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ABSTRACT

This paper reports on the classroom learning environment and teaching practices in a Papua New Guinea ninth-grade science class and the conflict between the informal, traditional learning paradigm and new school approaches to science teaching. Observations and interviews with teachers and four students were supplemented with questionnaires and test results. Findings indicate that teaching and learning strategies were basically teacher-centered and involved low-level cognitive structures, such as rote learning. There was less emphasis on meaningful learning, and the long-term retention of science concepts was not an important consideration. It became obvious toward the end of the study that this model of teaching and learning had become part of the culture of teaching and learning science at this school. In rural Papua New Guinea's informal, traditional teaching model of story telling and apprenticeship, students listened and learned by imitating what they saw over a period of time. In this study, students seemed to display those same behaviors, which contrasted with the teacher's expectations. The teacher, a recent graduate, desired, but was unable to create, a learning environment in which meaningful learning was the most desired outcome. He expected students to ask questions and be responsible for their own learning by participating actively in student-centered activities. The students were reluctant to do so and may have seen such behavior as inappropriate and disrespectful toward the teacher's authority. To improve students' learning and understanding of science, new components of cultural sensitivity should be included in the pedagogy, aimed at facilitating a bridge or "border crossing' from the students' culturally oriented views to the canonical views in science and science pedagogy. (Contains 39 references) (TD)

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Learning Science in a High School Learning Environment in Papua New Guinea

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Abstract

This paper reports part of a wider study that investigated classroom-learning environment, and the enacted teaching and learning practice in a Grade 9 high school science classroom in Papua New Guinea. Findings from the study revealed that the informal traditional practice of teaching and learning in Papua New Guinea differed significantly from the modern approach adopted by the country based on imported models from the West. There was evidence to show that the informal traditional teaching and learning practice in Papua New Guinea of "story telling" and "apprenticeship style" models did not readily facilitate learning for understanding and students taking responsibility for their own learning. Accordingly, there were conflicts in students' roles as learners between the new approach and the traditional expectations of students which impeded progress in learning. The study recommended that in order to maximise students' learning and understanding of science concepts in the Papua New Guinea classroom observed, cultural sensitivity should be incorporated in the pedagogy.

Introduction

Papua New Guinea is a relatively young developing Pacific Island country where 85% of its people live in rural agrarian communities with strong ties to their traditional beliefs, way of life and the land. The development of formal secondary education in

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Papua New Guinea had its genesis in the late 1950s, and the early 1960s saw the establishment of science education at lower secondary level. As in most developing countries, the early syllabuses were imported, and in this case Papua New Guinea's science syllabuses were modelled very closely on those in use in Australia, notably in New South Wales. In 1966 a science syllabus for Grades 7-8 was designed within Papua New Guinea by the Papua New Guinea National Department of Education (PNGNDOE) and released for use in schools. This was followed by a Grade 9-10 science syllabus a year later. The new syllabuses were laboratory-based and were taught by teachers recruited from Australia, New Zealand and the UK in multiple laboratories built in high schools by the colonial government (Maddock, 1983).

From primary to upper secondary school levels, science has been included in the syllabus as a core subject that all students had to study (PNGNDOE, 1977; Wilson, 1989). Science education featured prominently in the Papua New Guinea education system because it was considered by the Papua New Guinea Government to be an important tool for achieving national goals and objectives for development and prosperity (Matane, 1986). The Papua New Guinea Government also considered that improvements in scientific literacy would enhance personal standards of primary health care, nutrition, and safety with respect to using technology, as well as assist individuals to understand the problems associated with environment degradation (PNGNDOE, 1977).

This paper reports a small portion of a wider study conducted in Papua New Guinea. The aim of this paper was to report findings related to the problems encountered between the informal traditional learning paradigm of knowledge and skills, and the formal school science teaching and learning approaches evident in a high school classroom environment in Papua New Guinea.

Teaching and learning science in Papua New Guinea

A number of studies have shown that teaching and learning activities in developing countries that are similar to Papua New Guinea were usually teacher-centred, place less emphasis on learning for understanding, and provide fewer opportunities for students to take responsibility for their own learning. In these countries the primary aim was for students to pass external examinations, and learning in such environments involved low-level cognitive approaches such as rote learning (Maddock, 1983; Taylor, 1997; Waldrip & Taylor, 1999). In schools in Papua New Guinea today, teaching styles still reflect the behaviourist-learning paradigm that was introduced into the country in the 1960s with a Western education system (Maddock, 1983). Each science topic taught was included in the Teachers' Guides which had behavioural objectives explicitly stated for teachers to adhere to. The predominant teaching style in schools in Papua New Guinea at present involves 'chalk and talk,' some teacher demonstration of concepts and principles using science apparatus, and limited individual student group experiment work.

A trend in the science education scene in both the developed and developing countries throughout the world is the research focus on the cultural aspects of learning science (Cobern, 1996; Cobern & Aikenhead, 1998; Jegede, 1995; Maddock, 1981; Ogawa, 1986; Waldrip & Taylor, 1999) as the culture in which a student is situated influences his or her world view.

Influence of culture in teaching and learning science

In the past few decades, views on learning science have shifted from earlier psychological perspectives on the individual learner to encompass sociological perspectives that contextualised learning in social settings (Cobern & Aikenhead, 1998). Many researchers in science education believe that the cultural background of a learner plays a central role in learning. For example, Maddock (1981) proposed, "science and science education are cultural enterprises which form a part of the wider cultural matrix of society and that educational considerations concerning science must be made in the light of this wider perspective" (p. 1). Accordingly, research on the cultural aspects of learning science have increased over the past years to shed light on how a student's culture can affect his or her learning of science in school (Cobern, 1996; Cobern & Aikenhead, 1998; Jegede, 1995; Ogawa, 1986; Waldrip & Taylor, 1999).

In African studies, Jegede and Okebukola (1989) believe that the socio-cultural interferences in science learning arise through their traditional worldview. Similarly, in Papua New Guinea the students attend class with traditional cultural views that

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conflict with the school science view (Boeha, 1988; Pauka, Treagust, & Waldrip, 2000). The epistemological and ontological stances of students in developing countries are not the same as those for Western developed countries. As mentioned briefly earlier, the traditional Papua New Guinean worldview includes human and animal, the seen and the unseen, the living and the dead in a way that is very different from the Western view (Pauka et al., 2000). Pauka et al. (2000) further elaborates on what the Western world refers to as the 'supernatural categories.' For Melanesians these are simply the non-visible parts of a single continuum of life which are eminently natural and form a normal part of everyday life activities. In the Western system, knowledge is partitioned into areas or subjects and Western science is a segment of that body of knowledge acquired through particular ways and identified by participants as belonging to the area. On the other hand, in indigenous knowledge systems, knowledge is perceived as holistic and purposeful to the participants (Aikenhead & Jegede, 1999; Waldrip & Taylor, 1999).

Students' traditional worldviews and instruction

As alluded to earlier, Papua New Guinean students' traditional worldviews remain much the same as they were centuries ago because of the strong ties to land and the environment for survival. More than 85% of the people in Papua New Guinea live in rural villages with very limited modern conveniences such as running water and electricity. Traditional beliefs, stories and ideas to explain natural phenomena exist in every community in Papua New Guinea (Pauka et al., 2000), and these contribute significantly to the formation of the students' alternative conceptions prior to the study of science in schools. Working in Papua New Guinea, George (1991) identified examples of traditional views which he referred to as traditional science that were more influential in students' thinking than the Western science viewpoint. For example, traditional taxonomies of plants and animals seldom agree with the scientific taxa. This is illustrated by the grouping of snakes and scorpions in a single primary taxon. In another example, pregnancy, according to one clan, occurs when a spirit child enters a woman and is not directly related to sexual intercourse which is viewed as playing only an indirect part in preparing a woman for pregnancy. Frequent intercourse would, by sustained knocking on the womb, assist in producing the overflow of blood which is required before any woman could be possessed by the

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spirit child (Shea, 1978). Elsewhere, in developing countries similar traditional views abound. In the Caribbean, a database was developed which consisted of 236 items of what was called "street science" (George, 1989; George & Glasgow, 1989). These items consisted of beliefs and sayings that dealt with the same content areas that are found in school science, but which sometimes offered different explanations to those offered by school science. For example, human hair will grow longer if it is cut when the moon is full.

Teaching and learning of worldviews in the traditional context in Papua New Guinea is largely by "story telling" (Pauka et al., 2000) and the "apprenticeship type" model (Waldrip & Taylor, 1999). Elders usually do story telling as a way to educate children on the world around them. On the other hand, the apprenticeship type model is normally used to transfer skills by a skilled respected member of the community to children (Waldrip & Taylor, 1999). In a study conducted in a Pacific Island country very similar in many ways to Papua New Guinea, Waldrip and Taylor (1999) noted that such skills as those required for gardening, fishing, and building canoes were taught through an iterative process of imitation and practice by students under the guidance of a mentor who was usually a respected elder in the community. Students were not supposed to ask questions that would be seen as disrespectful or undermining the credibility and authority of the elder.

Thus, in Papua New Guinea, students' traditional worldviews and their teaching and learning approaches remain much the same as they have always been.

The researcher's previous study (Najike, 1993) and more than ten years of experience of work with high school students and trainee science teachers, led him to the challenge to study the difficulties with conceptual understanding in learning science in Papua New Guinean science classrooms. In particular, it appeared that there were serious problems associated with the development of meaningful long-term understanding of science in secondary schools. The next section discusses the design and methods of the study.

Design and Methods

The broad aim of the wider study was to investigate teaching and learning as they unfolded in a naturalistic setting in which a Grade 9 class was taught a unit on electricity in a high school by the regular class teacher in Papua New Guinea. The unit on electricity was selected because of the researcher's (first author listed in this paper) past experience of research in this area and also because it was typical of the science content taught in high schools which was conceptually difficult for most students to understand in a deeper meaningful way. As such, it provided a lens through which the author looked into the learning process to understand what went on in a Papua New Guinea classroom environment. The intention of the study was not to present a causal relationship between conceptual change and conceptual change conditions within the particular classroom environment, but rather to examine the learning process as it unfolded in its natural environment. This was accomplished by focusing on the classroom environment and closely following students' and the class teacher's interactions with teaching and learning activities that occurred. Social constructivist perspectives in a Papua New Guinea specific context informed the study.

In order to achieve the aim of the study an interpretive and naturalistic approach was adopted (Kelly & Lesh, 2000; Keeves, 1998; Maxwell, 1996 Gallagher, 1991) resulting in an interpretive embedded case study. In keeping with the tradition of classroom based researches in recent years the focus was on detailed descriptions of teaching and learning activities in the classroom environment leading to their interpretation in light of contemporary theories. Thus, the research design used in the study was underpinned by both quantitative and qualitative research techniques.

The research as a case study

In keeping with the epistemological underpinnings of the research an interpretive case study approach was adopted (Stake, 1994; Wittrock, 1986). In particular, the case study strategy used in this research study constituted an instrumental case study (Stake, 1994, p. 237); that is, a "particular case," a selection of students, "is examined to provide insight into an issue," the aspects of culture associated with the views, experiences and interactions of the students' and teacher's that influence learning in the classroom environment. The choice of a case study approach was also congruent with the decision to use both qualitative and quantitative research methods because as Stake (1994, p. 236) noted, "case study is defined by interest in individual cases, not by the methods of inquiry used." In support of such a position he adds:

> The case is of secondary interest; it plays a supportive role, facilitating our understanding of something else. The case is often looked at in depth, its contexts scrutinised, its ordinary activities detailed, but because this helps us pursue the external interest...The choice of case is made because it is expected to advance our understanding of that other interest. (p. 237)

Instrumental case studies require that cases be selected. This is because case studies are characteristically examples of research in depth rather than breadth. In order to select the case for this research, it was necessary to address an important issue concerning the selection of students for intensive study.

The four students selected (Allison, Ian, George, Demi) were, in the view of the researcher representative of the range of variations between students with respect to their views on science, experiences with technology and perceptions about the learning environment. Each of the four students in this report constitutes a perspective within the case. The perceptions of each of the four students were prominent in each of the perspectives. This was desirable in order to view each of the four students' beliefs and interpretation of their individually constructed reality as one of the multiple perspectives of the case. The consideration of a range of students' perspectives assists readers in the construction of their own understanding regarding a case (Stake, 1994).

Data sources

The multiple data sources used in the wider study were video and audio recordings of observations, interviews with students and teachers, classroom artefacts, researcher's field notes and reflections, questionnaire results, and regular class test results. During observations the researcher became a non-participant observer, taking field notes with specific attention given to a group of focus students of four. By using two unobtrusive mini video cameras fixed at suitable locations, the activities of all class members were recorded for the duration of the research period. One video camera focused on the selected students who sat as a group with three others near the front of the science laboratory. The other video camera was focused on the whole class of students in a wide-angle configuration. The class teacher's remote radio microphone output was fed directly to the video recording in the storeroom area where the recording equipment was set up.

Interviews were used to establish the students' initial knowledge of the topic, their beliefs about the nature of science and learning, and also to probe more deeply into issues that emerged from the data. In particular, semi-structured interview approaches were used (Osborne & Freyberg, 1985; White & Gunstone, 1992).

Instruments

Test instrument results provided the researcher with quantitative data for the entire class. Data from these instruments were useful for descriptive purposes, and thus they did not undergo thorough statistical analysis, as was the case with most quantitative data. They served to determine the basis for purposeful sampling for selection of the four focus students in the research and allowed connections to be made with other research in which the same instruments have been employed in different contexts. Purposeful sampling (Maxwell, 1996, pp. 70-72) had been conducted in order to study particular kinds of students more intensely as indicated by the researcher's emerging understanding of the classroom. Furthermore, the data collected using these instruments enhanced rich data collected from the activities in the classroom and participant's qualitative data. Data from two instruments tested students' views of science-technology-society (VOSTS), and students' prior content knowledge of electricity (Two Tier Diagnostic Test).

The VOSTS questionnaire measured students' views on science-technology-society. Developed and validated in Canada at the University of Saskatchewan by Aikenhead, Ryan and Fleming (1989), VOSTS was an inventory of student viewpoints about science, and about how science was related to technology and society. Canadian high school students' ideas were catalogued in a logical way to seek students' views (Aikenhead et al., 1989). Each question of the VOSTS inventory begins with a statement about a science-technology-society topic. Several positions on the issue raised by the statement were then made available for students to choose from according to their viewpoints. The VOSTS questionnaire used was designed to gather the students' views about science-technology-society. A number of criteria for the development of the adapted VOSTS version used in Papua New Guinea were considered. The wording of items was revised to suit the English literacy skill level of students from Papua New Guinea. The attention span of respondents was considered especially in the light of reports that VOSTS materials tended to require a lengthy response time and that reader fatigue became a factor.

The researcher selected eight items from the VOSTS inventory on the basis of their relevance to key elements of the intended study which included students' prior knowledge, students' viewpoints on the nature of science and learning, and the influence of students' cultural contexts on learning.

This questionnaire yielded data that facilitated purposeful sampling, and provided an initial starting point for data analysis. The questionnaire was not intended to be an end in itself but was planned to use the initial responses as spring boards to fuller pictures of the students views, to be uncovered in subsequent investigation. The criteria for including an item were its likelihood of eliciting a committed response and to stimulate the respondent to think deeply about and around the topic.

A Two Tier Diagnostic Questionnaire was used in the study. This was adapted from a test instrument developed and validated with different groups of Western Australian students to test first-year university students' qualitative understanding of electricity and Newtonian mechanics (Treagust, 1988; Treagust & Zadnik, 1991). The questionnaire measured students' conceptions of their understanding of physics concepts. The individual items have at least two parts that catered for further probes, crosschecking and confirming of responses from participants. The adapted instrument, which investigated students' conceptions of electricity concepts, had been successfully trialed and used to collect data in Australia and Papua New Guinea by the researcher (Najike, 1993).

Analysis

The analysis of data from multiple sources occurred simultaneously with data collection. Thus, the researcher made initial analyses of the data immediately after the lessons, and before the transcriptions had been completed. This led to a recursive process that became an integral component of interpretive studies the aim of which was to "make sense of, or give meaning to" the specific and diverse nature of daily life in the learning environment (Gallager, 1991; p. 8). Erikson (1998) aptly stated that qualitative research analysis is a bootstrapping operation in which reflexively, assertions and questions are generated on the basis of evidence, and evidence is defined in relation to assertions and questions. Data analysis, informal and formal, according to Erikson began as the researcher negotiated entry to the research site, and it often continued in re-study after supposedly final reports were written. Bodies of information were gathered in fieldwork and were held in documentary sources in various media such as field notes, interview tapes, videotapes and site documents. These were not yet data but regarded as resources for potential data as they appeared in raw form. The documentary sources contained many thousands of information bits, not all of which were relevant to the study conducted. Analysis consisted of a recursive review of information sources with a question or assertion in mind, deciding progressively which information bits to attend to further and which not to attend to (Erickson, 1998; Gallagher & Tobin, 1991; Lemke, 1998)

Results

Important data pertinent to the focus of this paper is presented in the form of a vignette, teachers' perceptions of their practice, and four selected focus students' perceptions relating to teaching and learning exhibited in the classroom learning environment investigated. The vignette serves to provide data on teaching and learning, as well as high lighting the specific context of the specific learning environment. The lesson covered by the vignette commenced at 11.40 am on 01.03.2001. It was a complete single 40-minute lesson observed by the researcher and videotaped simultaneously.

VIGNETTE

Three minutes after the bell rang, a handful of students walked into the science laboratory slowly - some whistled. It was a warm humid day. The researcher had taken his normal post at the rear of the laboratory before the students entered. Three to five minutes later a few more students made their entry. The teacher entered around this time.

1. **Teacher**: Some [students] are still coming, aren't they?
2. **Some students**: Yes
3. **Teacher**: Did I tell you about having lessons here?

Students have been using a different science laboratory for their lessons previously

4. **Most Students**: Yes

By this time half the class were present. Most of these students were slowly opening their notebooks. They seemed to be talking among themselves in low voices

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5. **Teacher**: Make sure you have this sheet [referring to worksheet] with you plus the homework. We'll do the corrections [to the homework] now.

David had the teacher's copy of a Worksheet that had problems for students to complete the previous day. The worksheets were part of the teaching activities included in the Teacher's guide for teachers to use. Students slowly opened their books. Some were mumbling. A few were looking out of the window. More students entered and found their places to sit.

6. **Teacher**: May we continue now? ... Good morning class?

7. **Students**: Good morning Mr. Mark and Mr. Najike

Some more students entered. The teacher hesitated, waited for the late students to settle down. Two students had no stools to sit on so they stood leaning against the bench.

8. **Teacher**: Okay, enough of the noise. Open your books to the problems. Sit down; don't make a lot of noise. Find a place to sit down.
9. Okay lets start the lesson.
10. We talked about static electricity in our last lesson.
11. What is static electricity? How do you define the term?

There was no response from students. The teacher looked around the class for students' response. After a few seconds he tried to prompt students to respond. This was David's introduction to the day's lesson. He was attempting to review main ideas from the last lesson.

12. **Teacher**: ...Give a try.

David paused for a few seconds.

13. **Some students**: ...Electricity at rest.
14. **Teacher**: Electricity at rest, that's what we said in the previous lessons.
15. How did we define current? Peter.

There was no response from students.

16. **Peter**: ...Flow of electrons
17. **Teacher**: That's what we said in the previous classes. As we discussed last time, electrons are in every thing. Metals have electrons because they are made up of atoms.
18. What is an electron? ...Yes, Joshua?

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19. **Joshua**: ...an electron is made up of charges

20. **Teacher**: Electrons are charges. Electrons exist in everything. What type of charge?

21. **Students**: Negative charge

22. **Teacher**: Very good, negative charges

23. In which direction in a circuit does the electron flow?

The majority of students did not put their hands up nor made any attempt to respond to the teacher's question. Some students appeared to be busy writing things in their books. In many cases it was only when students were called by name that they responded.

24. ...Paul?

25. **Paul**: Negative to positive

26. **Teacher**: Why is that? Paul

27. **Paul**: ...because negative terminal has lots of negative charges.

28. **Teacher**: We must not forget that. We say electrons are negative charges passing from negative terminal where there are lots of electrons to positive terminals where there are fewer electrons.

29. Last lesson we did an experiment by rubbing a ruler. We said that like

30. charges attract or repel?

31. **Some students**: Repel

32. **Teacher**: Unlike charges...?

33. **Some students**: Attract

34. **Teacher**: So when we rub a ruler against the hair of our skin, hair was attracted to the ruler. Hair has surface atoms. That's what we learned in our last lesson. Now I want us to complete this Worksheet.

He showed the Worksheet to the class.

35. **Teacher**: Take it out...

36. We have corrected the first stage, now we correct the rest of the problems.

37. I want a volunteer from each group to come and draw the circuit on the board.

38. ...Rose, good you can come and do it...that's a rep. from Group 5.

Rose was the group leader of Group 5 and took it upon herself to volunteer. Three minutes passed by where Rose copied onto the chalkboard a series circuit diagram from her notebook. Some students were talking away in little groups. Many students were writing things in their books with heads down, probably checking their work against

Rose's on the chalkboard. In general, it seemed students were reluctant to respond to their teacher's questions unless they were specifically called by name to respond.

39. **Teacher**: Thank you Rose.

40. The instruction says 3 dry cells connected to a light bulb and a switch also in series... Does that drawing have 3 dry cells...?

The teacher tried to lead the students along.

41. This is a positive terminal...

The teacher pointed at parts of the diagram while talking.

42. We have 3 dry cells, what else...this is a switch...good...

43. You should have something similar to this circuit.

The teacher followed in the same manner to correct work with students from different groups giving answers on the board, which took 20 minutes. After this he handed out a new Worksheet with problems for students to do. The Worksheet was photocopied from the Teacher's Guide for Unit 9.2 on Electricity.

44. **Teacher**: In tomorrows' lesson we will measure current and voltage.

The teacher was referring to a planned practical session in which students would develop skills in taking current and voltage measurements using ammeters and voltmeters from a simple series electric circuit.

Five minutes passed in which students tried to solve problems on the new Worksheet.

45. **Teacher**: Discuss with your friends. Share ideas.

Noise came from the field nearby where some boys were playing touch rugby. The majority of students in this class were working at a leisurely pace. However, they were quiet and busy with their work. After another 15 minutes the bell rang signaling the end to this class.

46. **Teacher**: Complete that?............ Yes or no?

47. Write your name at the top and I'll collect them. Tomorrow I'll return them

48. and we can connect these series circuits and do problems on them. If you

49. haven't finished, just write your name and hand in.

Students were slowly getting up. The majority of students were still writing on the

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Worksheets. The teacher urged the students to hurry because a class was coming in to use the laboratory.

Interpretations from vignette

The lesson highlighted in the vignette was a complete non-practical 40-minute lesson taught in the science laboratory in his usual way by the class teacher, David Mark (a pseudonym used). In the lesson David started off by reviewing important concepts on static electricity taught the previous day (line 17). Then he led students orally through the solutions to homework problems on a worksheet that was taken from the teacher's guide. At certain points in the lesson David asked students from each group to come to the front and write the group's answer on the chalkboard (for example, line 38). In general the lesson combined brief teacher explanation of important points (for example, line 14), questioning (for example, line 23) to test students' understanding, and student working on set problems (for example, line 36). The component on teacher explanation and questioning occupied a major part of the lesson, making the lesson more teacher directed and less student centred in nature.

Students' activities involved copying down notes on solutions to problems from the chalkboard and responding to the teacher's questions and instructions when required to. On many occasions students engaged in withdrawn non-participatory behaviour such as not responding to questions asked by the teacher unless specifically asked to by David, with their heads down and appearing to be busy copying notes (commentary after lines 23, 38). Some students were reluctant to participate fully in the classroom interactions with their teacher by asking questions and holding discussions in their groups (commentary after line 38).

In general, most students readily accepted what David taught without question and were reluctant to discuss subject content delivered through worksheet problems and experiments in student groups. Students showed limited evidence of taking responsibility for their learning, thus learning in this type of situation reflected a transmission perspective. This situation is reminiscent of assumptions made from transmission perspectives a few decades ago about learners, including the "tabula-rasa" (Gilbert, Osborne, & Fensham; 1982) and "teacher dominance" (Osborne & Freyberg, 1985) assumptions. The former assumes learners have a blank mind which can only be filled by the teacher or textbook author. The latter assumes learners have prior ideas related to topic under instruction but these ideas can easily be replaced with scientifically correct ideas at school. Thus, learning in this environment was seen as the transferring of knowledge from the teacher to the students, usually in the literal sense. The teacher dominated and directed teaching and learning while students became passive recipients of knowledge.

In the view of the researcher, (who is an insider familiar with the cultural and education situation in Papua New Guinea, and having had the benefit of both Papua New Guinea and Australian training) a large component of students' behaviour demonstrated in class was being derived from the students' epistemological stances based on their traditional worldviews. Students understood that as learners they should accept all information provided by the teacher (knowledge provider) without question. As students they should respect their teacher, thus allowing him to dominate, controlling all activities in the classroom. For students to take responsibility for their own learning was not acceptable and was seen as undermining the authority of the teacher, very much similar to teaching and learning in the informal traditional learning situation in the villages of Papua New Guinea (Maddock, 1983; Pauka et al., 2000; Taylor, 1997; Waldrip & Taylor, 1999).

Teachers' perceptions of teaching and learning

Interviews were conducted with teachers who were currently teaching Grade 9 or have had taught Grade 9 science in the past two years. One of these teachers was David who was the class teacher of the class participating in the study. David was a young recent graduate from University who had completed a Bachelor of Education Degree in Science Education. He considered his teaching role to be a facilitator whose task was to promote group work and greater student participation in class. He preferred to see students asking questions and actively participating.

> ...I think students should be participating and answering or asking questions if they are not sure of anything (Teacher Interview: David 13.03.01,line 25)

He had students sitting in groups for practical work and worksheet problem solving. Through questioning techniques David encouraged students to participate actively in the classroom. However, despite his efforts learning in the classroom was largely teacher-centred and resorted back to the traditional didactic, chalk-and-talk expository style. For example, see the following two excerpts, one from the researcher's field notes dated 13.03.01 and the other by one of the teachers interviewed:

I observed period 1 and 2 science lessons on " Electrostatics." I was unable to record on tape this particular lesson because there was a power blackout at 8:25 AM that lasted 25 minutes.

The lesson commenced with an introduction that quickly summarised the main points of the last lesson and made links to today's lessons. Then David wrote notes on the chalkboard for students to copy into their books. The next activity for David was to explain what electrostatics was with the aid of a simple demonstration.

The practical activity students did was simple and did not require extra equipment. They needed a polystyrene ruler that they rubbed against the palm of their hands and held within a few millimetres of the back of their hands. The electrostatic force present on the side of the ruler made hair on the back of their hands stand up, being attracted by the electrostatic forces. David facilitated student discussion on the outcome of the activity but as usual he was doing most of the talking with minimum input from students in the form of short responses to David's questions. The lesson concluded with David reinforcing main points about electrostatics. Overall, this lesson was teacher-centred and didactic in nature. (FN13.03.01).

...teachers tend to be more or less the blackboard and textbook teacher in the science classroom. (Teacher Interview: Norman 13.03.01, line 8)

Practical sessions became fewer in number as the unit progressed due to lack of apparatus and materials. Another teacher interviewed felt that "...some teachers wanted to conduct practical sessions but were constrained by the time factor, overloading of teaching hours, and the unavailability of basic science equipment in the laboratories" (Teacher Interview: Norman 13.03.01, line 9). It was not unusual for David to move apparatus across from the senior Grade 11 and 12 laboratories for his class to use when they were not in use in the senior laboratories.

... We don't have enough materials in the schools like the apparatus and these electrical appliances, meters, voltmeters, ammeters which I can give to the students to help them learn things better. (Teacher Interview: David 13.03.01, line 42)

David did make attempts to involve students during the lessons through questioning techniques and practicals. Despite his efforts the large student number and heavy workloads hindered his efforts to introduce any real improvements in student active participation in the classroom. For example during the first week of observations in the classroom, it was easy to notice the above features in the learning environment.

The excerpt from field notes describing a lesson in the first week of observation provides some evidence below.

Observed a period 5 lesson taught by David on 01.03.01.

1. Due to the large number of students in this class (22 female students and 21 male students), time is taken up for students to settle down in their groups.
2. There seems to be just enough space for students in the science laboratory. However, there were three students seen leaning against the benches because they have no stools to sit on. It is not easy for the teacher to move around the benches to attend to students requiring help.
3. As usual the teacher has a full teaching day today. The heavy teaching commitment tends to affect his movement from one class to another. He comes a few minutes late to the science lesson during period 5.
4. I continued my background interviews with students today.

This was a lesson taught in a single 40 minute period on Humidity that was the last lesson taught before lessons on electricity commence. Students' active participation in class was minimal. The lesson was very much teacher-centred. (FN01.03.01)

During one of his interviews David felt that … "from the general impression what [he] can say is that students tend to see things a bit hard and so at times [he] needed to break concepts down and explain things in more details for them to absorb" (Teacher Interview: David 13.03.01, line17).

David believed students in his class learned well by absorbing science concepts and ideas in small amounts, suggesting a transmissive model of learning. The existing culture in the classrooms promoted a didactic approach to teaching with the sole purpose being for students to pass examinations in contrast to meaningful learning. This situation is also the case in Fiji (Taylor, 1997) a neighbouring Pacific Island state similar to Papua New Guinea in many ways.

David possessed a strong view that his task as a teacher was to ensure that his students understood the science concepts he taught in class. As he stated below, he was concerned that students have difficulty with grasping concepts in science that were abstract.

> … It's not like other topics where things can be seen, felt, …like ecology where they study the environments and the animals, where they see things with their eyes…in real sense. But to do with electricity, it's a bit abstract.

> ...So from the general impression I can say that students tend to see things a bit hard. So at times I need to break concepts down and explain things in more details for them to absorb. (Teacher Interview: David 13.03.0 1, line 14)

David's colleague, a teacher of five years experience felt that teachers were more or less "blackboard and textbook teachers" (Teacher Interview: Norman 13.03.01, line 7). David aptly summarises the teaching and learning process in the classroom environment observed as follow:

> ...Teachers tend to take the whole time to teach them. Students observe only.
> (Teacher Interview: David 14.04.01, line 252)

In general David faced obstacles in his attempts to teach in the way he was trained to teach at University. Resource constraints and the contemporary teaching and learning cultures at school affected his outlook on teaching and learning. He was mindful of the informal traditional teaching and learning approaches inherent in students which influenced his practice in class.

Researcher: The students seem to accept what you tell them easily.

David: Yes, that's one thing that I see. Students don't tend to be asking questions. They think what the teacher says is all true and they don't need to question the teacher as the master of knowledge. I myself think that's not true. Sometimes I'm bound to make mistakes. What I put on the board and what I discuss is accepted as the knowledge which they come to learn and gain. So they accept everything that I say.

Researcher: Why do you think they have this attitude to accept what teachers tell them?

David: I believe it has to link back to their culture. From [our] Melanesian culture we believe that what an elderly person or somebody who is higher in status tells us anything we just accept it as it is true or correct. So culture has to contribute here. So it has determined how they think. Ways of doing things and accepting things has already been determined by the culture. So when they get into the classroom they think that I as a teacher I am somebody higher in status, and what I say is true and they just accept it. In Western countries it's a bit different. Students don't see things like that, they ask more questions and express their curiosity to learn more than just letting teacher becoming dominant over everything inside the classroom. It is the culture that determines the way students learn. (Teacher Interview: David 11.04.01, line 190-212)

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Selected focus students' perceptions of teaching and learning

In Table 1 the focus students' backgrounds, VOSTS results, and Diagnostic Test results are shown.

Table 1.

Comparison of Focus Students

	Student's Background	View of Science from VOSTS	Diagnostic Test Score
Allison	City	Canonical	30%
Ian	Rural	Transitional	30%
George	Town	Canonical	55%
Demi	Rural	Crude/naive	55%

Students in the class were grouped under three categories of rural, town and city; determined by where they attended primary school and spent most of their early years. A Student's background information was significant in providing clues to the level of the student's exposure to modern technology. For example, students who lived and attended primary school in a rural community in Papua New Guinea had less experience with say computers compared to their counterparts in town or city schools who have access to such modern technological equipment. The third column of Table 4.1 indicates the student's predominant view about science derived from the VOSTS questionnaire. Each students' view about science had been classified as either canonical, transitional or crude/naïve depending on the nature of their responses on eight VOST items explained earlier under data sources. These classifications were developed and validated with the assistance of two experienced tertiary science educators. The diagnostic test results in the last column of Table 1 display a score reflecting the correct responses received from students. These scores inversely correlate to the students' level of misconception encountered in the understanding of basic electricity concepts on the Two Tier Diagnostic Test Questionnaire. Thus, the higher the score on the Two Tier Diagnostic Test, the lower is the degree of alternative conceptions registered by the instrument.

To understand the focus students' perspective on teaching and learning in the classroom environment, data on each of the four selected focus students is discussed.

Perspective 1: Allison

Allison was 15 year old and attended community school in the city of Port Moresby before transferring to her home province with her family recently. She enrolled at a top-up community school near her village just outside the town boundaries in order to complete Grades 6, 7 and 8 before proceeding on to high school studies. Allison showed reluctance to neither discuss problems with her peers nor ask questions in class and kept to herself on most occasions. As stated by Allison, she believed she was an independent worker, always trying to find out answers herself and not learning from others. "I just like to do research on my own and …I don't like to learn things from others. I want to learn on my own " (Student's Interview: Allison 01.04.01, line 31).

Allison did not believe in collaborative group work in class during practical and problem solving sessions to enhance learning. The reason given for her behaviour was that she did not trust her peers because they were not experienced. She preferred to discuss schoolwork with experienced people such as her teacher, who she highly respected.

Researcher: Now when you are in class I notice that you normally sit on your own. You
don't discuss things with your friends…now why is that?.. are you shy with your friends or you find the lessons clear and easy to understand.

Allison: Like… as for myself when I see things that are easy I don't try to discuss.

Researcher: Now when you find things hard what do you do?

Allison: I just like to do research on my own and ...I don't like to learn things from others. I want to learn on my own.

Researcher: How about discussing problems with others?

Allison: Like experienced people is ok but …

Researcher: Not other students who are not…

Allison: I don't trust them and I don't like to talk to them. (Student Interview: Allison
01.04, line 15)

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As far as teaching and learning went in her classroom learning environment, she believed David was doing a fine job as a teacher.

> **Researcher**: You are free to comment on the science lessons and whatever that goes on
> in the class.
>
> **Allison**: I like the teaching by Mr. Martin. (Student Interview: 13.03.01, line 43)

Perspective 2: Ian

Ian was 18 years old and came from a rural village higher up in the mountains to the west of the main town. He attended a Community school near his village doing Grades 1 to 6. Due to the local school not being a top up, offering Grades 7 and 8 he transferred to another Community School in town to complete his primary education. His parents were subsistence farmers with no formal education. Their life style was very much unchanged by the influence of modern technology. They lived most of their daily lives as their ancestors did for many years.

As shown in Table 1, Ian displayed transitional views about science on the VOST test that was indicative of his views of science making transformations from a crude, naïve understanding to one which was approaching canonical state. In class he was enthusiastic and regularly responded to David's questions. To Ian, the teacher was always pleasant and very helpful to assist students better understand what he was teaching them.

> **Researcher**: What we are going to do is ask you a few questions on science and you will answer as best as you can – Did you understand the topic electrostatics taught on Tuesday?
>
> **Ian**: ……(No response)
>
> How do you find the teacher's lessons?
>
> **Ian**: Its alright. Mr Martin is a good teacher.
>
> **Researcher**: Why?
>
> **Ian**: Because…. He explains things clearly and is...helpful.
>
> **Researcher**: How is he helpful?
>
> **Ian**: …He explains very clearly… He is helpful. (Student Interview: 14.04.01, line 5)

Ian's views of science were positive and he displayed enthusiasm towards learning in a classroom-learning environment. He was happy with the way David taught the class.

Perspective 3: George

George was 16 years old and came from a family who enjoyed a high socioeconomic status. Having completed Grades 1 to 6 at a nearby Community school to his home, he went to High School to do Grades 7 to 9. Thus, George did not attend a top up Community School. George did exhibit canonical views about science. Of the 20 town students in class, George was one of 2 students and one out of seven students in the entire class of 43 students to register canonical views about science (refer, table 4.1). George portrayed an image of a serious student who wanted to make the most of the opportunity to learn presented before him. He readily participated in the experiments conducted during the practical sessions. On a number of occasions he appeared bored and not challenged enough but did not let his teacher know about it. Despite his strong views about the lessons he showed respect for his teacher.

> **Researcher**: Take a seat George, I am going to ask a few questions about the science lesson we had yesterday and the day before. George, how do you find the lesson in electricity covered by Mr. Martin?
>
> **George**: Most of the exercises Mr. Martin gives to us are easy.
>
> **Researcher**: Easy?
>
> **George**: Yes
>
> **Researcher**: Why do you say it is easy?
>
> **George**: Because..........its not hard to do.
>
> **Researcher**: Did you go to North Side for grades 7 and 8?
>
> **George**: No, here
>
> **Researcher**: So you did grades 7 and 8 here?
>
> **George**: Yes
>
> **Researcher**: So what topics (in electricity) did you cover?
>
> **George**: Electricity...circuits and all those things
>
> **Researcher**: So what you are learning now is all revision?
>
> **George**: Yes. (Student Interview: George 27.03.01, line 21)

Perspective 4: Demi

Demi was a 15-year-old female student living 18 kilometers out of town in a bush material house without power and running water. She completed grades 1 to 6 in a nearby

Government run Community School before attending schools in town. On the VOST test, Demi exhibited views on science which were considered crude/naïve. She was one of 6 out of 12 rural students in class who showed crude/naïve views of science. Demi was a very quiet person in class who only responded when approached. Her participation in class activities was minimal. She had somehow missed units in electricity taught in Community school.

> **Researcher**: How do you feel about your science lesson today on electrostatics? Was it easy to follow or
> was it hard?
>
> **Demi**: Some of them easy and some of them hard. Mr. Mark's tries his best to help us. He is okay.
>
> **Researcher**: Which parts were hard?
>
> **Demi**: ...(no response)...
>
> **Researcher**: You went to Komiufa Primary. Was it top-up school?
>
> **Demi**: No
>
> **Researcher**: Did you do electricity there?
>
> **Demi**: No
>
> **Researcher**: So this is your first time to learn electricity?
>
> **Demi**: Yes. (Student Interview: Demi 13.03.01, line 5)

Summary

The case study served to expand on the information about the teaching and learning activities that featured in this particular classroom from the perspective of the focus students. The focus students accepted their teacher's style of teaching even though George thought most of what was taught was easy to understand as they had been taught earlier in Grades 6 and 7. George was unable to talk to the teacher about how he felt about the lessons. The behaviour of the focus students was generally one of respect and obedience to their teacher, very much inline with teacher-student relationship under the informal traditional teaching and learning styles.

Discussion and conclusion

This paper has attempted to report a small portion of a wider study undertaken in Papua New Guinea which investigated and interpreted the teaching and learning of an abstract science topic of electricity in a Grade 9 classroom. The part of the study reported in this paper has provided an insight into teaching and learning practices in one high school classroom environment in Papua New Guinea. Two central tendencies that emerged from the study are reported below.

First, the study confirmed existing literature on the subject that in the classroom investigated, teaching and learning strategies remained basically teacher centered and involved low-level cognitive structures such as rote learning. There was less emphasis on meaningful learning and the long-term retention of science concepts was not an important consideration in the enacted classroom practice observed. It became obvious towards the end of the study that this mode of teaching and learning highlighted above had become part of the culture of teaching and learning science in this particular school at Grade 9 level. On many occasions David found himself in a situation where he was forced to adhere to the established culture.

Second, findings showed that the students displayed behaviour that was usually present in the informal traditional teaching and learning environment in Papua New Guinea. These included students' tendencies to exhibit non-participatory behaviours such as reluctance to ask questions, not responding to the teacher's questions unless specifically asked, and waiting on the teacher to provide most answers to questions on worksheets and exercises. In practical sessions the teacher was usually expected to show students in a detailed way how to connect electric circuits. These observed aspects of students' behaviour during teaching and learning in this classroom were congruent to the researcher's experience of classroom teaching in schools in Papua New Guinea. In the informal traditional teaching and learning situations of story telling and apprenticeship type model, students listened and learned by imitating what they saw over a period of time. In the classroom environment studied students seemed to display these same behaviours which contrasted with the teacher's expectations of students. David expected students to ask questions, and be responsible for their own learning by participating actively in student centred activities in class.

There seemed to be a mismatch of what the learning environment ought to be in David's class. Students attended the class with perceptions of a learning environment based on elements of the traditional informal model of learning whilst on the other hand, David's perception of a learning environment was one in which meaningful learning was the most desired outcome.

In order to improve students' learning and understanding of science in the particular classroom, new components of cultural sensitivity should be included in the pedagogy aimed at facilitating a bridge or "border crossing" (Aikenhead & Jegede, 1999; Aikenhead, 1996) from the students' culturally oriented views to the canonical views in science and science pedagogy. Aikenhead (1996) argued the following to emphasis the importance of border crossing.

> ...science educators, Western and non-Western need to recognize the inherent border crossings between students' life-world subcultures and the subculture of science, and that we need to develop curriculum and instruction with these border crossings explicitly in mind, before the science curriculum can be accessible to most students.
> (Aikenhead, 1996; pp. 2)

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