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Full Length Research Paper

Evaluation/impact assessment study of the chemistry student laboratory project

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The evaluation is about the implementation of a project aimed at testing the impact of the chemistry project in the secondary schools of the NorthWest Province. The selection of the sample followed a proportional random procedure. It was estimated that a sample of 400 learners was required in order to ensure adequate power of the Analyzes and generalizability. This sample comprised of the treatment group of learners who have experienced the chemistry programme to various extends in grades 11 and 12. The assumption was that the project will involve schools in a good deal of fundamental rethinking of the curriculum and this was more likely to show up in schools where the project has long been established. The interest was in the growth of learner performance through the programme which was offered in grades 10, 11 and 12. Since the evaluation was conducted in September 2006, performance was examined in grades 11 and 12 in both project and non project schools. The performance assessment tasks involved 10 learners from each grade in each school. The learners (5 boys and 5 girls) were chosen from the class list that was made available to the administrators. The performance assessment tasks were administered in 40 schools involving a total of 800 learners. The sampled learners also completed the attitude questionnaires to solicit their attitudes towards chemistry. In addition, the administrators also interviewed curriculum specialists and university lecturers who were involved in the training of educators. The educator questionnaire was also administered to the project educators. This data was used in answering the general evaluation questions relating to the achievement of the project goals and options for the future of the project. Results indicate that learners with more positive attitudes towards chemistry are more chemistry literate. The attitude and literacy scores for project schools were higher than those of non-project schools. This was hypothesized to be the case at the beginning of the project and is the major finding of the evaluation, verifying the project in terms of its goals and to increase chemistry literacy through the study of chemistry education. The project educators and curriculum specialists had a quite positive attitude towards the training they received, both in content and organization. Concern was expressed with regard to how the training related to the National Qualifications Framework, and what formal qualification will result from the training. A quite specific need has been satisfied by the project and materials, but then eventually (around the year 2007) these were no longer appropriate. Elements of them were valuable for certain aspects of the general year 7-9 Natural Sciences education. Prior to the year 2007, the materials were evaluated and some redesign took place in order to match them with the developing national curriculum.

Keywords: Evaluation, impact assessment, chemistry, student, laboratory project

INTRODUCTION

Background and terms of reference

Over the period 2003-2006, the North West Department of Education has provided funds in support of the Chemistry Student Lab Project. The goal of the project was to support scientific human resource development in

the province by assisting the improvement of the quality of chemistry education. The Chemistry Student Lab Project began in 2003 with the selection of 112 schools, the training of educators and the teaching of learners in Grade 10. In 2004 the project grew to include 115 more schools. In 2005 another 228 schools were supplied with the kits. In 2006, 455 schools were involved across grades 10, 11 and 12.

Booklets (worksheets and content modules), video cassette and mini chemistry lab kits were provided as educator support material. Educator training consisted of working through the books and kits. Lecturers from the Chemistry Department of North West University (Potchefstroom Campus) were responsible for the training of educators as well as the development and supply of the kits.

The objectives of the project were to enable educators and learners to:

- Be able to identify a problem and devise a plan of action to solve it,
- Be able to process data,
- Apply the scientific method of reasoning and scientific procedures to acquire data,
- Observe carefully and correctly the changes occurring during chemical processes,
- Develop manipulating skills by experimenting on their own,
- Construct the correct visual images necessary for the formation of concepts and models,
- Be able to give a scientific explanation for the phenomena that fall within their field of study,
- Be able to write down their observations,
- Develop a positive attitude towards chemistry and the natural sciences as a result of their experimentation, observation, interpretation, peer learning and group work, and
- Be conscious of the use and misuse of chemicals and chemistry

A significant feature of the project is the partnership between the Department of Education and North West University. The Professional Support Services Chief Directorate commissioned the Quality Assurance Chief Directorate to undertake an evaluation of the Chemistry Student Lab Project, on 01 September 2006. A major objective of the evaluation has been to make recommendations as to the nature of any potential future funding of the project. The empirical report would serve as a strong empirical data to decide if the project should continue or not.

Following discussions with Professional Support Services Chief Directorate, the specific brief for Quality Assurance was agreed to centre on the impact that the project has had in schools, on educator, subject advisors and learners and on project implementation issues concerning for example the training and preparation of educators. As part of this evaluation, we as Quality Assurance have been asked to make a judgment of overall project success by choosing one rating from the following scale:

Highly successful

Objectives/outcomes completely achieved or exceeded and very significant benefits in relation to costs

Successful

Objectives largely achieved and significant overall benefits in relation to costs

Partially successful

Some objectives achieved and some significant overall benefits in relation to costs

Unsuccessful

Objectives unrealized and no significant benefits in relation to costs

Largely unsuccessful

Very limited achievement of objectives and few significant benefits in relation to costs

In making this judgment we have been asked to provide a full commentary in and justification for our conclusions and to make recommendations on future strategies for North West Education Department support of the Chemistry Lab Project.

Evaluation Questions

This evaluation was designed to provide guidance with regard to the future of the project, given that NWED financial support will cease after 2006. The terms of reference for the evaluation research arose from an examination of the original goals of the project.

The evaluation questions are:

i. What impact does the project have on learners' concepts and attitudes towards chemistry?

- Do Grade 12 learners have significantly more positive attitudes and concepts about chemistry than grade 11 learners?
- Do learners participating in the project have significantly more positive attitudes and concepts about chemistry than other learners?
- Does the 2005 project group have significantly more positive attitudes and concepts about chemistry than the 2004 pilot group?
- What are the attitudes of educators towards chemistry student lab project?

ii. What impact does the project have on learners' performance in chemistry?

- Do Grade 12 learners know significantly more about chemistry than Grade 11 learners?
- Do learners participating in the project know significantly more about chemistry than other learners?
- Do the 2005 group have more sophisticated ideas about chemistry than the 2004 pilot group?

a. Are there significant gender differences within the learners?

Is there a significant difference between males and females in their concepts and attitudes towards chemistry?

Is there a significant difference between gender differences between the treatment and the control groups?

b. To what extent have the goals of the project been achieved?

c. What is the projected future of the project?

The collection of data to enable the evaluation questions to be answered involved both the qualitative and quantitative methodologies

METHODOLOGY

Qualitative methodology

Qualitative data was collected from descriptive documents about the project and from a structured interview process with people representing interested parties in the project. These included the subject advisors, educators of participating schools and Potchefstroom Chemistry Department features. This group represented a purposive sample, selected within the time and space limitations of the evaluation schedule and to ensure input from all representative groups. This data had been used to assist in answering the general evaluation questions relating to the achievement of the project goals and options for the future of the project.

Quantitative methodology

The main thrust of the quantitative methodology involved a comparison between learners who had participated in the project and other learners who had not participated, through the selection of treatment and control groups in the sample. An additional helpful methodology would have been a pre-test/post-test longitudinal design, but this was not feasible because of the absence of comparable initial data. A quasi-longitudinal design was possible be making comparisons between learners who had been in the project for a number of years (grade 12 learners) and those for whom this was their second year (grade 11 learners). The other aspects of the methodology revolved around the effect of the independent variables on the dependent variables in a number of combinations.

variables

The dependent variables were represented by two instruments which were administered to the learner sample, namely attitudes about chemistry and the performance assessment task. The independent variables considered were gender, treatment and grade. These are summarized in Table 1.

Table 1: Variables

Dependent variables
Chemistry literacy and knowledge
Attitudes about chemistry
Independent variables
Treatment
Gender
Grade

Instruments

The instruments used in the evaluation were designed and developed by Science Subject Specialists in the Quality Assurance Chief Directorate. The instruments were graphically designed, rechecked for face and internal validity, modified and printed. They were then administered to the selected sample.

Task validity

The question of validity is notoriously difficult but very important. If we wish to claim that our activity is valid we are making a claim that if learner does well at it, it is because they are good at chemistry. If they do poorly at our activity, it is because they are poor at chemistry. We would wish to claim that our activity is a valid predictor of real technological performance. The problem however, is that there is no simple measure of validity.

One way to establish validity would be to examine learner assessments on chemistry projects over an extended period using an educator who is recognized as an expert in the field. One could then create a rank order of learner capability. Thereafter, one would administer the activity to these same learners, assess the work and create another rank order. If the activity is a valid measure, then these two rank orders ought to correlate well. For many reasons, this means of establishing validity was not available to us and we therefore developed a different approach, based on the judgment of an expert panel. Given a set of experts in the field of chemistry education, it is reasonable to ask whether they believe that the activity represents what they regard as an authentic chemistry task. This is referred to as face validity.

Sample

The selection of the sample of learners followed a proportional stratified random procedure based on schools. It was estimated that a sample of 400 learners is required in order to ensure adequate power of the Analyzes and generalizability to the population of 4000 learners (40 learners in each 20 schools). This sample comprised the treatment group of learners who have experienced the chemistry programme to various extends in grades 11 and 12. The control group is of equipment size and distribution as illustrated in table 2.

Table 2: Proposed sample groups

ESTIMATED EVALUATION GROUPS		
Grade	Treatment Sample	Control sample
11	200	200
12	200	200
Total	400	400

Description of the Sample

A total of 800 learners were finally involved in the collection of quantitative data. This sample is described in the following tables in terms of the variables of treatment (Table 3), gender (Table 4) and grade (Table 5). The sample utilized was very similar to that proposed in order to ensure valid generalization to the population

Table 3: Sample divided into treatment and non-treatment groups

TREATMENT		
Category	N	%
Treatment	354	49
Non-treatment	372	51
Total	726	100

Table 4: Sample divided by gender

GENDER		
Category	N	%
Male	356	49
Female	348	48
Incomplete returns	22	3
Total	726	100

Table 5: Sample divided into grades

Grade		
Category	N	%
11	367	51
12	336	46
Incomplete returns	23	3
Total	726	100

FINDINGS AND DISCUSSION

Qualitative findings and discussion

The impression gained from talking to a broad range of people involved in the project is that it is received positively and it is beneficial. Very few voices of dissent were registered as far as the value of the project is concerned. The attitude toward the future of the project is generally optimistic, but not without concern in a number of areas. The following data describes the findings from interviews and discussion with the qualitative sample.

Project level and content

The project materials are well structured and the modules well organized. A quite specific need has been satisfied by the project and materials, but eventually (around 2007). These will no longer be appropriate. Prior to 2006, the materials will need to be evaluated and some redesign takes place in order to match them with the developing national curriculum. The links between the project and the curriculum need to be fostered well before them in order to maximize the experiences gained through the project, and maximize the experiences gained through the project, and in order to ensure the flow-on of its continued benefits.

Subject advisors

The subject advisors generated an effective enthusiasm for chemistry education. As fieldworkers their responsibilities have moved to more educator and school support. They recommend the student lab as a teaching strategy as it helps learners to develop the necessary skills, knowledge and values as stipulated in the Assessment Standards for Physical Science.

Concerning the dissemination of teacher experience, all the subject advisors to whom we spoke recognized the scale of the task of training educators in order to disseminate the chemistry student lab programme more widely. The following comments were commonly voiced:

- Satellite schools could be grouped around experienced schools
- Pilot schools could run workshops - a cascade model
- We could video some lessons and send them to other schools

Project educators

Concerning the training of educators, they commented that the training was highly effective in helping them to

completely transform their approach to teaching and learning. This pedagogic transformation was attested to by almost every educator in the project.

Concerning the pedagogy underpinning the programme, it has been the active, problem solving pedagogy, that educators have been trained to use. There are several elements comprising support for this new pedagogy:

It makes learning easy and enjoyable

- It is easier to learn because you have practical and theory put into practice
- Enjoy the teaching styles and interactive learning
- There is fun

In attempting to solicit from educators what they believe were the important issues regarding resources, the majority are of the view that the resources were not sufficient. Knowing how expensive and attractive chemistry resources are, security of facilities was seen as very important.

The benefits of the programme to educators are universally agreed by the subject advisors and the educators themselves. Stated simply it is that the programme has enriched and empowered them – as individuals and as professionals:

- The opportunity to grow
- The educator is very much enriched
- It has boosted their morale
- I am more skilful now – I don't match – I do

These benefits to the educator centre in their classroom practice, but over spill into their personal view of themselves as professionals throughout the school.

Quantitative findings

The scores are averages across the whole sample and are on a scale 1-4.

	Project	non project	difference	t-test
Holistic	2.53	2.18	0.35	0.03
Project sample	year 11	year 12	difference	t-test
Holistic	2.59	2.48	-0.11	0.63
Non project sample	year 11	year 12	difference	t-test
Holistic	2.27	2.10	-0.17	0.43

SUMMARY

In summary, the project has been successful in most aspects and is a model of education / industry partnerships. NWU is to be applauded for their foresight in establishing this programme in 2003. The verification for the need of such programmes in South Africa has only increased since then.

There are significant quantitative advantages to learners in studying chemistry through the NWU modules. Project material should continue to be developed with consideration given to the directions as indicated in the national curriculum, and the project should be more widely implemented within the province.

The management of the project should be transferred to the provincial department of education. The project model should be used in the development of chemistry education resources for primary and middle school educators.

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