INVESTIGATING SOME BACKGROUND FACTORS AFFECTING STUDENT PARTICIPATION IN SCIENCE FAIRS: A CASE STUDY OF A REGIONAL EXPO FOR YOUNG SCIENTISTS

Mdutshekelwa Ndlovu

Stellenbosch University Centre for Pedagogy (SOUTH AFRICA)

Abstract

Learners’ participation in science fairs has been encouraged on grounds of affording them opportunities to carry out hands-on practical activities such as scientific investigations oriented towards inquiry science. However, there has been some debate as to the usefulness of the science fair to ill-equipped learners in disadvantaged schools as their cultural capital deficits appear to deny them opportunities to compete on an even keel with learners from historically advantaged schools (where learners have higher accumulations of all forms of capital) in South Africa. The purpose of this study was to conduct an exploratory analysis of non-school (background) factors influencing student participation and success rate at a Regional Expo in South Africa’s annual science fair for learners – the Expo for Young Scientists. Participation in the Expo is acknowledged to be one opportunity for learners to experience the highest levels of scientific inquiry. The study was a quantitative analysis of a convenient sample of 36 schools that participated in the Regional Expo in respect of variables such as distance from the venue, school type (primary, intermediate, combined or high school) gender equity, and poverty quintile categories. Findings were that only 5.1% of eligible schools in the region participated. Distance from the venue was a deterrent for many potential schools. Historically advantaged schools in quintiles 4-5 (higher socio-economic status) did not only have a superior participation rate as a measure of equity, but also had a higher success rate as a measure of the quality of participation. However, not all schools in the so-called upper quintiles 4-5 category performed well, suggesting that the neglect of scientific investigations or scientific inquiry could be more pervasive in schools than initially assumed thus giving pre-eminence to home background factors. The study recommends democratization of participation through decentralization, increased funding for ICT, laboratory infrastructure, science centers, science fair participation logistics, and increased technical support for teachers in disadvantaged schools.

Keywords: Expo for Young Scientists, science fair, principles of scientific inquiry, scientific investigations, the nature of science, cultural capital, school poverty quintile

1 INTRODUCTION

South Africa’s learner achievement in mathematics and science has been unsatisfactory in both local and international assessments, e.g. National Senior Certificate, Annual National Assessments, Southern and East African Consortium for Measurement of Educational Quality (SACMEQ) and, most of all, the Trends in International Mathematics and Science Study (TIMSS). The 2003 TIMSS report shows that less than a third of the learners watched a demonstration or conducted an experiment or investigation [1]. This is a disconcerting picture for the effective teaching of science which, in its very nature is quintessentially a group of practically oriented disciplinary fields. Much of the low academic achievement of South African students, like in many other parts of the developing world, can be substantially attributed to the fact that mathematics and science teachers are among the least qualified and lack properly functioning schools (e.g. [1]; [2]; [3]). Competent teachers are a non-negotiable prerequisite for the effective functioning of school systems and, consequently, positive student learning outcomes, not just in South Africa but the world over. The Human Sciences Research Council (HSRC) reports that 53% of South African grade nine science learners who participated in TIMSS 2011 were taught by teachers who had completed a degree [4]. The less qualified teachers are the less the prospect of effective science teaching taking place. South Africa also unenviably has one of the highest indices of educational inequality in the world [5]. Understandably, the degree of educational inequality mirrors socio-economic inequalities in the broader society and thus a strong correlation unsurprisingly exists with the Gini index of income inequality in which South Africa is only second to Chile internationally. In the midst of the raft of inequalities, schools, which are constitutionally mandated to redress or atone for these inequalities in disadvantaged communities may actually carry the brunt of neglect as the quality of support they receive from their marginalized...
communities may be negligible. Given that the majority of learners come from disadvantaged state funded schools, it is not surprising that the national average quality of science and mathematics education falls dramatically short of international competitiveness by the World Economic Forum’s Global Competitiveness reports (e.g. [6]; [7]), where South Africa has consistently ranked very poorly (144th out of 144 countries) and by international benchmark test standards (e.g. [8]; [9]) where South African learners ranked second worst testifying to the crisis of educational inequality besetting the school system.

Participation in science fairs carries with it the potential to provide learners with experiences of high levels of inquiry science. It however, appears that successful participation, does not only depend on the teachers’ efforts but also on the cultural capital of the school and the individual learner. Teaching science in the traditional science classroom has characteristically meant that learners frequently sit listening passively or transcribing notes to commit to memory while teachers talk and chalk about the content, structure and results of scientific knowledge. This traditional orientation has been more dominant in under resourced schools implying that the authentic practical experience of the nature of science might be inadequate for many learners and more so those hailing form marginalized communities. The Expo for Young Scientists, a science fair sponsored annually in 26 regions by the power utility ESKOM in South Africa, offers learners an opportunity to engage competitively in scientific investigations that are in keeping with the principles of scientific inquiry and curriculum requirements. Many studies indicate that hands-on activities such as science fair projects are central to the epistemology and appeal of science (e.g. [10]; [11]). In light of the potential the Expo offers, this study sought to explore some extraneous socio-economic factors influencing learner participation in the Expo and to make recommendations for future redress. Such an exploration is pertinent in initiating and sustaining debate about levelling the seemingly uneven playing field. To accomplish that goal, the remainder of this paper first frames hands-on activities in science within scientific inquiry principles and then discusses [12]’s cultural reproduction theory as a possible explanatory framework for learners’ ability to participate and to succeed in the Expo. Secondly the research questions are formulated and the methodology adopted for the study is elaborated upon. Thirdly, the results are presented, discussed and conclusions drawn, and recommendations made.

1.1 Levels of scientific inquiry

While [13] state that at its heart inquiry is an active learning process in which students answer research questions through data analysis they point out that the most authentic inquiry activities are those in which students answer their own questions through analyzing data they collect independently. The superlative ‘most’ suggests the existence of levels of authenticity. [13] affirm that an activity can still be inquiry based when the questions and data are provided, as long as students are conducting the analysis and drawing their own conclusions. Building on the work of [14], [15] propose a hierarchy of four levels of inquiry activities, viz:

1.1.1 Level 1 - Confirmation activities

Students are provided the question and the procedure and the expected results are known in advance. For example laboratory experiments to verify results that are already known.

1.1.2 Level 2 – Structured inquiry activities

Students investigate a teacher-presented question through a prescribed procedure but results. Both level 1 and 2 are commonly referred to as ‘cookbook labs’ since they contain step by step instructions. The difference is that level 2 activities answer a research question or it can also be a matter of timing in that a Level 1 activity can become a Level 3 activity by presenting the experiment before teaching the target concept.

1.1.3 Level 3 – Guided inquiry activities

Students design or select the procedure to carry out the investigation. A teacher presented question features but the methods and solutions are left open to the students. Guided inquiry activities have the potential to take student engagement and ownership to a new level. However, the teacher still has to approve the procedures and ensure that proper safety precautions are taken before the investigation is carried out.

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1.1.4 Level 4 – Open inquiry activities

Problems, solutions, and methods are left to the student and science fair projects are the most common form of level 4 inquiries.

Level 4 activities assume that students have had prior experience with Levels 1-3 activities. That is, students cannot be expected to conduct high level inquiry investigations after having participated exclusively in low-level activities [13]. Accordingly students cannot be expected to participate successfully in Expo type projects unless they have a strong foundation of scientific inquiry activities at all levels in their science classrooms. However, the quality of student participation may not just be a proxy for the quality of instruction received but also the quality of out-of-school support provided which implies links to Bourdieu’s theory of cultural reproduction.

1.2 Bourdieu’s cultural capital theory

To avoid reducing the social world to a series of instantaneous mechanical equilibria between agents [12] proclaims the imperative to reintroduce the notion of capital, in all its forms, together with its accumulation and all its effect. He argues that the structure of the distribution of the different types and subtypes of capital at a given moment in time represents the inherent structure of the social world, i.e. the set of constraints, inscribed in the very reality of that world, determining the chances of success for practices. [16] defines cultural capital loosely as ‘those cultural traits that help people to gain educational success’. Bourdieu ([12]; [17]) claims that cultural capital or better, informational capital can exist in three forms: in the embodied state (or long-lasting dispositions of the mind and body); in the objectified state or cultural goods (such as pictures, books, dictionaries, instruments, machines, etc); and in the institutionalized state (such as educational qualifications). He claims that the notion helped him to explain the unequal scholastic achievement of children from different social classes, i.e. the profits obtained by the children in the academic market. In other words, success in modern societies is facilitated by the possession of cultural capital and of higher-class habitus[1].

This theory suggests that students are distributed in the overall social space according to the volume of cultural capital they possess and according to the composition of their capital, i.e. the relative weight of the various forms of capital (economic, cultural, social and symbolic) [16]. Therefore students with higher accumulations of cultural capital in the form of educated parents, higher socio-economic status, attendance of elite schools, would appear to stand a better chance of success in educational endeavors which may include participation with success in science fairs. Bourdieu’s concept of cultural reproduction is epitomized when cultural success breeds educational success which in turn breeds cultural success. That is, according to Bourdieu’s theory of cultural reproduction, cultural resources associated with the middle-class home facilitate the acquisition of educational credentials [18] which underwrite success in life. The school poverty quintile on the other hand is an indicator of the socio-economic status of the school in South Africa on a scale ranging from 1-5 from poorest to the least poor schools (e.g. [4]; [19]) and to that extent can serve as an indicator of accumulated cultural capital.

2 RESEARCH QUESTIONS

The aim of this study was to explore the factors influencing Expo participation and success rate of learners from different school quintiles in order to make recommendations for future improvements. To achieve this aim the following research questions guided the study: What factors impacted the participation rate of schools? What factors impacted the success rate of schools?

3 METHODOLOGY

The methodology adopted for the study was a quantitative design. To address the research questions participation records were analyzed in terms of school types (representative of the economic, cultural and social capital accumulations of learners) and the medals and special prizes won. The sample of participating schools was a total of 37 primary and secondary schools. The total number of learners who participated was 329 of whom 153 were juniors (grades 7-9) exhibiting 97 projects and 176 were seniors (grades 10-12) exhibiting 113 projects. Since all schools that participated were included in the analysis, this was a purposive sample. Of the 329 learners 112 were male and 217 were female. The total number of eligible schools was determined through a navigation of the Western Cape Education...
Department’s website according to district. The results of the participation and success rates were analyzed statistically using the appropriate graphs, tables and indices.

4 RESULTS

4.1 Analysis of the Expo participation rate of schools by type

Overall, 36 schools participated in a region consisting of four districts with a total of 712 schools of all types. The overall participation rate was therefore about 5.1% of all eligible schools. Of the 36 schools that participated more than fifty percent of them were high schools and only 13.5% were primary schools and the rest were either intermediate or combined schools. The intermediate and combined school entrants were largely grades 7-9 and 10-12 suggesting a bias towards secondary school learners in these schools in keeping with the region’s emphasis. Fig. 1 is a pie chart showing the proportion of schools that participated by type.

Table 1 shows the distribution of school participation by distance from the venue. Some schools had to traverse long distances by virtue of the rural nature of the districts that make up the Stellenbosch region.

Table 1: Participation rate by school distance from the venue

<table>
<thead>
<tr>
<th>Distance from venue</th>
<th>0&lt;d&lt;20</th>
<th>20&lt;d&lt;50</th>
<th>50&lt;d&lt;200</th>
<th>200&lt;d&lt;300</th>
<th>300&lt;d&lt;400</th>
<th>400&lt;d</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of participating schools</td>
<td>6</td>
<td>10</td>
<td>9</td>
<td>2</td>
<td>9</td>
<td>1</td>
<td>37</td>
</tr>
</tbody>
</table>

For state funding purposes, South African schools are classified according to poverty quintiles as described above. More money is allocated to poorest schools and less is allocated to the least poor schools. The quintile score of a school is calculated based on the national census data for the school catchment area with respect to income, unemployment rate and level of education [19] which correlates with the cultural capital accumulated by the school. Fig. 2 shows participation of schools by poverty quintile levels 1-3 and 4-5. At 70.3% the least poor schools clearly dominated the participation rate.
Fig. 2: Proportion of school participation by poverty quintile category

Fig. 3 is a graphic illustration of the participation rates of learners by grade category (junior/senior) and school poverty quintile category and confirms the numerical dominance of learners from the quintiles 4-5 category. Although the least poor school participation rate stood at 70.3% the participation by number of learners and projects averaged 84% in both junior and senior categories. This meant that the majority of learners who participated in the Stellenbosch region Expo in 2010 came from well-to-do schools.

4.2 Analysis of the Expo success rate of schools

The Expo awards were of two kinds: medals and special prizes. Judges awarded marks in three parts, Part A (maximum of 30 marks for written communication of the project as contained in the poster and the project file), Part B (maximum of 20 marks for oral communication in the interview of the learner(s)) and Part C (maximum of 50 marks for the overall scientific and originality levels of the research investigation project). An exhibit was awarded a gold medal if it scored 80% or above, a silver medal for a score of 70-79% or a bronze medal for a score of 65-69%. Special prizes were awarded to best projects in categories sponsored by various organizations.

Overall the schools in the quintiles 1-3 category won 4 medals and two special prizes out of a total of 137 medals and special prizes awarded in the event. That is, schools in quintiles 1-3 although constituting 29.7% of the schools that participated (and 15.3% of the learners that took part) actually won only 4.4% of the medals and special prizes. Fig. 4 graphically illustrates the success rate by medal or prize type and school poverty quintile category. Ninety-six percent of the gold medals, 97%
of silver medals, 96% of bronze medals and 93% of special prizes were won by schools in quintiles 4-5. Only one gold medal was awarded to a school in the quintile 1-3 category out of eleven schools in this category. Ten out of 26 schools in the quintiles 4-5 category managed to win gold medals but 12 (7 plus 5) or nearly half of the gold medals were scooped by the two best schools in this quintile category. Sixteen of the schools in the quintiles 4-5 category did not win any gold medal.

![Fig. 4: School success rate by medal type and school quintile category](image)

Furthermore, Table 2 shows the Spearman-rank correlations between the success rate of the school at the Expo and school fees levels, as well as between the number of computer laboratories and science laboratories. The results suggested a strong positive correlation between the school income level and success at the Expo and a fairly strong correlation between the number of laboratories and the success rate at the Expo.

<table>
<thead>
<tr>
<th>Variables of correlation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation between success rate at the Expo and school income level</td>
<td>0.7</td>
</tr>
<tr>
<td>Correlation between success rate at the Expo and number of laboratories</td>
<td>0.6</td>
</tr>
</tbody>
</table>

5 DISCUSSION OF RESULTS

5.1 Socio-economic factors influencing the participation rate at the Expo

That only 5.1% of total eligible schools (or 17.3 % of high schools) participated in the Expo, suggested that it was a fairly exclusive club. That only one percent of primary schools eligible attended, reflected the absence of emphasis in encouraging them to participate although it could be a logistical challenge if all of them attended. That of those schools which participated 70.3% were in the quintiles 4-5 category suggested that participation in the Expo was largely for elite schools. However, the varied income levels of schools in quintiles 4-5 (R220-R445002 per annum per learner) suggested that the allocation of some schools to this category could have created an illusion that they were well-resourced. Distance was a major deterrent, even though ten schools located more than 300 kilometers away from the venue managed to participate courtesy of corporate funding for the furthest district. Limitations imposed by distance could, however, be overcome by decentralization of the

\[1\text{US$} = \text{R11.30 at the time of going to press}\]
preliminary rounds of the Expo to district level but more funding would have to be mobilized from the corporate sector. The participation of girls exceeded expectations as two in every three participating learners were female. A factor partly accounting for this unexpected distribution could have been the location of two quintile 5 girls high schools close to the venue and together accounting for close to 25% of the girl participants. By contrast, a quintile 5 high school for boys also located in the proximity of the venue opted to participate in another region.

5.2 Socio-economic factors influencing the quality of success at the Expo

The success rate as measured by the number (and type) of medals and special prizes won evidenced gaps in the quality of projects between school poverty quintile categories. That 26 schools in the quintiles 4-5 category between them won 96% of the prizes was evidenced the gaps in the quality of guidance learners received. However, not all so-called quintiles 4-5 schools produced high quality projects. More surprising though, was that about half the gold medals were won by two schools making it a non-contest for the eleven that did not win any medal at all. On the surface of it this suggested that some schools participated without adequate preparation to enhance their learners’ chances of success and teachers of such schools needed more support from the university organizers.

That school success rate correlated strongly with school income as measured by school fees levels (coefficient of 0.7) and the availability of infrastructure as measured by the student to laboratory ratio (coefficient of 0.6) suggested that schools which were under-resourced (with poorer socio-economic capital) stood a worse off chance of participating effectively in the Expo and a worse off chance for dispensing effective mathematics and science education on a routine basis.

6 CONCLUSION

The results of this study suggest that non-teacher factors that worked in favor of participation were school type, school distance from the venue and school poverty quintile. Factors that favored success were largely school socio-economic status (school poverty quintile) as a proxy not only of the accumulated cultural capital of the learners but also accumulated economic and social capital. The poorer quality of projects produced by schools in the lower poverty quintile category suggested weaker school and out-of-school cultural capital support systems. This study thus concurs with [20]’s observation that township school learners find it difficult to compete at science fairs fairly with learners who have laptops when they don’t have any themselves. This study also appears to support the claim by [21] that South Africa’s education system is still predominantly a tale of two schools: one which is wealthy, functional and able to educate students, while the other is poor, dysfunctional, and struggling to equip students with the necessary skills they should be acquiring in school.

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REFERENCES


