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Teachers' perceptions of inquiry-based learning in urban, suburban, township and rural high schools: The context-specificity of science curriculum implementation in South Africa

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HIGHLIGHTS

- Physical Sciences teachers' perceptions of inquiry learning in South African high schools.
- Positive perception of inquiry learning regardless of the teaching context.
- Didactic method considered more effective for student learning in disadvantaged schools.

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ABSTRACT

This study investigated the perceptions of physical sciences (physics and chemistry) teachers on the implementation of inquiry-based learning at a diversity of high schools in South Africa. The findings show that teachers at all locations of school have a positive perception of inquiry-based learning, with benefits for learners that include the development of experimental skills and making science more enjoyable. However, with regard to inquiry facilitating conceptual understanding, teachers at township and rural schools believe a didactic approach to be more effective than learners doing inquiry, whilst teachers at suburban and urban schools favour an inquiry-based approach in this regard. The significance of this study is that the lack of resources, large classes, and the limited exposure to inquiry of learners at township and rural schools constrain the implementation of inquiry-based learning at these schools, and result in teachers at such schools resorting to a didactic pedagogy.

1. Introduction

"Inquiry" has become a perennial and central term in the rhetoric of past and present science education reforms (Abd-El-Khalick et al., 2004). According to the Inter-Academy Panel (IAP) (2012) Science Education Programme that promotes an inquiry-based science education approach, inquiry-based learning allows learners to develop "key scientific ideas through learning how to investigate and build their knowledge and understanding of the world" by using "skills employed by scientists such as raising questions, collecting data, reasoning and reviewing evidence in the light of what is already known, drawing conclusions and discussing results" (p.19). This conception of inquiry means that it is more encompassing than practical work where learners observe and/or handle objects or materials (Millar, 2009).

A revised South African school science curriculum advocates an inquiry-based approach to learning that encourages learners to "explore objects, situations and events in their immediate environment, to collect data and record information and draw conclusions accurately" (Department of Education, 2002, p.34). This imperative is also expressed in the new *Curriculum and Assessment and Policy Statement* (CAPS) document which states that physical sciences is a subject that "promotes knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships" (Department of Basic Education, 2011, p.8).

These developments in South Africa mirror the worldwide reform trends in science education. In the United Kingdom, Attainment Target 1 for Science in the National Curriculum has apportioned much priority to inquiry (Department for Education

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and Employment, 1999). In the United States, the American Association for the Advancement of Science (AAAS, 1993) and the National Research Council (NRC, 2011) endorse inquiry-based science curricula. In the recent publication of the NRC (2011) entitled "A Framework for K-12 Science Education" when referring to inquiry, the term "practices" is used instead of "skills" to stress that engaging in inquiry requires the coordination of both knowledge and skills simultaneously. The following "practices" are identified: asking questions (for science) and defining problems (for engineering); developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations (for science) and designing solutions (for engineering); engaging in argument from evidence; and obtaining, evaluating, and communicating information (p.42).

This study investigates the perceptions of physical sciences teachers from urban, suburban, township and rural schools in South Africa on the implementation of scientific inquiries. Physical sciences is a high school subject in grades 10, 11 and 12. Learners are taught topics in physics and chemistry. Bybee (1993) underlines the pivotal role of the teacher in curriculum implementation by maintaining that teachers are the "change agents" and the ones that shape the nature of classroom instruction and curriculum reform efforts. This suggests that if teachers do not represent the curriculum innovations in their practice, the entire process of curriculum change is compromised and eventually fails. Furthermore, the context-specificity of curriculum implementation is described in that "individual decisions are neither directly culturally universal nor policy-specific" but are "absolutely singular, applicable in one case and one case only" (p. 43). The weight of classroom decisions and how they relate to curriculum reform, therefore, falls most heavily on the individual science teacher. Understanding teachers' views about an innovation in the science curriculum could therefore possibly increase the chance of success in implementing such an innovation (Brown, Abell, Demir, & Schmidt, 2006; Roehrig & Kruse, 2005).

A number of studies throughout the world have revealed that despite the strong curriculum endorsement for inquiry-based learning, implementation has been varied across educational landscapes. Classroom contexts are complex and diverse in terms of resources, the educational and cultural backgrounds of students and teachers, school culture and class size, and these all factor in the extent and degree to which educational change is manifest (Chin & Chia, 2006; Howitt, 2007; Zion, Cohen, & Amir, 2007). In South Africa, these differences are quite pronounced. The previous Apartheid education system was segregated into departments for Blacks, Whites, Coloureds, and Indians. The funding of these departments was unequal, with the per capita expenditure for a White student five times that for a Black student (Foundation for Research Development, 1993). Most teachers at high schools for Black learners were unqualified to teach science (Murphy, 1992). Learners at such schools produced dismal results in high stakes national examinations in science (Naidoo & Lewin, 1998).

The scenario of poor facilities, poorly qualified science teachers and poor science performance still prevails amongst Black learners despite the integration of the previous racially aligned departments of education into a single department (Kriek & Grayson, 2009). In most cases, schools which were previously reserved for a particular race, still remain overwhelmingly populated by that group (Chisholm & Sujee, 2006). A legacy of the apartheid policies is, therefore, the enormous diversity of schools. Black learners mainly attend township and rural schools that are located in communities with a low socio-economic profile. Despite attempts by the post-Apartheid government to redress the historical imbalances, these township and rural schools remain poorly resourced (Magopeni & Tshiwula, 2010). The parents of learners are generally poorly educated and have low paying jobs. In contrast, urban and suburban schools that are largely attended by White learners, generally have better facilities and are located in communities with a higher socio-economic status (Erasmus & Ferreira, 2002). In view of this persistent inequality in the South African education system and the curriculum imperative for inquiry-based learning, this study investigated the perceptions of physical sciences teachers at urban, suburban, township, and rural high schools on four key issues that lie at the heart of the interplay between research, policy and practice of inquiry-based learning. These issues are now discussed and later invoked in the investigation.

2. Framing the implementation of inquiry-based learning: Four key issues

An extensive review of research on the implementation of inquiry-based learning raises four key issues. These are, the benefits that are perceived to accrue when learners do inquiry, inquiry-based learning and assessment, the extent of autonomy that learners are allowed during inquiry, and the competence of teachers in enacting inquiry in their classrooms. A review of literature on these issues now follows.

2.1. *Benefits of inquiry-based learning*

Studies have reported that inquiry-based learning experiences stimulate interest in science (Deboer, 2002; Gibson & Chase, 2002; NRC, 2005), improve understanding of concepts (Gott & Duggan, 2002; Westbrook & Rogers, 1996), lead to an understanding of the nature of scientific knowledge (Quintana, Zhang, & Krajcik, 2005), facilitate collaboration between learners (Hofstein & Lunetta, 2003) and help to develop experimental skills (Drayton & Falk, 2001). Furthermore, a research review by Minner, Levy, and Century (2010) that synthesised the findings from research conducted between 1984 and 2002 on K-12 student outcomes, reported that 51% of the 138 studies in the synthesis showed positive impacts of some level of inquiry science instruction on student content learning and retention. The overall finding was that having students actively think about and participate in the investigation process increases their science conceptual learning.

One of the aims of the study reported upon here was to explore the perceptions of physical sciences teachers from diverse school settings on these benefits. By doing so, it would be possible to establish whether there were trends or patterns in the perceptions of South African physical sciences teachers on the benefits of this curriculum reform.

2.2. *Inquiry-based learning and assessment*

Despite curriculum reform that underlines inquiry-based practices in the science classroom, there is a strong focus on high-stakes summative assessment in the form of tests and examinations in South Africa's education system. This is significant as Blanchard et al. (2010) allude to studies (e.g. Saka, Southerland, & Brooks, 2009; Settlage & Meadows, 2002; Shaver, Cuevas, Lee, & Avalos, 2007; Wideen, O'Shea, Pye, & Ivany, 1997) that indicate the influence of the high stakes nature of standardized summative assessments on the classroom practice of science teachers. Blanchard et al. also point