

Socio-Cultural Factors: A Missing Variable in Mathematics Pedagogy in Ghana

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Abstract

This study draws on theories relating to the local aspects of mathematical knowledge and to mathematics pedagogy to explore how the teaching and learning activities carried out in mathematics classrooms in Ghana deal with these aspects. It focussed on the teaching of measurement of money at the primary school level. The primary school level was considered in this study because it is during this period of time that pupils develop the foundation for learning mathematics at higher grade levels. The current Ghanaian primary school mathematics curriculum, three of the popular primary school mathematics textbooks, and lessons from two experienced primary school teachers constituted the main sources of data for the study. The data collected were analysed qualitatively and presented as narrative description with some illustrative examples. The study revealed amongst others that the approaches used by teachers in the lessons observed reflected those suggested in mathematics curriculum and the textbooks, and these approaches pay very little attention to the social and cultural contexts of the pupils. By way of recommendation the authors provide an alternative approach to the teaching of measurement of money in context, based on a three-tier teaching strategy.

Key words: Pedagogy, mathematics, primary, socio-cultural, Ghana.

Background to the Study

“They [pupils] know the home one [everyday mathematics] so if they bring it up you teach them what the syllabus says or what has been prepared to be followed.” (Teacher C, Davis, 2010, p.186)

In the view of Teacher C, a Primary Four teacher with 15 years of teaching experience in different government (Public) schools, everyday mathematical conceptions and practices of students have no place in mathematics pedagogy. This view may reflect the views of many teachers who work in the contexts where school mathematics and everyday mathematics are seen as being mutually exclusive. However, these views are not tenable. Literature points to the local/cultural aspects of mathematical knowledge and mathematics pedagogy. Bishop (1988) argues that "mathematics must be understood as a kind of cultural knowledge, which all cultures generate but which need not necessarily 'look' the same from one cultural group to another" (p180). Figure 1, shows how local mathematical knowledge could be. The Figure shows estimate prepared by an accountant of a restaurant for food that would be served at the end of a board meeting. The unit of measure of quantity of items would not make sense to anybody who is foreign to the local culture. For example, unit of measure of "black eye beans", butter and crab would not make sense to anybody who does not share in the culture that produced these mathematical representations. In some cases, no quantities were given but the prices were given, for example, salted fish and grinding. Once again this would not make sense to somebody who is foreign to the local culture but for the local it makes sense because the price gives the idea of the quantities involved. All these show the local aspect of mathematical knowledge and mathematical representation.

CHALET/RESTAURANT
LIST OF ITEMS TO BE PURCHASED FOR SPECIAL PROFESSIONAL

ITEM	QTY	UNIT PRICE	AMOUNT GHC
BAL B/O			3249.00
Dawadawa	5 pcs		10.00
Potatoe chips	5 satchets		110.00
Butter	2 cakes		31.00
Salted fish			50.00
Selt	1 bag		65.00
Ga kenkey	200 wholes		200.00
Avocado	10 wholes		20.00
Macaroni	10 satchets		35.00
Crab	lot		20.00
Palmnut	3 tins		10.00
Cooked beans	lot		10.00
Black eye beans	5 olonka		75.00
Hausa koko	lot		30.00
Eggs	7 crate		112.00
Grinding			20.00
Corn flour (brown / white)	4 olonka		70.00
Gas			411.00
TOTAL			4528.00

Figure 1: Local aspect of mathematical knowledge exemplified in the units of measurement

Researchers in mathematics education have also distinguished between the mathematics students encounter in their everyday social and cultural practices (m) and the mathematics they encounter in school (M) (Bishop 1988; D' Ambrosio, 1985). Vygotsky (1987) distinguishes two kinds of concepts, one being everyday concepts and the other, scientific concepts. From Vygotsky's perspectives, an everyday concept is acquired through the child's participation in social activities within the child's culture. Their (everyday concepts) development occurs in out-of-school settings, they are experience-based, situated and often spontaneous. Scientific concepts on the other hand are systematic. They are acquired through a system of formal instruction. The discussion so far shows that different sociocultural activities students engage in even within the same geographic settings such as school and out of school produce different kinds of mathematics. As long as the societal practices that generate these different mathematical practices and therefore different mathematical representations continue to be

carried out in the society, students would have to grapple with the onerous task being proficient in both practices in order to fit into the society in which they find themselves. For example, the information in Figure 1 requires proficiency in both everyday mathematics and the school mathematics in order to make sense of the whole document. One needs local knowledge in order to understand the quantities and school mathematical knowledge in order to follow the amount column. However, everyday mathematical representations and practices are often devalued or ignored, especially in contexts where teachers and in some cases curriculum developers see the two as being mutually exclusive (Abreu & Duveen, 1995; Davis, 2010).

Redenomination of the Ghanaian local currency the Cedi

In 2007 the government of Ghana, through the Bank of Ghana redenominated the local currency, the Cedi. Some of the main reasons why the local currency was redenominated included “general inconvenience and high risks of carrying loads of currency” and “difficulties in maintaining book keeping and statistical records” (BOG, 2007, p.1). The redenominated currency was named the Ghana Cedi. One new Ghana Cedi was equivalent to ten thousand old cedi, implying that four zeros were slashed. The redenomination did not affect the basket of goods and services the old currency could buy. For example, if an item cost C200,000 the same item could be purchased at GH¢20. The redenomination brought with it the need to review the Ghanaian mathematics curriculum at all levels. Topics such as measurement of money, for example, at the primary school level had to be redesigned to reflect the change. Teachers had to adjust to the use of the new currency in the teaching of measurement of money.

A decade after the implementation of the new currency, many ordinary Ghanaians, especially those in the deprived, rural communities still communicate prices of goods and services in the old currency, even though the old currency is no longer in circulation. Some educated people even communicate money in both the new and the old currency as shown in Figure 2. The figure depicts a receipt the first author was given by a restaurant attendant (Comfort) who claimed she had finished Senior High School (Grade 12) in Accra, the capital town of Ghana. It could be seen from Figure 2 that the sum should have been 86 but Comfort wrote 860, which is the usual way of communicating 860,000

among the locals. Although Comfort had been taught measurement of money in school, she could not calculate the total cost of the items bought in the new currency correctly. Comfort identified the cost of each of the items using the new currency as names signifying the old currency but not numbers. For example, she treated C20 as 200, 000. Being a local, Comfort's arithmetic made sense to the first author but this receipt will definitely confuse anybody who is foreign to the Ghanaian societal and cultural practices. While Comfort's example shows the local aspect of mathematical knowledge, it also raises question about how measurement of money is taught in Ghanaian schools. One does not expect Comfort to go through the difficulty she experienced communicating money in the new currency, after she had gone through lessons on measurement of money in school. Studies in Ghana have shown that primary school pupils, especially those from rural school settings treat numbers written on currency notes as names but not numbers (Davis & Sullivan, 2011). The study found that pupils used the new currency to communicate the old currency, for example, "Twenty pesewas (20p)" was named "two thousand" (Davis & Sullivan, 2011, p.57). This often made operation on money difficult for some pupils. Some of these pupils, like Comfort, would end up completing secondary education without being proficient in operation on money.



Figure 2: Example of the use of new Ghanaian currency to communicate the old currency

Purpose of Study

Our main objective in this paper was to investigate how the teaching and learning of mathematics take on board some of the social and cultural practices of students to help them understand school mathematics generally, and measurement in particular. The study therefore sought to explore how socioculturally-related the teaching and learning activities carried out in Ghanaian primary school mathematics classrooms are; focusing on the teaching of measurement of money. The authors focused on the teaching of measurement of money because of the encompassing transitions (Abreu, Bishop & Presmeg, 2002) Ghanaian pupils find themselves in as a result of redenomination of the local currency in 2007. This has resulted in the general societal practice whereby some people communicate old currency using the new currency notes. This study is important and necessary because the different ways in which the currency is communicated is not just a source of confusion, but also potentially the reason for someone to scam the public. For example, it is common for fuel attendants to lose income because some driver customers would mention the amount of fuel they want to buy and later say they had meant to communicate the amount in the old currency.

The Research Question

The main research question that guided the study was: “How socioculturally-related are the pedagogical activities used in teaching measurement of money in primary schools in Ghana?”

Method

Two average achieving public primary schools, one each from a rural area (School R) and an urban area (School U) were randomly selected from a list of average primary schools in the Cape Coast Metropolis of Ghana. In each of the schools, primary four pupils were purposely selected because they had just entered primary four and the teachers were revising some primary three topics, including measurement of money with them. In all, 60 pupils comprising 38 from School R and 22 from School U participated in the study. One lesson each on measurement of money was observed from each of the teachers. The lessons were observed in September, 2016 by the first author, with the help of a trained research assistant. For the purpose of triangulation, the results from the lesson observation, the suggested teaching approaches used in the teaching of measurement of money in the Ghanaian primary school mathematics curriculum, and the approaches used in the development of measurement of money in three popular government approved textbooks used by schools in the Cape Coast Metropolis of Ghana were studied to ascertain how they reflect the social and cultural practices of the pupils. Triangulation in educational research is recommended for the purpose of ensuring concurrent, convergent and construct validity (Torrance, Gorard & Taylor, 2004). This was therefore done to enhance the validity of the findings from the study. The data collected were analysed qualitatively and presented as narrative description with illustrative examples. For the purpose of analysis, pupil participants from School R were coded SR1, SR2, SR3, ..., SR38 and those from School U were coded SU1, SU2, SU3, ..., SU22. The teacher participant from School R was coded TR whereas the teacher participant from School U was coded TU. The first author explained the whole research project to the research participants and their consent were sought before the start of the project. Permission was sought from heads of the two schools as well.

Results and Discussion

Lesson Observation

The lessons were delivered mainly in the English Language, which is the official language of instruction from Primary Four onwards in Ghana. Pupils, at this level often struggle to understand lessons delivered in English language because this is the level where they begin to experience the use of English language as medium of instruction. Classroom discussions and interactions were mainly vertical in the form of teacher posing questions and pupils responding to the teacher's questions. In each of the lessons, the teacher introduced the pupils to the current Ghanaian currency in circulation (i.e. Ghana Cedis) and took them through identification of the coins and the notes after which they went through operation on money.

In School R, for example, the lesson proceeded as shown in the excerpts below:

TR: [writes the topic "Money" on the board]

TR: What is money?

SR17: Sika

TR: Every country has its own currency, what currency do we use?

SR5: Cedis and Pesewas

TR: Ghana Cedis and Pesewas

SR: [mention the denominations in Pesewas in chorus, referring to their text book]

TR: [writes each of the denominations on the board as students mention them]

SR: [mention the denominations in Ghana Cedis in chorus]

TR: [writes each of the denominations on the board as student mention them]

Although a growing body of literature points to the importance of the recognition of the culture and history of pupils in the development of lessons (Hedegaard & Chaiklin, 2005), the use of pupils' everyday social and cultural practices relating to measurement of money was not evident in the development of each of the lessons, as shown in the excerpts below. The teachers rejected the use of everyday conceptions and practices involving measurement of money.

TU: We go to the notes. We start from the smallest to the biggest.

TU: What is the smallest notes?

SU4: One Ghana Cedi.

TU: What is the next?

SU17: Two Ghana Cedis

TU: What is the next?

SU16: *Five hundred thousand*

TU: *You are taking us to the olden days. We are not using it any more.*

TU knew the source of SU16's problem; "I know that some of you are using the old currency because you sell" (TU). However, she did not see the need to help the pupils to appreciate the need to operate in the new currency by engaging them in cultural negotiation (Abreu, Bishop & Presmeg, 2002). TU rather accused SU16 for taking the class back to the olden days; meanwhile the pupils know that communicating prices of commodities in the old currency is a common acceptable practice in the Ghanaian society. This constitutes cultural conflict because the practice of communicating measurement of money in the old currency is accepted in the out of school setting but is prohibited in the classroom. It also shows how Ghanaian primary school children, especially those who are deeply involved in the socio-cultural practices such as buying and selling have to manage to experience two worlds within the same country. Such deliberate attempts to avoid the mention of everyday mathematical practices within the sociocultural practices of pupils often results in situations where the pupils end up seeing the two sets of mathematical practices as being mutually exclusive. They also end up not being proficient in both mathematical practices (as was seen in Figure 2) because the everyday mathematical conceptions and practices which should support the development of school mathematics (Vygotsky, 1978), is ignored. Pupils therefore end up learning many school mathematical concepts in abstract.

The exposure of pupils to rules appeared to be the main aim of the teachers, "when we write we bring the Ghana Cedis first but when we are calling it, mention the number before the Cedi" (TU), "the Pesewas is coin and Cedi is notes" (TR). By just concentrating on rules, teacher TR, for example, taught the pupils the wrong concept and ended up confusing them because the teacher forgot that the new one Ghana Cedi consists of both coins and notes. Telling them that pesewas are the coins and Cedis are the notes was therefore incorrect because there is a

Cedi coin and the pupils knew but were very careful not to question the teacher's knowledge (see Appendix B).

Primary School Mathematics Curriculum

Measurement of money is covered in primary one, primary two and primary three (i.e. the first three years in the primary curriculum). The curriculum highlights teaching of only the new currency notes and coins and the use of currency notes and coins in a play shop (Ministry of Education, 2012). By Primary 3, pupils are expected to use notes and coins up to GhC50.00 in a play shop. They are expected to find the total cost of two or more items from a corner shop or school canteen (Ministry of Education, 2012, p.58). The suggested teaching approaches do not mention the old currency and how to help pupils to make transition from the old currency to the new currency, perhaps because the curriculum developers assumed that all Primary 1 to Primary 3 pupils were born after the introduction of the new currency notes. Using the old currency to communicate the prices of goods and services was not envisaged. However, the social practices involving buying and selling still equip pupils with the knowledge of the value of goods and services using the old currency as unit of measurement even though the old currency is no longer legal tender.

The Primary Textbook

Three government approved pupils' mathematics textbooks 1-3 namely, "mathematics for primary schools" by Ofantseh and Ayernor (2012), "new mathematics for primary schools" by Ashworth and Wilmot (2012), and "Practical mathematics for primary schools" by Nkani and Homiah (2012) were studied to ascertain how they approached the teaching of measurement of money. The results from the analysis of the approaches used by each of the textbooks showed that they introduced pupils to the local currency (the Ghana, Cedi), Ghana Pesewas and Ghana Cedi notes, the various denominations for the Ghana Cedi notes and coins (see Appendices A and B), and the use of currency notes and coins in a play shop (see Appendix C). As with the curriculum, the textbook did not mention the old currency and how they relate to the new currency, by drawing on the history of the new currency to help pupils appreciate the relationship between the past and the present and the need to communicate prices of goods and services

in the new currency. The play shops shown in the textbooks did not reflect the sociocultural practices of all students, especially those from the rural and very deprived communities (see Appendix C, for example). The unit of measurement of beans in Appendix C, for example, does not reflect the usual societal practice of measuring the volume of the beans rather than the weight (see Figure 1 for example). The examples presented in the play shop do not therefore reflect some of the major sociocultural practices pupils engage in their society.

The concepts relating to currency, buying and selling taught in the lesson may rather confuse pupils, especially those who are deeply engaged in buying and selling. Children know that exchange of goods and services does not always involve money. It may also involve exchange of one good for another or service. Their notion of total cost may not involve only the use of money/currency. Pupils also know that if a ball of “Kenkey” (a staple food made from corn dough, common in Ghana and some West African countries) is One Cedi and you buy GH¢ 5.00 worth of “Kenkey”, you will not always take 5 balls of “Kenkey”; you will sometimes take more than 5 balls, (usually 6 balls of “Kenkey”) (see Figure 3). In Figure 3, there are five balls of “Kenkey” in the black polythene bag and one extra ball, which is added to the five once a customer buys GH¢ 5.00 worth of “Kenkey”. However, some of these everyday mathematical representations and practices did not have any place in the development of concepts. In the attempt to immerse pupils in school mathematical representation and practices by ignoring some of the everyday mathematical representations and practices some of them end up being inefficient in both sets of mathematical practices, as was seen in the case of Comfort in Figure 2.



Figure 3: Pupils everyday mathematical practices involving buying and selling

Conclusion and recommendation

The approaches used by the teachers in the teaching of the measurement of money as well as those suggested in the mathematics curriculum and the textbook in Ghana have not reflected the social and cultural practices of pupils, especially those living in the rural area. The development of concepts appeared to have taken place without considering the background of the learners. As a result, school mathematics lessons did not promote in-depth understanding of the measurement of money and the need to communicate measurement in the new currency, since they did not draw on pupils' prior knowledge on buying and selling from their communities. Furthermore, teachers would often simply follow what is included in the curriculum and textbooks, which in this case, involve introduction of new currency coins and notes followed by operation on money in a play shop, using only the new currency. Although pupils had been already introduced to the use of only the new currency in the measurement of money, that did not prevent some of them from still using the old currency. This shows that, the fact that the curriculum is deliberately designed and delivered to avoid the use of students' everyday mathematical practices and representation involving measurement of money did not stop students from using their everyday mathematical representation and practices in the school mathematics classroom.

It might seem logical for one to argue that the version of the new currency only should be represented in the textbooks, which is to ‘force’ pupils to operate and think in terms of the new currency only, and thus ‘training’ to be independent of the old currency, or the societal way of buying and selling as it is the case presently. However, this study has shown that forcing pupils to operate in only the new currency might not be the best way to help pupils who are engaged in social and cultural practices that still use the old currency to learn measurement of money meaningfully. The practice of ‘forcing’ pupils to learn the new currency without reference to the old currency might end up producing more of the likes of Comfort who are not efficient in communicating measurement of money in neither the old nor the new currency. This shows the need to respect all cultures of mathematics present in the classroom and to resolve all cultural conflict in mathematics classroom by engaging pupils in cultural negotiation (Abreu, Bishop & Presmeg, 2002) to enable them learn mathematics meaningfully. As long as sociocultural issues continue to remain a missing factor in mathematics pedagogy, the school system would continue to produce people like Comfort who are neither proficient in the school mathematics nor the everyday mathematics.

Although this study was done on a small scale, the findings nevertheless suggest the need for curriculum developers in Ghana to reconsider what counts as mathematics to be included in the school curriculum and eventually taught in the classroom. Authors of mathematics textbook are unlikely to include everyday mathematical conceptions and representations in their textbooks because their books will not be recommended for use in schools if they contain contents that are not prescribed in the school curriculum. Teachers are also likely not to include everyday mathematical representations and practices in their teaching because they have to focus on what is in the curriculum/syllabus and textbooks. At the end of it all it is the pupils who lose because they have to struggle to make sense of school mathematics. Meanwhile there are several culturally relevant approaches to teaching mathematics in context to pupils (Davis, 2010; Presmeg, 2007).

There is the need to create the space for the everyday mathematical representation and practices to support the development of school mathematics in school since at the end of the day the student

would need to learn school concept meaningfully and at the same time engage in the everyday mathematical practices efficiently. As long as the societal activities that produce everyday mathematical representations and practices persist, the student would have to be proficient in both mathematical practices in order to fit into the society. There is therefore the need for teachers to adopt culturally relevant approaches to teach mathematics meaningfully to pupils (Gay, 2000). We shall draw on the work of Davis (2010) to exemplify the use of a three-tier model for teaching mathematics in contexts like Ghana where in-school and out-of-school mathematics are often perceived as being mutually exclusive.

A three-tier approach to the teaching measurement of money in context

Stage One (Enculturation Stage): Draw on pupils' everyday experiences involving buying and selling by involving them in activities on buying and selling which will draw on their everyday mathematical representations and practices.

Here tasks involving both the use of goods as medium of exchange for other goods as well as money as medium of exchange would have to be carried out by the pupils.

At this stage pupils are free to communicate measurement of money in either old or new currency, since that reflects their societal practice.

Stage Two (Transition Stage): Draw pupils' attention to the local aspect of their everyday mathematical representation and practices involving buying and selling. For example, difficulty people who are foreign to the Ghanaian culture would have using new Ghana Cedi to communicate measurement of money in the old currency (i.e. identifying Gh¢ 5.00 as fifty thousand).

Here, teachers may draw on Ghana's relationship with the world through trade to justify why foreigners' perspectives should be taken into consideration when communicating measurement of money. Pupils may be given a project to look at how different countries communicate measurement of money.

Stage Three (Acculturation stage): Guide pupils to understand the school (and official) notion of the measurement of money and related concepts, such as cost price, selling price and change. This would be achieved by drawing on their understanding of these concepts in stages one and two. At this stage, pupils are guided to the understanding of

money as the main medium of exchange of goods and services and the Ghana Cedi as the official unit of measurement of money in Ghana. This will help change the how teachers such as TC's perceive mathematics and mathematics teaching and learning. This enculturated understanding of not just the difference between the two systems of measuring money, but also of the rationale and advantages of the change, should promote students' effective communication of money using the new unit of currency, the Ghana Cedis.

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Appendix A: The New Ghana Cedi Notes



Appendix B: The New Ghana Cedi Coins





Appendix C: Play Shop

UNIT 10

Using shopping prices

Here are some items with prices. Make a list of these. Find out how much they cost now.

Pen 50 Gp 	Exercise book GH¢ 3 	Pencil 30 Gp 
Banana 20 Gp 	Ball GH¢ 10 	Yam GH¢ 4 
Milk GH¢ 2 	Towel GH¢ 10 	Pineapple GH¢ 5 
Bucket GH¢ 20 	Orange 30 Gp 	Mathematics text book GH¢ 10 
Bread GH¢ 8 	$\frac{1}{2}$ kg sugar GH¢ 5 	One egg 50 Gp 
Small bar of soap GH¢ 5 	Toilet roll GH¢ 1 	Toothpaste GH¢ 2 
One mango GH¢ 1 	Tomato 20 Gp 	$\frac{1}{4}$ kg beans GH¢ 5 