Chapter 13
What Do Low-Educated Adults and Children Think About the Uses of Mathematics?

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Abstract The chapter presents an investigation about the conceptions of low-income children and adults about mathematics. The children in the study were students in the elementary school, and the adults were students of a specific educational program aimed at teaching people with late schooling who for social and economic reasons did not attend regular schooling as children. Their conceptions about mathematics were obtained through an interview in which the key question was: *What is mathematics for?* Answers to this question were classified into different types: (i) school uses, (ii) everyday uses associated with everyday activities in which mathematics is inserted, (iii) professional and academic uses, and (iv) conceptions related to intellectual gains arising from acquired mathematical knowledge. The comparisons between the two groups of students and final discussions focus on the role played by school and out-of-school experiences in the participants' conceptions about mathematics.

Keywords Mathematical conceptions · Children · Low-educated adults · School experiences · Out-of-school experiences

13.1 Introduction

Asking someone *What is mathematics for?* is undoubtedly a matter of a pragmatic nature that refers to the uses the individual's attribute to it in society. However, this question inevitably is related to the conception of the nature of mathematics that influences the way of teaching (in the case of teachers) and learning (in the case of students). Presmege (2002) states that the conception about the nature of mathemat-

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ics can both facilitate and restrict the relationship between everyday mathematics and school mathematics and also influences students' opinions about learning mathematics, as documented by Howard and Perry (2005) and Grootenboer (2003).

Therefore, people's opinions about mathematics and mathematics education have been identified as essential for directing public policies regarding educational practices. Therefore, researchers have examined the public opinion in general and the opinion of parents, teachers, and students about the nature of mathematics, its relevance in people's lives, its uses, and about teaching and learning issues in this subject.

According to Young-Loveridge et al. (2006), little is known about the perception of students, especially those who attend the early years of elementary school. The authors emphasize the importance of listening to students about their opinions about mathematics and learning mathematics. To contribute to this topic, the research presented in this chapter focuses on the opinion of students who attend early years of basic education about the uses attributed to mathematics.

It is important to note that studies carried out with students usually investigate those who attend school grades corresponding to their age group, that is, students who have a typical school trajectory. However, in Brazil, there are students in the early grades who are low-income adults who, for adverse social and economic reasons, did not have access to basic education or failed to complete it at an appropriate age. On the one hand, if these students had limited access to formal education, on the other hand, they have an expressive set of mathematical knowledge from their life experiences, acquired informally in situations outside the school context. This knowledge is reported in studies conducted with low-income children, adolescents, and adults involved in informal commercial transactions such as selling snack foods and seasonal fruits in open markets and in the streets in Recife, Brazil (Carraher et al. 1985; Nunes et al. 1993; Saxe 1991). Here, we examined the conceptions of these students, comparing them with children of the same social class and educational level to investigate the similarity and difference between these two groups of students in terms of the uses they attribute to mathematics.

However, before examining specifically the uses of mathematics, we need to show the research results that deal with the opinion of parents, teachers, and students about mathematical education and the nature of mathematics.

13.2 What Is Thought About Mathematics Education

Public opinion about mathematics education was the subject of some research carried out with a large number of participants. Authors of these studies argue that public opinion is important and should be considered in public policy decisions regarding educational practices and bringing the school closer to the community in which it is inserted.

Thus, Lucas and Fugitt (2009) investigated the opinion of residents of a rural community in the United States about mathematics education and the impact on the future success of students when they graduate. They were young, adults, and elderly participants whose opinions were obtained through interviews. The data were analysed according to the frequency of answers and the narratives obtained during the interviews. In general, it was found that the participants had an understanding that mathematics would have a positive impact on people's reasoning and lives. According to them, developing mathematical skills would be important for the future, increasing the opportunities for individuals, especially having a career and getting better jobs. Opinions also expressed the idea that the quality of mathematical education would strengthen the development of the community. Differences were also found between age groups since adults and the elderly participants recognized the application of mathematics in their daily lives more often than young people.

Brez and Allen (2016) also investigated the opinion of adults about mathematics and mathematics education. The participants were adults over 18 years old. They answered a questionnaire about their attitudes and beliefs of mathematics and mathematics education in elementary school, specifically. The questionnaire included open questions (*At what age do you think children should start learning about math?*), questions answering yes or no (*Are parents responsible for teaching math to their children outside of school?*), and statements about which respondents should indicate the degree of disagreement or agreement (*I think math is useful in everyday life*) on a Likert scale of 1 to 5. In general, adults considered mathematics useful and mathematics education important, although they showed some dissatisfaction with the school system in their community. According to the interviewees, children should start learning mathematics at around 4 years old. Comparing parents who had children attending elementary school and those who had not, the opinions differed on two aspects. Parents of elementary school children were more apt to say that parents were responsible for teaching mathematics outside of school than parents who did not have. This finding corroborates the results obtained by Kadlec et al. (2007) that parents of students in the last years of elementary and high school are little concerned with their children's mathematical education. There seems to be more concern when children are in early school grades. Parents of elementary school children also thought that students should start learning mathematics earlier than those who did not have children attending this school segment. As in the research carried out by Lucas and Fugitt (2009), the data also showed that adults valued mathematical education and recognized its applicability in daily life.

Hawighorst (2005) investigated the perception and attitude of parents (immigrants and non-immigrants from different social and cultural backgrounds living in Germany) of 15 students in the 7th grade about mathematics and teaching of math. The author assumed that family circumstances have an impact on the way students deal with mathematics at school, and ways of conceiving and approaching mathematics vary between families, especially in families of different cultures. The interviews followed the model called "episodic interviews" in which participants are encouraged to report and judge their experiences on a given topic. In the case of this investigation, parents were encouraged to express their perceptions and experiences with mathematics and teaching mathematics. The qualitative analyses revealed that the parents' perspectives are marked by references to situations in their original social context, and these perceptions had an impact on the family mathematical education offered to their children, and on the way, they evaluated mathematical education in Germany. The results showed that their perceptions varied in two directions. On the one hand, mathematics was considered an intellectual tool that enabled us to understand the world and the way it is governed. On the other hand, mathematics was conceived as a practical tool that enabled us to deal appropriately with diverse day-to-day demands. For parents who presented this second perspective, mathematical education should be realistic, in the sense of being useful in everyday situations. There were interviewees among the immigrants who, when comparing mathematics education in their countries and Germany, commented that in Germany the relationship between teachers and students was more distant, that students were little challenged, and that teaching did not favour the learning of basic and essential mathematical concepts.

Several studies looked at teachers' opinion about mathematics education. The reason is that how they conceive mathematical education affects their way of teaching. Hannula et al. (2007) investigated high school mathematics teachers on the teaching of mathematics. The answers obtained through questionnaires were analysed according to several topics such as the opinion about the teaching of mathematics and its objectives. Three different opinions about the teaching objectives were identified. One emphasized the importance of training basic skills through exercise. And the other valued the use of axioms, emphasizing the teaching of theorems and formulas that would lead the student to learn to think. The third perspective privileged the student's understanding and realistic problem-solving situations in the classroom. Regarding teaching, teachers mentioned that they needed to promote more in-depth learning, pointing out the limited time, assessments, and the extension of the curriculum as factors that prevented this type of teaching. The respondents reported the difficulty in helping students with different skill levels. Thus, some of them thought that both the content and the teaching time should vary depending on the ability of the students. The motivation to learn mathematics was also pointed out as relevant with different opinions about how teaching could motivate students: promoting didactic situations that stimulate discovery, establishing relationships between school knowledge and practical everyday situations, and creating a friendly atmosphere discussion in the classroom. This study observed that teachers have different opinions on different aspects related to mathematics education, specifically on teaching issues. These opinions are sometimes conflicting such as those about the goals of teaching mathematics. However, there are different opinions, but they are not conflicting, such as those about how to motivate students. It is possible to think that they are complementary since motivation can be stimulated through different didactic situations.

Gellert (2000) investigated future teachers, in Germany, on the nature of mathematics they intended to teach and the possible implications of these conceptions. Participants were asked to keep diaries for recording their thoughts and reflections during a given period of their teacher education about the aspects mentioned above. The content analysis procedure evaluated the material of the diaries, revealing that most participants had a negative relationship with mathematics. During the analysis of the diaries, some principles about teaching were identified:

(i) To make up teaching situations through playful activities such as games.
(ii) To classify the contents as relevant mathematics versus irrelevant mathematics, based on the principle of necessity so that all students would learn the necessary mathematical knowledge and the unnecessary mathematical knowledge would be learned only by those who wished to learn that.
(iii) To classify the contents as abstract mathematics versus practical mathematics, based on the principle of applicability, that is, practical mathematics is oriented towards reality, while abstract mathematics is oriented towards theoretical-conceptual construction.
(iv) To emphasize the mathematics of everyday life, based on the principle of the cultural value of mathematics in society necessary for everyday situations.

In general, it was found that the opinion of future teachers was that math classes should be less scary and more focused on safe and friendly spaces, centred on children. To achieve this goal, the mathematical content would need to be reduced with a focus on useful knowledge, necessary for everyday life, and fun. Gellert (2000) highlights that this reduction in content could generate a possible loss of mathematical knowledge in the future.

Not only the voices of parents and teachers are heard about the mathematical education offered to students. Children have also been invited to express their opinion on this topic. Before presenting some of the research in which these voices are heard, it is relevant to consider the position of Lange (2007) who defends the idea that it is important to know the children's perspective since they have knowledge and experiences as relevant as adults. For Lange, they have different opinions from other people within the education system, such as parents and teachers. The heart of the children's perspective lies in the meaning they attribute to the actions they take when learning (or not learning) mathematics at school.

Within this perspective, Borthwick (2011) carried out a study on how students in the early years of elementary school perceived mathematics classes. The author commented that one of the reasons for having few studies with young children on this topic is due to the difficulty of consulting them. Thus, the research methodology had drawings made by children, as a primary source of data, and a complimentary interview. In the classroom, children were asked to draw a picture of their math classes. In total, 162 drawings were analysed from a set of 15 categories. A more detailed analysis was carried out on 15 drawings, considered prototypical cases of each of these categories. A few weeks after the drawings, an individual interview was conducted to validate the interpretations of the drawings. From the drawings and interviews, the data were analysed based on four axes, two of which are of interest in this chapter: the children's perceptions about their colleagues and the teacher in math classes. The drawings contained numbers and calculations and, also, people (teacher, colleague, and the child). It was found that despite drawing themselves sitting in a group with their colleagues, the children did not perceive themselves as being effective in working in groups. In the interviews, they preferred to work more interactively and collaboratively, and the teacher should encourage this type of practice in math classes. It is important to mention that Young-Loveridge and Taylor (2005) obtained a similar result when analysing the answers of 5th and 6th graders in New Zealand. In that study, the interviewees said that explaining to others and listening to the explanations of colleagues about the strategies they adopted to solve classroom activities were important for learning.

An interesting fact mentioned by Borthwick (2011) was that many of the drawings did not include a teacher. The conclusion was that much can be explored about the child's view of mathematics classes from his drawings. The author also adds that when knowing the perceptions of their students, teachers can reflect on their role in the classroom.

Taylor et al. (2005) investigated students' opinions about the teacher's role in learning mathematics. Students of 5th and 6th grades of elementary school (between 9 and 11 years old) were asked to answer the following question: *How do you think your teacher helps you learn math?* About 20% of the interviewees said they did not know how to answer this question. The analysis of the answers of the other participants allowed to identify four roles attributed to the teacher:

(i) Knowledge transmitter, who is responsible for students' learning
(ii) Mentor, who is asked when the student needs assistance and guidance in carrying out activities
(iii) Classroom manager, who takes care of time, space, and organizing students for the proper performance of activities, informing them how to proceed
(iv) An authority, who obtains information to make decisions regarding the progress of students

A significant percentage of students highlighted the teacher as the knowledge transmitter, assuming a passive attitude towards their learning. Taylor et al. (2005) emphasize that the role that students attribute to the teacher influences their perception of how mathematics is learned and how he is positioned in his learning (in a more passive way or assuming greater responsibility and autonomy). According to the authors, teachers should be aware of what role they assume for their students.

Pehkonen (1994) examined perceptions about the teaching of mathematics by students from different countries. The study aimed to compare the conceptions of students from Finland, Hungary, Estonia, Sweden, and the United States, among other aspects. In each country, a questionnaire was applied to 7th graders, aged between 11 and 13 years old. The instrument had 32 statements whose degree of agreement or disagreement was assessed using a Likert scale of 1 to 5. Three aspects guided the data analysis: opinion on mathematics, on learning, and on teaching mathematics. Taken together, these aspects showed that the students' conceptions vary more strongly between countries than within the same country. One of the differences found was that, according to the interviewees' opinion, teaching in Estonia and Hungary is characterized by a more formalization of mathematics than in Finland, Sweden, and the United States. Also, in Finland and Estonia, students viewed teacher directivity as an integral part of mathematics teaching. This conception is different from the students of other countries, especially those from the

United States, who tended to disagree strongly on this point. The conclusion was that the students' conceptions about teaching mathematics are marked by cultural aspects.

In the opening chapter of his book, de Zunino (1995) discusses, in general, the answers given by 1st, 3rd, and 5th graders, parents, and teachers of these children about various aspects related to the teaching and learning of mathematics. The answers obtained express opinions that reveal the perspective of those involved in this process. Regarding the learning of mathematics, when the author asked the teachers about how children learn and to describe the way they teach, the most frequent answer was giving exercises for students to perform and presenting examples. Some of them also mentioned out-of-school experiences that were expressed only when the interviewer directly asked if they thought that children were able to learn on their own. In these answers, the idea was clear that children learn mathematics only if taught by their parents or teachers. As for teaching, they mentioned the use of concrete material, the need to repeat the activities many times, give explanations, and the opinion that each subject should be taught separately so as not to confuse students.

To get the children's opinion about teaching, de Zunino (1995) addressed the following question: *If you were a teacher, would you change anything in the way you teach?* Only a few 5th graders proposed any changes, commenting that school mathematics should be related to problems of daily life, such as buying and selling situations, for example.

The parents had a slightly different opinion from the teachers because they believe that their children learn on their own much of what they know about mathematics. They tended to agree with the teaching proposed at school, and the few criticisms were concerned on the fact that they felt that books and the teacher facilitated everything, so that children were not encouraged to reason and make discoveries for themselves. Some parents commented that there should be more interaction in the classroom so that students could present their ideas. The conclusion was that there are two conceptions of teaching mathematics: one based on exposing, explaining, repeating, and leading to memorizing and another based on discovery, investigation, interpretation, and discussion. The author adds that these conceptions permeate teachers' and parents' views.

From the results obtained in these studies, we observed that parents, teachers, and students tend to have an opinion about teaching and learning mathematics. In general, the absence of opinion was more observed in students than in other participants. These views are not always similar, as they vary according to cultural aspects and the roles that respondents play in educational institutions. Often, the conceptions of teaching and learning are characterized by a dichotomy. However, the researchers are unanimous in emphasizing that teachers should be aware of students' perceptions of the role assigned to them and how they perceive mathematics teaching situations.

13.3 What Is Thought About Mathematicians, About Nature, and About the Uses of Mathematics

The previous discussions dealt with people's opinions about mathematics as an object of teaching in the school context, with most participants as teachers and students. The importance of investigating this topic is a consensus among researchers that teachers' conceptions influence the way they teach mathematics, while students' conceptions influence the way they learn mathematics and the performance they present in this subject. However, other research deals with people's opinion of mathematics as an object of knowledge, without examining what they think about teaching issues. This is the focus of this section of the chapter. It is not possible to separate the opinions about mathematical education from the conceptions that people have about mathematics as we showed that many of the studies investigated these two facets together (Brez and Allen 2016; Gellert, 2000; Hawighorst 2005; Pehkonen 1994). However, research that specifically focuses on people's conception of mathematics seeks to examine how they conceive the nature of this object of knowledge.

In this investigative scenario, it is relevant to show the study conducted by Picker and Berry (2000) on the perception of students about mathematicians, specifically. This research adopted drawings as a methodological resource to reveal students' perceptions. Middle school students (12–13 years old) from the United States, Finland, United Kingdom, Romania, and Sweden were asked to draw a mathematician at work and explain their drawings in writing. About 20% of the drawings represented a teacher, associating this professional with a mathematician. It was observed that the images did not differ between countries, as they were stereotyped images like those of a scientist: a white man, middle-aged, bald, or with unkempt hair. The explanations given revealed that many of the participants did not know what mathematicians did, while others believed that mathematicians performed activities similar to those performed by teachers, bankers, and accountants, solving complex mathematical problems. An intriguing result in almost all countries was the image of a child frightened by an authoritarian and frightening mathematician. At the end of the article, the authors pointed out that teachers are unaware of the limited information that students have about mathematicians and the impact on learning mathematics.

The nature of mathematics has been considered in several studies. Young-Loveridge et al. (2006), for example, asked students aged 6 to 12 years old, *What do you think math is all about?* The answers were grouped according to the nature they attributed to mathematics:

(i) As a content related to the performance of calculations, mentioning numbers and operations
(ii) As a cognitive process, involving learning, reasoning, and problem-solving
(iii) As a utilitarian instance, with immediate or future use

This last category was the most frequent. It was also found that a significant number of respondents did not have an opinion about the nature of mathematics. According to Young-Loveridge et al. (2006), these children possibly experienced mathematical situations without reflecting on their meanings. In general, children perceive mathematics in a dichotomous way: some of them consider mathematics as something that needs to be learned, while others consider it as something that needs to have meaning.

Hawera and Taylor (2011) investigated the opinion of students from the 5th to the 8th grade of elementary school about learning mathematics. Among several questions addressed to the participants, one was focused on the nature of mathematics: *What do you think math is all about?* Many students expressed no opinion, while others said that mathematics is numbers and operations. Few of them suggested that mathematics could be related to situations outside the school context.

Ogliari (2008) analysed the opinions of high school students about mathematics in the context of society. The opinions were obtained through questionnaires and interviews. Some questions aimed at examining whether students perceived the relationships between the content taught at school and their daily activities. If the answer was affirmative, a justification was requested, followed by examples. Almost half of the interviewees did not perceive any relationship between the content taught and its application in activities performed by them in their daily lives outside of school. Those who perceived applicability provided examples that illustrated relationships between mathematics and commercial activities that required the use of money. Another question was whether the students knew anyone who applied the content taught at school in their profession. Many of them mentioned people who worked in the trade dealing with money; and more than half referred to professionals whose activity required knowledge of mathematics such as architects, engineers, accountants, and system analysts. Although most participants stated that they rarely identified the need to apply the content taught at school in their lives, many of them said that they would apply mathematics frequently in the future to enter university and to carry out professional activities.

Some studies deal with a specific facet of mathematics: the uses that individuals attribute to this object of knowledge. For this, some investigations address questions to participants such as: *What is mathematics for? What is the use of learning math?* For this chapter, we found three studies of particular interest since they deal with the same topic addressed here and for investigating elementary school students: de Zunino (1995), da Silva (2009), and Spinillo (2018).

de Zunino (1995) addressed the following question to parents, teachers, and students in the 1st, 3rd and 5th grades in Caracas, Venezuela: *What is mathematics for?* The teachers' answers were generic and focused on the students. For them, mathematics prepares the student to reason quickly, to understand other school subjects, and for everyday situations. On the other hand, parents provided more specific and different answers than teachers, assigning uses related to everyday situations such as making calculations, budgets, and shopping at the supermarket. They also related mathematics to work activities and professions, an aspect that was not mentioned by the teachers. According to the parents, mathematics at school was used for academic purposes to learn other subjects such as physics and chemistry. Football matches and music were also mentioned. It was noticed that parents seem to have a more precise notion of the specific uses of mathematics (work, academy, sport, art, and situations of daily life) than teachers. However, the students' opinions did not express the same conception as parents and teachers, as they tended to attribute school uses to mathematics, such as doing arithmetic operations and homework. Rarely, and only when directly questioned, some children referred to the use of mathematics in recreational and professional activities.

da Silva (2009) dedicates an entire book to answer a crucial question: *Why learn math?* Students from the 1st to the 5th grade attending schools in Aracaju, Brazil, were asked to answer open questions presented and answered orally by those who had reading and writing limitations and presented and answered in writing by those who did not have such limitations. The questions were about different topics such as (i) the importance and usefulness of mathematics and its learning; (ii) success and failure in learning mathematics; and (iii) the social relationship and the personal relationship with mathematics. Considering the focus of this chapter, we only discuss the data related to the first topic. The key question was *Why do you learn mathematics?* The author listed numerous examples that, grouped, indicated that 29% of them expressed school uses (to pass the year, to do the tasks, to learn). Only 11% of the answers were about the use of mathematics in everyday life and 14% about its importance for getting a job in the future. There were answers that, in the author's interpretation, evoked changes in the individual, such as being someone in life, becoming intelligent, and growing (11%). Some rare but interesting responses expressed the pleasure of studying mathematics, an opinion mentioned only by students in the early grades. The results showed that school uses decreased with advancing schooling, while the idea that one learns mathematics to get a job increases. It was concluded that the school uses of mathematics permeate the children's conceptions about the reasons that lead them to learn mathematics, in which its relevance lies in the learning: one learns mathematics because it is a subject taught at school. In other words, mathematics was limited to being a school object.

Mumcu and Aktaş (2019) developed an intervention study with prospective teachers in Turkey about the uses of mathematics. The intervention involved discussion groups about open-ended everyday mathematical problems and their solution procedures. Initially, in the pretest, the participants recognized the importance of mathematics, but had difficulties in connecting mathematics with their everyday life. After the intervention, in the post-test, they were able to relate mathematics with their everyday life and to develop abilities that helped them solve mathematical problems and to teach mathematics through methods based on the understanding concepts instead of memorizing rules. It was also found that the intervention had a significant and positive influence on the attitudes of prospective teachers towards mathematics.

Spinillo (2018) carried out an investigation that involved two studies, one focused on examining the uses attributed to mathematics by low-income and middle-class children aged between 7 and 8 years old in Recife, Brazil. However, unlike previous research in which the question addressed to participants was generic (*What is* *mathematics for? What is learning mathematics for?*), the author addressed specific questions regarding three areas of mathematical knowledge: numbers, operations, and measurement. Each child was asked to answer the following questions: *What are numbers for? What are sums for? Why do we measure things?* The answers were classified into four types: school uses (to do the homework, to get good grades); everyday uses (to count objects, to get the right change, to know a person's height); professional uses (to find a job, to be a dressmaker); and to develop intellectual abilities (to be clever, to know more). The results showed that middle-class children attributed outside-school uses more often than low-income children. On the other hand, low-income children are assigned professional uses more often than middle-class children. These children mentioned uses associated with work activities and opportunities to get a good job in the future. For low-income children, school uses were the most frequent, while for middle-class children, school uses and outside school uses were equally often mentioned. The conclusion was that the uses attributed to mathematics vary according to the children's social background. This result corroborates Spinillo and Cruz (2018) study when comparing the mathematical activities carried out in the home environment of children from different social classes.

Despite the differences between the groups, Spinillo (2018) also identified similarities. It was observed that children from both social classes tended to attribute school uses to numbers and operations and out-of-school uses to measures. According to the author, a possible explanation for this is that textbooks adopted in the early school years tend to prioritize activities related to solving arithmetic operations (alone or in the solution of word problems), while measurement activities are less frequent. The opposite occurs in the home environment in which activities involving measurement are more frequent than activities with arithmetic operations, as verified by Spinillo and Cruz (2018). Thus, both the school and the family context come into play in relation to the uses that children attribute to mathematics.

Taken together, the studies revealed that the uses attributed to mathematics are most clearly characterized as follows: school or academic, relating to everyday situations, professional activities, and referring to intellectual gains. Another feature is that the uses can be immediate or related to future situations. Immediate uses would be those that have an application at the actual moment in the life of individuals, for example, shopping or getting a good grade in school. Future uses would be those that would be applied in situations still to be experienced by the individual, such as getting a job or entering university. In the research reported below, these characteristics will be considered in the analysis of the participants' answers.

It is also important to comment on the participants in studies that investigate the uses of mathematics. de Zunino (1995), for example, stresses the differences between parents, teachers, and students. da Silva (2009) compares the school years stating that the uses tend to change with the advance of schooling. Spinillo (2018) compares children from different social classes, pointing out the differences and similarities between them. The study described below compares participants from the same socioeconomic background and with the same level of schooling, but with different cognitive and social profiles. Some of the participants were low-income children in the early years of elementary school, and others were low-educated group of low-income adults who were students in a teaching program aimed specifically at people with this school profile (Youth and Adult Education program – EJA). Would the uses attributed to mathematics vary between these two groups of individuals? Or would the fact that both groups are at similar levels of education bring them closer together? Regardless of comparisons between groups, it is relevant to investigate how low-educated adults think about the uses of mathematics since research with participants with this profile is rarely carried out. In Brazil, studies with adults attending the EJA program tend to focus on the area of acquisition of reading and writing. Therefore, the study reported below may contribute with more information regarding the mathematical knowledge of these late-schooled individuals.

13.4 What Low-Educated Adults and Children Think about the Uses of Mathematics

In order to answer this question, an interview was conducted in which the key question was: *What is mathematics for?* Additional questions were asked to make the interviewees explain their answers in the best possible way. The interview, applied individually, was recorded in audio and later transcribed for analysis.

The participants were 20 children and 20 low-income adult students from public schools in the city of Recife, Brazil. The children were between 6 and 8 years old, students of the first year of elementary school with typical schooling for their age. Thirteen of the 20 children were boys. The adults were between 36 and 85 years old, students in the early years of a teaching program called Youth and Adult Education (EJA). Eleven participants were between 30 and 50 years old, and nine of them were over 60 years old. Sixteen of the 20 adults were female. This was because, in general, there is a predominance of women in the EJA program.

The Brazilian Federal Government created the EJA program to guarantee the right to basic education for people over 15 who did not have access to education or who were unable to complete schooling at an appropriate age. The program consists of initial and final modules. Initial Modules I and II correspond to the 1st, 2nd, and 3rd grade of elementary school; initial Modules III and IV correspond to fourth and 5th grade of Elementary School. Final Modules I and II correspond to the 6th and 7th grades of Middle School and final Modules III and IV correspond to the 8th and 9th grades of middle school and high school. The average time to complete the initial modules is 24 months, and the final modules are 18 months.

The adults participating in the investigation were students of the initial Module I so that the level of education was equivalent to the level of education of children who attended regular education. Some of the adults had previously participated in the EJA program and were resuming their studies, while others were participating in the program for the first time.

13.5 The Uses Assigned to Mathematics

We analysed the answers given to the question *What is mathematics for?* according to the classification proposed by Spinillo (2018) that also involves aspects documented by de Zunino (1995) and da Silva (2009). The answers were classified into types[1] that are described and exemplified below.[2]

Type 1 (school uses): answers expressing the uses associated with the fulfilment of school activities, performance in assessments, and learning mathematical content. Examples:

To do the homework. (child)
To pass the year and to get good grades. (child)
To do the sums, right? I'm good at math. I'm good in doing addition. In division sums, I'm still learning. (adult)

Type 2 (everyday uses): answers expressing the uses in activities of everyday life carried out in social contexts that involve different instances of mathematical knowledge, such as numbers, arithmetic operations, and measurement. Examples:

To make a call, to find out the house number in the streets. (child)
To see how many things there are. (child)
To go to the grocery store to buy and see prices. (child)
Mathematics is when we go to an open market, a do a big purchase. Then, let's suppose, this was R$ 600. You have R$ 1000. Then, you have to add how much is, how much is not. (adult)
To learn about the hours, the time to leave (at the end of the class). (adult)

Type 3 (professional and academic uses): answers expressing the relationship between mathematics and professional activities. Two uses have been identified in this type of answer: the use of mathematics to carry out professional activities and the use of mathematical knowledge to obtain a profession or a job or to attend a training course. Examples:

To go to college. (child)
Working to repair someone's house. (child)
In my opinion, for many things. The person wants to take a course, perhaps. (adult)
If you want a job, an important position in a hospital, in a bank, in a post office, in something like that. (adult)
What do I do with the sums? So, when my boss tells me to buy something, then I do the right sums and tell her how much was. (adult).

Type 4 (intellectual gains): answers expressing the use of mathematics as a condition for the acquisition and development of intellectual skills. Examples:

[1] In each group, five hybrid answers were given that involved more than one type.
[2] In the answers, we made the necessary punctuation mark adjustments.

Table 13.1 Number and percentage of types of answers in each group of participants

	Type 1 (school uses)	Type 2 (everyday uses)	Type 3 (professional uses)	Type 4 (intellectual gains)
Children ($n = 25$)	13 (52%)	4 (16%)	3 (12%)	5 (20%)
Adults ($n = 25$)	1 (4%)	13 (52%)	7 (28%)	4 (16%)

To study to not get stupid. (child)
To be intelligent. (child)
To multiply your mind. Mainly, clear your doubts and confusion. (adult)

Two independent judges analysed the answers who disagreed only in six case answers (four in the group of children and two in the group of adults). These were discussed between the two judges until they reached a consensus.

As can be seen in Table 13.1, children's answers are concentrated in Type 1 (school uses, 52%), this result being significant, as revealed by the chi-square test ($\chi 2 = 10.04$, $df = 3$, $p = 0.018$). This shows that children attribute predominantly school uses to mathematics. It is interesting to note that 20% of the answers expressed the idea that mathematics could bring gains of an intellectual nature. Answers regarding daily and professional uses had less expressive percentages.

According to the chi-square test ($\chi 2 = 12.60$, $df = 3$, $p = 0.006$), adults attribute everyday uses to mathematics (Type 2, 52%), followed by professional uses (Type 3, 28%). School uses were extremely rare.

We also identified differences between groups as showed by the chi-square test ($\chi 2 = 16.76$, $df = 3$, $p = 0.001$). This was because school uses (Type 1) were significantly more frequent in children than in adults, while everyday uses (Type 2) and professional uses (Type 3) were more observed in adults than in children. The similarity between the two groups of participants was only in relation to intellectual gains (Type 4) that were rare.

Specific aspects regarding the uses attributed to mathematics were analysed and discussed below.

13.6 Relationships Between the Individual and Mathematics

In general, both adults and children tend to attribute a utilitarian character to mathematics, in the sense of considering what is done with it in school and everyday situations since 62% of the answers were about what the individual does with math. Less frequent was the view of what mathematics can do for the individual such as getting a job, entering university, and obtaining intellectual gains (28%). Table 13.2 shows examples of these answers.

The utilitarian view was also present in the answers of adults and children, while the other perspective was more observed in the answers of children than in adults.

Table 13.2 Examples of the answers regarding the relationship between the individual and mathematics

	Children	Adults
What the individual does with mathematics	To do homework. Also, to do activities at school	I keep using math to sell popsicles and ice cream. Some of these are commercial transactions
What mathematics does for the individual	To go to a university	For anything I want to do later. It is the future for us to learn more, and for us to help our grandchildren to learn

Table 13.3 Examples of the answers regarding the occasion when mathematics is used

	Children	Adults
Past uses	-------	My life was to be a merchant, do you understand? I worked in a bakery, supermarket. I had my own business. I already had three bakeries, you know? No study, but good at math
Immediate uses	I do a lot of math activities	And math is good because when you go to the open market, you know how much you've already spent and how much you have
Future uses	Having a car, motorcycle	For when you have your own business. Then you already know the sums, you already know an order. You are already there with the calculator

We noted that both children and adults attribute a utilitarian character to mathematics and rarely mentioned what mathematics can do for the individual. When this was mentioned, mathematics was associated with aspects related to learning and the acquisition of knowledge in general.

13.7 When Using Mathematics

Another characteristic identified in the participants' answers was related to the moment when the uses occurred in the individuals' lives: past, immediate, and future uses. Past uses were those associated with activities carried out by the interviewee previously. Immediate uses were those that had an application in the present moment of their lives. Future uses were those related to situations still to be experienced by the interviewee. Table 13.3 shows examples of these responses.

One single answer by an adult mentioned past uses, while future uses were observed in 14% of the answers, equally present in both groups. On the other hand, immediate uses were the most frequent (30%), more present in the answers of adults than children. We found that children and adults tend to attribute immediate uses to mathematics related to situations of everyday life or school situations.

13.8 Where Mathematics Is Used

Another aspect analysed was the nature of the contexts of use of mathematics. Previous research (e.g., da Silva 2009; Spinillo 2018; de Zunino 1995) has shown that children, parents, and teachers mentioned different contexts of use of mathematics such as academic, business transactions, entertainment, sports, and professional. In this investigation, the use of mathematics was limited to three contexts, academic, professional, and commercial transactions, as shown in Table 13.4.

Considering the total number of answers, it was found that 20% of them referred to uses in the academic context, 18% to professional uses, and 30% to uses in commercial transactions. Professional and business uses were frequent in adult answers, occurring only once among children. Academic uses, especially school uses, were more often observed among children. Adults related mathematics to a greater diversity of contexts than the child who tended to attribute markedly school uses to mathematics.

13.9 What Mathematical Knowledge Do the Uses Refer to

Another characteristic analysed was the mathematical knowledge that was being considered in the participants' answers. Cebola (2007) and Spinillo (2018) pointed out that different meanings can be attributed to numbers, such as an identity, a measure, and a quantity. The use of mathematics as an identity occurred only once, with the answer given by a child (*to make a call, to find out the house number in the streets*). The use of mathematics as a measure was rare, occurring only concerning time (*mathematics? It is for us to learn numbers, hours. To know what time it is*). On the other hand, the use of mathematics as something related to the amount of money was very frequent (*to go to the grocery store to buy. To see the prices. I like that. I'll see the prices. Then I'll see the numbers. How much the price is*), especially in adults (52%). This was because the use of mathematics in situations related to commercial transactions was significant.

Table 13.4 Examples of answers related to the contexts of use of mathematics

	Children	Adults
Academic context	Mark the X when the teacher orders	In my opinion, for many things. The person wants to take a course, perhaps
Professional context	Working to repair someone's house	I do business. And I sell a magazine product, right? I look for these magazine catalogues, right? And then it is essential to know how to do the sums, to write things down properly. I write down the prices, do the sums. Everything
Commercial transaction context	Go to the grocery store to buy and see prices	He bought a dozen, it cost R$ 25

13.10 Finals Remarks

What is mathematics for? In previous studies, this question was presented to students, parents, and teachers (da Silva 2009; Spinillo 2018; de Zunino 1995). In this research, the age of the students was compatible with the school years they attended. In this investigation, this question was addressed to students who had a different profile from the usual: they were low-educated adults who attended a basic education program aimed at low-income people who did not have access to education or who were unable to complete schooling at an appropriate age. This particular group of students was compared to a group of children of the same social class whose age group was compatible with the school year they attended. The aim was to examine whether the uses attributed to mathematics would vary or not between these two groups of participants.

In general, the results showed that despite belonging to the same social class and being at the same level of schooling, adults and children presented a different pattern of results. The main difference was that while children attribute school uses to mathematics, adults attribute uses related to daily and professional activities. The similarity between the two groups was only in the answers that indicated intellectual gains, which, however, were rarely mentioned.

As observed by da Silva (2009) and de Zunino (1995), children conceive mathematics as a school object, whose use is limited to the activities they need to carry out in the school context to learn mathematics and guarantee academic success. On the other hand, adults attribute uses associated with activities that they need to perform in situations of everyday life to deal with them successfully.

Once again, this dichotomy reveals the contrasting views about mathematics documented in the literature. Dossey (1992) and Begg (1994), for example, differentiate external and internal conceptions. In the external conception, mathematics is considered a stable body of knowledge (contents and procedures) to be presented to students, while the internal conception conceives mathematics as an internal knowledge, constructed by the individual, involving reasoning and communicating. Huckstep (2000) highlights a perspective that considers mathematics as an activity as an end in itself (the beauty of mathematical reasoning and the pleasure it brings) and another in which mathematics is seen as a useful activity to accomplish or obtain something. Nunes et al. (1993) discussed the different facets of mathematics: oral mathematics and written mathematics acquired and developed through different contexts and social experiences.

Resuming the discussion about the results of this investigation in the light of the views on mathematics shows that the dichotomy persists, revealing itself in the answers of the two groups of participants in terms of trends that characterize two distinct ways of attributing uses to mathematics. This dichotomy, as stated by Presmege (2002), hinders to recognize the connection that exists between mathematics learned at school and mathematics present in practical everyday situations. According to the author, this distance may compromise the ability of students to capitalize on the potential that learning situations can provide.

Despite the difference found, we observed that both children and adults attributed uses that were limited to their personal experiences. The idea that mathematics could be used beyond the personal universe, that is, in society more broadly, was not identified in the answers of the participants. Although the question *What is mathematics for?* is a general question, it was interpreted as a question of a personal nature in which the interviewee should answer based on the uses in his/her life and not on the uses that could be given to mathematics in society or people's lives. Perhaps, for this reason, children have concentrated heavily on school uses, not realizing the use of mathematics in other contexts in which they did not participate. For adults, the use of mathematics was characterized by what can be done with it in everyday situations outside the school context. For these interviewees, mathematics does not seem to be understood as a school object.

We should highlight that none of the interviewees mentioned uses related to typical situations in the family context that involve mathematics, such as culinary, recreational activities, and measurement of spaces and objects, among others. Although in the home environment several mathematical activities are carried out (see Blevins-Knabe and Austin 2016; Spinillo and Cruz 2018), they seem invisible to the eyes of children and adults, or at least are not recognized as being mathematical activities (see de Abreu et al. 1997).

Another similarity between the participants was regarding the individual's relationships with mathematics. This relationship was highlighted by a utilitarian and immediate character: what the individual does with mathematics at the present moment of their lives. Few answers referred to what mathematics could do for the individual. This aspect is related to the intellectual gains that were scarce in both groups and to the fact that mathematics was rarely considered a means to achieve future goals. The immediacy in the use of mathematics documented previously in research with children (Ogliari 2008; Young-Loveridge et al. 2006; de Zunino 1995) was also observed in adults in this investigation. Answers in which the uses of mathematics were associated with past and future facts were rare.

It is also worth noting the fact that, in addition to the school context, the context related to commercial transactions involving money was widely mentioned, especially by adults. One of the social representations that the individual makes about the use of mathematics in everyday situations is those related to commercial transactions, either as a customer or as a seller. Thus, money appears as a referent that gives meaning to numbers and arithmetic operations.

To conclude, two points appear as relevant to be considered: one related to research issues and the other to educational issues. The system of analysis adapted, based on different information from previous studies (da Silva 2009; Spinillo 2018; Young-Loveridge et al. 2006; de Zunino 1995), can be applied in future research. The way the answers were classified can contribute to a more systematic analysis of the conceptions about the mathematics of both children and adults. Of course, this system can be improved and adapted to other research scenarios.

In education, it seems necessary to create didactic situations that allow students to broaden their conceptions so that they attribute to mathematics' different uses that can contemplate the multifaceted nature that characterizes it. For this, the teacher needs to become aware of the students' opinions about mathematics. Their opinions can be obtained through questions similar to the one addressed to the participants in this investigation or through situations such as those discussed by McDonough and Sullivan (2014), with the necessary adaptations to the classroom context. Once these opinions are known, the second step would be to broaden them, generating situations and discussions that lead students to have a vision of mathematics that goes beyond personal, utilitarian, and immediate uses. This does not mean disregarding the student's perspective, but, on the contrary, valuing and expanding it.

To conclude this chapter, we invite an interviewee to answer what mathematics is for:

> Everything is a number. Everything in our lives is a number, right? It is from the day we are born until the day we die. I was born on 20/02/57 (referring to the 20th of February 1957). The day I go (referring to the day of her death), it will also have the same thing. There will be another date and so life goes on. The number is part of human life. Everything is a number. I mean, everything like that, in the way of speaking, do you understand? The number is fundamental. And I love math, oddly enough! I really like math. (M. M., 61 years old)

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