THE DEVELOPMENT, IMPLEMENTATION AND EVALUATION OF

INDUSTRIAL SCIENCE 203

AT

KILDONAN EAST REGIONAL SECONDARY SCHOOL

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ABSTRACT

No suitable science curriculum materials existed for the vocational students at Kildonan East Regional Secondary School. This study is concerned with the development, implementation and evaluation of the Industrial Science Course 203.

The population for whom the course is intended consists of students that range in age from seventeen to twenty years. Their communication and mathematical skills range from a grade five rank to a grade ten rank with the majority of the population at a grade eight level. The course content is activity orientated and is based on laboratory work that aligns itself with the students' vocational requirements. The content consists of single concept activities that are expressed in terms of behavioural objectives. The course was implemented in a highly structured manner that gives students a reliable routine. The structure is designed to give the students maximum security, success, and a feeling of accomplishment.

The effectiveness of the course was measured by:

a) Compiling and analyzing the results of tests and laboratory activities that were submitted by the teachers involved in the study.

b) Evaluating the results of a semester end achievement test.

c) Evaluating the results of an attitude scale. Form A of the Purdue Master Attitude Scale was used as a pre and posttest.

The evaluation indicates that the students accomplished the goals of the course. The evaluation also indicates that the positive attitude that the students had formed in the 103 Science Course increased as a result of the 203 course.

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CHAPTER I

INTRODUCTION

Rationale

At the beginning of the academic year 1971 - 1972 the first comprehensive schools in Manitoba opened their doors to the student public. Kildonan East Regional Secondary schools (KERSS) was one of the first to start its operation. Kildonan East serves the eastern suburbs of the city of Winnipeg.

During the first two years of operation it became very apparant that the existing Industrial Science Curriculum, which consisted of the traditional courses of IME, IPS, BSCS, Chem Study and PSSC was not meeting the needs of many of the students attending the school. These courses were developed for University bound students; ninety-five percent of the KERSS students are not university bound. Lloyd M. Cooke (1975) in his address to the NSTA National Convention recognizes this type of situation. He stated that the teaching of science to the disadvantaged student becomes a challenge. In fact,

> The Challenge becomes an overwhelming problem when students are below grade level in the three R's disinterested in science, and in school and sometimes openly rebellious.

He also stated that in order for these students to learn,

> It should be a standard practice to help a student achieve success early. There are few disciplines and few areas of learning to which students are exposed that offer as many success opportunities as do science classes. Here the student can be encouraged to carry out experiments that lead to verification of basic laws. Almost no place else can you do this.

The author and the science teachers at Kildonan East had come to a similar conclusion; the vocational students must be offered a new and improved curriculum suited to their needs and interest. An extensive search of literature and known resources revealed that no suitable curriculum materials in the Industrial Science area existed. A decision was made to construct our own curricular materials. Edward C. Buller and the author accepted the responsibility of compiling and constructing a science program for three years of industrial science education.

The development of this alternative Industrial Science curriculum began during the spring term of the academic year 1972 - 73. The first year of Industrial Science 103 was implemented in the first semester of the 1973 - 74 academic year. Edward C. Buller monitored the implementation of the course and completed the initial evaluation in the spring of 1975.

The second year Industrial Science 203 was completed by September, 1974 and was implemented in the first semester of the 1974 - 75 academic year. The author monitored the implementation of the Industrial Science 203 course and conducted the evaluation in accordance with this study.

Identification and Statement of the Problem

The purpose of this study is:

i) To trace the development of the course materials for the Industrial Science 203 course by describing the specific steps taken in constructing the curriculum,

ii) To describe the teaching techniques developed to implement the science 203 course,

iii) To evaluate the course and teaching techniques by seeking answers to the following questions:

a) To what extent did the students meet the instructional objectives of Industrial Science 203?

b) To what degree did the students maintain the attitude acquired as a result of the 103 course of study?

Limitations of the Study

Industrial Science 203 was developed to meet the needs of a very special situation. Since the first implementation of the course in the first semester of the 1974 - 75 academic year the requirements of the provincial Department of Education have changed greatly. The course has become optional. Consequently, students that are registering in the course tend to be more motivated than the original population and may thereby have a more positive attitude toward science than originally anticipated.

The rapid change in technology as related to the vocational areas is changing the course demands. One of the most revolutionary changes that occurred during the period in question is the dramatic advent of the cheap multifunction pocket calculators. It is therefore evident that this study and its results are most relevant to the stated interval of time.

The vocational students, and students in general identify a course of studies very closely with the teacher responsible for the course. This study dealt with five individual classes taught over two semesters by three different teachers. The study makes no effort to isolate any of the teacher variables.

The sample number involved in the study is relatively small. This is because of the optional nature of the course and the wide choice available to the students in their second year.

Kildonan East usually experiences an eight to ten percent withdrawal rate during each semester of the second year. The students that withdraw are usually experiencing insurmountable difficulties in their vocational and academic endeavours. These students are not part of the study population. The fact that they are omitted will tend to skew the study results toward the positive sector.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Before setting up the Industrial Science Courses an attempt was made to find curriculum materials pertinent to the circumstances at KERSS. A search of known resources did not produce the necessary materials.

Therefore the following parameters were designed to provide a framework for a search of literature that would allow the writer to construct curriculum materials pertaining to the described student population:

i) Characteristics and problems of the disadvantaged student,

ii) Successful teaching strategies for the disadvantaged student,

iii) Curriculum structures concerned with the disadvantaged student,

iv) Curriculum structures for vocational students,

v) Curriculum evaluation,

vi) Similar studies.

Problems for the Disadvantaged Student

With the advent of the comprehensive schools in Manitoba many students who formerly dropped out of school now remain in school for the full twelve year term, which brings about a whole set of new problems.

As E. C. Kelly (1971) writes:

> The dropouts in school and out are legion. In some ways they seem faceless. Our society being what it is they have no place in it except in school. They are wasting their time often deteriorating rather then improving. They constitute our greatest waste. They can give us our greatest opportunity.

The Nuffield project in England concerns itself with similar students and suggests a direction:

> Rapid technological changes mean that their world is likely to be different in many ways from the present, we can help them to appreciate that changes will occur and to have some understanding of the scientific and technological factors involved.
>
> For that reason a narrowly vocational approach is unsuitable; interest in possible future jobs can be a form of motivation for some but if present trends continue many of our people will have a variety of jobs for some years after leaving schools.

The education of the vocational students must be as general as possible. This, hopefully, will enable them to cope with a rapidly changing technological society and fluctuating employment conditions.

Another problem that many schools are grappling with, is that of the sporadic attendance of the students in question. R. W. Bybee (1974) gives a possible reason for this situation:

> If a student has continually been told he is a failure and underachiever who can't cope with science, the conditions are established for fear, anxiety or non involvement to be associated with science classes---so why try.
>
> At upper grade levels this type of fear is seen in an overt rejection of class or school "you can't fail in school if you aren't there".

Attendance is one of the chief problems plaguing the industrial courses. In fact attendance or lack of it could be used as an indicator as to whether or not the courses are satisfying the students needs.

Teaching the Disadvantaged Student

The science teachers experienced considerable difficulty in attempting to employ techniques and methods that were successful in academic classes. These students require very structured and activity orientated instruction. The students had to be given a great deal more personal encouragement and success. R. W. Bybee (1974) suggests a set of five parameters of science teaching:

1. Provide activities that are an academic challenge to the student while opportunity for success is at a maximum.

2. Give personal encouragement to each student as often as possible.

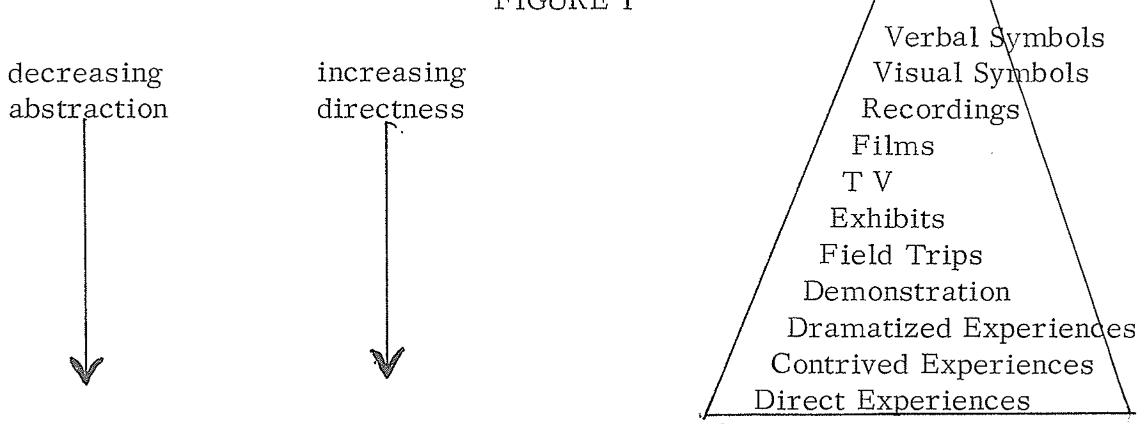
3. Encourage cooperation rather than competition.

4. Allow students some freedom within defined limits.

5. Accept errors and mistakes as part of developing learning and growing.

In his description of learning processes of slower learners D. Manning (1971) uses Edgar Dales' pyramid of methods:

FIGURE I



It is apparent that any effective teaching must utilize the base of the pyramid. Science is ideally suited to operate in this area.

J. Merrit (1972) brings in another dimension in the teaching of secondary students and one that is often neglected:

> The work must have significance not only for the pupils as adolescents but also because it is concerned with realistic matters of adult stature and it needs to be remembered that many of these pupils will already be assuming responsibilities of an adult kind outside the school situation.

Students in the senior grades of secondary schools range in age from seventeen to twenty-one. They are generally well acquainted with the realities and the responsibilities of the industrial world and therefore should be treated as adults.

The teaching techniques must be well organized and give the student structure. As Allan Ornstein (1969) states in his paper on "Techniques and Fundamentals for Teaching the Disadvantaged":

> These children in particular demand a strict structured workable routine. They need and want a teacher who can assure them the stability they usually do not receive at home.

Russel C. Doll and Daniel V. Levine (1972) further emphasize the need for structure in their paper "Toward a Definition of "Structure". They list the following four components of an effective teaching structure:

1. Structure involves the choice and sequencing of instructional experiences and materials in accordance with the particular learning problems and characteristics of the disadvantaged student.

2. Structure involves the initiation of procedures and arrangement to obtain order, so that teaching and learning can begin.

3. Structure involves the systematic choice and creation of situations and educational materials which provide disadvantaged students with experiences of success in the school.

4. Structure involves the use of requirements and ground rules in such a way as to:

   a) Clearly define what students are expected to do,
   b) Require participation on the part of the student,
   c) Provide for increasing student participation in setting subsequent ground rules,
   d) Ensure that students understand as thoroughly as possible the rationale underlying the activities and assignments.

Curriculum Concerns

Science should be a preferred subject to the vocational student. It allows him to reap rewards that were previously denied to him in many academic subjects. Science is directly related to most of the vocational areas and requires similar manipulative activities. He can see things happening and has to respond in terms of his experience in the laboratory.

J. Merrit (1972) in commenting on the Nuffield project in England describes the role that Science must play in order for it to be meaningful to the student:

> Science must be experienced at first hand and, if something of its flavour is to be savoured and something of its spirit caught there is need for a considerable measure of empirical work at this stage. Its spirit should be one of investigation and opportunity to experience this as necessary. It is important that inert ideas should be avoided and first hand observation and experiment should provide essential opportunities for acting and thinking scientifically.

He goes on to give the general objective of science teaching:

1. Accurate observation,
2. Deducing generalizations,
3. Inferring results from a concept or generalization,
4. Simple experimental design,
5. Forming hypothesis,
6. Verbal fluency, literacy and numeracy,
7. Self-discipline and self-programming.

The National Committee on Employment of Youth (1969) describes a vocational science curriculum as follows:

> -----The curriculum must emphasize the concrete rather than the abstract; the uses and application rather than the rules, theory and formulas. It must be person orientated, as well as craft or trade orientated with strong emphasis on behavioural objectives.-----

Harvey Goldman (1971) in his paper on "Nature of Curricular Relevance" states:

> A relevant curriculum is active rather than passive. It is based on the assumption students learn by doing.
>
> A relevant curriculum should be based on experiences with which children are familiar and in which they are interested.

To make a course meaningful to vocational students the course cannot afford to give them the impression that the activities are kept on an elementary level because of their lack in computation skills. These students work with sophisticated equipment and carry out meaningful projects such as constructing entire residential homes and fitting these with all conveniences.

To overcome this difficulty the course was designed to present real situations and computations. To facilitate successful mathematical experiences for the students electronic calculators were purchased.

Donald R. Quinn (1976) supports this technique by stating:

> ---a lack of proficiency in computational skill could close many vocational avenues for students. Fey (1974) reported that 61 percent of a sample consisting of teacher, mathematicians, and laymen agreed with the statement: "Weakness in computational skill acts as a significant barrier to learning of mathematical theory and applications." The group voted 84 percent agreement for the statement: "Speed and accuracy in arithmetic are still essential for a large segment of business and industrial workers and intelligent consumers."

Curriculum Design

A desirable curriculum design should be able to satisfy the needs of the student and secondly modify his behaviour to bring it into harmony with the environment in which the student must function.

Jeanne Freeman (1974) suggests three approaches or theories of curriculum design:

> The First Curriculum Theory ----- The intellectual discipline orientation holds that education serves to impart the content and skills of the organized fields of knowledge-----this philosophy set in motion curriculum projects that continue to pervade schools i.e. PSSC, IPS, Chem Study.
>
> This emphasis on knowledge limits students' ability to express other dimensions of their personalities.

Attempts to water down this type of curriculum to suit the vocational students did not meet with much success. The concepts and ideas present an unrelated situation to the students. Science became meaningless and something to be disliked and avoided. As Jeanne Freeman further quotes:

> The Second Curriculum Theory holds that education should

develop and fulfill the individual students talents, needs, interest and abilities (Combs 1962, Rogers, 1971). In contrast to the subject matter curriculum, content, organization, methodologies and activities are designed to suit the student's needs. Curriculum designers determine the appropriateness and effectiveness of varied materials, resources and strategies.

The goal for the teacher is to expand and intensify students experiences. The teacher is a craftsman who through empathy, openess and understanding creates a rich, varied, open safe growth climate for students. (Rogers, 1971)

The Third Theory ----- the behaviour controlled orientation holds that education serves to control the student and shape him into a socially acceptable product (Skinner, 1971). This view creates a technology of behaviour designed to condition the individual by scientifically controlling and shaping his environment. i.e. Performance Based/ Competency/ Accountability/ Behavioural Objectives movement. (Zifferblatt 1973, Popham 1970) Efficiency and effectiveness are the major goals. (Krasner 1973)

The teacher performs a single role as behaviour modifier whose primary function is to control and shape behaviour.

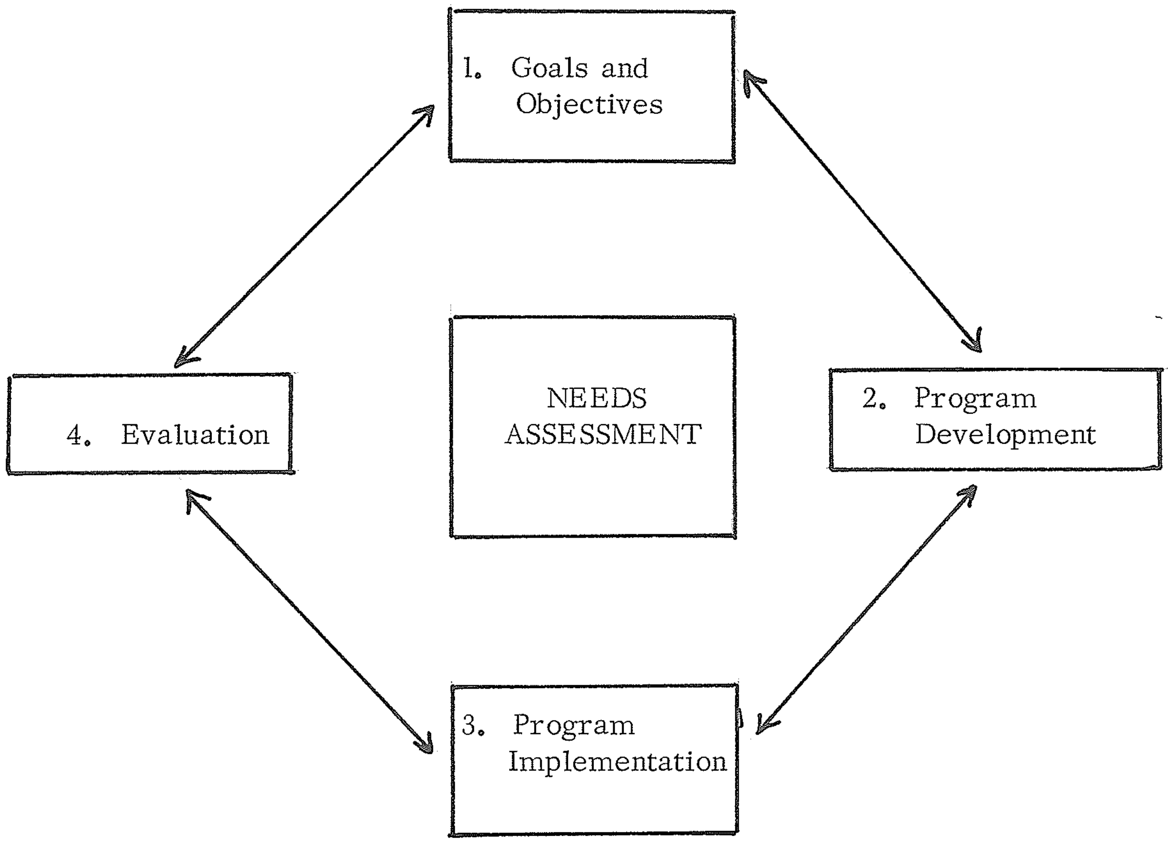
In considering the foregoing descriptions of teaching techniques and characteristics of curriculum for the disadvantaged student, the logical approach seems to be one that is based primarily on the second theory; relying on the products of the first theory for resources and employing the methodology and techniques of the third to achieve the desired goals.

The Manitoba Teachers (1975) Society recently issued a pamphlet entitled "Curriculum Development". In this pamphlet the committee presents a curriculum development model:

(Refer to figure II on following page)

FIGURE II

Curriculum Model 1

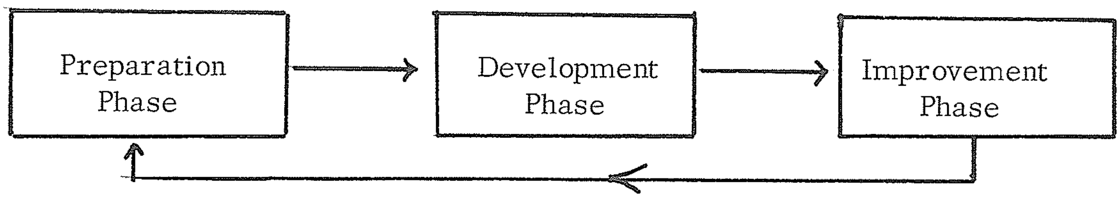


The model revolves about a continuous assessment of student need. The student needs then influence statement of goals and objectives, program development, program implementation, program evaluation. The model represents a very fluid condition that is continuously modified by its central theme of needs assessment.

R. F. Mager and K. M. Beach (1968) offer a simpler model:

FIGURE III

Curriculum Model 2



The preparation phase includes the assessment of needs and circumstances, the setting of criteria, and the writing of course objectives. The developmental phase involves sequencing of content, selection of procedure and course tryout. The improvement phase involves comparison of performance with objectives, comparison of objectives to the original requirements, and revision and tryout.

There are ample examples in educational literature describing various models of curriculum development. Many recent models follow the following pattern:

1. Describe the persons at whom the effort is aimed.
   That is, needs.

2. List the goals.
   That is, "What is the course designed to achieve?"

3. Develop the course.
   That is, behavioural objectives, content and methodologies.

4. Implement the course.
   That is, use the designed course and make necessary adjustments in accordance with needs.

5. Evaluate the course.
   That is, were the original goals achieved?
   Were the needs satisfied?

6. Modify the course to correct inconsistencies in the goals.

7. Rerun the cycle.

Evaluation of Curriculum

A newly developed curriculum must be evaluated after initial implementation. The evaluation can take two forms. First, the immediate evaluation (formative) and subsequent modification while the course is in progress. Secondly, an overall evaluation (summative) and modification at the conclusion of the course. The evaluation should center on the following questions:

i) Is the content appropriate for the population?
ii) Are the methods employed successful?
iii) Is the student reaction favourable?

R. F. Mager (1968) sees a similar system:

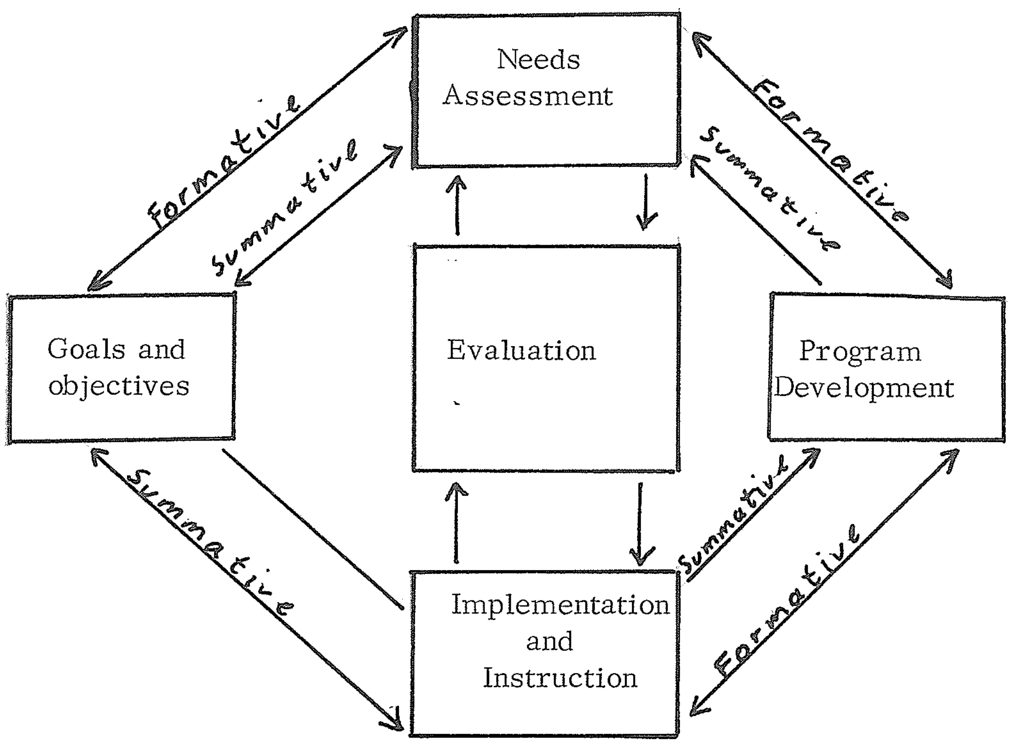
> One is on assessment of whether our students appear to be as willing to approach our subject at the end of our influence as they were when it began. The other is the assessment of the process. In other words, results evaluation tells us something about how well we are doing; process evaluation tells us how we might do it better.

The Manitoba teachers Society (1975) also presents a second and more complex model:

(Refer to Figure IV on following page)

FIGURE IV

Evaluation Model



The model uses the terms formative and summative evaluation. Michael Scriven (1962) originated the terms and makes the following distinction:

> Formative is "in course" evaluation and subsequent modification. Summative is "end of course" evaluation and looks at the total picture and its implication.

Similar Studies

Two recent criterion referenced studies dealing with similar subjects and subject matter are reported below: