Soweto Science Centre as a flagship community engagement initiative

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Abstract. A flagship community engagement initiative is coordinated within the Faculty of Science at the University of Johannesburg. This initiative takes the form of a strategic and innovative instructional intervention which makes provision for tutoring of learners in the Further Education and Training (FET) band by providing tuition through contact sessions on Fridays, Saturdays and during school recess at the Soweto Science Centre. Learners are drawn from schools located within Soweto Township and the surrounding areas. Prior to the commencement of the mentoring intervention, learners' pre-entry characteristics in terms of the conceptual competence in various Physical Science knowledge areas covered at school were established through carefully structured knowledge, synthesis and application-type questions which formed an integral part of a diagnostic conceptual assessment instrument. In particular, the findings of this research revealed inadequacies in relation to the Physics content covered at schools as well as the competency of the FET teachers in the Physics conceptual knowledge areas investigated. Key findings that emerged from this investigation appear to be commensurate with documented research studies on Physical Science teachers' content knowledge and pedagogical content knowledge within the broader South African educational context. Implications for the coherent infusion of strategic and innovative instructional interventions in various educational settings are discussed.

1. Introduction

Skills development remains a key facet in terms of the realisation of sustainable growth in various sectors of the economy. This development hinges on the demonstration of competence in key knowledge areas such as science, mathematics, engineering and technology. However, South Africa's global ranking in terms of the quality of mathematics and science education as well as the quality of the overall education system paints a gloomy picture as compared to other developing countries [1,2]. Concerted efforts are required to bring about a fundamental transformative change that would serve to generate the desired appropriate quality leading to the restoration of public confidence in the South African education system.

In response to these crucial imperatives, the Soweto Science Centre (SSC) was established in 2010 as a flagship community engagement initiative located within the Faculty of Science at the University of Johannesburg. In terms of its key strategic mandate, the Soweto Science Centre provides tuition to Grade 10, 11 and 12 learners from schools located within Soweto Township and the surrounding areas. The key activities of the Soweto Science Centre include teaching theory lessons in Mathematics, Physical Science, Life Sciences and Environmental Sciences, conducting supervised laboratory and tutorial sessions, teaching English for scientific communication, provision of computer training, presentation of public lectures, participation in Science Expos, participation in the annual national science week, as well as the provision of career guidance and other science related activities [3]. Table 1 below provides learner enrolment information at SSC during the period 2013-2016.

Table 1. Learner enrolment at SSC during the period 2013-2016

Year	Subject	Grade 10	Grade 11	Grade 12	Total
2013	Mathematics	211	190	231	632
	English	211	190	231	632
	Life Sciences	143	140	135	418
	Physical Sciences	157	150	144	451
2014	Mathematics	169	201	198	568
	English	169	201	198	568
	Life Sciences	169	198	170	537
	Physical Sciences	186	192	191	569
2015	Mathematics	312	277	232	821
	English	312	277	232	821
	Life Sciences	62	57	40	159
	Physical Sciences	250	220	192	662
2016	Mathematics	255	319	196	770
	English	255	319	196	770
	Life Sciences	242	287	175	704
	Physical Sciences	251	317	194	762

2. Instructional approach

Evaluating the efficacy of instructional interventions is an inevitable and indispensable task requiring meticulous execution in order to ensure coherent achievement of envisaged outcomes. The instructional approach adopted and utilized by the Soweto Science Centre is underpinned by Peer-Mediated Instruction and Intervention (PMII) [4] as an instructional philosophy. In terms of theoretical clarity, PMII is an alternative classroom arrangement in which students take an instructional role with classmates. This approach makes provision for students to work in pairs or small cooperative learning groups. In addition, PMII provides alternatives to traditional arrangements of lecture, demonstrations and independent study. In essence, students are taught roles by the teacher for purposes of systematically instructing other students coupled with the provision of monitoring and facilitation of students' progress [4].

3. Research design and methodology

A survey was conducted through the administration of a conceptual assessment instrument probing students' conceptual knowledge in various knowledge areas in Physical Science. The conceptual assessment instrument was essentially administered as a pre-test in 2014 when the learners were in Grade 10 and as a post-test in 2016 when the same sample of learners were in Grade 12. The instrument consisted of 20 multiple choice items.

4. Findings

Figure 1 below illustrates Physical Science knowledge areas perceived to be difficult to comprehend by the learners. Mechanics as a vast conceptual area characterised by a myriad of alternative conceptions appeared to be the most difficult conceptual knowledge area for the learners as indicated by a higher percentage of students. This observation is commensurate with the notion that students come to the study of Physics with pre-conceived conceptions about how the world works [5]. In addition, Chemical Bonding as well as Waves were perceived to be abstract conceptual knowledge areas to grapple with by virtue of their complexity.

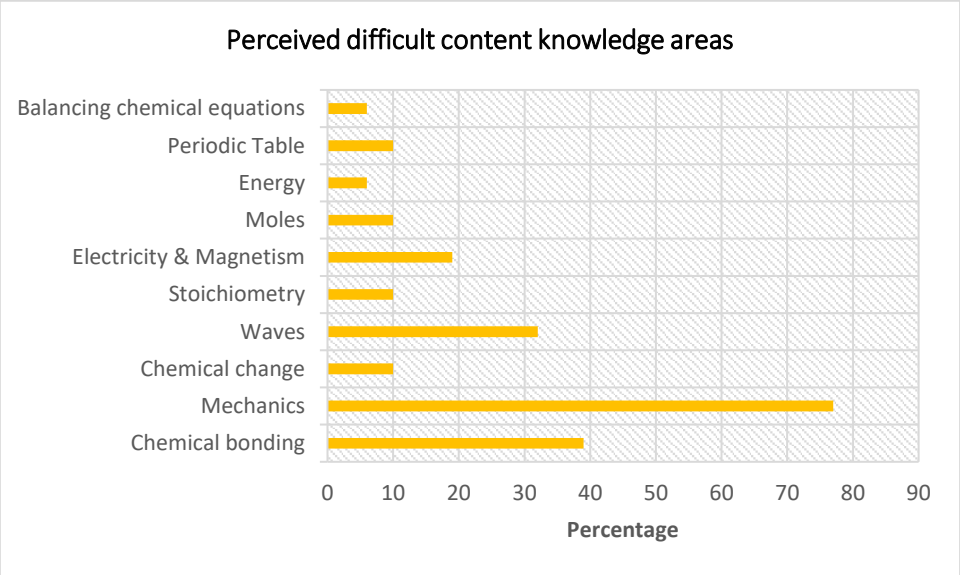

Figure 1. Perceived difficult content knowledge areas

Table 2 below depicts learners' pre-test and post-test performance.

Table 2. Grade 10 learners' pre-test and post-test performance

Percentages	Pre-test (Number of learners)	Post-test (Number of learners)
0 – 10%	67	0
11 – 20%	2	0
21 – 30%	0	1
31 – 40%	0	12
41 – 50%	0	15
51 – 60%	0	25
61 – 70%	0	14
71 – 80%	0	4
81 – 90%	0	0

The pre-test performance revealed that a substantial number of learners fell within the 0-10% performance range. However, the post-test scenario reflected a marked improvement in the overall learner performance which appears to be a positive shift in terms of the comparative performance. Pre-test and post-test numbers were slightly lower than the enrolment due to learner absenteeism. In addition, it is important to note that the same students were tracked over the period under review. As indicated in Figure 2 below, the learners largely expressed positive sentiments in relation to the mentorship opportunities provided by the Soweto Science Centre as compared to mentorship opportunities provided at school.

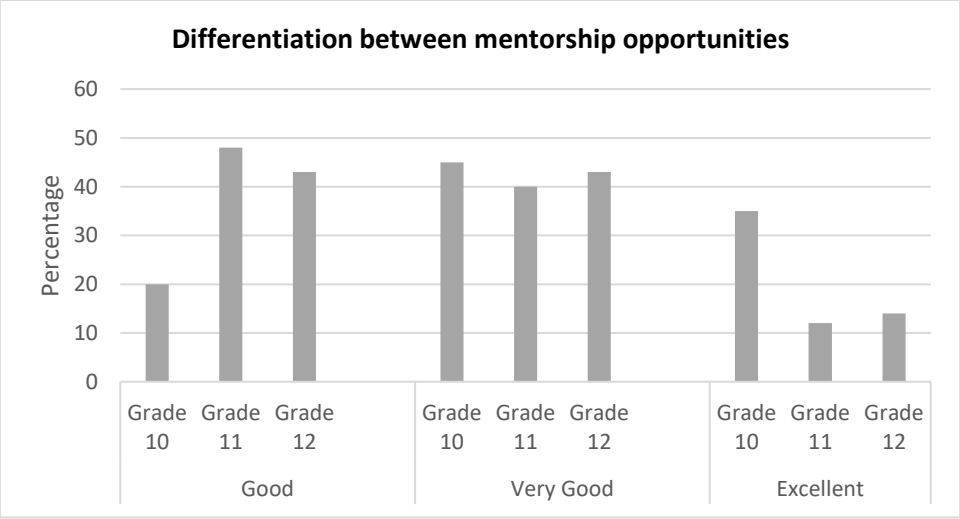

Figure 2. Overall differentiation between the mentorship opportunities provided by the SSC and mentorship opportunities provided at school

The mentorship opportunities provided by the Soweto Science Centre appear to provide the capacity to consolidate the maximisation of the learners' academic experience leading to an enriched learning environment. More specifically, a substantial number of learners who wrote National Senior Certificate (NSC) Examination during 2016 obtained bachelor (B) and diploma (D) passes as indicated in Table 3 below.

Table 3. SSC NSC examination results (2016)

Achievement level	Number of students
Level 6	102
Level 4	42
Level 2	14

Cognitive and affective factors associated with learning are central to meaningful learner performance in any instructional setting. Figure 3 below provides an array of content domains perceived to be intellectually stimulating as indicated by the learners.

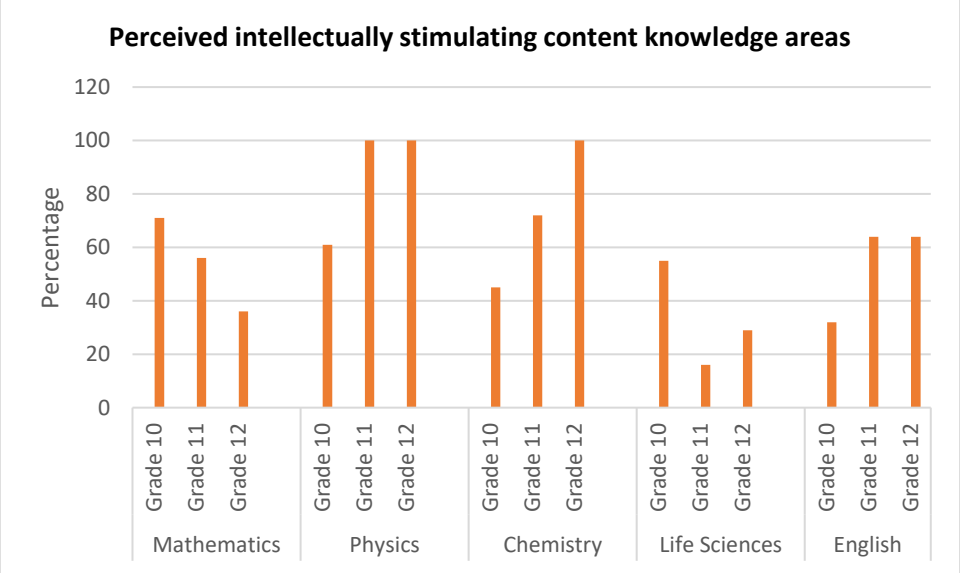

Figure 3. Perceived intellectually stimulating content knowledge areas

5. Discussion

Research on students' conceptual understanding remains a key strategic focus area of immense significance. Research into students' construction of scientific concepts concludes that most students exhibit creativity and intransigence in their quest to circumvent the construction of scientific concepts [6]. In addition, conceptual difficulties encountered by students in Newtonian Mechanics in particular have their origins in their understanding of kinematical concepts [5,7,8]. At another pragmatic level, deeply rooted alternative conceptions are associated with intuitive ideas or preconceptions acquired prior to learning at school [9]. It has also been established that these intuitive ideas are not just learned from experience but are built into the hardware of the brain [10]. The potential efficacy of the mentoring opportunities provided as part of the instructional intervention by the Soweto Science Centre resulted in a positive shift in terms of learner performance post instruction. Such interventions ought to be fully explored particularly within a broader South African context for purposes of adequately addressing conceptual knowledge gaps and conceptual inadequacies associated with various content domains.

6. Conclusion

Meaningful human capital development within the South African context requires effective and innovative instructional interventions geared towards the provision of appropriate mentorship opportunities. Mentorship opportunities provided as part of the instructional intervention by the Soweto Science Centre appear to have huge potential which ought to be harnessed for the benefit of learners in the medium to long term.

References

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