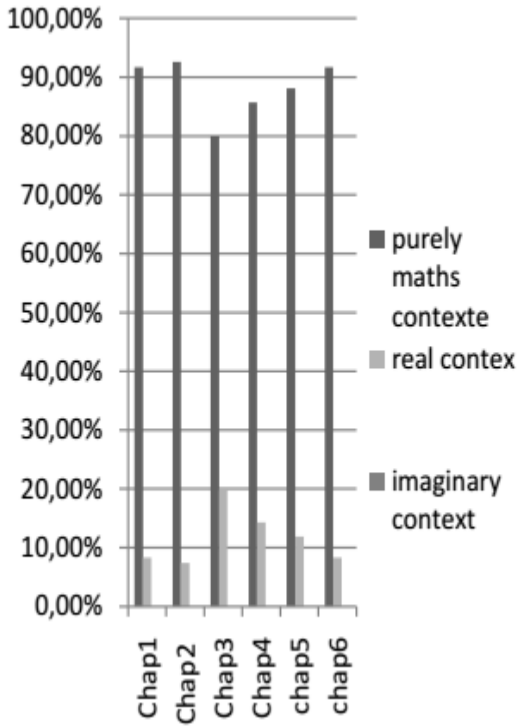

Fig. 2 Context type in the Almofid manual

4.2. Types of Contexts in the Activities

In the following, we will look at the sample chapter for the Sésamath manual Chapter 1 "Integers1". This chapter contains 59 mathematical tasks. The following are examples of activities:

- *Example 1:* The purchase of a home cinema for Christmas by Mr. Martin, who will pay in 3 parts (here, the pupil is asked to calculate the amount paid each month).

- *Example 2:* The fishing competition in which Damien caught several fish of different types (the pupil must calculate the total number of fish caught by Martin);

As for the Moroccan Almofid textbook, we will also look at the 1st (sample) chapter, "Operations on the Whole and Relative Numbers." The chapter contains 60 mathematical tasks of various types:

- The purchase of a schoolbag at 70DH and five notebooks at 4.30 DH each by Ahmed (here, the student is led to calculate the amount paid). It should be noted that this activity has chosen a Moroccan first name, Ahmed, and that the situation of buying school supplies represents an activity that is well known and expected by Moroccan families and shared with their children.

For these two sample chapters, for example, we found:

Table 4 Context types in the two textbooks

Context types	Sesamath	Almofid
Real context	30.5%	8.3%
Purely mathematical	66.1%	91.7%
Imaginary context	3.4%	0%

The figure below compares the context types used in the sample chapters in the two manuals.

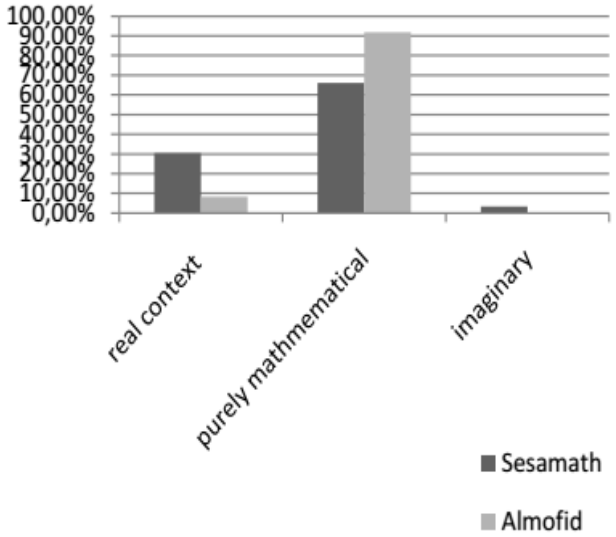

Fig. 3 Type of contexts used in the two manuals

From the analysis of the two chapters of the textbooks (Almoufid) and (Sésamath), we notice that the number of purely mathematical activities is higher than that of real or imaginary activities in both textbooks. These results show the great difference between the two textbooks in the use of contexts. The Moroccan textbook does not contextualize its learning sequences, whereas the French one makes an effort to do so.

4.3. Types of Contexts of Activities According to the Time of the Sequence

Once the types of context in the two textbooks for

different chapters were analyzed, we divided the sequence of solving a mathematical problem into three moments: preparation, realization, and integration phases.

The following question was asked: what are the privileged moments for each textbook to contextualize learning?

Table 3 summarizes the data collected for the sample chapters in the two textbooks.

Table 5 Contexts of the activities according to the time of the sequence

Moment sequence / Context of activity		Real	Purely mathematical	Imaginary
Preparation	Almofid	0	8 (13.3%)	0
	Sesamath	0	0	0
Realization	Almofid	2 (3.3%)	5 (8.3%)	0
	Sesamath	0	0	0
Integration	Almofid	3 (5%)	42 (70%)	0
	Sesamath	18 (30.5%)	39 (66.1%)	2 (3.4%)

We have analyzed (only for the real and imaginary contexts used) the type of reality of these contexts in the sample chapters. The following table confirms the preference of the French textbook "Sésamath" for the integration phase as the privileged moment to contextualize learning, whereas the Moroccan textbook tends to vary the use of contexts during the three moments.

4.4. Types of Activities According to the Moments of the Sequence

Next, we analyzed (only for the real and imaginary contexts used in the sample chapters) the types of activities according to the moment of the sequence (Table 5).

Table 6 Types of reality according to the time of the sequence

Moment of the sequence / Context of activity		Natural	Human	Imaginary
Preparation	Almofid	0	0	0
	Sesamath	0	0	0
Realization	Almofid	0	2 (40%)	0
	Sesamath	0	0	0
Integration	Almofid	0	3 (60%)	0
	Sesamath	0	18 (90%)	2 (10%)

The French manual "Sésamath" uses the integration phase as a privileged moment to contextualize learning, while the Moroccan one tends to vary the use of contexts during the two moments of the sequence. The contexts used are almost human.

4.5. Tasks Attached

The following table informs us about the tasks attached to each activity and their frequency.

Table 7 Distribution of the task according to the time of the sequence

Moment of sequence / Context of activity		Artificial	Authentic fictitious	Authentic real
Preparation	Almofid	0	0	0
	Sesamath	0	0	0
Realization	Almofid	1 (20%)	1 (20%)	0
	Sesamath	0	0	0
Integration	Almofid	1 (20%)	2 (40%)	0
	Sesamath	4 (22%)	10 (55.6%)	4 (22.2%)

The analysis focuses on the task attached to the real contexts and its distribution according to the sequence time. Three types of tasks are distinguished: artificial, fictitious authentic, and real authentic.

4.6. Degree of Relevance

Finally, the functions attributable to the contexts relate only to the real contexts used in the sample chapters. Therefore, we were interested in the functions attributable to this type of context during the three moments of the sequence.

Table 6 summarizes the results obtained in terms of relevance during the moments of the sequence.

Table 8 Distribution of relevance according to the moments of the sequence

Moment of sequence / Relevance to reasoning		Essential	Relevant	Irrelevant
Preparation	Almofid	0	0	0
	Sesamath	0	0	0
Realization	Almofid	1 (20%)	1 (20%)	0
	Sesamath	0	0	0
Integration	Almofid	1 (20%)	2 (40%)	0
	Sesamath	4 (22.2%)	10 (55.6%)	4 (22.2%)

The results show that the French textbook almost privileges the integration phase and ignores the other moments completely. In contrast, the Moroccan textbook varies the use of these moments. However, what the two manuals have in common is that about half of the contexts they use are relevant.

5. General Conclusion

Contextualized teaching is connecting real-life context to the culture of the learners [32].

It is a teaching process that connects lessons directly to a concrete application that will be appealing to the students' interests [33]; thus, teachers should use activities, events, issues, or authentic materials to meet the needs of the students.

In this study, we grounded the development of our framework in the research literature.

Mathematics education researchers and practitioners have lately placed a strong emphasis on contextualization and problem-posing tasks. Contextualization in the textbook may foster students' conceptual understanding and improve their mathematical reasoning and communication ability [34].

We can conclude from this first detailed analysis of the sample chapters on the whole numbers that the activities proposed by the Sesamath textbook are purely mathematical; they do not allow students to leave the classical learning framework and apply the knowledge obtained in class in different or similar situations or everyday life. This first result does not conform to our initial intuition. Given the innovative approach of the Sesamath team, we expected figures that would support our hypothesis that the majority of the contexts proposed by the Sesamath textbook would be purely real.

The Moroccan textbook Almoufid relied more on purely mathematical activities than on real or imaginary ones. The observation is immediate: the Moroccan textbook 'does not contextualize' its learning sequences, while the French one 'makes an effort' in this sense; it also offers a sufficient number of real contexts but should 'make an effort' in its temporal distribution.

Mathematical formulas are indeed important to assess a well-focused skill. However, to encourage imagination and ease of understanding of mathematics, it is essential to make more use of real-life activities. The latter motivates students more to solve mathematical problems by encouraging them to visualize the usefulness of mathematics in everyday life.

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