FACTORS INFLUENCING THE LEARNERS’ PERFORMANCE AT SCIENCE FAIRS
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ABSTRACT: Rural learners do not perform well at science fairs although research indicates learning science in the out-of-school setting is beneficial. This qualitative research is a case study and seek to determine the factors influencing the performance of learners at science fairs, and more specifically in the Limpopo province of South Africa. Furthermore, the study determined differences among learners from rural and urban schools in terms of the factors applying the 3rd generation activity theory framework as an analytical tool. To address triangulation, Personal Meaning Mapping, Focus Group Discussions, and Observations were used. Every instrument addressed issues of dependability, credibility and trustworthiness. The study involved eleven learners, 6 from rural schools and 5 from urban schools in a province in South Africa with the lowest performance. Themes were identified that could be useful for understanding the best way to increase learner engagement and focus as well as quality of science projects. Findings from this study established that poor performance of learners at science fairs is due to; poor school facilities, lack of support, lack of mentors, lack of equipment, lack of computers and computer illiteracy. This study has contributed 2 new areas which are level of attention and depth of knowledge of learners'; criteria which were not used with science fairs studies before.

Keywords: Science fair; activity theory, personal meaning mapping

1. INTRODUCTION

Science fairs are events where learners’ science projects are shown and judged for prizes (Merriam-Webster, 2016). However, the original idea of science fairs is for all citizens of a country to make them understand science and what it is all about (Flanagan, 2013). In South Africa, the best-known science fair is the science expo and called Eskom Expo (EE). The purpose of this Eskom Expo is to provide a platform for learners to gain valuable work experience, to connect high-achieving youth to innovators, to enrich their skills, to inspire them to explore their passions and become more knowledgeable on the topic they are studying (National Research Council, 2012).

A significant number of teachers believe that science fairs could help learners to develop skills, attitudes, and knowledge leading to a career (Czerniak, 1996). Therefore, schools, parents and science mentors should provide a platform for learners to explore their interests in a less formal environment to enable innovation and creativity in Science, Technology, Engineering and Mathematics (STEM) (Wagner, 2012). It is also known that learners who participate in science fairs improve academically (Kahenge, 2013).

In South Africa, the science fair competitions are done from school level, regional or provincial level and finally national level. The learners with the best science projects from the provincial competitions will proceed to the national science fair, which are normally held in the first week of October each year. In order for a project to win a gold medal, it must score 80% and above, a silver medal 70-79% and a bronze medal 61-69% as judged by adjudicators. Sadly, for the past 3 years, learners in Limpopo province have not won a single gold medal at the national science fair. This is a cause for concern, given that at the local provincial competitions the learners win gold medals.
Therefore, this study have two aims. Firstly, to determine the factors influencing the performance of learners at science fairs, and more specifically in the Limpopo province of South Africa. Secondly, to determine if there are differences among learners from rural and urban schools in terms of the factors.

2. THEORETICAL FRAMEWORK

The activity theory, initiated by Lev Vygotsky, is a philosophical framework used to study human activity, practices and actions (Barab, Evans, & Beak, Activity theory as a lens for characterizing the participatory unit. In D. H. Jonassen (ed.), Handbook of research on educational communications and technology: A project of the association for educational communications and technology (pp. 199-214), 2004). The activity theory was modified and it was decided to choose the 2 interacting activity systems with interacting objects which give rise to the 3rd object (see figure 1) and thereby to the 3rd generation activity theory as it includes the interconnecting of individuals and the community as an analytical tool. This tool was chosen, firstly to analyse the components of activity and secondly to compare the 2 groups of participants; the rural and urban learners.

The Activity Theory describes a triangular structure with 6 interdependent and related components as follows:

![Activity Theory Diagram]

Figure 1: Two interacting activity systems with shared object as model for the third generation of activity theory (Engeström, 2001: 136) (Engeström, Expansive learning at work: Toward an activity theoretical reconceptualization, 2001)

The newly appeared ‘third object’ gives rise to a driving force for the transformation of the original activity system by means of feedback to the respective activity systems namely the rural and urban learners.

The various components of the activity triangle (Engeström (1987) are described below as well as how it is implemented in this study:

The **object**—the purpose of the activity is the science fair, the school based science fair (object 1) is improved to the regional science fair (object 2) which is later upgraded ti the international science fair (object 3).

The **subject**—the individual actor in this study are the participating learners.

The **community**—the combination of all actors; in this study, the community refers to all stakeholders, learners, teachers, school administrators, department of education officials, science fair personnel, judges, mentors, and parents.

353
The **tools**—the artifacts are what is used by the learners in producing their science projects for example laboratory equipment, materials, documents etc.

The **division of labour**—refers to how the research projects are carried out; if it’s a group project it must be clear who does what and using what.

**The rules**— all science fair regulations and ethical requirements.

The **outcome**- this is the outcome of learner activity, the final research project and it also includes the result of the science fair adjudication.

According to the activity theoretical framework, learners’ science projects are to be taken as tools and have a mediating role between the outcome and the subject in the activity systems of research work.

### 3. METHODOLOGY

To gain an in-**sider** view (Creswell, 2014) of the factors influencing the performance of learners the constructivism and interpretivist paradigm was taken as point of departure. An exploratory case study research design was followed. An inductive analysis, which is the identification of patterns and themes in the data, was applied (Bertram & Christiansen, 2015; Creswell, 2014; Leedy & Ormrod, 2010; Nieuwenhuis, 2010). This provided insight into the learners` view on science fairs and possible reasons for their performance or failure.

#### 3.1 Sampling

The sampling was purposeful and participants for this study were drawn from the 4 Eskom Expo districts of Limpopo province. A simple random selection procedure using project category numbers was utilised to select participating schools. The selected sample consisted of 11 learners (6 from rural schools and 5 from urban schools) taken from the regional science expo finalists.

#### 3.2 The instruments

The instruments used to collect data were, Personal Meaning Mappings (PMM), interviews, observations and focus group discussions.

##### 3.2.1 Personal Meaning Mapping (PMM)

The PMM afford the learners` the platform for communicating their science fair experiences, yielding descriptive qualitative data (Leftwich, 2012). The PMM provides a methodological tool for learners to evaluate their experiences at science fairs in terms of type of experience and depth of knowledge.

##### 3.2.2 Observation protocol

An observation protocol was set up in terms of the level of attention shown by the participants throughout the science fair activities. This was important as it could offer a base of how the learners were focused and engaged during the science fair. In addition, learner behaviours and activities in terms of interaction with other exhibitors, and for example, the reading of display boards of other participating learners were noted.

##### 3.2.3 Focus Group discussion (FGD) protocol

354
To elicit what learners think are the factors influencing the performance in the science fair, 8 questions were used as guideline, namely:

What are the reasons according to you for poor performance in science fairs? What do you think is the expectations to achieve well from your school?

What are your views on your teachers` involvement with your research project? What form of assistance do you expect from your school?

What would you expect your parents/guardian to do for you in order to assist you with your science project?
What are your views on the science fair judges?
Do you understand the scientific method of doing a research project? What should be improved on science fairs?

The Focus Group Discussion protocol was piloted with a group of 5 learners who were not part of the group under study. These students had to indicate any unclear questions that needs to be changed. One of the questions for example, “If your circumstances were changed do you think you could perform better?” was changed to “What are the reasons according to you for poor performance in science fairs?”

4. DATA COLLECTION AND ANALYSIS

The learners completed the PPM; the researcher completed the observation protocol and the answers to the FGD were captured on a voice recorder.

4.1 Data analysis of the PPM

The analyses of the PMM were done both within and across participants (Bertram & Christiansen, 2015). The type of learner experience was separated into four options: object, cognitive, introspective and social (Pekarik, Doering & Karns, 1999). For example object experiences entail “seeing “the real thing”, while cognitive experiences describes the gaining of information or knowledge. The introspective experiences include imagining different places and times and social experiences entails the spending time with friends, family and others.

The depth of knowledge of the learners were analysed based on a four-level categorisation: recall, concept, strategic thinking and extended thinking (Webb, Alt, Ely & Vesperman, 2005).

4.2 Data analysis of the observations

The levels of attention of the learners were evaluated by using the following categories: distraction, focus and engagement (Bitgood, 2010). Their engagement were analysed by observing the learners` behaviours and activities in terms of how they interacted with other exhibitors and reading display boards of others.

4.3 Data analysis of the FGD

The FGD were analysed using thematic analysis (Mayring, 2014; Seidman, 2012). This method was chosen because it would give science fair organisers specific details on what influences the learners’
performances at science fairs so that they can make informed decisions about current and future science fairs.

5. RESULTS
5.1 Personal Meaning Mapping (PMM)

The learners’ PMM in terms of types of experience was analysed using four dimensions which are; object experience, cognitive experiences, introspective experiences and social experiences.

The learners’ PMM in terms of the depth of knowledge was analysed based on the four-level categorisation; recall, concept, strategic thinking and extended thinking.

![Depth of Knowledge](image)

**Figure 2: Depth of knowledge**

**Observations**

Observations were done by looking at the level of attention using the three categories (see Table 3) formulated by Bitgood (2010).

**Table 3: The level of attention showed by both rural and urban learners.**

<table>
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<tr>
<th>Level of attention</th>
<th>Indicators</th>
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<tr>
<td>Distraction</td>
<td>Of the 11 learners under study, 4 learners (36.4%); 3 from rural school and 1 from an urban school, were distracted, not involved, they were talking outside most times, carefree attitude and playful.</td>
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<tr>
<td>Focus</td>
<td>5 learners (45, 6%); 3 from urban schools and 2 from rural schools were seen looking at other science projects in passing.</td>
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<tr>
<td>Engagement</td>
<td>Only 2 learners (18%) from urban schools were observed reading other displays and asking other learners, and teachers, or judges.</td>
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![Level of attention: Rural school learners](image)

**Figure 3: Level of attention**
Focus Group discussion (FGD)

Three themes emerged from the analysis of the FGD, namely communication, support and assistance, equipment and computers. Rural learners said they were not getting information about science fairs on time and that support they get from their school, teachers and parents is very minimum. Unlike rural learners, urban learners enjoy a lot of support and their schools have equipment and computers which they use in their researches.

Discussion and findings

The purpose of this study was to identify the factors influencing the performance of learners at science fair competitions in the Limpopo province and determine if there are differences among learners from rural and urban schools. All the activity systems are interrelated and they inform each other for effective object; the science fair project.

The qualitative data from the FGD, PMM and observation were triangulated in order to validate results due to the small sample size and the 3rd generation activity theory lens was used to interpret the data accordingly.

Data across all the three instruments indicate that the main reasons for performance of learners are due to the following:

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<th>Table 5: Findings table</th>
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<td>Rural learners</td>
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The differences in learners’ perceptions towards science fairs between learners from rural schools and those from urban schools:
Learners in the majority of rural schools indicate that they are not supported by the school, teachers and parents. The communication of information about science fairs does not get to the rural schools on time.

The urban learners’ views science fairs as a link to becoming a scientist, meeting scientists and making new friends. The lack of resources has been documented as disadvantaging learners (Gifford & Wiygul, 1992; Flanagan, 2013). The results of this study concur with previous studies that the poor quality of judges affects their competence and that some judges are biased (Atkins, 2014; Bernard, 2011). The findings in this study show that teachers and parents are not supporting learners and this concurs with other previous studies (Betts, 2014; Finnerty, 2013; Kahenge, 2013). This study has further introduced the aspects of level of attention and depth of knowledge of learners which provided more light as to why learners fail to perform at science fairs.

Summary and Conclusion

The overall findings of this study show that while learners embraced the use of scientific methods of research, their understanding of the same is very shallow. Learners in Limpopo province perform poorly in the international science fairs because they lack parental and teacher support, schools do not have computers and those with computers do not allowed learners to use them. Teachers indicate to learners that science fairs are extra work for them and are not part of the school curriculum. The judges at science fairs are incompetent and biased hence poor quality projects are allowed to sail through to national competitions. The learners are supposed to learn from each other during science fairs; this study has revealed that learners’ levels of attention are too low and they are distracted and not focused during the science fair.

Future studies

For future studies, this paper draws attention to three areas that could be investigated. Firstly, to investigate the effect of computer literacy and availability of computers with the carrying out of science fair projects. Secondly, to investigate the teachers’ views and conceptions on science fairs since they are the ones mostly assisting the learners and finally to replicate this study in all provinces of South Africa.

References