

**AFRICAN JOURNAL OF
EDUCATIONAL STUDIES**

IN MATHEMATICS AND SCIENCES

VOLUME 11, 2015



ISSN: 2508-1128

AFRICAN JOURNAL OF EDUCATIONAL STUDIES IN MATHEMATICS AND SCIENCES

Centre for School and Community, Science and Technology Studies (SACOST)
Institute for Educational Research and Innovation Studies (IERIS)
University of Education, Winneba, P. O. Box 25, Winneba, Ghana

Editor in Chief

Prof. J. Anamuah-Mensah, Institute for Educational Research and Innovation Studies (IERIS), University of Education, Winneba, Ghana

Editorial Board

Names	Affiliations	Contact Email Addresses
Prof. J. Ghartey-Ampiah	College of Education Studies, University of Cape Coast, Cape Coast, Ghana	jgampiah@gmail.com
Prof. S. Asiedu-Addo	Faculty of Science Education, University of Education, Winneba, Ghana	skaaddo@uew.edu.gh
Prof. A Asabere-Ameyaw	Faculty of Science Education, University of Education, Winneba, Ghana	asabereameyaw@yahoo.com
Prof. Kolawole Raheem	Centre for School and Community, Science and Technology Studies (SACOST), University of Education, Winneba, Ghana	kol12ra@yahoo.com
Prof. M. F. Alonge	University of Ado-Ekiti, Ado-Ekiti, Nigeria	mfalonge@gmail.com
Prof. Kofi Mereku	Department of Mathematics Education, University of Education, Winneba, Ghana	dkmereku@uew.edu.gh
Prof. S. Erinosh	Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria	serinosho@uew.edu.gh
Prof. C. A. Okpoti	Department of Mathematics Education, University of Education, Winneba, Ghana	caokpoti@uew.edu.gh
Prof. I. Yidana	Department of Mathematics Education, University of Education, Winneba, Ghana	yyidana@yahoo.com

Managing Editor

Prof. Kofi Mereku, Department of Mathematics Education, University of Education, Winneba, Ghana.
Email: dkmereku@uew.edu.gh

© University of Education, Winneba, Ghana, 2015
All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the copyright owner.

ISSN: 2508-1128

CONTENTS VOLUME 11, 2015

A radical-local approach to bringing cultural practices into mathematics teaching in Ghanaian primary schools, exemplified in the case of measurement

Davis¹, E. K. and Chaiklin², S. 1

Students' errors in solving linear equation word problems: Case study of a Ghanaian senior high school

Adu¹, E., Assuah,² C. K. and Asiedu-Addo,³ S. K. 17

Technology use among Ghanaian Senior High School mathematics teachers and the factors that influence it

Agyemang M. and Mereku, D. K. 31

A radical-local approach to bringing cultural practices into mathematics teaching in Ghanaian primary schools, exemplified in the case of measurement

Davis¹, E. K. and Chaiklin², S.

Abstract

The main aim of this article is to put forward the idea of the general value of the radical-local approach to teaching and learning for the development of mathematics teaching in Ghana, both in relation to classroom teaching and for teacher training. To illustrate this idea, this article reports on a study that drew on aspects of the radical-local approach to teaching and learning (Hedegaard & Chaiklin, 2005), to teach the idea of measurement to primary four school children from an average rural school in Cape Coast Metropolis of Ghana. The first four teaching sessions with a primary four class are described. Each of the teaching sessions drew on the social and cultural practices of the children to help them form an idea of what measurement is and which physical properties could be measured from given objects. Qualitative analysis of the teaching sessions revealed that the teaching approach enabled children to change their notion of measurements as involving measuring tables, chairs and human beings and so on, to measuring attributes of these objects. It also helped the pupils appreciate that several attributes could be measured from a given object. The study supports the idea that a radical-local approach can be used to teach measurement meaningfully to pupils, and has potential to be used for mathematics teaching more generally. Implications for mathematics teacher education in Ghana and similar sub-Saharan African countries are discussed.

Keywords: attributes; measurement; radical-local; teaching; understanding; sub-saharan Africa mathematics teacher education

Introduction

The main aim of this article is to put forward the idea of the general value of the radical-local approach to teaching and learning for the development of mathematics teaching in Ghana, both in relation to classroom teaching and for teacher training. We believe the radical-local approach to teaching and learning provides a perspective that can be used to develop mathematics teaching that will be appropriate for the majority of pupils in Ghana, and viable in relation to historically existing conditions of mathematics education in Ghana. A main premise of the article is that a contradiction exists between what is needed for good mathematics pedagogy in Ghana and what Ghanaian teachers are willing to consider in their teaching practices. For example, school and out-of-school mathematics have been treated as in opposition or as mutually exclusive. We believe this conception blocks the realisation of particular goals formulated in the Ghanaian mathematics curriculum. For example, teachers do not attempt to draw on pupils' experiential

¹Dr. Ernest Kofi Davis is an Associate Professor in mathematical education at the College of Educational Studies, University of Cape Coast, Ghana. Email: davebiex@yahoo.com.

²Dr. Seth Chaiklin also an Professor in Mathematics Education at the University College UCC, Denmark

background to include pupils' out-of-school mathematical knowledge in teaching (Davis, 2010; Abreu, 1995). One way to overcome this contradiction is to help teachers see how they can achieve the goals of the curriculum, by using a pedagogy they had mistrusted. We believe the radical-local approach has potential for providing a way to address this contradiction.

To underpin this belief and give a more concrete focus to our argument, we present an example of an actual teaching experiment in which this approach was used to integrate school mathematics and everyday practices teaching the concept of measurement to primary school pupils. This example is meant both to introduce the general idea of radical-local teaching and learning, to show that it can be achieved under normal working conditions in a typical school classroom in Ghana, and to exemplify a theoretically-based perspective for how everyday and school mathematical practices can be integrated. The article develops this argument concretely in relation to the topic of measurement in the primary mathematics curriculum, but we claim that the main ideas that motivate the approach can be generalised and adapted to the rest of the mathematics curriculum in Ghana.

A second aim of the article is to highlight that the radical-local approach to teaching and learning provides a distinctly different approach to connecting pupils' cultural mathematics practices to school mathematics practices that contrasts with the framework presented by Wager (2012). The main difference lies in the epistemological and conceptual origin of the two analyses. Wager's framework is derived empirically from observing actual practices of teachers (without arguing or justifying that there were special reasons to consider these practices) and then nominating uncritically the observed categories as a framework. In our analysis, we focus on principles for analysing subject-matter content and conceptual ideas about how to relate everyday practices to mathematical concepts. These differences are explained more concretely at the end of the article, after we have presented the example.

The necessity and challenge of bringing everyday life into the mathematics classroom in Ghana

Our interest in working with connections between school mathematics and everyday situations outside of school is motivated both by research on mathematics learning, the goals of mathematics education in Ghana, general views about the needs of teacher education, and the current state of teacher education and teaching practice in Ghana.

Many educational researchers have highlighted the important role that out-of-school mathematical practices and conceptions play in mathematics pedagogy (Bishop, 1988; Presmeg 2007; Wager, 2012). A general objective of mathematics teaching at the primary school level in Ghana is to help pupils develop their ability to use mathematical knowledge to solve everyday problems. This objective requires that the mathematics teaching in school classrooms connects with pupils' societal practices. This characteristic remains missing in Ghanaian mathematics pedagogy, and in mathematics pedagogy more generally (Wager, 2012), despite the importance of a pedagogy that connects school mathematics with out-of-school mathematical experiences in a way that pupils can come to understand and act with mathematical aspects in those practices within their social and cultural setting.

The need to expose prospective mathematics teachers to sociocultural issues in teacher education programme has been highlighted by some mathematics education researchers (Presmeg, 2007). Similarly, Chapman (2012) highlights the importance of connecting of school mathematics to other situations outside of school, as one of the four challenges for mathematics teacher

education. She raises a series of challenges that should be addressed by teacher education as part of preparing teachers to be well positioned to make connections between school mathematics and real-world contexts. One of the challenges was: “what approach will help teachers to learn to work with real-world contexts in a way that does not trivialize or dismiss the important mathematics embodied in them?” (p. 265).

Identifying and drawing on the out-of-school mathematics in teaching school mathematics generally appear to be a problem for teachers not only in Ghana but in other countries as well (Civil, 2002; Wager, 2012) and therefore requires urgent attention of mathematics educators and mathematics education researchers (Chapman, 2012).

Support for this way of working is especially important for mathematics teacher education programmes in countries such as Ghana where many of the everyday mathematical conceptions and representations differ from school mathematics (Davis, Bishop & Seah, 2009), which makes it particularly difficult for teachers to attempt to draw on out-of-school mathematics into teaching school mathematics.

The training of primary and junior high school teachers in Ghana takes place mainly at colleges of education, where each college is affiliated to the University of Cape Coast. Trainees who complete a three-year programme of study, certified by the University of Cape Coast, are awarded a Diploma in Basic Education. All programmes employ a concurrent model of teacher training, where trainees study the various subject-matter contents and general teaching methodology courses within the same programme (Tatto, Lerman & Novotna, 2010). A major criticism of the concurrent model of primary school teacher preparation in Ghana is curriculum overloaded (Akyeampong, Lussier, Pryor & Westbrook, 2013). Trainees are often saddled with too many courses within the training period in an attempt to give content and professional training in the same programme.

Many problems need to be addressed in preparing prospective teachers to teach mathematics at the primary school level in Ghana, especially in relation to improving pupils’ learning outcomes (Akyeampong, Pryor & Ampiah, 2006; Akyeampong, et al., 2013; Davis, 2013). Initial teacher training in Ghana and some sub-Saharan African countries have been criticised as usually equipping trainees with a fixed sequence for presenting mathematical knowledge to pupils and omitting attention to other important aspects such as drawing on and integrating pupils’ experiential background as part of the teaching. Training does not equip trainees to conceptualize teaching as problem-solving requiring the understanding of pupils’ learning needs and how to address them (Akyeampong, et al., 2013). Current primary mathematics teacher preparation in Ghana does not help trainees conceptualize teaching as problem-solving, or to draw on pupils’ cultural background (Akyeampong, et al., 2013), even though these aspects are now widely considered as important characteristics for effective mathematics teaching (e.g., National Council of Teachers of Mathematics, 2000). For trainees to be able to consider the experiential background of pupils in their teaching, training should equip them to be able to identify pupils’ everyday mathematical practices which afford the development of concepts and use that to develop the school concepts.

The lack of attention to cultural issues by Ghanaian primary mathematics teachers in relation to mathematics teaching can be understood because teacher training does not orient trainees to sociocultural issues in mathematics pedagogy (Davis, 2010; Davis, 2013). Social and cultural

issues in mathematics pedagogy continue to remain a missing feature in Ghanaian mathematics teacher education (Davis, 2013). None of the teacher training programmes in Ghana, for example, equips prospective primary school teachers with a theoretical basis and skill needed to draw on children's everyday societal and cultural practices to teach mathematics meaningfully to pupils (IoE, 2005; IoE, 2014; Martin et al, 1993; Duedu & Asare Inkoom, n.d.). The radical-local approach gives prospective teachers a way to conceptualize teaching as problem-solving and at the same time take pupils' background into consideration in teaching and learning of mathematics through investigation of the pupils' sociocultural practices (Hedegaard & Chaiklin, 2005).

A Radical Local Approach

In our view teacher preparation programmes should equip prospective teachers with the necessary theories and practical examples that would prepare them to draw on pupils' out-of-school mathematical practices to teach mathematics meaningfully to pupils. Furthermore, we agree with the point emphasized by Chapman (2012) that connecting mathematics with real-world contexts should not lose the mathematical content.

Researchers have proposed different ways to draw on pupils' social and cultural practices to scaffold their deeper understanding of school concepts. Some have argued that a useful way to make visible connections between school mathematics and everyday practices in mathematics classrooms is to use a semiotic framework where chains of signifiers and signifieds are used to draw everyday discourse into academic discourse (e.g., Presmeg, 2006; 2007). This proposal gives a way to develop appropriate chains of signifier and signified that link, at least logically, everyday situations with mathematical content; it also provides a systematic technical language for analysing processes of mathematical thinking, symbolizing and communicating, but as developed so far, semiotic approaches do not seem to have engaged with analysis of the conceptual structure of mathematical content or how they help pupils understand the concept being taught. At the same time, the problem, in our view, is not only about how to draw on out-of-school content to support the study of school mathematics, but also how to support pupils in investigating everyday practices as a way to understand mathematical content. The semiotic approach seems to focus on drawing on everyday content to illustrate mathematical ideas. By way of contrast, the radical-approach approach is directed toward discovering mathematical ideas through the investigation of everyday practices.

Hedegaard and Chaiklin (2005) developed a radical-local approach to teaching and learning, where instruction aims to develop pupils' theoretical or conceptual understanding of content areas through classroom tasks that are meaningful to the pupils, and which draw, in part, on their personal and everyday knowledge. This approach draws directly from El'konin and Davydov's ideas about developmental teaching (e.g., Davydov, 2008), especially the idea of developing a general theoretical understanding of subject-matter content. However an important part of the radical-local approach is to develop this theoretical understanding through the investigation (in teaching activities) of the everyday societal and cultural practices in which the pupils live. At the same time, the choices of content are made in relation to supporting the development of children's relation to their life situation. For pupils to be able to relate school mathematics to life outside school, we believe it will be important, almost necessary, to draw on cultural practices of pupils.

To illustrate these ideas, we describe a radical-local approach for teaching measurement in Ghana. Measurement is an important topic in the school mathematics curriculum. Bright and

Clement (2003) argue that measurement is important both as a foundation for many applications of mathematics in real life and an essential element of more sophisticated mathematics. However, this important concept has often been viewed as being difficult for Ghanaian school teachers to teach and for Ghanaian pupils to learn (Davis, 2004; Davis & Hisashi, 2007; Mereku, 2004).

The Ghanaian primary school mathematics curriculum proposes the introduction of measurement by teaching pupils attributes, terms relating to measurement, direct measurement involving direct comparison and indirect measurement involving the use of arbitrary and standard international units of measurement (Ministry of Education, 2012; Martin et al., 1993). A primary school headteacher described for example how measurement is introduced in his school as follows: “the teachers take them through the units of measurement, that is, units assigned. We [teachers] normally take them through cm, metres, mm, kg and what have you. We take them through those terms used, before we introduce the actual measurement” (Davis, 2010). The description of how measurement is introduced by teaching pupils terms such as centimetre, metres, and so on shows clearly that measurement is still introduced to some pupils out of context. This observation is consistent with what Mereku (2004) observed about the teaching of the same concept in primary six in a different research locale in Ghana.

Past research studies in Ghana have shown that this approach to the introduction of measurement does not permit pupils to understand measurement generally and the idea of ‘attribute of measurement’ specifically. Furthermore, it does not enable pupils to see measurement practices in school as having a relationship with their social and cultural practices involving measurement. For example, Davis (2010) found in a study of Ghanaian primary four and six pupils that they generally perceived measurement practices in school and their measurement practices outside school practices as being unrelated. Interviews with their teachers revealed that the teachers rejected the use of out-of-school measurement practices in class mainly because they must follow exactly what the curriculum says. This situation where teachers reject the use of outside-school practices in teaching mathematical concepts often arises in contexts where teachers perceive school mathematics and out-of-school mathematics as being mutually exclusive (Abreu & Duveen, 1995).

Many teachers are not able to teach measurement meaningfully by drawing on societal and cultural practices involving measurement, especially when their training does not offer them the opportunity to do so (Davis, 2013). The value of the teaching approach described here is that we believe it provides a feasible way to teachers in Ghana to connect subject-matter content and pupils’ everyday knowledge and experience with mathematically relevant content. In other words, we aim to develop an approach that can overcome the lack of attention of everyday practices in relation to mathematics teaching.

Similar to other countries, Ghana also has general goals to be achieved through mathematics teaching. In order to attain these more general goals or intentions of the syllabus, teachers need to be able to go beyond literal interpretation of the syllabus. For example, one of the general goals for mathematics teaching is that pupils are able to communicate mathematically. Therefore, the teacher should be able to organize each stage of measurement teaching outlined in the syllabus, so that pupils achieve these general goals while learning measurement concepts meaningfully. We believe that mathematical communication should include being able to relate conceptually to everyday mathematical practices which children encounter outside of school.

The Teaching Experiment

The empirical results reported here come from an attempt to use a radical-local approach in designing teaching for Ghanaian pupils about the ideas of measurement and attributes of measurement through activities that draw on their local social and cultural practices involving measurement. These results are part of a larger study that explored the use of a radical-local teaching approach to teach measurement generally. The present article reports the introduction of the meaning of measurement and attributes of measurement, in order to show what pupils are able to do in the teaching tasks that were developed in this radical-local approach, which exemplifies the teaching and learning situation where out-of-school mathematical practices are included as part of the development of school mathematical concepts.

As a first step, the authors analysed the conceptual structure of extensive measurement. From this analysis, we arrived at the view that a central idea of extensive measurement involves giving a magnitude to a given attribute, and that an important part of having a theoretical understanding of measurement is for children to become reflectively aware about that characteristic. The initial teaching activities used an innovative approach that aimed to introduce attributes in a meaningful way and to help the pupil develop an awareness of the general idea of the meaning of measurement. The general idea was developed through the investigation of specific/concrete situations involving measurement by looking at what we measure? Why we measure? and What is measured from things we measure?

The lesson plan, outlining the objectives to be achieved for the sessions generally and each day's session, is summarised in Table 1. Generally, the activities in the sessions aimed to help the pupils form the idea of measurement and appreciate that it is part of their sociocultural practice. The critical idea in this approach is to first give children an opportunity to explore specific concrete examples of measurement practices in their everyday experience, and then, through reflection and discussion about these examples, seek to formulate a content-grounded generalisation about the general idea of measurement (as determining the magnitude of an attribute).

The first author conducted the classroom teaching experiment in an average achieving rural school in the Cape Coast Metropolitan area of Ghana. This school was randomly selected from the list of average achieving rural schools in the Cape Coast Metropolis. Grade four was chosen because it is the stage where the pupils learn to study all subjects including mathematics in the English language. This transition is difficult for many Ghanaian schools pupils.

All the lessons were delivered through group activities where the teacher posed problems involving some aspect of measurement, where the intention was that the problems would be meaningful and interesting to the pupils. The pupils first discussed the problem in their group, after which each group presented their solution on the blackboard. These solutions were discussed with the whole class, with the teacher serving as the facilitator of the class discussion. At the end of the group presentations and discussion the teacher and pupils made a verbal review and summary of what was discovered or agreed upon from their investigations. Sometimes the teacher might highlight relevant points in the summary, but the summaries were always conducted in a process of consensus about what was achieved. The teacher never asserted that something was right or wrong or tried to give direct instruction or remediation. All the classroom sessions were observed by a research assistant who recorded field notes of the activities and the

children responses. These notes were supplemented with photographs of the blackboards where the children wrote the results of their tasks.

Results

Observations from the first four teaching sessions and the authors' interpretation are provided. This presentation is meant to communicate how the teaching activities were organised and what the pupils were able to do in these activities. Table 1 provides a summary of the objective(s) of each the four sessions and the main task for each teaching session.

Table 1 Objectives of the teaching sessions and the tasks

Main Objective	Session	Date	Session Objective	Main Task
	1	26/10/11	Explore what pupils know about measurement	“What do we measure”?
	2	31/10/11	Explore pupils' understanding of why we measure	“Why do we measure”?
Form idea of ‘what is measurement?’	3	3/11/11	Form idea of an attribute	Identify what is measured from things that were identified as measurable.
	4	4/11/11	- Explore various ways people have measured things in the present and past - Investigate the indifference in measurement procedures for the same quantity	Identify kinds of measurement procedures from pictures

Session 1 (45 minutes)

Observation. The pupils were organised into groups of five. The groups were given the task to produce an answer to the question: “What do we measure”? That is, to give examples of things that could be measured. The pupils wrote the results of their discussions on the blackboard (see Box 1).

The pupils are then asked ‘why do you think we measure each of what you have indicated’? Box 2 provides examples of the answers that were given.

There was a disagreement about whether a tree could be measured (see Group 3 in Box 1). Some pupils did not think that a tree could be measured. However, when the teacher drew a tree on the blackboard, then some of the pupils explained that the stem and branches could be measured.

The session concluded with the teacher encouraging the pupils to continue to think about what could be measured, in light of the day's investigation.

Interpretation. The objective of this session was to explore what pupils know about measurement. The task addressed this objective directly. The children did not appear to have difficulty in identifying things that could be measured. Many of their choices seem to reflect examples that they know from everyday experience. This was particularly evident when they gave reasons for

why measurements were made. The examples that they gave for why measurements are made provide clear evidence that within the class of pupils, there was meaningful, even sophisticated, knowledge about the reasons that measurements are made in everyday situations. The examples provided included length, area, and weight, even if the children did not refer explicitly to these attributes.

The difficulty about whether a tree can be measured indicates the need to be able to identify clearly what attribute is being measured.

Group 1	Group 2	Group 3	Group 4
Farm	Rice	Door	Land
Dress	Beans	Table	Cloth
House	Human beans (sic)	Chair	Human beings
	House	House	Wood
	Suger (sic)	Book	
	Land	Tree	
		Box	
		Blackboard	
		Mat	

Box 1 Group answers to “what do we measure?”

<p><i>Group 1:</i> a pupil explained why they think ‘farm’ is measured as “when you employ people to weed on your farm you need to measure for them to know the size/area they have to weed.”</p>
<p><i>Group 2:</i> pupils also explained that when the community health nurse comes to the village she usually asks children to stand on the scale before she gives them medicine.</p>
<p><i>Group 3:</i> a pupil explained why ‘door’ is measured as “if you do not measure the door it may not fit exactly into the door post, it may be either too big or too small.” And added that a house is measured because “when builders are building the house they measure the foundation.”</p>
<p><i>Group 4:</i> human beings are measured because “when they go to the tailor he use the tape to measure them before he sows their dress”</p>

Box 2. *Examples of answers to “Why do you think we measure?”*

Session 2 (75 minutes)

Observation. The session started with the children reviewing briefly what they did last time, identifying things that could be measured like ‘farm, tree, and human being’. The teacher posed the question ‘Why do we measure’. The children worked on this task in their groups for 15 minutes. Box 3 shows the answers that were produced. The session finished with a reflection from the pupils that they had learned things that they can measure.

Interpretation. The objective of this session was to explore the children’s understanding of why measurement is used in societal practice. Again the task was posed directly to them, and there was no apparent difficulty in understanding the question. It is striking that the groups discussed

this question for 15 minutes, even requesting more time when the teacher tried to interrupt them. This suggests that the pupils found this question engaging and challenging. This apparent intense engagement contrasts with the ‘thinness’ of the reports that were received at the end of the group work. It is possible that the problem was in recording their answers in the field notes, but for now we will interpret this ‘thinness’ as reflecting a general difficulty for most of the children to formulate their thoughts in a self-conscious way.

The answers from the first group show an appreciation of the need to use measurement if precision or accuracy is required in an action. The fourth group also had an answer in this direction, even if their formulation did not express it clearly. The second group indicated examples of (important) things that are measured in everyday life, perhaps with the implication that this is why we are measuring, while the third group could only approve of the idea of measurement, without apparently giving explicit arguments or reasons. Overall this session gives some indication that children are able and interested to reflectively investigate measurement practices in their everyday life, and to attempt to formulate some generalisations about these practices. This observation is meant only to suggest that the children are capable of understanding the question without obvious difficulty and are willing to discuss the question. But the ‘thinness’ of their answers also highlights that they will need help with interpreting and developing the results of that discussion so that they can explain more fully why we are measuring.

<p><i>Group 1</i></p> <ol style="list-style-type: none">1. When you don't measure the farm the farm will be big or small2. If we don't measure the person's dress will be big or small <p><i>Group 2</i></p> <ol style="list-style-type: none">1. When you go to market to buy rice that person measure it for you2. We measure rice, sugar and beans <p><i>Group 3</i></p> <p>Measurement is good</p> <p><i>Group 4</i></p> <p>When we don't measure the land the land will be small</p>

Box 3. Examples of answers to “Why do you think we measure?”

Session 3 (50 minutes)

Observation. Pupils enumerate things that they have learned to measure in previous sessions (e.g., tree, table, farm, shoes, human beings). The teacher then asks “what do we measure from the things that you have indicated”? The pupils discuss this question in their groups, and then the results were written on the blackboard. Some of these results are shown in Box 4. The teacher asked the pupils to explain what they had written. Examples of some of the responses include: “we can measure the height of a human being; we can also measure the weight. We can measure the edge of a table and the height”. The session ended with the teacher asking what was learned for the day, and the pupils mention ‘height, weight, capacity’.

Interpretation. The objective of the session was to help children become aware of specific attributes that are often in focus in measurement. The task was designed to have them reflect

about examples that they had already generated in the previous sessions. Again the task was formulated somewhat directly, and again, despite the clumsiness of the language in which the question was expressed, it was possible for the children to work with this question. This session shows that pupils are already familiar with the attributes that are normally taught in year 4, and have some idea that different attributes can be measured on the same object.

Group 1	Group 2	Group 3	Group 4
weight	height	edge	
height	weight	height	weight

Box 4 *What can we measure from what is measured?*

Session 4 (50 minutes)

Observation. The teacher asks: “What are we studying from the past three lessons?” The pupils say: “Measurement”. The teacher asks what was studied yesterday. The pupils enumerate length, edge, capacity and weight. The teacher asks: “Why do we measure length, edge, capacity and weight of things? Pupils explain “to know the quantity [ama ye hu no dodow, in Fante]; how long or how heavy they are, to know how much rice fills a cup.” The teacher asks: “How do we measure?” Pupils discuss this question (briefly) in their groups, and then tell the teacher when they are ready with their answers. The teacher writes their answers on the blackboard. Some of the responses include: the use of tape measure, “olonka”, measuring scale, hands and ruler. The teacher asks: “Have people always measured the same way?” The pupils say: “No, because some may use rope to measure length of a land while others may use measuring tape” and “Some use hands to determine weights whilst others use measuring scale”. The teacher writes on the top of the blackboard: “Write three things that are measured and indicate what you can measure.” The pupils discuss this in their groups, and then a child from each group writes the results on the blackboard under the teacher’s question as shown in Box 5.

Group 1	Group 3
Tree — Height	Door → height
Blackboard — Length – width	Table → Edge, width
Table — edge	Farm → Length
Group 2	Group 4
Area — Length	Land — length
Human being – width (sic)	human being — height
(not recorded)	Rice — capacity

Box 5. *Attribute measured from each of the things listed by pupils*

Interpretation. The objective of the session was to help children become aware of different processes for measuring specific attributes, and to relate those processes to their history, social and cultural practices. The last task was designed to help them reflect on what they had already learned in the previous sessions. This task shows that the children are readily able to recognize that different measuring procedures are or have been used, even though the year 4 curriculum does not prepare children to appreciate the relationship between measurement practices that exist in various contexts. It is also shows that helping children to acquire a general idea of measuring

an attribute (i.e., a theoretical concept) helps them to relate it meaningfully to the specific situations.

Discussion and Conclusion

The present research used a radical-local approach to teaching and learning as a way to integrate everyday content of children's lives into mathematics teaching, while still supporting the learning of the conceptual content of mathematics. The four introductory lessons presented here and the pupils' performance with the tasks in these lessons exemplifies how a teaching approach can draw on social and cultural practices of pupils in a way that motivates them to participate actively in class and to learn concepts meaningfully. At the same time, we believe the demands on the teacher in this example are within the capability of schoolteachers in Ghana.

The teaching approach involved investigation of examples of measurement through the use of group work, followed by the presentation of results by groups and class discussion of these results, coupled with a flexible language policy where the pupils were free to express their ideas in either the local language (Fante) or English, which enabled the active participation of all pupils. This built the confidence of the pupils and gave them the impression that their ideas count. This outcome is consistent with other investigations into mathematics learning which have shown that allowing bilinguals in the classroom setting to use their local language has helped them to learn concepts in the target language (De Avilla, 1988; Setati & Adler, 2001; Moschkovich, 2002).

The tasks did not distinguish between everyday and school-based measurement methods, and the pupils drew on methods from both sources. This approach facilitated the recognition that a common conceptual aspect of measurement as the magnitude of an attribute, where this aspect appears both in everyday systems outside of school and formal systems taught in school. We expect this integrated way of working with measurement helps pupils understand the conceptual relation between different measurement systems.

The first two sessions, focused on the questions "what do we measure?" and "why do we measure," providing the opportunity for the pupils to express their everyday conceptions of measurement as a societal activity that measures things like farms, tree, human beings, and to reflect about the many kinds of purposes for which measurement is used. It was striking to us that the pupils (as a collective in the classroom) already had a considerable amount of knowledge about everyday situations in which measurement is used and why. While these tasks are important for helping pupils to recognise many examples of measurement in everyday practices, and the need to be able to measure, they are not sufficient for highlighting the critical point that extensive measurement is focused on specific physical attributes of everyday objects such as farms, trees and human beings. Answers to the question "what do we measure?" provided the motivation for the task in the third session (to identify what is measured from things that were identified as measurable). This question provided the opportunity for the pupils to now focus on the attribute of measurement or physical properties of what they had earlier identified as being measurable. The results from the investigations in the previous sessions became the content for this new investigation. The results show that the task provided conditions where the pupils were able to identify relevant attributes. This was evident in pupils' responses to the question "what do we measure from the things that you have indicated?" in Box 4. Pupils in Group 1, for example, mentioned human being as what can be measured and identified weight and height as

attributes that could be measured. The teaching approach provided pupils with opportunities to independently use familiar cultural objects to exemplify various attributes instead of being told by the teacher. They also saw that it was possible to measure different attributes from the same objects or things, for example human beings. Although the content of the teaching activities focused on examples that the pupils brought from their knowledge of everyday situations, it is possible to see that the pupils were starting to generalise the ideas from the specific examples to measurement in general. For example, as seen in Session 4, when the teacher asks the pupils why different attributes are measured, they are able to give a generalised answer (in relation to quantity).

The pupils showed strong interest and engagement in these four introductory lessons, as evidenced by their engagement in the group discussions, and their attention to the answers provided by the other groups. We believe the tasks in these lessons were interesting to the pupils because they could understand the tasks and could draw on their existing knowledge. The answers that pupils produced in each of the tasks show that they have a lot of rich relevant previous knowledge about measurement in their societal practices, which could be drawn upon to teach concepts meaningfully.

Although this study was carried out using only one topic (measurement) and in one school, it has shown that it is possible to draw on the societal and cultural practices of pupils in a context like Ghana, and countries which share similar characteristics as in Ghana to teach mathematical concepts meaningfully at the primary school level.

We expect that approaches that draw on social and cultural practices of pupils such as the radical local approach described here could be productive for primary school teachers and researchers in mathematics education in Ghana specifically and other sub-Saharan African countries that share the same conditions as Ghana, both for teaching mathematics generally and measurement specifically. The particular example given here was accomplished within the normal working conditions of a rural school. This suggests that such approaches can be a viable way to improve pupil performance and interest in the study of school mathematics.

Perspective on the use of cultural background in the classroom mathematics teaching

Wager (2012) has put forward a framework for incorporating cultural and out-of-school practices. The framework was generated from a study of 17 elementary-school teachers from three ethnically diverse elementary schools in the United States. The teachers participated in a semester-long professional development seminar where they each conducted a survey of how their 8-10-year pupils used mathematics outside of school. The results of this survey were used by the teachers to plan lessons or write word problems that incorporated or built on these observed uses. Wager analysed the kinds of problems and situation that these teachers developed in this programme, identifying four general categories that encompassed these materials: out-of-school context, out-of-school activities related to mathematics, embedded cultural mathematics practices, and teacher initiated situation setting.

Wager claims that these four categories reflect increasing demands on the teacher (which is designated as complexity). She suggests that this framework can be a powerful tool for designing professional development and methods courses for prospective teachers (p. 21), where the idea is to consider the increasing complexity of these four categories as a trajectory or sequence for presenting problems to pupils.

We agree with Wager that “validating students’ out-of-school experiences are not ends in themselves” (p. 21), and that the purpose of connecting school mathematics with out-of-school practices is aimed at meaning-making. From that perspective, we cannot understand why one should focus on the teacher demands as a principle for working with out-of-school content. That is, focus on a formal characteristic of the demands for working with out-of-school content has replaced a focus on the meaning-making aspect of mathematics. The same problem arises by focusing solely on how the content is used in the teaching sequence, because the focus is now on how the out-of-school content is being used, and not a focus on the conceptual content of the mathematics.

We would like to highlight that the radical-local approach starts from a more principled perspective that starts from examining the conceptual demands of the mathematical content and then explores situations where this content is present, where the focus is on illuminating the conceptual ideas (i.e., meaning-making), where the investigations draw on content that is known from everyday experience.

While Wager’s proposal reflects some observed empirical characteristics about the ways in which elementary school teachers are using out-of-school content in mathematics teaching, we believe that it directs attention away from the critical issue of understanding how to use out-of-school content in a way that is aimed at developing general conceptual understanding.

Implications of the study for primary mathematics teacher education in Ghana and other sub-Saharan African countries that share the same situation as Ghana

The example of measurement teaching presented here illustrates some of the reasons why we believe the radical-local perspective is appropriate for primary mathematics teacher education programmes for both pre-service and in-service teachers in Ghana and similar sub-Saharan African countries. As just noted, the radical-local approach focuses on the conceptual structure of the subject-matter content, which is used to organize the investigation of concrete situations from everyday life that involve these conceptual relations.

Furthermore, although English is the language of instruction in Ghana, most children have grown up and continue to speak another language at home. As Setati and Adler (2001) have noted, it can be valuable to allow both languages to be used interchangeably (code-switching). This is absolutely necessary in Ghana, where a variety of traditional terms are used as part of daily speech, also in English. More importantly, pupils who are often deeply involved in societal practices such as petty trading, have to cross several barriers such as those between informal and formal levels of mathematics and linguistic barriers in order to access school mathematics (Setati & Adler, 2001). This makes teaching in such contexts very difficult as the teachers have to take pupils through all these barriers before the pupils are able to access school mathematics. This calls for conscious training on how to draw on and use pupils’ everyday societal and cultural practices in the teaching of primary mathematics so that they would have smooth transition from informal mathematics (out-of-school mathematics) to formal or school mathematics. The content of such a training should expose trainees not only to general methods of teaching mathematics as it pertains in many sub-Saharan African countries but also to theories and models on how to draw on socio-cultural contexts in the teaching of primary school mathematics to pupils for proper understanding.

The radical-local approach provides a way to meet these special demands because it recognises and draws on pupils' societal and cultural practices related to mathematics as part of the content used to investigate and highlight mathematical ideas, and because of its orientation to getting a conceptual understanding of the mathematical ideas found in everyday societal and cultural practices. We believe that if trainees are exposed to models of how to teach primary mathematics using the radical-local approach it will improve the curriculum for primary mathematics teacher education in Ghana and similar sub-Saharan African because they illustrate something that has worked within a teaching situation that trainees are likely to encounter in their future professional teaching work. This should help them experience possibilities to draw on and use pupils' everyday societal and cultural practices to teach mathematics meaningfully.

References

- Abreu, G. de, & Duveen, G. (1995, July 22-27). Teachers' practices and beliefs in a community where home mathematics diverges from school mathematics. Paper presented at the PME 19, Recife, Brazil.
- Akyeampong, K., Pryor, J., & Ampiah, J. G. (2006). The vision of successful schooling: Ghanaian teachers' understanding of learning, teaching and assessment. *Comparative Education, 42* (2), 155 - 176.
- Akyeampong, K., Lussier, K., Pryor, J., & Westbrook, J. (2013). Improving teaching and learning of basic mathematics and reading in Africa: Does teacher preparation count? *International Journal of Educational Development, 33*, 272-282.
- Bright, G. W., & Clement, D. H. (2003). *Classroom activities for learning and teaching measurement 2003 year book NCTM*. Reston, VA: National Council of Teachers of Mathematics.
- Chapman, O. (2012). Challenges in mathematics education. *Journal of Mathematics Teacher Education, 15*, 263 – 270.
- Davis, E. K. (2013). Socio-cultural issues in mathematics pedagogy: A missing variable in Ghanaian basic school mathematics teacher preparation. *Journal of Educational Development and Practices, 4*(1), 41- 69.
- Davis, E. K. (2010). *Cultural influence on primary school students' mathematical conceptions in Ghana*. Unpublished PhD Thesis, Monash University, Melbourne, Australia.
- Davis, E. K. (2004). *The effectiveness of in-service teacher training for the improvement of basic school mathematics in Ghana: A case study of the Outreach Program conducted by the University of Cape Coast*. Unpublished master's Thesis, Hiroshima University, Hiroshima, Japan.
- Davis, E. K., Bishop, A. J., & Seah, W. T. (2009). Gaps between in-school and out-of-school mathematics in Ghana. *Mathematical Connections, 8*, 1-15.
- Davis, E. K., & Hisashi, K. (2007, January 13-15). *Country Report - Children*. Paper presented at the Third workshop on the International research project towards Endogenous Development of Mathematics Education, Tokyo, Japan.

- Davydov, V. V. (2008). *Problems of developmental instruction: A theoretical and experimental psychological study* (P. Moxhay, Trans.). Hauppauge, NY: Nova Science.
- De Avilla, E. A. (1988). Bilingualism, cognitive function, and language minority group membership. In R. R. Cocking & J. P. Mestre (Eds.), *Linguistic and cultural influences on learning mathematics* (pp. 101-121). Hillsdale, NJ: Lawrence Erlbaum.
- Draisma, J. (2006). *Teaching gesture and oral computation in Mozambique: Four case studies* (Unpublished PhD thesis), Monash University, Melbourne, Australia.
- Duedu, C. B., & Asare-Inkoom, A. (n.d.). *Methods of teaching primary school mathematics: Mathematics 103 course book for Diploma in Basic Education*. Cape Coast: Centre for Continuing Education, University of Cape Coast.
- Hedegaard, M., & Chaiklin, S. (2005). *Radical-local teaching and learning: A cultural historical approach*. Aarhus University Press.
- IoE (2005). *Three year diploma in basic education, revised syllabus*. Cape Coast, Institute of Education, University of Cape Coast.
- IoE (2014). *Three year diploma in basic education, five semester programme, revised syllabus*. Cape Coast, Institute of Education, University of Cape Coast.
- Martin, J. L., Afful, E., Appronti, D. O., Apsemah, P., Asare, J. K., Atitsogbi, E. K., Mereku, D. K. (1993). *Mathematics for teacher training in Ghana: Student activities*. Accra, Ghana: Unimax Publishers.
- Mereku, K. (2004). *Mathematics curriculum implementation in Ghana*. Accra, Ghana: Danjoe Production.
- Ministry of Education Science and Sports. (2012). *Mathematics syllabus for primary schools*. Accra: Ghana Education Service.
- Moschkovich, J. (2002). *A situated and sociocultural perspective on bilingual mathematics learners*. *Mathematical Thinking and Learning*, 4(2&3), 189 – 212.
- National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- Presmeg, N. C. (2006). Semiotics and the “connections” standard: Significance of semiotics for teachers of mathematics. *Education Studies in Mathematics*, 61, 163-182.
- Presmeg, N. C. (2007). The role of culture in teaching and learning mathematics. In F. K. Lester (Ed.). *Second handbook of research on mathematics teaching and learning* (pp. 435-458). Charlotte, NC: Information Age Publishing.
- Setati, M., & Adler, J. (2001). Between languages and discourses: Language practices in primary multilingual mathematics classrooms in South Africa. *Educational Studies in Mathematics*, 43, 243-269.
- Tatto, M. T., Lerman, S., & Novotna, J. (2010). The organization of the mathematics preparation and development of teachers: A report from the ICMI study 15. *Journal of Mathematics Teacher Education*, 13, 313 – 324.

A radical-local approach to bringing cultural practices into mathematics teaching in Ghanaian primary schools, exemplified in the case of measurement

E. K. Davis & S. Chaiklin S

Walkerdine, V. (1988). *The mastery of reason: Cognitive development and the production of rationality*. London: Routledge.

Wager, A. A. (2012). Incorporating out-of-school mathematics: from cultural context to embedded practice. *Journal of Math Teacher Education*, 15, 9 – 23.

Acknowledgement

We wish to express our sincere gratitude to the British Academy for financing the trip of the first Author to the United Kingdom to stay in the University of Bath for three months through the British Academy Visiting Scholar Scheme in 2011.