ABSTRACT

Studies in astronomy education have shown that socio-cultural factors combine with everyday human experience to create learning difficulties that are unique to this field. The history of astronomy also shows a complex link between science and religion. The foundations of modern astronomy lie in religious beliefs and practices, but over time, in the West, as science grew ever more powerful in explaining the apparently mechanistic processes of nature, the beliefs and understanding associated with scientific explanations came into conflict with those of the Christian church. In Africa, Western religious and scientific beliefs were brought by the missionaries, and imposed onto already existing beliefs systems. From colonial times to the present, Western knowledge has been privileged over local knowledge in African formal schooling. Little recognition has been given to the learning difficulties that may be caused in situations where the knowledge system taught at school is different to that imbibed through home and culture.

The difficulties of epistemic access have been highlighted through the development of socio-cultural constructivist theories of learning. This study, which is based on the socio-cultural constructivist theories of cultural border crossing and collateral learning, represents an investigation of the learning difficulties experienced by South African first year university students who study a compulsory course in basic astronomy called 'The Earth in Space'. The sample was thus a convenience sample, made up of 191 students who took the course between 2000 and 2004.

The investigation was carried out using a pre-instruction questionnaire to record the pre-course knowledge of the students. The questions that were asked focused on knowledge related to some of the key concepts in basic astronomy, such as an understanding of the nature of stars, the rotation and revolution of the earth and the phases of the moon. These questions had the dual purpose of benchmarking South African students' knowledge of the scientific explanations for these phenomena against similar international studies, as well as establishing the prevalence of cultural or traditional ideas held by these students. After the course had been completed, a post instruction questionnaire was used to establish students' views on the difficulties they had experienced in learning in the course. This was followed up by semi-structured interviews with 25 of the students.

The data obtained from the questionnaires were analysed using two methods: the first used a deductive coding system where the students' responses were allocated to chosen categories, i.e. whether they conformed to the explanations of Western Modern Science or to cultural knowledge and beliefs, or both. The second method used a computer software programme, Atlas.ti, where each statement made by the student was recorded and coded, leading to an inductive, fine-grained analysis of their responses.

The results from the pre-instruction questionnaire indicated that South African students display similar poor levels of knowledge in this field, to students from other Western and non-Western countries. The explanation for this lies in the fact that understanding the scientific explanations requires the ability to think abstractly, and to be able to construct complex mental models, in situations where the processes involved run counter to normal daily experience. However, the explanations given by the South African students also indicated that there were epistemological and ontological issues, related to conflicting beliefs in terms of culture and religion, which exacerbated the barriers to border crossing

in this field. However, the data indicated that students did not find it as difficult to cross the barriers created by cultural or traditional beliefs as those caused by fundamentalist Christian beliefs. The biggest obstacle to learning related to conflict between creationist and scientific accounts of the formation of the Earth and Universe. While this is not unusual, as shown by studies carried out in the United States, where religious students are also affected by the apparent conflict between Christianity and science, the most significant finding of this study related to the existence and extent of this conflict in Black African students.

In post-1994 South Africa, the revision of the national education system has resulted in a science curriculum that recognizes 'other ways of knowing'. These refer specifically, however, to Indigenous Knowledge Systems (IKS) rather than religious beliefs. The curriculum does not acknowledge that African ontology is religious. It also does not recognize the duality of this ontology in terms of African Traditional Religion and Christianity, which is the stated religion of the majority of Black South Africans. The findings of this study indicate that because of the nature of African philosophy, religious ways of knowing need to be explicitly acknowledged as one of the 'other ways of knowing'. Such acknowledgement by science teachers and lecturers would help to prevent these different knowledge systems from being discarded or compartmentalized, which was found to lead either to the promotion of scientism, or to the preclusion of meaningful engagement with science.

DECLARATION

I declare this thesis my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or Examination in any other University.

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DEDICATION

Breaking the silence
Of an ancient pond,
A frog jumped into the water -
A deep resonance.
Basho Matsuo
(in Rhor, 2004, 53)

This work is dedicated to the
students who broke their silence
and shared their experiences with me.
May the ripples they created
be helpful to others involved in
teaching and learning.

I also dedicate this work to
my husband Roger,
and our daughters
Kathleen, Megan, Hayley and Rachel
who shared the journey with me

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LIST OF ACRONYMS

AB	Alternative Beliefs
ANT	Actor Network Theory
ATR	African Traditional Religion
COS	College of Science
CDE	Centre for Development and Enterprise
CNE	Christian National Education
ESL	English Second Language
G	Geography Preliminary and Geography Foundation
HPS	History and Philosophy of Science
IKS	Indigenous Knowledge Systems
MS	Mainstream Geology course
NOS	Nature of Science
OBE	Outcomes Based Education
PD	Primary Document
RNCS	Revised National Curriculum Statement
SAARMSTE	Southern African Association for Research in Mathematics, Science and Technology Education
SAASTE	South African Association for Science and Technology Educators
WMS	Western Modern Science