South African teachers’ ability to argue: The emergence of inclusive argumentation

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Abstract

This paper explores the argumentation ability of ten science teachers in two South African schools on opposite ends of the resource spectrum. Toulmin’s model is used to analyse individual contributions in six group discussions. The findings show that levels of argumentation improve with teachers’ involvement in the development of teaching resources and the closeness of the argumentation task. The nature of the arguments is permeated by inclusiveness, thus precluding the use of rebuttals, traditionally a requirement for high-quality arguments. Based on the ubuntu worldview, a model of inclusive argumentation is proposed with implication for teaching and a scheme of assessable levels of argumentation.

1. Introduction

This paper presents a study on the argumentation levels of secondary science teachers who participated in a continuous professional development (CPD) programme aiming to support them through the joint development of learning resources in teaching argumentation. Specifically, this paper provides base-line data of the levels of argumentation used by teachers involved in the first phases of this CPD programme, drawn from schools across the educational spectrum. It also sets out to identify factors which impact on the nature of the argumentation used by these teachers. The findings will contribute to the shape of the CPD activities and to initial teacher training programmes, and also to the development of supporting resources.

In the last decade, South African teachers have been confronted with a frequently changing educational milieu. Since the emergence of democratic government in the early 1990s, education has been high on the agenda for reform as a vehicle for evening-out the life chances of the citizens of the future (Lester, 1997). The previous apartheid regime had perpetuated inequalities, by providing white, Indian, coloured and black children with separate educational systems that were differentially administered and funded. The democratic government planned a common and unifying curriculum (Department of Education, 1997) based on ‘outcomes based education’ (OBE). The emphasis is on students achieving competence in specific outcomes. This is intended to provide the same quality of learning opportunity for all citizens. The new
curriculum was termed ‘Curriculum 2005,’ as it was envisaged that it would be fully operative in all educational institutions by 2005. The principles which guided the new curriculum are purported to be based on co-operation, critical thinking and social responsibility, thus enabling individuals to participate in all aspects of society. Concomitant with this is the envisaged need for teachers to change their pedagogy from one that is more didactic and teacher controlled to one which encourages more active learner participation. The aim of the curriculum innovation is to transform pedagogic practices by getting students actively involved in their own learning, rather than being passive receivers of knowledge.

As a consequence of great criticism from many quarters (for instance, see Jansen, 1999; Kraak, 1999; Taylor and Vinjevold, 1999), Curriculum 2005 was revised to be grade specific, give clearer guidelines on the content to be covered, provide more detailed strategies for assessment and remove some of the confusing terminology (Department of Education, 2000). Despite these changes the original intent of Curriculum 2005 remained.

Implementation of the new curriculum started in early 1999 in grades 4 and 7 of all state-aided schools. In January 2006, the first implementation phase of the revised national curriculum commenced for grade 10.

Critical and creative thinking (expressed as Critical Outcome 1) is a key aim of the curriculum revision in South Africa (Department of Education, 1997). This move is a consequence of the intention to develop a more informed and empowered citizenry. In grades 10–12 (typically ages 16–18) learners in science will be required to think critically, make decisions on adopting often competing science ideas on the basis of strength of supporting evidence, and make evidence-informed decisions related to ethical and social issues (Department of Education, 2004). One major area of critical thinking (CT) is considered to be the ability to formulate an argument (Siegel, 1995). This need for developing the skills of selecting evidence, and linking evidence to support theory and inform decision-making is an explicit requirement of the science curriculum in South Africa (Department of Education, 2004). These abilities in dealing with evidence are incorporated in the practise of argumentation (Andrews, 2005).

Argumentation and dealing with evidence is seen as an integral component of several school subjects such as the understanding of English Language (see Andrews, 1995), of History (Pontecorvo and Girardet, 1993), Citizenship (Davies, 2005), Mathematics (Le Roux et al., 2004) and Science (Siegel, 1995). The inclusion of argumentation in the curriculum may serve four partly overlapping purposes. Firstly, argumentation may be included in the curriculum in order to equip students with the skills to critically interrogate public claims and the strength of supporting and refuting evidence (Zohar and Nemet, 2002). The intention is to increase responsible engagement with socio-economic and ethical issues. Secondly, argumentation can be used as a learning method capitalising on the requirement of discussions and group interaction. In line with the theory of social construction of knowledge (Vygotsky, 1978), these discussions will provide opportunities for sense making. The often controversial nature of argumentation tasks may provide an additional reason for group members to pay attention and respond to contributions by their peers, thus integrating new ‘evidence’ in to existing cognitive constructs (Driver et al., 2000). Thirdly, for school science, argumentation is often seen as a way of emphasising the nature of scientific knowledge as temporary and changing on the basis of resolving controversy emerging from new evidence (Kuhn, 1970). Lastly, argumentation is essential to practise subject specific modes of scientific discourse (Lemke, 1997).

Exploring the effectiveness of strategies for strengthening students’ abilities to construct robust arguments, many studies (Osborne et al., 2004; Zohar and Nemet, 2002; Jiménez-Aleixandre, 2000; Erduran and Osborne, 2005) assume teachers have these abilities. This paper problematises this position, and explicitly explores the teachers’ ability in this respect. We do not assume that teachers’ proficiency per se will result in effective teaching of argumentation. However, we suggest that teachers’ argumentation proficiency is a pre-requisite for professional development in this area.

Four models of argumentation are examined for their appropriateness for our purposes. These models include those developed by Toulmin (1958) and Toulmin et al. (1984); Mitchell and Riddle (2000); Andrews (2005); and Kaufer-Geisler (1991) as reviewed by Andrews (2005). The Mitchell and Riddle model (2000) identifies key words from everyday language such as ‘because’, ‘then’ or ‘since’ which serve to extend or stimulate an argument in a dialogic rather than a static manner.
Andrews suggests that this is helpful not only in assessing the quality of arguments but can also serve as a guide in generating or composing arguments. The Andrews (2005) model depicts an evolution of concepts in relation to narrative and argumentative structure. It presents a progression in argument from unconnected concepts towards associated linkages of increasing, yet unifying complexity resulting in a fully fledged argument. Andrews suggests that the Kaufer and Geisler’s main path/faulty path model is more applicable to academic written arguments in which the writer seems to deviate from the main path of an argument, but uses pivotal words and phrases to return to the point that is being made, in a rhetorical fashion. For the purposes of this study, we chose to use the Toulmin model (Toulmin, 1958) as we concur with Andrews that the particular function of this model is to provide a test for the soundness of argument. This is borne out by the many applications of Toulmin’s model in varied contexts.

The ability to formulate a strong argument hinges on the effective use of evidence to support claims made and, at a more sophisticated level, to challenge the claims and supporting evidence made by others. Toulmin (1958) proposed a general scheme identifying different components of an argument, including a claim (an assertion or conclusion), based on data (evidence that can either be explicit information or views based on ethics or morals) supported by warrants (a reason for making the claim) in turn supported by backings (scientific models or laws). The claim may have a qualifier (limitation of the applicability of the claim), and be challenged with a counter claim (an alternative assertion) or a rebuttal (a reasoned rejection of claim, warrant or backing).

Considerable research has been carried out into ways of teaching argumentation in science classes using applications of the Toulmin model as a basis (for instance, Osborne et al., 2004; Jiménez-Aleixandre et al., 2000; Duschl and Osborne, 2002), and these studies have suggested several teaching strategies which support students in learning argumentation. Although this paper will draw on this body of research, the research focus is different in three ways. Firstly, this paper explores teachers’ own ability of ‘how to argue’—it focuses on subject content knowledge of argumentation, whereas the researchers mentioned above explore teaching strategies, and professional development strategies to support such teaching—they focus on ‘how to teach argumentation,’ thus on professional content knowledge (Shulman, 1987). Secondly, this paper intends to document the individual ability in argumentation, rather than the group’s ability. And thirdly, this study is set in an educational environment of a developing nation (South Africa), whereas all previous studies took place within industrialised systems. Thus, the research questions addressed in this paper are:

1. What are the abilities of teachers in participating in argumentation?
2. What factors facilitate or hinder the development of these abilities?

2. The context: the CPD intervention

The CPD intervention intended to develop proficiency in argumentation in participating teachers and, secondly, equip them through the development of lesson materials with teaching strategies to develop argumentation skills in their learners. The intervention applied a model of CPD where teachers, curriculum developers, researchers and teacher advisers worked together in a ‘community of practice’ (Brown, 1994; Wenger, 1998). The focus of the community is the shared responsibility for the development of learning and teaching materials to support the teaching of argumentation.

An initial workshop in September 2004 involving teachers, educators from the participating universities and other members of the community of practice, aimed to raise awareness about critical thinking through argumentation. This was followed by on-site training in two schools—one less advantaged/medium resourced (School A) and one advantaged/well resourced (School B). Teachers in both schools planned and taught a pre-written lesson based on materials developed in England (Osborne et al., 2004). A teacher in the advantaged school also devised and taught an argumentation lesson of his own design. The lessons were videotaped and the teachers were interviewed. These teachers attended a second workshop in December 2004 at which their own arguments around a hypothetical problem concerning reasons for variation in the feather colour of chickens were recorded. Further development of their skills in, and understanding of, argumentation and critical thinking took place.

In January 2005, the teachers returned for a third workshop. This provided a further opportunity for
them to engage in discussions/argument, this time about different scientific scenarios that required discussion about the status, reliability and validity of data collected from typical school science investigations. Then teachers were asked to draft argumentation lessons in groups based on a lesson template, which guided the structure of the draught lessons. They were asked to consider topics from the new curriculum for grade 10 that would lend themselves to argumentation. They worked on their draft lesson plans and then presented them to the workshop participants for comment.

Since these initial phases, a number of teachers from other schools and additional teacher advisers have joined the community of practice. Data from members of the community have been collected throughout the pilot phase and through a number of modes listed below but since the 10 teachers at the two schools mentioned above form a core sample—it is they who will form the focus of the research reported here.

3. Methods

At the second workshop in December 2004, questionnaires were used to gather background data on school contexts, teachers’ expectations and perceptions of the CPD project as well as information on current teaching practices. Teachers were also asked to comment on aspects of the cpd programme, which contributed to their own ability to think critically, as well as the extent to which the CPD programme helped them to teach critical thinking. Teachers’ individual responses have been coded for frequencies of similar ideas, and for constructing a vignette for some individual teachers.

Secondly, teachers’ ability to participate in argumentation was investigated through data from group discussions of argumentation tasks at two instances during the CPD programme. In the second workshop in December 2004, a scenario was used describing the colour differences in the feathers of farmed and wild chickens (see Jiménez-Aleixandre et al., 2000). The task had two parts. The first part was open-ended, where participants had to argue why the colour of the feathers of farm chickens were different to those of the same species in the wild. The second task component was closed, where participants were presented with a number of different possible reasons (claims) as to what might have caused the different colours of feathers and they were required to discuss the merits/demerits of each claim.

Subsequent argumentation scenarios, used at the workshop in January 2005, were more closed. Teachers sat together in their school groups, except for Andile from the disadvantaged school (school A) who joined the school B teachers for their activity. The teachers at school B were shown three different graphs that illustrated the stretch of an elastic band. They had to argue which graph most closely represented the behaviour of an elastic band under increasing loads. The task given to teachers from school A consisted of two sets of data for repeated measurements of the distance a ball will roll off a slope, each with their (slightly different) average values. The participants had to indicate whether they felt that the two sets of data were similar or not. All discussions of the teachers were audio-taped and transcribed verbatim.

In order to identify the linguistic moves, background ideas and the social dynamics of discourse, a coding framework was developed (see Appendix A). Based on a model of critical thinking descriptors developed by Paul and Elder (2004) the coding framework captures the nature of teachers’ engagement, the way they deal with assumptions and relevant concepts, and of the structure of their contributions to the argument. For each teacher, the framework also traces the different components of argumentation identified by Toulmin (1958), i.e. claims and counter claims, warrants, backings, rebuttals and qualifiers. These components, in turn, allow for an assessment of the sophistication of a teacher’s argumentation in line with the five levels described by Osborne et al. (2004) as indicated in Table 1.

The coding framework was based on issues identified independently by two researchers reading and re-reading transcripts of two argumentation discussions. After comparing and agreeing on the issues, thus validating the coding framework, it was used independently by two researchers for analysing the transcripts of all six discussions. The reliability of the allocation of codes was reasonably high with a 72% inter-coder agreement.

4. The sample and school contexts

The study focuses on ten teachers from two schools, schools A and B. The contexts for each school will be described below, each with vignettes of selected teachers. The descriptions draw on
questionnaire responses from the teachers, and field
note observations.

School A is a medium-resourced school set in a
poor urban township environment. The homes
surrounding the school are a mixture of informal
dwellings, consisting of wood, corrugated iron and
some small brick dwellings. The medium of
instruction is English, even though the home
language of most of the learners at the school is
Xhosa. The average class size is 60 learners. The
teachers at school A, two men and four women, all
have around five years’ teaching experience. Most
obtained a basic teacher qualification from a
College of Education covering science content
required for teaching high school at a basic level.
The teachers come from similar backgrounds to the
learners that they teach. Four of them live in the
area of informal dwellings that surround the school.
The home language of these teachers is also Xhosa.

<table>
<thead>
<tr>
<th>Levels</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Arguments that are a simple claim versus a counter-claim or a claim versus a claim</td>
</tr>
<tr>
<td>2</td>
<td>Arguments consisting of a claim versus a claim with either data, warrants or backings but no rebuttals</td>
</tr>
<tr>
<td>3</td>
<td>Arguments with a series of claims or counter-claims with either data, warrants or backings with the occasional weak rebuttal</td>
</tr>
<tr>
<td>4</td>
<td>Arguments with a claim with a clearly identifiable rebuttal. Such an argument may have several claims and counterclaims</td>
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<tr>
<td>5</td>
<td>Displays an extended argument with more than one rebuttal</td>
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Andile expects learners to be enthused by new approaches in CT lessons and to use CT to be able to critique data provided for them. So far all of the phases on the project have helped Andile to develop his own CT ability. In-school training and having to teach a lesson using argumentation have been fundamental in helping him to teach CT.

In contrast, School B is a well-resourced school for gifted learners set in an attractive semi-urban and leafy environment. The learners are mostly residential boarders who have been encouraged to attend the school and are drawn from various previously disadvantaged schools around the province. The school was established by the Western Cape Education Department (WCED) to increase the percentage of learners who choose to do Science and Mathematics in the Cape Town metropolitan area. The medium of instruction is English or Afrikaans, which is the home language of most of the learners at the school. The average class size is 16 learners. The one female and three male teachers at school B have an average of 11 years’ teaching experience. They all have a university science degree, and two hold a further degree. These teachers then obtained a Higher Diploma in Education (HDE), equivalent to a Post Graduate Certificate of Education (PGCE). The home language of all teachers at school B is Afrikaans.

Vignette of teacher B1: Barry
Barry is the Head of Science at school B and has taught grades 10–11 for 14 years. He has a BSc honours degree in science and an HDE. He has no previous experience of INSET. In 1994 he was involved in syllabus development for teachers in the Eastern Cape. He also assisted in an evaluation of material for training Biology teachers. Barry reports he often uses teacher talk/exposition, group discussion and reading from texts in his lessons. Occasionally he might use role-plays/simulations. Barry expects to gain personally from the project by learning new methodologies.
and strategies and by being stimulated to explore new ideas. He expects to share new approaches with his colleagues. He would like his learners to be more involved in their lessons and to develop a range of skills in thinking about science and the environment.

So far, involvement in planning and teaching his own lesson as well as attending all the workshops has helped Barry to develop his CT ability. Attending workshops, where the theory of argumentation has been explained, and watching the video from the UK, have all provided insights that will help develop Barry’s teaching of CT. He is confident of his ability in argumentation.

Vignette of teacher B2: Brendan

Brendan is a chemistry teacher in school B and has taught grades 10–11 for nine years. He has a BSc and an HDE. He has no previous experience of INSET. Brendan has some previous experience of developing materials as part of a chemistry curriculum project. He reports often using teacher talk/exposition in most lessons but only occasionally including group discussion. He never uses role-plays/simulations.

Brendan expects to gain personally from the project by developing a better understanding of critical thinking and new innovative teaching methods. He expects to help enrich the school by transferring knowledge to his colleagues. He wants his learners to have a deeper appreciation of science by using problem solving and an investigative approach.

5. Teachers’ ability to argue

First we present a summary of the longitudinal data on the development of argumentation abilities for three focus teachers—those for whom vignettes have been provided above. These include one male teacher (Andile) from school A, and two male teachers (Barry and Brendan) from school B. (These teachers were chosen as they had participated in both tasks and, though similar in terms of the subjects they taught, the teachers at school B had more years of teaching experience and they operated in a very different context from the teachers in school A, as indicated previously.) Then we will discuss issues contributing or hindering the development of teachers’ argumentation abilities drawing on data from all ten teachers in schools A and B.

5.1. The issue of the CPD exposure

Table 2 shows the levels of argumentation (Osborne et al., 2004) in the two components of the chicken task. This discussion took place after Andile and Barry (but not Brendan) taught an argumentation lesson, but before the structure (Toulmin, 1958) and levels of argumentation (Osborne et al., 2004) were clarified. The table also shows the level of argumentation in the elastic band task, which took place after all three teachers attended workshop sessions highlighting the structure of a complete argument, and critiquing several argumentation lessons.

The levels of argumentation for the chicken task suggest that Barry has a high level of argumentation, which has been achieved, he says, through developing, planning, teaching and reflecting on his own argumentation lesson. Andile who has a good but lower level of argumentation also taught—and reflected on—an argumentation lesson, although this lesson was not self-designed. It should be noted that, in general, Barry is a confident professional in a well-resourced school, with solid teacher training and an assertive style of communication. Andile is a confident leader at a medium-resourced school with a less firm science content base, and a style of communication aiming at consensus and mutual support.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Level of argumentation</th>
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<tr>
<td></td>
<td>Chicken task</td>
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<tr>
<td></td>
<td>Open-ended</td>
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<tr>
<td>Andile</td>
<td>2</td>
</tr>
<tr>
<td>Barry</td>
<td>2</td>
</tr>
<tr>
<td>Brendan</td>
<td>2</td>
</tr>
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</table>
Table 2 also indicates that Andile’s argumentation level during the elastic band task has decreased considerably from level 3 to 0. In fact, it seems Andile withdrew from the argument after a very brief initial engagement. This strategy may be related to several factors. For instance, it is possible that he felt a little intimidated by the articulate repartee by his discussion partners including Barry and Brendan. The way of dealing with the (often) confrontational nature of argumentation and the dominance of individuals skilled in argument is an issue worth further exploration. Note that the evaluation of the argumentation levels could only be based on the contribution of articulated argument, that is, the explicit contributions made to the discussion. The approach is unable to track reasons for silence or thoughts that are not uttered.

5.2. The issue of the nature of the task

Looking at the argumentation in the two components of the chicken task, Table 2 shows that a closed task (where different claims are provided for participants to consider and merits and demerits of each are asked for) may allow for higher argumentation levels than an open task (where a reasoned explanation for a problem or observation is sought without providing any prompts or guidelines). This may well be related to the descriptions of the levels of argumentation in the scheme of Osborne et al. (2004): achieving levels of argumentation above level 2 heavily depend on the use of counter claims and/or rebuttals. Teachers may not, spontaneously, include counter claims and rebuttals in a discussion amongst peers. However, for closed argumentation tasks several alternative claims are provided and the request for merits/demerits for each forces these alternative claims to be considered as counter claims, and invites explicit rebuttals. This issue will be explored further below.

As the episode above shows, Teacher B3 makes an initial claim (it’s because of the huge buildings), B2 amplifies the claim supportively (let’s call it the environment), followed by B3’s suggestion of the first warrant (buildings make chickens stressed) and a parallel warrant—not a rebuttal—from A2 (in buildings chickens will lack sunlight) and another parallel warrant by B2 (in buildings the temperature is constant, outside it varies). In the last turn, note B2’s inclusive phrase ‘coupled with the environment you’ve mentioned …’. Another typical example of inclusive communication is illustrated in Episode 2 from the open-ended argumentation discussion of the other group:

Episode 2:

B1(M) I would think that yellow coloured feathers could be because of genetics and the fact that the chickens don’t have animals, predators, that could kill them.
A gene, a yellow gene is carried to the next generation and that causes the fact that continually they have more and more chickens with yellow feathers.

A3(M) Yes, to add, also the chickens now are on the farm so they don’t go out for other genes so they have the same genes.

A1(M) Ja (means yes), you know we are talking here about chickens in the farm and they are compared with the one, like in the wild that are in the forest. But these ones are just kept in one place, grow up on the farm, definitely we are only focusing on the same gene.

B1(M) It’s the same gene.

A1(M) Ja you know, because really in terms of mixing different birds then you get different ..., that’s how you get, eh, crossing. It seems here [on the farm] there is no crossing.

Teacher A3 introduces the notion that there will be no mixing of genes in the flock inside the building. Teacher A1 elaborates and contextualises this idea, signalling adoption of this view by the group, whilst frequently using inclusive terminology such as the word ‘we’.

Subsequently in the same discussion Teacher A1 again elaborates and contextualises an idea suggested by a peer, in this case the influence of predators.

Episode 3:

B1(M) In the wild, there is—what do you call it—natural selection, the kind of thing where there is predation, but inside the building there is no predation.

A3(M) Predation, in the wild it’s easy to spot them.

B1(M) So obviously they [yellow chickens] will be killed off first, while in this case, there is no predators so they are able to carry the gene in the pool.

A1(M) You know, the ones that are in the wild, still when they are small chickens, they have to be strong because they have to be safe in terms of predators. They have to be able to secure themselves without depending on the parental care. For the ones that are in the farm definitely there is a fowl-run there, you know where they normally stay. That’s which makes the difference. But for the ones that are really in the wild there is no other way out. In two days, three days that one has to be strong, to stay on their own, to find ways of securing themselves.

The last move by Teacher A1 in Episode 3 slows the pace of the discussion, and serves to contextualise a previous ‘scientific’ statement. It provides group ownership of an individual contribution.

It is only after the second workshop that teachers realise that contrasting views are part of argumentation. The discussion on the elastic band task includes ‘an argument about an argument’ halfway into the discussion when little disagreement arose about the preferred graph representing the elastic band:

Episode 4:

B1(M) Must we write it down?

B2(M) Ja.

A4(M) So we’ve got to finish the discussion. There wasn’t much of a discussion.

B1(M) Yes there was quite a bit of a discussion.

A4(M) OK

B4(M) We just didn’t argue with each other.

A4(M) You did.

B4(M) No we didn’t argue with each other.

Teacher A4 suggests that only controversy constitutes a discussion, whereas B1 and B4 contradict him to suggest that arguing is based on controversy, but discussion can be a collection of reinforcing contributions as in this case.

5.4. The issue of voicing socially acceptable disagreement

The instances of inclusiveness reflected in the data seem to suggest there is no room for contradiction, and thus for counter claims or rebuttals. However, from the transcripts two socially acceptable ways of contradiction emerge, i.e., phrasing a contrasting view as a question, and reference to the authority of the task description, both illustrated in Episodes 5 and 6.

Episode 5:

B2(M) Or it could be that, I think chickens in the wild certainly eat different types of food. They prefer those different types of food, and when the environment changes, that
maybe helps with the camouflage. Bring out the colour. It could be that maybe they get more or they get less of a particular nutrient.

A5(F) Wouldn’t it also depend on the type of chicken? A chicken must grow quickly so that it can produce meat. Then you have a chicken that must lay eggs. Wouldn’t that be a factor as well?

B2(M) Could be.

A5(F) Then you must feed them different kinds of food. In this particular chicken you’re looking for meat and in this particular chicken you’re looking for eggs.

B2(M) I think from the question the way it is [phrased]. I just naturally assumed they are still the same chickens.

Episode 5 shows that Teacher A5 disguises a rebuttal [the type of feed depends on the type of chicken] as a question. After a few more moves, B2 refers to the discussion task for support for his original warrant. An episode later in the discussion contrasting environmental adaptation and hereditary variation replicates this pattern.

Episode 6:

I Can you remember that story, the story about the moth? It was in the UK. And then you had one kind of moth being the predominant form, and then with the pollution you started getting the spotted moth. I seem to remember that from a long time ago.

A5(F) I just want to ask a question. Does that mean now the chickens in the wild, they’re exposed to a lot of pollution, to a lot of rain and dust and all those things where as the other chickens are in a building and they are protected from all those factors outside?

B2(M) I think ja, that’s exactly right, because we know that the environment is very important in terms of animals. They adapt. I’m not so sure if they do it genetically. They adapt, and those ones that adapt are the ones that survive. Those that don’t adapt, you know if you are going to be yellow in the wild, you can forget about it, they are going to catch you. Eventually you know, there’s not going to be any yellow chickens left. It’s the same case where you get these, what’s it now, these albino animals, they never survive because they’ll always be spotted. They can’t hide between the bushes and things like that.

I Do you think there’s any information or evidence to suggest that any of those things [the given claims] is incorrect?

B2(M) Can I say something? They mentioned here in the text, that in the last year they had some problems because many chickens had yellow feathers. Which means, I assume, that this problem only came about in the last year. That period is very short for hereditary variations. If you get hereditary variations, it should go from one generation to the next. Then that assumes that if you get this colour variation and hereditary variation is a factor, it should happen maybe towards the end of the year or little bit longer than a year because you want to get that effect to be captured into the genes and carried from one generation to the next.

Here the interviewer provides an example for the claim that the feather colour is explained by adaptation to the environment. Teacher A5 expresses reservation, certainly not as strong as a rebuttal, by asking a question. Teacher B2 provides a warrant (safety from predators) supporting the claim of variation, and another example as a backing. When asked to suggest rebuttals of any of the other (stated) claims, teacher B2 reverts to the text for a circumstantial inference ruling out the claim of hereditary variation as an explanation.

Reading through the transcripts, it is striking that both strategies for voicing socially acceptable disagreement are used by reasonably accomplished ‘arguers’ (such as A1 and B2), less accomplished participants (A5) and also by total novices. In contrast, it is notable that the most accomplished ‘arguer’ (B1) uses a very different strategy for his rebuttals. He often draws on everyday examples for directly contradicting claims or warrants offered by other participants.

5.5. The issue of introducing new directions

Several participants introduce new directions in the discussions. This may be through introducing
a new major scientific concept, or provide an explicit assumption, thus refining and focussing the argument. Most of the new directions are initiated by teachers from school B. For example, in Episode 1 teacher B1 introduces the notion of the environment, in Episode 2 he suggests genes and predators, and natural selection in Episode 3. In Episode 5 teacher B2 introduces the concept of camouflage, and in Episode 6 the notions of adaptation and hereditary variation. Teacher A1 only introduces the concept of crossing (for cross breeding) in Episode 2. Seemingly the introduction of new directions in the argument may be influenced by the teachers’ confidence in their subject content knowledge.

Quite separately, women seem to open up new directions through posing a question—an example is provided in Episode 5 when teacher A5 asks about different types of chickens. In contrast, men mostly use direct statements for introducing new directions, sometimes preceded by a (selective) summary of the discussion up to that point.

6. Perceptions of the impact of the CPD programme on teachers’ argumentation abilities

Seven out of the 10 teachers suggested aspects of the CPD programme that helped their abilities in argumentation. Six of these teachers indicated that developing argumentation lessons helped, in turn, their own ability to construct valid arguments. Three of the four teachers who agreed to teach pilot argumentation lessons in their respective schools also indicated that this assisted them in improving their argumentation skills. The practice of teaching actual lessons rather than talking about how to teach might be more valuable in helping teachers to reflect on the subject content knowledge of argumentation. Two of the teachers from school A found that in-school training assisted them, as it sensitised them to critical thinking in the contexts of their own schools.

One aspect of common concern for three of the teachers at school A was the use of language during training. One of these teachers pointed out: “Keep in mind that we are not all English language speakers. People need to communicate in simple terms so that it is understandable to everyone.” This dependency on a particular language might be limiting. One advantage of group discussion is that it enables participants to converse in their home language as well, which, in parts of the discussion, the teachers certainly did. However, some scientific concepts might not always have a match in an indigenous language.

7. Discussion and implications for the development of teaching

In their review of the literature on argumentation in science education Erduran and Osborne (in press) conclude that the use of valid argument does not come naturally. They advise that argumentation is a form of discourse that needs to be explicitly taught to students through suitable instruction, task structuring and modelling. Our data show that this need for explicit training also applies to South African teachers. Two effective ways of such training emerge from the data. Firstly, teacher awareness is increased by familiarisation with Toulmin’s model of argument, i.e. the different components of an argument and how they can be recognised. This represents the basic level of the in-service model by Joyce and Showers (1988). It is notable that the second level in this model (practise in a sheltered environment) was included in the cpd programme, but not identified as a way of strengthening teachers’ argumentative abilities. Teachers perceived a second effective training method in their collaborative development of lesson outlines and learning materials involving argumentation. Such resource development is not part of the Joyce and Showers model for curriculum change. Models of CPD, where materials development has been at the core, have met with successes in England (Braud and Campbell, 2005) and, in a developing nation context, in Trinidad and Tobago (George and Lubben, 2002).

There seems to be a link between a strong subject content knowledge base and the ability to argue in science. Koslowski (1996) emphasises the knowledge base and points out that theory and data are both crucial to reasoning. This is a particularly difficult challenge to address, as many teachers have a narrow content background. It is hoped that as teachers grapple with developing materials, they will also improve their subject knowledge base. This is an aspect that is worth exploring further during the remainder of the CPD programme.

We need to seriously consider an appropriate approach to the language concerns of the teachers in school A. Effective argumentation does depend on confident and competent articulation of ideas through language. Hence, participants can be handicapped when they attempt to externalise or
make public their ideas in a language that is not their own, whether verbal or written. Graham Wells (1996) talks about the need for people to develop a tool-kit of discourse for effective teaching and learning to take place. In addition, there is a need for developing a ‘communicative competence’ (Edwards and Mercer, 1987) drawing on a repertoire of ways of speaking. The Russian linguist Bakhtin (1981) is of the opinion that every utterance is always partly a response to things that have been said before and (more crucially to our data here) is often designed to take account of the responses that the speaker expects. In our analysis of the argumentation data it certainly seemed that there was a tendency to being agreeable, especially in the open-ended task.

As the data shows, verbal argumentation depends to a great extent on the group dynamics, which in turn is influenced by the relative status of the group members, either in terms of their perceived subject content knowledge (here knowledge about genetics or measurement), gender or language proficiency. This higher status may project some group members whereas men prefer open confrontation whereas male colleagues would use statements. However, there is no suggestion that women look for communalities amongst the views of the group members whereas men prefer open confrontation of differences in their views (Tolmie and Howe, 1993).

To the contrary, the data indicate persistent attempts at inclusiveness in the discourse of both female and male teachers. This may well relate to teachers’ use of the concept of ubuntu (literally translated as human-ness from Nguni languages used in Southern Africa). The ubuntu worldview is based on the “indivisibility of human nature, and the commonness of purpose of human beings which make […] interests, aspirations and objectives intertwined” (Pityana, 1999, p. 169). The ubuntu concept centres around the fundamental idea of maintenance of harmonious relationships within the community and with nature (Boon, 1996). Philosophers using the ubuntu worldview to interpret society suggest that the concept of an autonomous individual, a basis for Western thought, is absent from African thought, as Self can not be separated from the community and from nature (Nsamenang, 1999).

Within South Africa, the development of the discourse of ubuntu coincided with the reconciliatory politics of post-apartheid transition. A case in point is the controversial work for amnesty and forgiveness by the Truth and Reconciliation Commission (McCarthy, 1999) who attempted to shift the discourse from conflict, violence, racism and instability towards reconciliation, cooperation, oneness in diversity, shared moral values and sound community life. The ubuntu worldview has also strongly influenced the development of the whole-Africa political philosophy of “moral renewal” for the ‘African Renaissance’ (Pityana, 1999, p.168). In the debate across Africa about African thought and indigenous knowledge production, ubuntu has been held up as one mode of grappling with conflicting perspectives on a common theme that differentiates it from hegemonic and normative ‘Eurocentric’ analysis of critique (for instance, see Amin, 1998; Ntuli, 1999). Pertinent to this study, Ntuli (1999) contrasts the Eurocentric binary logical reasoning structure of either/or and yes/no solutions with the recognition of complimentary in African thought. Similarly, Ramos’ (2002) philosophical interpretation of ubuntu emphasises that the western understanding of ‘fact’ and ‘truth’ is rendered relative since “human beings are not made by the truth, they are the makers of truth.” (p. 235).
In the first instance, the use of the concept of *ubuntu* seems to conflict with the aim of teaching argumentation, as the quality of the latter is directly related to confronting and rebutting claims, warrants and backings proposed by discussion partners. The discourse data in this study show several *ubuntu* features avoiding such confrontation. For instance, we note the frequent use of the word ‘we’, and the provision of new claims, warrants and backing as parallel contributions rather than opposing those of others. Even if opposing evidence is suggested, it is often preceded by a summary of agreed views. However, that data also reveal some socially accepted ways, seemingly within the *ubuntu* worldview, for making contradicting contribution as a form of rebuttals. Posing questions, referring to a (neutral) authority such as the task description, and introducing qualifiers are used as non-confrontational ways of disagreement. The data also show a clear advantage of the use of the *ubuntu* worldview in argumentation: the participants listen to and engage with the comments made by their discussion partners, which is not always the case when Western, more competitive, principles underlie argumentation discussions (Forman et al., 1998).

The findings have several implications. Firstly, we propose that teaching argumentation within a society using an *ubuntu* worldview recognises the notion of inclusive argumentation. Inclusive argumentation in science could be defined as the ability to provide evidence and justifications for claims or decisions taking cognisance of the views of others. This distinction parallels Deanna Kuhn’s (1992) emphasis on dialogical argumentation, which also changes the nature of the argument from confrontational to collaborative (Munford and Zembal, 2002). However, Kuhn’s concerns were with the use of argumentation for conceptual development, whereas this study focuses on the development on argumentation skills per se.

The second, and closely related, implication is that the criteria for a high-quality argument should then allow for inclusive moves. We suggest modifying the levels of argumentation we used for this study (from Osborne et al., 2004), de-emphasising the use of a rebuttal, and highlighting the use of qualifiers and questions suggesting disagreement. Both of these aspects feature prominently in scientific reasoning: qualifiers delineate the applicability of the claim and thus make it more precise, and probing questions suggest a critical interrogation of the claims, etc. of others. This shift in emphasis brings inclusive argumentation closer to the model suggested by Mitchell and Riddle (2000) as outlined by Andrews (2005). The proposed levels of inclusive argumentation are indicated in Table 3.

The third implication is that additional argumentation ‘prompts’ for teachers and ‘writing frames’ for students (see Osborne et al., 2001) need to be included in the CPD programme. Inclusive argumentation prompts could include: How does this new claim/warrant/backing compare with the previous positions? Does this always apply? When does it not apply? If you did not agree, what would you ask? Writing frames should include similar inclusive argumentation prompts. Although there are indications that South African pupils indeed use inclusive argumentation structures, at least in mathematics lessons (Le Roux et al., 2004), there is a need to execute research into the extent of the use of this form of argumentation in science classes. The same research may also test the validity of the suggested levels of inclusive argumentation.

The research attempted using Toulmin’s argumentation model for describing the level and nature of argumentation abilities of individual discussion participants. We wanted to explore the possibility of using the model as a basis for individual student assessment. It is ironic that the emergence of inclusive argumentation clearly focuses on the

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Levels of inclusive argumentation</th>
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<tbody>
<tr>
<td>Levels</td>
<td>Description</td>
</tr>
<tr>
<td>1</td>
<td>Arguments that are a simple claim versus a counter-claim or a claim versus a claim</td>
</tr>
<tr>
<td>2</td>
<td>Arguments consisting of a claim versus a claim with either data, warrants or backings</td>
</tr>
<tr>
<td>3</td>
<td>Arguments with a series of claims or counter-claims with either data, warrants or backings with either a meaningful and detailed qualifier/explicit assumption or a weak rebuttal</td>
</tr>
<tr>
<td>4</td>
<td>Arguments with a claim with a reasoned question querying the claim, warrants, backings or use of data or an identifiable rebuttal</td>
</tr>
<tr>
<td>5</td>
<td>Extended Argument with a clearly identifiable rebuttal supported by data, warrants or backings</td>
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</tbody>
</table>
group (rather than the individual) as a unit of analysis, and assessment. Three alternative ways of assessment may be considered. Firstly, teachers may need to be made familiar with methods to derive individual marks from group activities. The validity of this assessment method in an African context may, however, be seen as contentious by policy makers and parents. Students could also be presented with a written contentious scenario with evidence for two potential claims and be asked to write conclusions with justifications. This method does not fully represent the context of argumentation with counter claims and personal suggestions to be taken into account. Lastly, the written scenario may be replaced by interactive computer software, which allows for counter claims and tailor-made additional evidence, but this form of assessment still lacks the personal peer contributions and information on the social interactions. If the ubuntu worldview is to be the basis for the assessment of the abilities in inclusive argumentation, such arguments will need to be constructed as part of a community.

Acknowledgements

We would like to acknowledge the Western Cape Education Department for allowing us access to the schools and the teachers involved in the project for their enthusiastic participation.

Appendix A

For teachers’ discussions and argumentation—coding framework see Table A1.

Table A1
Teachers’ discussions and argumentation—coding framework

<table>
<thead>
<tr>
<th>Main-C</th>
<th>Sub-C</th>
<th>Comment/example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement</td>
<td>Clarification</td>
<td>Identifying/clarifying the problem or task</td>
</tr>
<tr>
<td>Checking</td>
<td>Making sure that lines of argument/discussion are understood and productive</td>
<td></td>
</tr>
<tr>
<td>Steering</td>
<td>Moves that significantly shift or steer lines of argument or discussion (could be +ve or −ve?)</td>
<td></td>
</tr>
<tr>
<td>Assumption, concepts and ideas</td>
<td>Identification</td>
<td>Draw on assumptions, concepts, theories and ideas—make them known to others</td>
</tr>
</tbody>
</table>

Table A1 (continued)

<table>
<thead>
<tr>
<th>Main-C</th>
<th>Sub-C</th>
<th>Comment/example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternatives</td>
<td>Consider alternative concepts, theories and ideas; challenge assumption</td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>Debate different theories, concepts and ideas and their relevance to the task/problem</td>
<td></td>
</tr>
<tr>
<td>Structure of argument</td>
<td>Claims</td>
<td>Makes a claim (based on problem, question or data)</td>
</tr>
<tr>
<td>Counter claim</td>
<td>Makes an alternative claim to challenge one already made</td>
<td></td>
</tr>
<tr>
<td>Warrants</td>
<td>Provides reasoning for a claim or counter claim</td>
<td></td>
</tr>
<tr>
<td>Backings</td>
<td>Provides scientific or other evidence (e.g. from knowledge or experience) or a case to support a warrant</td>
<td></td>
</tr>
<tr>
<td>Rebuttals</td>
<td>Challenges the basis of a warrant or backing</td>
<td></td>
</tr>
<tr>
<td>Qualifiers/cases</td>
<td>States a case under which a line of argument/claim may hold true or be invalid</td>
<td></td>
</tr>
</tbody>
</table>

References

Bakhtin, M., 1981. The Dialogic Imagination. University of Texas Press, Austin, TX.


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