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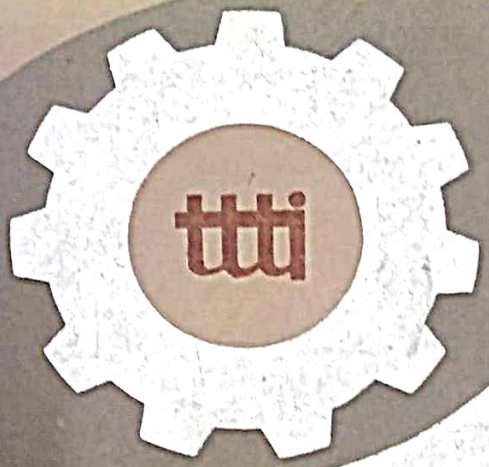

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TECHNICAL TEACHERS TRAINING INSTITUTE

MADRAS

CONTENTS

EDITORIAL

With this issue The Journal completes six years of its publication. It includes a wide range of articles on various aspects of technical and vocational education, which we hope will be of interest to our readers.

Mr Hermann G.D., in his article on 'Implementation of a Curriculum' suggests involvement approach to designing the syllabus, planning implementation, developing teacher competence and solving implementation problems.

Dr Nelson R.E., in his article on 'Entrepreneurship Preparation of Youth in Developing Countries' advocates a model of an innovative vocational programme featuring integration of business concepts into vocational courses with provision for business apprenticeships, entrepreneurship development, and incubator businesses for programme graduates.

Dr David L. Passmore et al attempt a synthesis between labour supply theory and expected labour market effects in their article on 'Labor Supply Theory and Outcomes of Technical and Vocational Education: Toward an Evaluation Theory'.

In the article on 'Retention and Transfer of Teaching competencis from Training to Practice', Dr Subrahmanyan et al discuss various issues relating to in-service training programmes and suggest guidelines for identifying, designing and implementing in-service programmes with focus on enhancing retention and transfer of competencies from training to practice.

The article by Dr Okeke C.C. on 'Improvisation and Students' Performance in Introductory Technology in Junior Secondary Schools in Anambra State of Nigeria' emphasises deployment of improvisation and actual manipulation of equipment in teaching Introductory Technology effectively and reports the findings of a study conducted to validate this view.

In his article on 'Ph.D Education and Australia's Industrial Future : An agenda for Reform', Dr J.G. Sekhon reports an investigative study on the issue of responsiveness of Ph.D. education to the needs of industry in Australia. He highlights the important factors responsible for the inadequacies of Ph.D. education as a preparation for a career in industrial research and suggests directions for reform.

Dr M Adithan et al report the findings of a Case Study of a polytechnic in their article, on 'Management of Polytechnics : A Case Study'. It highlights the strengths and weaknesses of the various system components of the polytechnic studied and attempts to create an awareness among the planners and administrators to base their planning and management functions on profiles of institutions developed through such case studies. □

Implementation of a Curriculum

HERMANN G.D.

ABSTRACT

If a curriculum is designed by one group of people, and implemented by a different group (i.e. teachers), it is necessary to do much more than simply hand the syllabus document to the teachers. The implementers need to be assisted to gain competence to teach the curriculum effectively. The paper suggests a competence-involvement approach to implementation with respect to designing the syllabus, planning the implementation, developing teacher competence and solving implementation problems.

Approaches to Curriculum Implementation

If a curriculum development team has spent countless hours in devising a curriculum that it considers to be brilliant, it is obviously not very happy if the class room teachers fail to implement it beacuse they do not understand what is intended, or do not like what is intended. All relevant bodies - the development team, the school or faculty, the educational institution, the accrediting body - expect that a curriculum be implemented as intended.

Implementation is the translation of the intended (approved) curriculum into reality : the instruction and assessment of learners. The *implementers* are those presenting the new or revised curriculum to the learners - the lecturers/teachers/trainers actually involved in instruction.

Implementation is the step taken after a decision has been made to adopt the curriculum. The adoption process is not discussed here; this topic can be examined in Finch and McGough (1982, pp.177-191).

Lack of implementation may occur because of many reasons. The teachers may disagree with the rationale of the curriculum. The teachers may not understand the rationale. The teachers may disagree with the teaching methods specified. The teachers may not know how to use the teaching methods specified. The teachers may not be convinced of the need for certain content. The teachers may not be competent to teach certain content. And so on.

In many small courses provided at one college only, the person who developed the curriculum is the person who implements it; in this case there should be no teacher factors involved in any lack of implementation.

Here we examine implementation procedures with respect to the teachers who are implementing the curriculum. Successful implementation involves many other factors - such as the availability of sufficient finance to buy or hire the equipment and facilities specified in the intended curriculum.

Curriculum implementation can involve different types of innovation. Perhaps the most frequent in Occupational Curriculum Development is the introduction of new content (due to technological change, different work practices, or whatever). A second type of innovation is the adoption of a different teaching approach, such as CBVE (Competency-based Vocational Education) or Problem-based learning; there is often a theoretical rationale associated with a specified teaching approach. Many innovations specify both new content and a new teaching approach; e.g. introducing the topic of numerical control machines, and specifying a simulation approach to teach this topic.

As suggested in Table 1, curriculum 'implementation' frequently involves simply handing a syllabus to teachers. Most of these teachers were not involved in the design of the curriculum, and have no knowledge of the rationale for the curriculum. No implementation planning takes place. No inservice courses are held. No teacher guide is produced. No consultants are available to give advice. Full-time teachers in a large college may be able to discuss the new or revised curriculum with fellow teachers; often part-time teachers have no readily-available sources of advice.

A brief introduction to a complex innovation which is considered adequate by the course designers may be considered inadequate by the course implementers (e.g. Kennedy, Williamson, and Patterson, 1986). Much more is generally needed.

A *competence-involvement* approach is advocated here, ensuring that the implementers are *competent* to teach the new or revised curriculum, and ensuring that the implementers are *involved* in planning the implementation of the curriculum. An outline of this approach is presented in Table 1.

For this discussion, it is assumed that in the curriculum design, implementation factors have been adequately taken into account, and that the innovation has been trialled or observed in action and has been found to work successfully. This is especially important if the innovation is a different teaching approach.

Theory versus competence approaches

Guskey (1986) has reviewed research on staff development and the process of teacher change. He found that teachers are primarily interested in staff development activities that lead to improvements in student learning. He also found that "to be effective, a staff development program must offer teachers practical ideas that can be efficiently used to directly enhance desired learning outcomes in students." (p.6)

Staff development, especially when directly related to curriculum change, may be designed to produce one, two or three outcomes:

* change in teachers' classroom practices
* change in student learning outcomes
* change in teachers' beliefs and attitudes

Two models have been developed which sequence these three outcomes.

The *theory-based model* assumes that if teachers accept the theory (rationale) underlying the curriculum change, this change in teachers' beliefs and attitudes will result in a change in the teachers' classroom practices and in the student learning outcomes. Guskey provides data which suggest that this model is deficient, as it is very difficult to obtain a change in teachers' beliefs and attitudes simply by asserting to experienced teachers

TABLE 1: Some approaches to implementation

		What happens too frequently	*Suggested approach*	
			Primarily new content	*Primarily new teaching approach*
I.	**Design of Syllabus**			
	Involvement of implementers:			
	• Nil	X		
	• Some			√
	• Much		√	
II.	**Implementation Planning**			
	Extent of planning:			
	• Nil	X		
	• Medium Detail		√	√
	• Extremely detailed			
	Involvement of Implementers:			
	• Nil	X		
	• Some			
	• Much		√	√
IIIa.	**Inservice Courses**			
	• Not held	X		
	• Support from occupational analysis data		her √	N/A
	• Theory based		N/A	
	• Competence based		√ (content competence)	√ (teaching method competence)
IIIb.	**Teacher Guide**			
	• None	X		
	• Available to all teachers		√	√
IV.	**Consultants available** (During implementation, to assist teachers to develop competence)			
	• No	X		
	• Yes		√	√

that they need to change. There is also no automatic transfer of changes in teachers' beliefs and attitudes into changes in teachers' classroom practices; valuing an innovation is not sufficient in itself for implementation to occur (e.g. Fullan & Pomfret, 1977). It would seem that teachers would like to find out for themselves whether a recommended classroom practice will actually work for them and their students.

Rather than the theory-based model Guskey advocates a *competence-based model*, in which competence to perform the new teaching approach is the key; if the new teaching approach leads to increased student learning, *then* the beliefs and attitudes of the teachers will change. Guskey's model is presented in Fig.1.

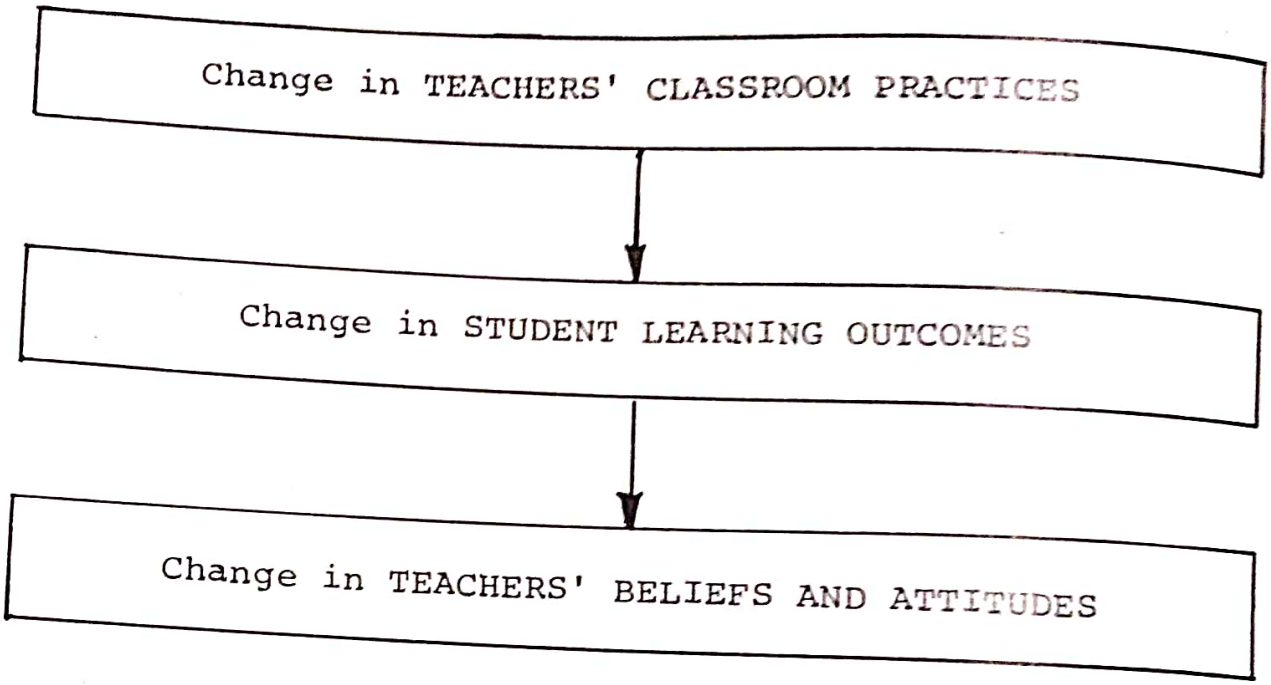

Fig.1 GUSKEY'S MODEL OF THE PROCESS OF TEACHER CHANGE

Guskey provides data to support his model. For example, he indicates that Fullan (1985) found that teacher changes in attitudes, beliefs, and understanding generally *followed* changes in teacher behaviour (e.g. teaching method). Guskey also refers to one of his own studies on staff development. The teachers who implemented the recommended new classroom practices and obtained increased student learning, developed more positive attitudes to teaching and greater personal responsibility for their students' learning, than did teachers who implemented the new practices without improvement in student learning or who did not implement the new practices in their classrooms.

Guskey suggests three implications of his model for staff development:

* Recognise that change is a gradual and difficult process for teachers
* Ensure that teachers receive regular feedback on student learning progress
* Provide continued support and follow-up after the initial training.

Based on an analysis of data on implementation attempts, Huberman (1983) has described four scenarios. The scenario found to be most effective involved strong continuous pressure from administrators, little latitude for teachers to make changes, and substantial assistance leading to teachers' technical mastery. The commitment of teachers developed strongly when they were "able to master a *well-designed, technically challenging innovation while receiving sustained assistance*. The assistance comes not only prior to project execution but also - and more decisively - in the course of project execution" (p.25). This finding is a very strong support for Guskey's model.

It is probably Fullan who has studied implementation most thoroughly (e.g. Fullan and Pomfret, 1977). Many of Fullan's findings from reviews and from his own studies support the competence-based model : that teachers who are competent in the specified content and teaching approaches are those who tend to implement successfully. Such findings include :

* teachers tend to implement more effectively if they know exactly what they have to do in the classroom; there should be a high degree of explicitness of the details of the innovation
* specified complex changes in teachers' behaviours (including teaching approach) are unlikely to be implemented effectively unless teachers are given adequate guidance
* in-service training (staff development) tends to aid implementation, if it provides teachers with adequate demonstration models and experiences; it is more effective if it continues while implementation is in progress so that problems occuring during implementation can be addressed
* the availability of consultants during implementation aids effective implementation
* initial investment of teacher-time tends to aid implementation (However, this time investment should be over a relatively short span)
* the provision of adequate materials (e.g. teacher guides) tends to aid implementation
* the discussion with fellow teachers of implementation problems tends to aid implementation

Fullan and Pomfret (1977, p.391) state: "If there is one finding that stands out in our review, it is that effective implementation of social innovations requires time, personal interaction and contacts, in-service training, and other forms of people-based support."

The following findings obtained by Crandall (1983) also support the comptence-based model :

* unless the innovation really works, teachers will not see results and the effort will fail.
* implementers learn most from "revealers of trade secrets"; i.e. from peers, who share similar experiences and a common collegial bond with the implementers, and who are already successfully practising the innovation.

It would seem that 'telling the implementers that an innovation is good' is generally completely inadequate; effective implementation is most likely if the implementers are assisted to become competent practitioners of the innovation.

Involvement approach

It has long been assumed that involvement of the implementers in decision-making will

aid implementation. The research and reviews of Fullan suggest that there is much truth in this assumption, but that there are also many qualifications.

Decision-making can be discussed with respect to the development of the curriculum document (syllabus), the writing of teacher guides, the planning of the implementation procedure, and the solving of implementation problems.

With resepect to the *development of the syllabus*, it would seem that much teacher involvement does not greatly assist implementation, especially if the innovation is a new teaching approach. For example, it has been found that 'over-participation' in the early stages of curriculum development can lead to burn-out and frustration in the final implementation stage. It has also been found that 'ownership' tends to develop at the implementation stage rather than at the syllabus document stage. However, involvement at the syllabus development stage has been found to aid implementers to identify what they need to learn, which, in turn, leads to more effective implementation.

If the implementation relates to new content, it is assumed that teachers need to be aware that changes in the occupational area have occurred or are about to occur before they will accept the need for change. In this case, involvement of the implementers in gathering occupational analysis data is recommended (See Hermann, 1987).

It has been found that implementers who have actually worked on the development of *teacher guides* snd other materials tend to implement more effectively than those who have not (including those who were only involved in making decisions as members of curriculum committees).

With respect to *planning the implementation*, it has been found that implementers involved in this procedure tend to implement more effectively. It has also been found that it is better to develop a plan in moderate detail than in extreme detail; too many teachers tend to lose interest if the planning goes on for too long without the commencement of the acutal implementation.

There is clear evidence that participation in *solving implementation problems* aids implementation. The full involvement of the implementers is especially important for this phase.

The data clearly suggest that involvement in implementation planning and solving implementation problems is much more important than involvement in the development of the syllabus document.

As suggested above, implementation should not be conceived of as simply teachers implementing independently as individuals. Effective implementation generally involves teachers collaborating with their colleagues to solve problems, so providing support for each other and occasionally an impetus to encourage others to get on with the job.

Implementation also tends to be more effective if the implementers' supervisors (e.g. Head of Department, Head of School, Principal) actively support the implementers.

Suggested approach to implementation

This section extends the basic implementation approach suggested in Table 1, and emphasizes the need to ensure the competence of the implementers. It discusses in turn the designing of the sysllabus, implementation planning, developing teacher competence in the new content and/or teaching approach (e.g. via inservice courses and teacher guides), and solving implementation problems.

Designing the syllabus

Whether planning a new course or reviewing an existing course, it is suggested that all persons who will be involved in teaching the course should collect some occupational analysis data. Suppose 20 teachers in a department interview 3 or 4 job incumbents or immediate supervisors, much data can be collected readily without excessive time requirements of any one teacher. If it appears that there is a need for new content based on actual or anticipated changes in the occupational area, any straightforward method to demonstrate this to teachers should be utilized.

For a variety of reasons, it is generally impossible to involve all teachers in the design of the syllabus. However, at least one teacher should be involved in any occupational analysis, at least one teacher should be involved in the preparation of any draft syllabus, and at least 2 to 3 teachers should be involved in any curriculum committee activities. Such teachers should report to their colleagues via written materials; and via workshops where feasible.

Planning the implementation

A good implementation plan consists of two major phases : developing teacher competence *before* the implementation occurs, and solving problems *after* implementation commences. There is a third major phase: monitoring the activities of the implementation plan to ensure that the objectives of the first two phases are attained.

An implementation plan will list each activity in each phase, specify the person responsible for ensuring that the activity is developed effectively and specify the person responsible for ensuring that the effectiveness of the activity is monitored and that feedback is provided to the relevant persons. The implementation plan should be in moderate detail (*not* too detailed), and be flexible enough to be amended as necessary.

If the implementation is wide-spread, there will generally be a need for a 'System' implementation committee, plus a committee at each college offering the course. Each committee needs a co-ordinator (executive officer), whose role is to follow through all decisions, to cajole implementers into participating effectively, and to support them as necessary. As many teachers as feasible should be involved in implementation planning at the college level.

Various 'brainstorming' techniques have been used in implementation planning. The **Nominal Group Technique** has been found useful in reaching consensus on the major problems likely to be encountered in an implementation. **Force Field Analysis** may be useful in solving such problems. These techniques are discussed by Anderson and Jones (1986).

The use of field centres has been found very useful in agriculture to demonstrate innovations to farmers, especially if the demonstration farm is similar to their own farms. A similar idea can be used in the implementation plan. If the innovation has already been successfully implemented, visits of implementers can be arranged. If, however, there are no such demonstration sites, it may be feasible to implement the innovation as a pilot project at a few centres, develop them so that the innovation is clearly successful, and then to use these sites as demonstration centres. The emphasis is on implementation of an already adopted innovation - to assist the implementers to gain the competencies needed for successful implementation.

To the greatest extent possible, people who provide inservice courses and act as co-

ordinators and consultants should themselves have successfully used the program.

Developing teacher competence

The first phase of the implementation plan is to develop teacher competence in the new content and/or teaching approach before the implementation occurs. This initially involves the determination of the specific competencies needed by the teachers to successfully implement the program. Activities are then developed which will ensure that the teachers attain these competencies. Activities could include inservice courses, preparation and study of teacher guides, teachers attending courses provided by manufacturers or suppliers of equipment, teachers working in industry, and so on. A visit to a similar institution which has already successfully implemented the innovation is a very rewarding activity, especially if there is adequate time for discussion with teachers who undertook the implementation, and teachers who are using the innovation. As stated above, it is necessary to monitor the effectiveness of theses activities.

New content can be presented via an inservice course, or a teacher guide, or, preferably, both. It is considered that occupational analysis data should be presented so that each teacher can appreciate the rationale for the new content. If it is not feasible for teachers to attend an inservice course, videotapes, audiotapes, and telephone conferences can be utilized.

Different teaching approaches can be demonstrated by a tutor, a video, and/or the use of lesson transcripts. Such demonstrations should be very explicit, very concrete, and directly relevant to the implementers. The training should have a "hands-on" focus. Activities will need to be devised which allow the provision of feedback to teachers on their progress, and ensure they attain competence.

Solving implementation problems

The second phase of the implementation plan is to provide assistance to teachers facing problems *after* implementation has commenced. The bulk of the problems tend to occur immediately after implementation commences; the plan should especially be of assistance at this stage.

Perhaps the most important activity is the scheduling of workshops at which implementers can work together to solve problems. Inservice courses can be continued until they are no longer needed. Consultants can be made available to assist teachers either individually or in groups. Consultants can be teachers who have already successsfully implemented the program on a pilot basis, senior teachers, and/or people external to the college with relevant expertise. If, for example, competency-based vocational education (CBVE) is being introduced into a specific course in New South Wales, it could be very appropriate to utilize, as consultants, teachers from another state who teach the same course, and who have been successfully using CBVE approaches for many years.

Formative evaluation of the implementation activities is considered to be very necessary. Obviously, the activities should be amended as appropriate.

The discussion above is based on two major assumptions. Firstly, that the resources needed for implementation have been made available sufficiently early. Secondly, that the innovation has been trialled and is known to work successfully. Implementation problems due to deficient recources and/or a defective innovation need to be resolved rapidly.

Implementation and Curriculum Evaluation

In evaluating an occupational program, one activity is to study how effectively the program was implemented.

Suppose a curriculum innovation is adopted by the 'administration', the teachers are told to implement it, and a summative evaluation of the curriculum innovation is conducted. Suppose that it is found that the students who have taken this curriculum have performed badly. All too often, the innovation is blamed for the poor performance, the innovation may be discontinued, and the evaluation stops there. However, in many cases, the problem is not the innovation itself, and lies elsewhere : *the curriculum innovation was not implemented as intended.*

A good curriculum evaluation will examine *both* the products (observed outcomes), *and* the extent of implementation (by asking the question: to what extent can the **intended** antecedents and processes - as defined below - be **observed** in actual practice). Such an approach is present in the model of curriculum evaluation shown in Fig.2. which has been derived from Stake (1967).

The term ANTECEDENTS is used to refer to the *inputs* into the system, especially to the learners, teachers, and facilities/ materials. The most important input of the *learners* is their entering behaviours. To ensure that the entering behaviours are appropriate, the curriculum developers can state the prerequisite competencies needed by learners before commencing the course. Other antecedents specified or assumed by the curriculum developers could include the need for concurrent relevant employment involving appropriate skills development and/ or general industrial experience, (say) 10 hours per week study time in addition to actual attendance at an institution, and that the learners have adequate study skills.

The curriculum developers could specify or assume that the teaching staff know their discipline subject very well, that they have attended an inservice program to study the philosophy and implementation of the new curriculum, and that they are competent in teaching.

With respect to *facilities/materials*, the curriculum developers could specify or assume that there were sufficient reading materials in the classroom and/or in the library, that there was one audiotutorial carrel available for every ten students in the course, that there was one microscope available for every person in a practical class, and so on.

The term PROCESS refers to the interaction of the learner with teacher(s) and/or materials; i.e. the teaching/learning process. This interaction can refer to the time involved and/or to the activities specified or recommended. Specifications or assumptions concerning time could relate to the minimum period of time a learner is to interact with set materials, or to the maximum period of time that a learner must wait before equipment or materials become available. For individualized instruction, the minimum period or time the teacher is to interact with each learner could be specified. Activities could relate to the specification of the placement of the rules and examples in a learning by discovery approach; the specification of the sequence of procedures in a problem-based learning approach; the use of mastery learning and alternative learning strategies in a competency-based approach ; the use of student problem solving, where specified; and the use of specified teaching methods whether in the educational institution or in a clinical,

workshop, or other position (whether employed or supernumerary).

The intended OUTCOMES relate to those objectives to be attained by *students* in the educational institution (whether occupational or college competencies) and to those to be demonstrated in the workplace (occupational

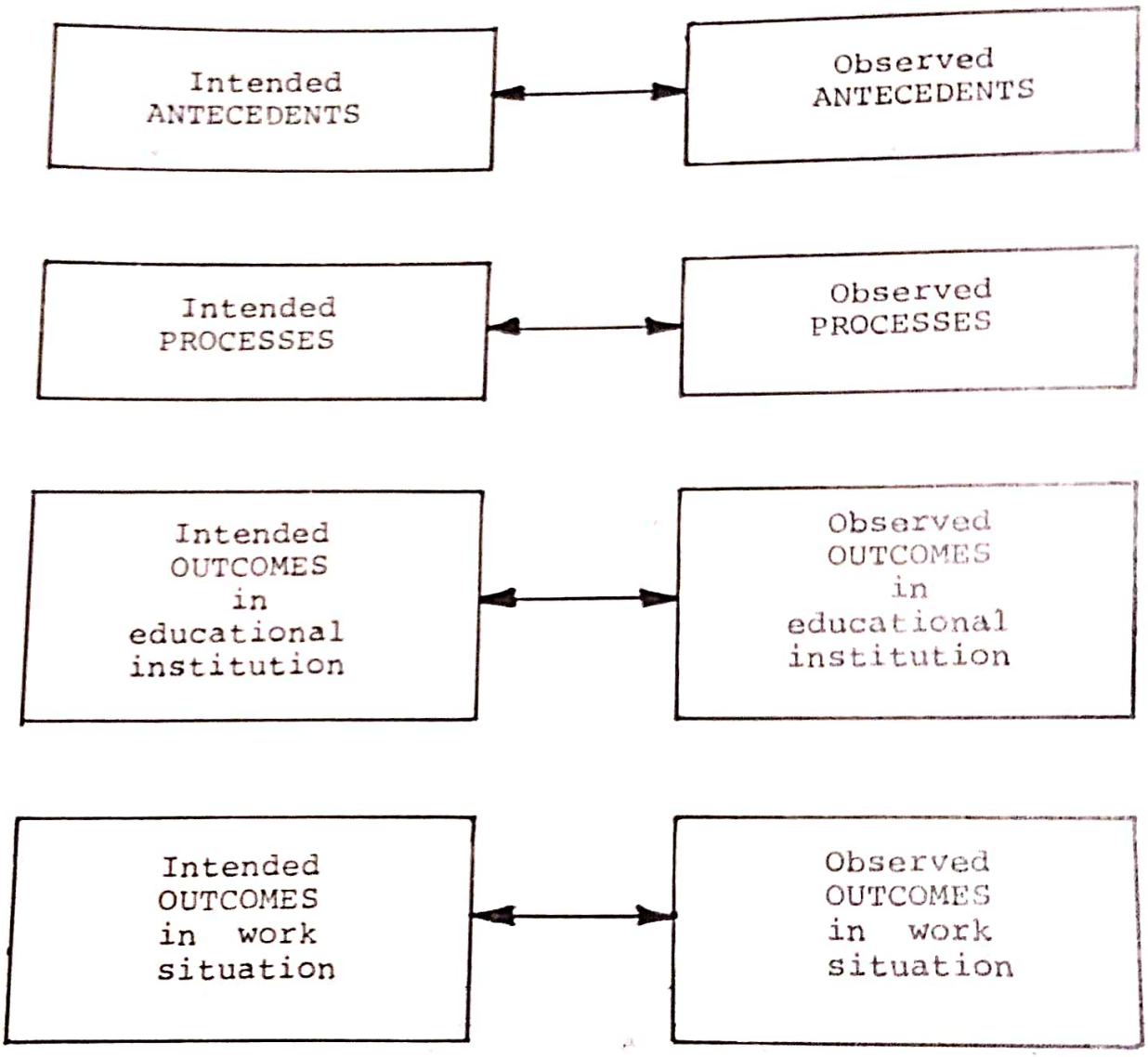

Fig.2 A MODEL OF EVALUATION FOR AN OCCUPATIONAL CURRICULUM

competencies). Generally, but not necessarily, testing in the educational institution precedes testing in the workplace.

If the observed antecedents and processes are different to, and apparently inferior to, the intended antecedents and processes, then the implementation has been inadequate.

The evaluation of an occupational cur-

riculum is incomplete without an assessment of the degree to which the curriculum (as intended by the designers and adopters) has been implemented.

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Entrepreneurship Preparation of Youth in Developing Countries

ROBERT E. NELSON

ABSTRACT

The paper emphasis that in vocational education programs, self-employment and entrepreneurship concepts should complement instruction in vocational skills. It describes a model of an innovative vocational program for developing countries involving integration of business concepts into vocational courses with provision for business apprenticeships, entrepreneurship development programs and incubator businesses for program graduates.

Overview of Training for Self-employment.

Educational systems, technical colleges and vocational programs in most developing countries appear to prepare their pupils, both technically and psychologically, for paid employment either in the formal sector or in government. However, it is generally believed that these two sectors together cannot absorb more than ten percent of the total labor force in most developing countries. The magnitude of unemployed youth, especially in rural areas, has inspired a number of developing countries to introduce training programs which prepare people for self-employment.

In addition to vocational skills, vocational training programs should include instruction to develop proper attitudes towards self-employment and entrepreneurship. In vocational education programs, self-employment and entrepreneurship concepts should complement instruction in vocational skills. Many graduates of vocational training programs would have the potential to become self-employed if they had the knowledge and understanding of what it means to own and operate an enterprise. Training programs would be more practical because they would not only focus on the vocational skills, but would also focus on the business skills and entrepreneurial attitudes which are necessary whether a person is seeking employment or seeking to become self-employed.

Currently, vocational education programs focus their efforts on teachinfg specific vocational skills. However, if training for self-employment is to become an important objective for vocational programs, additional training in management and entrepreneurship must be provided as well as business experience for those persons contemplating self-employment as a potential career.

Content of Self-employment Programs

Technical ability, managerial ability and entrepreneurial ability are the three components essential for successful operation of an enterprise. Technical and managerial ability, which are skills, can be taught through vocational and managerial training courses. However, entrepreneurship is a behaviour

which can be developed in those individuals who want to use their entrepreneurial characteristics and traits in business.

Figure 1 is an example of the various training components for a self-employment program which begins at the secondary vocational level. The first and second year of the vocational program focus on teaching vocational skills (80%) and business skills (20%). Additional components which would be the responsibility of the vocational institution for selected participants include: (a) a business apprenticeship (one year); (b) an entrepreneurship skills development course (two months); and (c) incubator businesses for highly talented vocational program graduates (indefinite time). Other institutions, both public and private, would provide training and assistance for the remaining self-employment components of initiating, maintaining, and expanding a small business.

During each phase of training in the total self-employment program, vocational students would acquire a different set of discrete skills and knowledge. The model represents a total system and the various training components should be integrated to form a process which would enable vocational program graduates to increase their chances for success in being self-employed.

Although Figure 1 represents a process, it is unlikely that most vocational students would complete all components uninterrrupted. Some of the students who complete the second year of the vocational program might become employed or unemployed. Only a portion of the vocational program graduates would enter the business apprenticeship program or the entrepreneurial skills program. Although students completing these two programs would have some preparation to start an enterprise, only a small proportion would actually do so immediately, either as an incubator business or on their own.

Over the long term, however, there will be a more informed group of vocational program graduates who will have the ability and knowledge to initiate an enterprise at some time in the future. Providing training for self-employment in vocational education programs helps to develop the infrastructure which will allow the small enterprise sector in developing countries to expand in the future; such training should also help to reduce the failure rate in the small enterprise sector.

Vocational Training (first and second years)-

The content of the total self-employment program within vocational education might include: (a) basic business skills, (b) small business skills, (c) a business apprenticeship, and (d) entrepreneurship skills. Activities during the first year are designed to create an awareness of business among youth and provision of basic knowledge and information necessary for operating a small enterprise such as : overview of the business sector, business math, managing money, costing, principles of work study, business English and communication, giving and receiving credit, industrial safety, and organization of production tasks.Identification of youth with camparatively high entrepreneurial potential for further development should also be an objective. The specific business skills and content to be taught would be determined by the administrators of the local vocational education program.

Approximately 20% of the second year's vocational education program would be related to self-employment skills such as : identifying business opportunities, conducting a market survey, developing a business

plan, business decision-making, banking services, business and financial planning, being entrepreneurial, choosing suppliers, human relations, and business location.

Business Apprenticeship (third year)

Once students graduate from the two-year program, they should have the opportunity to become employed in their vocational skill area or to pursue further training in the procedures of operating an enterprise. Another alternative would be for vocational graduates to serve a business apprenticeship for approximately one year. The small enterprise sector would be an active partner in providing training for aspiring entrepreneurs. A listing of experiences that the apprentices would be involved in would be prepared and would include activities in all phases of small business operations.

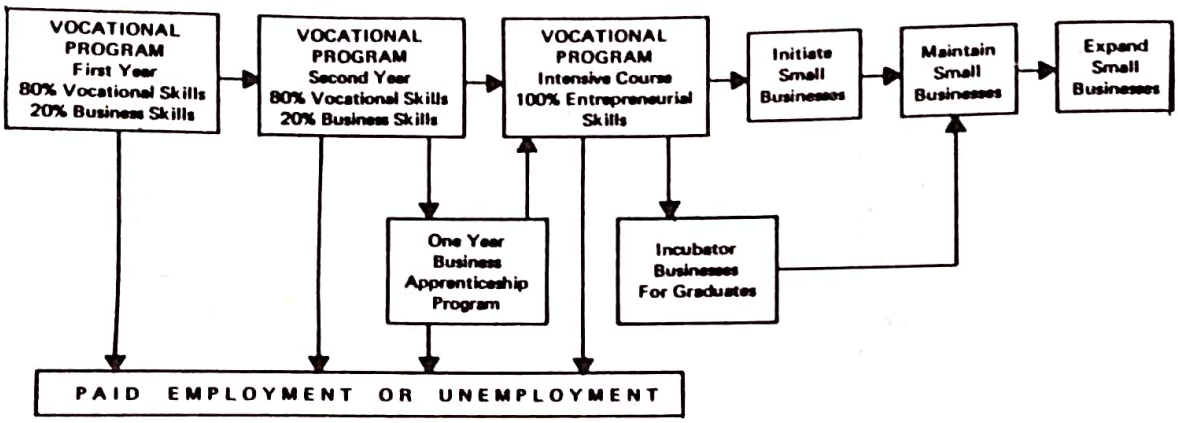

Figure 1. OVERVIEW OF TRAINING FOR SELF-EMPLOYMENT

The apprenticeship program would focus on the practical aspects of operating on enterprise. The apprentices might attend formal classes one night a week. Once the apprentices have been exposed to all aspects of the enterprise, they might focus on a specific aspect of the small business which is of special interest to them. For example, an apprentice might develop an alternative strategy for marketing a particular product. This type of project would not only provide information to the enterprise, but would allow time to the apprentice to pursue in-depth a specific aspect of operating a business. The project report might also serve as an evaluation of the apprentice's work.

Entrepreneurship Skills Training (two months)

After completing two years of vocational skills training, including the basic business skills training and the small business skills training, students would be prepared for employment in the private sector. The vocational program should also create other options for its graduates.

One option would be for the vocational program to establish an entrepreneurship training component for a highly selective group of students from various vocational

schools within a district. Between 15 to 25 graduates who have the desire to become self-employed would be provided with in-depth training in the entrepreneurial aspects of operating a business.

The purpose of entrepreneurship training would be to prepare vocational program graduates as future business owners. The training would be designed for graduates who are highly motivated and express a strong interest in becoming self-employed.

The timing of the training is important. Having just graduated from a two-year vocational program, the students would remain at a centrally located vocational institution, and there would be no interruption of their training. In some cases, students who leave educational institutions are less likely to return. The training might be offered for two months at the institution.The training would be full time and highly intensive. The training period would be for only two months so that student interest, motivation and participation can be maintained at a high level.

Hopefully the interaction among highly motivated participants will provide mutual reinforcement and support. A common goal of all participants would be to become self-employed at the completion of the two month training period. Participants would be able to learn concepts regarding entrepreneurial behaviour in a relatively short period of time which would normally take many years for potential entrepreneurs to learn on their own through experience.

SUGGESTED CONTENT The two-month entrepreneurship skills training might be divided into three major learning clusters (achievement, planning, and power) and include teaching the following nine essential personal entrepreneurial characteristics and their behavioural indicators which have been identified by research*.

A. ACHIEVEMENT CLUSTER

Opportunity Seeking : Sees and acts on new business opportunities; seizes unusual opportunities to obtain finance, equipment, land, work space, or assistance.

Information Seeking : Personally seeks information on clients, suppliers, and/or competitors; consults experts for business or technical advice; uses contacts or information networks to obtain useful information.

Persistence : Takes repeated or different actions to overcome an obstacle; makes a personal sacrifice or expends extraordinary effort to complete a job. Sticks with own judgment in the face of opposition or early lack of success.

Risk Taking : Takes what he or she perceives to be moderate risks; states a preference for situations that involve moderate risk.

Demand for Efficiency and Quality : Acts to do things that meet or exceed existing standards of excellence or improve on past performance; strives to do things better, faster or cheaper.

B. PLANNING CLUSTER

Goal Setting : Sets clear and specific short term objectives; sets clear long term goals.

Systematic Planning and Monitoring : Develops and uses logical, step-by-step plans to reach goals; evaluates alternatives;

* A five year research project was funded by the U.S. Agency for International Development and was conducted by Management Systems International (Washington, D.C.) and McBer and Company (Boston) to identify specific and observable behaviors associated with successful entrepreneurships.

monitors progress and switches to alternative strategies when necessary to achieve goals.

C.POWER CLUSTER

Persuasion and Networking : Uses deliberate strategies to influence or persuade others; uses business and personal contacts to accomplish own objectives.

Self Confidence : Has a strong belief in self and own abilities; expresses confidence in own ability to complete a difficult task or meet a challenge.

Incubator Businesses

Once graduages of vocational programs have completed the two month intensive entrepreneurship skills program, some might be ready to implement a business plan and initiate an enterprise. The vocational program staff might facilitate this process by providing space to accomodate some enterprise which would be located near the vocational institution. Several inexpensive sheds might be constructed by the institution and rented to selected graduates, either as individual entrepreneurs or as work groups, at relatively low rent. Tools owned by the vocational institution could be used by the graduates during off-hours.

The purpose of this part of the program would be to provide young entrepreneurs opportunities to start enterprises in a relatively safe environment and have access to the resources of the vocational program such as: Management assistance, technical assistance and tools. Other community resources might also be available to the participants.

A vocational program staff member might be assigned as a resource person to assist graduates initiate and maintain their enterprises. In a real sense, these new entrepreneurs would be continuing their education on an informal basis with the vocational program. One test of the value of the self-employment component of the vocational program is the number of viable enterprises established by vocational program graduates. The more support and assistance given during the critical phase of initiating an enterprise, the more likely the enterprise will succeed. As these new entrepreneurs develop their enterprise and are aware of the need for continued education and training on an informal and formal basis, the more likely they are to enroll in short courses and workshops and continue learning "on their own" to develop their enterprise and entrepreneurial talents.

Depending on the experience of the vocational program incubator businesses, a limit may be established regarding the length of time a vocational program graduate can remain in the incubator business phase of the program. Allowing them to stay indefinitely is not recommended because the enterprise will tend to become dependent on the vocational institution.

As new graduates from the vocational program plan to initiate new enterprises, space should be provided for them at the incubator site. As vocational program administrators of this phase of the program gain experience, a general policy should be established as to the maximum length of time a vocational program graduate can operate an enterprise at the incubator site.

Curriculum Development Needs

If self-employment becomes a primary concern in vocational education, there will be a need for curriculum materials to be developed. The following concerns should be addressed before the curriculum is developed.

The self-employment curriculum should

be kept simple and easy for both (a) instructors to use and (b) students to understand. The curriculum should not be cumbersome or involve a great deal of teacher preparation. Each lesson should stand on its own as a separate entity and highlight one important concept relating to self-employment.

The first part of the self-emplomet curriculum should be highly structured and should contain basic principles which would be common to the types of enterprises appropriate for youth. This structured portion of the curriculum would also ensure that all students would receive similar information. During the latter part of the program, instructors should have some flexibility in choosing content which pertains to their specific teaching situations. Factors which would account for the need for flexibility include (a) rural training versus urban training or (b) focus on a special industrial area (i.e., garment making or manufacturing of wood products). Instructors should have the responsibility for selecting and adapting materials to satisfy the specific needs of their students.

The curriculum should be "action-oriented" and students should be actively involved in realistic activities pertaining to the operation of an enterprise. Activities should relate to specific situations young people would encounter if they were self-employed.

Evaluation is an important part of the learning process and should be thought of as a teaching technique which has potential value. For example, the completion of a business plan would help determine the student's knowledge of business as well as serve as documentation needed to apply for financial assistance.

The curriculum should be valid in that there should be a direct relationship between the educational experiences and the desired outcomes. Only experiences which actually contribute toward desired outcomes should be included in the self-employment curriculum.

The self-employment curriculum should include a variety of learning experiences which are interesting to students. The self-employment curriculum should also be suitable to the age, background and previous experiences of the participants.

Students should have a part in determining the self-employment curriculum. For example, the type of self-employment opportunities students might want to pursue after leaving the program should determine some of the learning experiences.

Student Concerns

The following recommendations pertain to the various student concerns which should be considered when developing the curriculum. For example, when students are at school they should not only be concerned with learning vocational skills but they should also be concerned with learning techniques for owning and operating a business (such as, recordkeeping, inventory control and increasing worker efficiency). Students can learn self-employment concepts by actually doing them on-the job, in simulated experiences, or in production-oriented activities at the institution.

Students should clearly understand the importance of self-employment and the small enterprise sector in the economic development of their community. For example, they should know how the growth of small enterprises contributes to job-creation and increases the economic viability of their community.

As learning is affected by individual goals, values and motives, students must understand how knowledge of self-employment will personally help them. For example, a knowledge of recordkeeping and costing will help students make an easier transition from paid employment to self-employment.

The more opportunities students have to apply knowledge of specific self-employment concepts in various learning situations, the more likely the learning of generalizations will occur. For example, if several teaching techniques are used to illustrate the problems encountered by not keeping accurate accounts, students will be able to make generalizations concerning the need for keeping accurate written records.

The same learning situation will affect students differently. For example, solutions to case studies will elicit many different responses. It is essential for students to understand that some business problems may have no one best solution, but it is important for them to be able to justify their solutions. Environmental differences affect student learning in educational institutions. Urban students might approach business situations differently from rural students. For example, establishing a marketing strategy will be different for rural and urban enterprises.

If students are to value the self-semploy-ment curriculum, they must be able to observe self-employed persons who have come through similar vocational programs. Those vocational graduates who have become entrepreneurs might serve as role models for current vocational students.

A placement office might be established to assist students in : (a) locating employment opportunities or (b) initiating enterprises on their own. The placement office would help students locate financial, technical, and managerial assistance to start an enterprise. Continuous monitoring by various government agencies will help ensure the success of self-employed graduates. Maintaining visibility for successful small enterprises initiated by graduates will have positive effects on currently enrolled students.

It is important for students to identify with those successful entrepreneurs who are located near the vocational institution. These entrepreneurs would represent role models, that students might emulate. Vocational students need to be in contact with people who have chosen self-employment as their career and are successful.

Ways should be identified for graduates to continue their education on a part-time basis. Graduates who become self-employed have specific needs for business knowledge which can be met through a variety of means such as: correspondence courses, radio programs, booklets on various aspects of small enterprise management, and short term workshops and seminars.

Summary

The growing problem of unemployment in most developing countries is especially serious for young people. Only a small portion of school leavers find employment in the formal sector. For those young people who are unable to find employment, there is a great deal of anger and frustration which can have serious social and political ramifications.

In an effort to increase employment opportunities, vocational education programs are beginning to include training for self-employment. Instead of seeking employment, some young people will be able to engage in income-generating activities on their own

or in small groups.

Vocational programs in developing countries are experimenting with (a) integrating business concepts into vocational courses (b) business apprenticeships, (c) entrepreneurship development programs, and (d) incubator businesses for vocational program graduates. These activities can provide students with an understanding of entrepreneurship and business which will be helpful to them if they decide to become self-employed at some time in the future. For those who cannot find employment but are highly capable and entrepreneurial, self-employment may be an alternative to being unemployed.

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Labor Supply Theory and Outcomes of Technical and Vocational Education: Toward an Evaluation Theory *

David L. Passmore, Norma K. Olsen and Dan-Shan Wang

ABSTRACT

This paper aims to forge a synthesis between labor supply theory and expectations for labor market effects of technical and vocational education. A concise summary of labor supply theory is first given, followed by the author's prescription for application of this theory to the problem of stating the expected labor force outcomes of this sector of education. The synthesis attempted is a major contribution towards developing a theoretical basis to guide evaluations of technical and vocational education.

Introduction

Technical and vocational education represents substantial public and private effort in the United States. An estimated $15 billion is spent annually on public and private technical and vocational education in the United States (NCRVE, n.d.g). For federally-supported technical and vocational edcation alone funds increased by 500% between 1962 and 1970; $3.5 billion was obligated by the federal government between 1981 and 1984 for vocational and adult education programs, which is approximately 5% of the total obligated for all educational programs administered by the Unites States Department of Education (Grant & Snyder, 1986). Secondary and post-secondary student enrolments in technical and vocational education increased from 5.4 million in 1965 to 13.7 million in 1980 (Bottoms & Copa, 1983). Approximately three-fourths of all secondary school students in the United States are enrolled in at least one vocational education course (Campbell, Orth, & Seitz, 1981; National Association of Vocational Education, 1988).

Recent estimates by the American Society for Training and Development (Feuer, 1988, p.32) reveal that 1.2 billion hours of formal training will be delivered during 1988 to 37.5 million participants in organizations in the United States employing at least 100 workers at a total cost of $39.6 billion. In 1988, production workers will make up the largest group of trainees (8.5 million) and will account for the most training hours (270 million) (Gordon, 1988,p.52). Training will occur in such diverse areas as management skills, basic computer skills, personal growth and health, technical skills and remedial basic

* *The authors acknowledge the help rendered by Diane Berkell, Thomas Long and Alfred Mannebach in improving this paper substantially through their comments and suggestions.*

education (Gordon, 1988, Table 2).

The most common goal of public investment in technical and vocational education is to improve the employability, employment, and, as a consequence, economic well-being of citizens (see, e.g., Evans & Herr, 1978, and Wenrich & Wenrich, 1974).There may be desirable social outcomes from training in the private sector, also. A review of the vast literature pertaining to technical and vocational education programs would reveal that this goal provides focus for many evaluations of these investments in education and training. Comparable analysis of the social outcomes of private sector investment in education and training is rarely considered.

Consistent with these goals evaluators often choose to examine whether technical and vocational education have produced, or are associated with, relatively higher labor force participation and employment rates, lower unemployment rates, and higher wages for its participants. The assumption is that effective technical and vocational education will show a positive relationship with employment and earnings. This assumption may match common sense. However, is this a reasonable expectation, given our understanding of the labor force behaviour of individuals, households, and aggregate society? We assert in this paper that, no, this expectation is neither consistent nor necessary proof of effective technical and vocational education.

Our goal for this paper is to forge a synthesis betwen labor supply theory and expectations for labor market effects of technical and vocational education,. We produce at least three benefits from our attempt at this synthesis:

1. Our synthesis provides theoretical economic underpinnings that are necessary to guide analysis of the outcomes of technical and vocational education, but which have been so lacking in previous descriptive studies (see, for instance, Geer, 1984, Grasso & Shea, 1979, or Peng, 1987, among many others).
2. Our synthesis highlights the influence of participation in technical and vocational education on household, as well as individual, economic factors which can limit net employment effects of these educational investments on society (refer to Gronau, 1977, and Becker, 1965, for consideration of the household as a fundamental economic unit). Neglect of the role of household economic decisions on individual labor supply has, we believe, permitted and encouraged the blindly optimistic hopes and *a priori* judgements about the unalloyed benefits of technical and vocational education that are held by many educators and policy-makers as well as by the public (refer to a critical analysis of these hopes and judgments by Passmore, in press).
3. Our work uncovers several labor market measures that, although common in studies of labor supply, have rarely been applied to evaluate technical and vocational education. Use of these labor market measures would not only enrich evaluations of strategies for technical and vocational education, but they would also allow the labor market effects of these strategies to be weighed against the myriad of alternative and competing strategies already under the scrutiny of economic methods and models.

We view this evaluation problem, unabashedly and unapologetically, through the lens of microeconomics, which provides an explicit theory about how economic entities (individuals, households, firms) decide to

allocate scarce resources to achieve desired ends. This theory, in turn, leads to testable (and, therefore, refutable) hypotheses about the effects of participation in technical and a vocational education on labor supply. Lack of a theory to guide evaluation of investments in technical and vocational education produces, at best, inconclusive results and, at worst, findings that are nothing more than sham and humbuggery hidden behind the patina of pseudoscience.

We divide this paper into two major sections. In the subsequent section, a concise summary of labor supply theory is presented by describing the nature, characteristics, and imperfections in labor markets and by explaining the role of opportunity costs, wealth, and consumer preferences in labor supply decisions. We realize that there are many "theories" of labor supply. We attempt to present a modal picture of these theories. We hope that this summary will be instructive, but we are not under the illusion that it is at all original. An interested reader could be better informed, although after absorbing much more technical detail, through study of any basic labor economics textbook (see, e.g., Killingsworth, 1983, or Kreps, Somers, & Perlman, 1974).

The second major section of this paper contains our prescription for application of labor supply theory to the problem of stating the expected labor force outcomes of technical and vocational education. We specify four research questions, stimulated by labor supply theory, that could be answered about the labor market effects of technical and vocational education. Our synthesis of these questions reveals four integrated and consistent expectations for returns on investments in technical and vocational education. The second section, we believe, embodies the major value added by this paper.

Labor Supply Theory

The Market

NATURE

As defined by Samuelson (1961), economics is the study of how individuals and society *choose*, with or without the use of money, to employ *scarce* productive resources to produce various commodities over time and distribute them for consumption, now and in the future, among various people and groups in society. (p.6)

The term, *commodities*, in Samuelson's definition connotes more than merely consumer goods such as radios, cars, or rice. Rather, concepts and methods of economics are applied to understand human choices of many kinds that are made to allocate scarce resources to achieve desired ends. Some people may dislike putting human labor on the same footing as a good to be bought or sold like bushels of corn or pounds of tofu. However, theorists conceptualize labor as a commodity only in an allegorical, analogical, and metaphorical sense, not with the intention of treating human beings as commodities (see, e.g., the distinction made by Chamberlain, 1969, p.230, p.233).

CHARACTERISTICS

Supply...demand...price these three economic factors govern markets for commodities. A "perfect" market for a commodity has at least six characteristics. First, the commodity bought or sold in the market is defined clearly. Second, the number of buyers and sellers is too large to permit collusion to limit supply or demand of the commodity or to fix its price. Third, the equilibrium price of a commodity is the amount of money for each unit of the commodity necessary to clear the market of the commodity. Fourth, shortages and surpluses of the commodity

are eliminated quickly through rapid changes in price. Fifth, information about the quantities of the commodity available at a specified price is exchanged perfectly and instantaneously among buyers and sellers. And sixth, sellers are motivated to maximize their profits, buyers to minimize their costs. Perhaps the closest conformance to the features of the perfect market is the securities market.

IMPERFECTIONS

Markets for labor, however, are far from perfect. Neither jobs nor workers are clearly defined commodities. Not all firms are alike in, for example, working conditions or attractiveness of location, nor are all workers in the same occupation alike in attitude, motivation, knowledge, and, of course, skill. Depending upon the mobility of firms and workers, geo-economic boundaries of labor markets for the same occupation may be local, regional, national, or international. Moreover, labor markets have a different character than commodity markets-a human character requiring labor markets barter continuing personal relationships among employers and employees. By way of contrast, transactions in commodity markets are brief and impersonal.

Because there are more workers than employers, firms often collude to affect employment practices (e.g., "anti-pirating" agreements between employers not to try to hire each others' employees). Collective bargaining agreements often limit the hiring flexibility of firms. Some analysts assert that minimum wage laws set the price of labor higher than would be the case if firms were allowed a freer hand in bidding for labor in an open market.

In a perfect labor market all workers performing the same occupation would receive the same wage corresponding to their contribution to production. Yet, wages differ within the same occupation, even within the same geographic area. All of these factors work together to make the wage an employee receives an elusive measure of the balance between the supply and demand for labor.

Perfect and instantaneous exchange of information is the *sine qua non* of the perfect market. However, contrary to the premise of a perfect labor market model,

> surveys indicate that most workers have only the haziest ideas about alternative employment opportunities, even in their local community; they know even less about the wages, working conditions, and possibilities of promotion in job openings elsewhere; and even those workers who do state wage rates in other establishments are often grossly wrong in their estimates..... Efforts to improve labor-market information...[are] one investment in human beings which may have a higher rate of return than many other kinds of investment that have received considerably greater publicity. (Kreps, Somers, & Perlman, 1974, p.27)

In practice, all markets, even for well-defined commodities, are imperfect. Nevertheless, the conceptual and methodological apparatus used to describe the classic perfect market often proves useful in the analysis of practical problems from an economic viewpoint. This is especially true for labor market problems.

The Supply Side

LABOR SUPPLY AS DEMAND FOR LEISURE

The demand for labor in an economy is the number of workers needed to produce

a desired amount and kind of goods and services for distribution and consumption (Rees, 1973, chap.4). On the other hand, the total supply of labor in an economy is the number of people willing to work at prevailing wages (cf. Hamermesh & Rees, 1988, p.l,Perlman, 1969, chap. 9 or Rees, 1973, p.3). Because of vast employment opportunities and personal liberties enjoyed, the United States'labor force is highly flexible and mobile, and, as a result, clear understanding of the nature and determinants of the supply of labor is especially difficult.

Models of open, non-totalitarian economies treat labor supply as a decision about the demand for leisure. In general, the demand for any good is a function of at least three general factors: (a) the opportunity cost of the good; (b) the consumer's level of wealth; and (c) the consumer's preferences. By extension, then, of general demand theory, three factors dominate the demand for leisure: (a) the opportunity cost of leisure- measured by an individual's market wage rate; (b) the individual's wealth-often measured by assets and other non-labor income; and (c) individual preferences for work over leisure-expressed by showing the range of work/leisure mixtures that are equally satisfying to the individual (see, e.g., Ehrenberg & Smith, 1988).

Opportunity costs, wealth, and consumer preferences have special significance in microeconomic theories of demand. An opportunity cost is the cost of foregoing one good as a result of consuming another. For example, the opportunity costs borne by the worker who travels to work by bicycling rather than driving his car are the value of the extra time necessary to bicycle and the added risks of collision and injury posed to bicyclists. These costs must be weighed against the ecological and health benefits of bicycling. The opportunity cost is a more formal way of expressing the maxim, "Everything has its price." Wealth, of course, increases consumption possibilities. "The rich are different from us", Ernest Hemingway was claimed to have said once to F. Scott Fitzgerald, "they have money." Consumers' preferences are revealed through their consumption choices, but the psychology behind the choices is not considered in demand theory. After all, who is to know why, say, only one in ten thousand persons is rabid about garlic or why teenagers are wild about music recorded by people who look like bald poodle dogs? The fact that a quantity of a commodity sells at a certain price is all the information that suppliers need to plan the production and distribution of goods and services. *De gustibus est non disputandum*-that is, loosely translated, there is no accounting for taste.

Labor supply decisons occur over the entire life of an individual. In the remainder of this section, however, we describe a static, single period model of individual labor supply decisions rather than a model with dynamic, multi-period, and intertemporal features. A static model of labor supply portrays decisions about the consumption of leisure in one period, with current opportunity costs, wealth, and preferences as influencing factors. Our coarsely simplifying assumption is that individuals make their decisions as though current actions are not affected by previous actions and do not affect future decisions (Killingsworth & Heckman, 1986; Pencavel, 1986). However limiting this assumption may seem, static models of labor supply usefully describe individuals' entry into the labor force and selection of the number of hours of leisure to be exchanged for hours of work. In addition, static models provide insight into how these decisions are influenced by shifts in opportunity costs,

wealth, and preferences faced by individuals.

OPPORTUNITY COSTS, WEALTH AND PREFERENCES

The role of opportunity costs, wealth, and preferences in individual labor supply is shown in Figure 1. The horizontal axis is scaled by increasing hours of leisure moving to the right and, as a complement, by increasing hours of work moving to the left. The maximum hours of leisure, or minimum hours of work, available to the individual for work or leisure are indicated by h(m). The value of h(m) is less than the total hours available because some time is absorbed by sleep and similar necessary functions. Also, other amounts of time, representing fixed costs of entry into the labor market, are allocated to, for example, commute to work or transport children to day care. Of course, time for sleep and other functions and fixed costs of entry into the market vary over individuals. Therefore, h(m) is treated as a random variable in this formulation.

The right vertical axis of Figure 1 is total money income scaled by some common unit such as the dollar, dirham, rupee, or lira (the currency actually does not matter). The left vertical axis is the amount of goods and services that the income scaled on the right axis can buy. A person with v(l) income can buy no goods and services [g(o)]. The importance of showing income and goods and services on the same graph is that changes in taxes or prices can change real income and, in turn, can expand or contract the bundle of goods and services that can be purchased by an individual.

Line v(l)g(l) is a budget constraint that defines an individual's consumption opportunities afforded by trading leisure for work. As the number of hours of work increase (represented by a move to the left on the horizontal axis), income and, therefore, possibilities for consumption of goods and services also increase. The slope of v(l)g(l), or the change in income produced by a one hour increase in hours supplied to work ($\Delta \$ / \Delta$ hours), is the market wage rate. An individual with a budget constraint defined by v(2)g(2) has a higher wage rate than an individual defined by v(1)g(1), because the slope of v(2)g(2) is greater than v(1)g(1).

All other things held constant, an individual with market wage [g(2) - g(0)]/h(m) has greater income and therefore, more consumption opportunities than someone with market wage [g(1) - g(0)]/h(m) because of the differences between these two individuals in the height of the left vertical axis intercepted by the budget constraint. Individual differences in h(m) due to variations in sleep and personal care needs or in fixed costs also create differences in income possibilities among individuals who have the same market wage rate. For instance, the income of a commuter or working parent may be lower than another person earning the same hourly wage who does not commute or has no children because fewer hours are available for work. The market wage, then, is a measure of the opportunity cost of leisure because it indicates the cost of consuming an hour of leisure rather than an hour of work.

Wealth derived from sources other than the labor market is considered in decisions about the demand for leisure. For instance, individuals may receive rents, dividends, and income from trusts. They may have tangible assets which can be quickly converted into income. The may reside in households which receive welfare or disability income transfers or in which other household members earn income in the labor market or through other sources.

Wealth obtained through sources other than the labor market-often termed *non-labor income*-profoundly affects labor supply decisions by creating differences in the initial income positions of individuals. In Figure 1, the amount of non-labor income is indicated by the intercept of the budget line with the right vertical axis. The amount of non-labor income for an individual with budget constraint v(2)g(2) is equal to v(2); this person's income from the labor market is equal to i(f) - v(2), where i(f) often is termed the *full income* of the individual. Any person with v(2)non-labor income can consume some goods and services without working at all

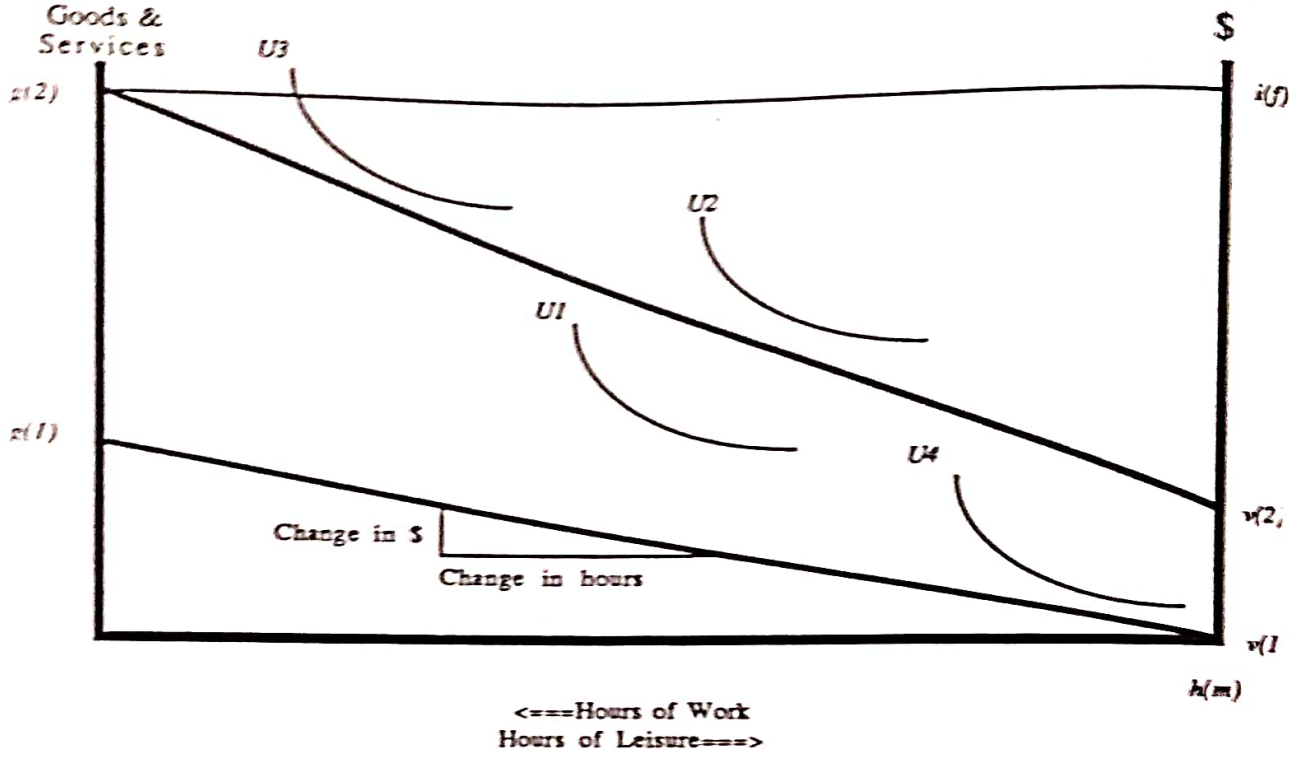

Figure 1. **Opportunity Costs, Wealth, and Preferences in Individual Labor Supply**

We have defined two key factors in the demand for leisure: wealth and the opportunity cost of leisure. The parameters of labor supply theory are fully specified by the inclusion of a third factor-preferences for leisure and income. U1, an arc convex from the lower left intersections of hours and goods and services axes in Figure 1, shows the alternative combinations of work (which produces income) and leisure that leave an individual equally satisfied. Said in another way, U1 is an *indifference* curve in the sense that it shows points at which the individual's economic well-being is indifferent to the relative mix of work and leisure chosen. Economic well-being or satisfaction is called *utility* be economists. People are assumed to maximize their utility by consuming as much leisure and as many goods and services as possible. Utility is the economist's analogue for happiness.

Indifference curves U1 and U2 are

parallel. The level of utility preferred by an individual with indifference curve U2 is greater than for the individual with preferences described by U1 because U2 shows a higher level of income with more leisure than U1. An individual whose preferences are described by U3 might be termed an "income lover" because high income and many work hours are preferred. On the other hand, an individual with indifference curve U4 might be called a "leisure lover" because plenty of leisure and low income define this individual's range of satisfaction.

The slope of the indifference curve is called the *marginal rate of substitution* (MRS) between competing preferences for leisure and consumption of goods and services. Portrayal of the trade-off between consumption and leisure as a curve rather than as a straight line implies that work and leisure are imperfect substitutes. The market wage rate shows the opportunity cost of consuming an additional hour of leisure, that is, the income gained by foregoing leisure. The MRS defines the value of leisure lost for each additional hour of work, or, said in another way, the MRS is the opportunity cost of work. In this sense, the MRS often is called the *home wage rate* because it defines the wage foregone for staying at home rather than entering the labor market.

LABOR SUPPLY DECISIONS

Next we describe how the opportunity cost of leisure, wealth, and preference for the consumption of leisure affect two fundamental labor supply decisions made by an individual. The first decision is whether to work at all. The second decision faced is how many hours to work. The analytical framework for these two decisions is shown in Figure 2.

Should I work? Point v(1) on Figure 2 is where the budget constraint v(1)g(1) and indifference curve U1 interesect when h(m) is equal to zero hours of work and maximum leisure time. In this point, the greatest level of utility is obtained by not allocating any hours to work becuse the slope of the MRS is greater than the wage rate. In this case, the satisfaction obtained by consuming leisure is greater than the economic well-being that could be obtained through working, or, said in another way, the home wage rate exceeds the market wage rate. The decision to work at all in this situation would require lowering the utility that could be obtained, which is contrary to our assumption that people want to obtain the greatest utility possible. Utility cannot be raised higher than v(1)g(1) because income opportunity is limited by the wage rate, which is why v(1)g(1) is called a budget constraint. The general work decision has two alternatives. First, if the MRS intersecting the budget constraint at zero hours of market work is greater than the market wage, then the individual is better off not working. Second, if the MRS at zero hours of work is less than the wage rate, then the individual is better off working.

How many hours should I work? The point of tangency, a, of budget line v(1)g(1) and indifference curve U2 in Figure 2 represents the highest level of utility that could be obtained by a person with this budget constraint. At this point, the individual supplies h(m) - h(0) hours of work for which i(0) income is derived that can purchase g(0) goods and services. The most satisfying number of hours for this person to work is h(0) because more or fewer hours would require the person to lower their utility. Said in another way, the optimal number of hours for the rational individual to choose to work is the point on the indifference curve where the home wage rate equals the market wage rate. More simply, whether a person choses

to go to work or to consume leisure depends upon how they value the use of their time. The individual portrayed in Figure 2 can obtain higher utility only by increasing the wage rate, becoming more wealthy, or shifting the utility curve itself to the left to reflect greater motivation for income through a stronger preference for work over leisure. Education can influence each of these changes.

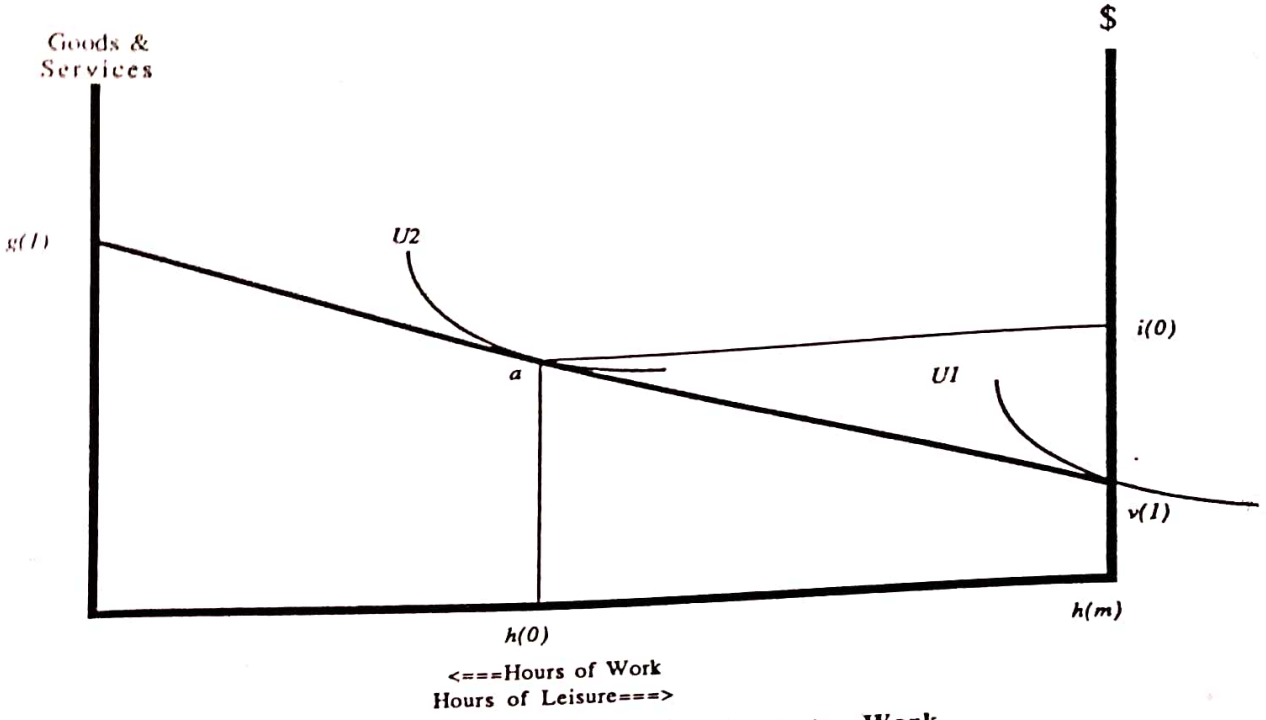

Figure 2. **Utility Maximization in Decisions to Work and to Supply Work Hours**

CHANGES IN OPPORTUNITY COSTS, WEALTH AND PREFERENCES

Thurow (1970, chap.2) defined human capital as individuals' capacities to produce goods and services. Individuals, firms, and society invest in human capital to enhance and maintain these capacities. As with all investments, human capital investments are expected to yield returns to investors in the form of current or future benefits. Benefits derived can be tangibles, such as lifetime earnings or productivity, or intangibles, such as feelings of pride in work or loyalty to employers. A primary means for enhancing and maintaining human capacities (some of which are innate, some of which can be developed) is through education, which, if defined broadly, includes more than formal schooling. Returns on investments in education for work are often sought by individuals and society through participation in the labor force.

Education for work could change the values of each of the three parameters of labor supply through its effects on human capital. In the short run, people cannot alter their wage rates. In the long run, though, an individual's market wage can rise through investments in human capital formation. Also, an investment in the human capital

of another household member may increase an individual's non-labor income. In this way, the net effects of education for work on households may differ from its effects on individuals. Moreover, education for work may so alter an individual's preferences for consumption and leisure that more leisure than work and, in turn, low income no longer are satisfying. This economic perspective on labor supply decisions, then, reifies abstract, psychological concepts such as "work attitudes" and "commitment to work" that educators and trainers frequently cite as foci of their interventions (see, e.g., model described by Pasmore, Richer, & Ay, 1987). Attitudes changes mean very little unless they result in changes in behavior.

The relative influences of simultaneous changes in opportunity costs, wealth, and preferences on labor supply is an empirical issue that cannot be predicted from theory. Leisure in our formulation is a *normal* commodity. By this we mean that we assume that people wil consume more leisure as their utility increases. In line with this assumption, two competing forces move in opposition. First, an increase in the market wage increases income, and one way for utility to increase is to consume more leisure. However, a second, and competing, force exerted by a rising market wage is that the opportunity cost of leisure rises, and utility can be increased by earning more through working more.

The decrease in working hours caused by increased consumption of leisure due to higher wages is called an *income effect;* the increase in working hours due to higher wages is called a *substitution effect.* Both effects can occur at the same time and reveal markedly different patterns of preferences for consumption of leisure. As a result, the net change observed in labor supply decisions may increase or decrease depending on the strength of either effect. The strength of these effects is dictated by tastes of the individual for income or leisure. Therefore, the observed labor supply effects of education for work usually are a combination of these two effects.

A situation in which the income effect is stronger than the substitution effect is displayed in Figure 3. Suppose that an individual's wage rate increases from the slope of line v(1)g(1) to the slope of v(1)g(2). Under budget constraint v(1)g(1) and with indifference curve U1, this utility-maximizing person works h(0) hours. After an increase in wage rate, this person decreases labor supply to h(1) hours with increased utility U2. The total observed change in hours is h0)) -h(1). However, suppose that non-labor income could have increased by v(1), which is just enough to create the same increase in utility that was caused by the wage increase. In such a case, this person's working hours would have reduced to h(2) rather than merely to h(1). The change from h(0) to h(2) is the income effect; the change from h(2) to h(1), which is never observable directly, is the sustitution effect. Many empirical studies of labor force behavior consistently show negative income effects, but indeterminate effects of changes in the wage rate. Many studies calculate a negative substitution effect for males and a positive substitution effect for females. Econometric methods, which are not reviewed in this paper, are used to decompose income and substitution effects in empirical studies of labor supply (see Ashenfelter & Heckman, 1974, as well as a review by Killingsworth, 1983, chap.3).

We are not aware of an empirical study that has evaluated investment in technical and vocational education in the light of labor supply theory. Perhaps the unclarified combination of competing income and

substitution effects is why so many studies of former participants in technical and vocational education reveal negative or minimal labor market effects. At least five

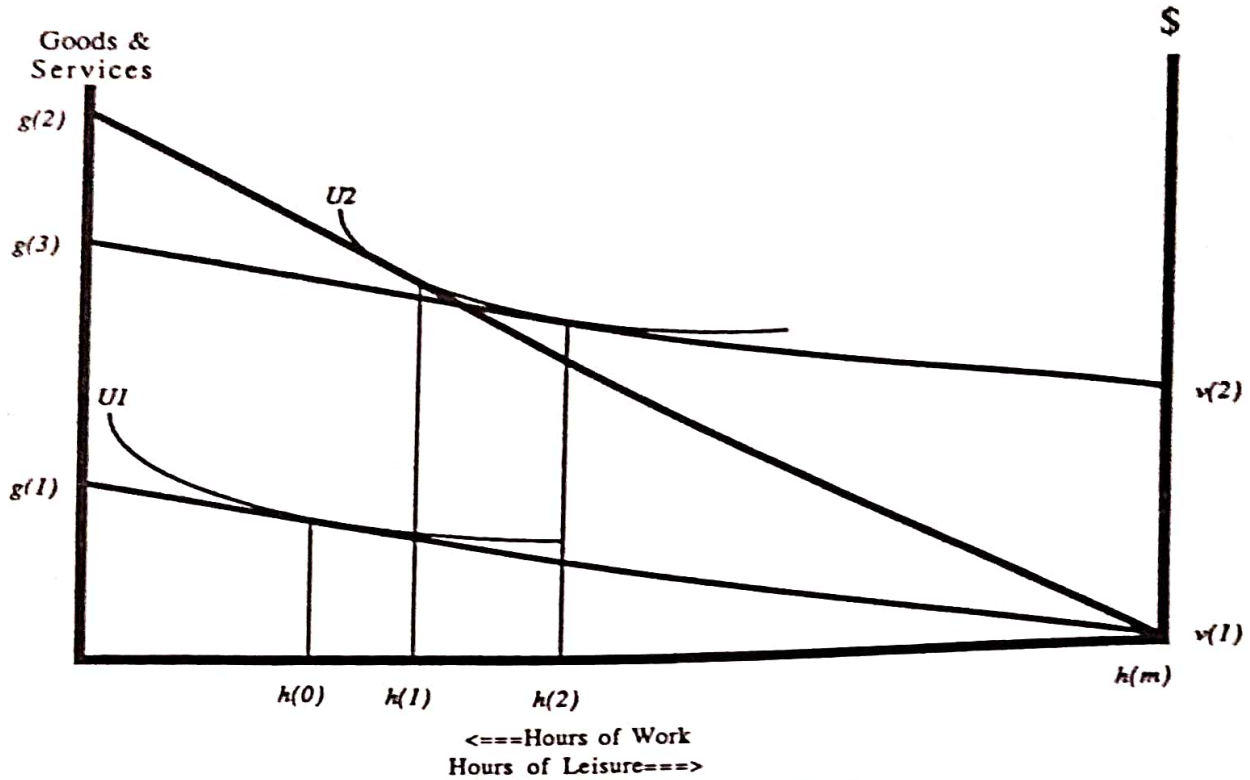

Figure 3. **Changes in Opportunity Costs, Wealth, and Preferences**

implications are pertinent, though, from our analysis for technical and vocational education:

1. Education designed to increase the human capital of its participants might not, for good reasons, improve their observed employment. Effective technical and vocational education might make leisure more easily attained.
2. Non-labor income can have a profound influence on the observed effects of technical and vocational education. For instance, education, no matter how well conceived or implemented or effective at increasing human capital, might not exert stronger effects than the economic wisdom of staying on welfare, the financial lure of participating in the illegal, "underground" economy, or confidence in knowing that a spouse makes enough money to support an entire household.
3. Increase in employment and income for one person may merely be an increase in non-labor income for another member of the household. Thus, creation of income potential in one person in a household may make it easy for another household member to leave the workforce.
4. Merely descriptive tabulations of participation rates in technical and vocational education by employment rates (the typical vocational school follow-up study) do not yield any definite information about the actual effects of technical and vocational education.

5. Curricula that attempt to improve preferences for work in the labor market over leisure might yield unexpected benefits. Many technical and vocational educators have a jaundiced view of such curricula because the direct labor market relevance of commitment to work is not obvious. Technical and vocational educators, instead, prefer educational experiences that have high fidelity with the workplace. However, employment and employability might be best served by ensuring that students are properly motivated to desire entry into the labor market after completion of training programs.

Application

We assume that policy-makers, parents, students, teachers, employers and the public in general invest their time, effort, and tax dollars in technical and vocational education with the expectation that individual and social benefits will flow from consequent increases in wages, employment, and overall economic well-being. From this assumption and from the labor supply framework we delineated in the previous section of this paper, we derive a set of four research questions on expected outcomes for investments in technical and vocational education. In the process, we outline some conceptual and empirical needs to apply theories of labor supply to this evaluation problem.

Four Research Questions

1. Is participation in technical and vocational education positively associated with market wage rates?

Wages should be positively associated with effective investments in technical and vocational education for at least two reasons. First, improvements in human capital should affect wages. Second, as an outcome of effective program planning, technical and vocational education that is offered in occupations for which there is an adequate demand for trained workers should have competitive wages.

Several measurement problems make the relationship between wages and participation in technical and vocational education difficult to observe, however. First, many definitions of wages are available; therefore, conclusions about the effectiveness of technical and vocational education may vary depending on the wage measure applied. Second, the market wage is observed only for workers; however, applications of the theory of labor supply require examination of market wages for all individuals, even those whose market wage rates are less than their home wage rates.

Measures of market wage rates have two components which are usually combined to express wages per unit of time. One component is earnings; the other is time. For instance, hourly wage rates may be observed directly as earnings per hour of work. Or, weekly earnings or annual earnings may be divided by measures of hours worked per week or hours worked per year. Hours worked per week may be actual hours worked during a survey reference week or some measure of usual or typical hours worked. Hours worked per year may be some combination of actual or usual weekly work hours and weeks worked during the year. Many combinations are available and many possibilities exist for errors of measurement in the components. Analysts need to be specific about which measure of the wage rate is chosen because the differences among market wage rate measures applied may account for potential differences in results of studies.

Observed distributions of hourly wage rates are only available for workers, resulting

in censored distributions of market wage rates for all individuals. The practical problem is that measures of participation in technical and vocational education usually are available for all members of a sample, but wages are available for only workers. Focusing only on workers will bias evaluation results. The resulting restriction of the sample for evaluation is affected by what has been termed *selection bias* (Fomby, Hill & Johnson, 1984, p. 358).

Selection bias occurs when some subgroup of a population is selected for inclusion in sample according to endogenous factors-that is, factors that are determined along with labor supply such as wages or observed hours worked. An instrumental variable technique proposed by Heckman (1979) often is applied to solve this analytical problem. Passmore (1981, 1982) provided an example of use of Heckman's method to estimate and correct selectivity bias in a labor force participation equation.

2. Is participation in technical and vocational education associated with larger substitution effects than income effects?

Technical and vocational education could increase employment and hours of work of former participants by increasing the opportunity costs of leisure (substitution effect), or it could decrease employment and hours of work through higher wages which make leisure more possible without a loss in economic well-being (income effect). Although a positive income effect may be desirable for an individual, we argue that social benefits from investment in technical and vocational education are produced only if there is a substitution effect.

The reaction of buyers and sellers to changes in market price is acalled *elasticity* by economists (Hyman, 1986, p.35) and is usually expressed as a percent change in amount bought or sold for each percent change in market price. Non-zero elasticities show sensitivity to price changes. Positive or negative elasticities show that the commodity bought or sold is sensitive to changes in market prices. For comparability across studies and between subgroups analysed within studies, income and substition effects often are expressed in empirical studies of labor supply as elasticities that describe the percent change or differences in employment or hours worked in response to changes or differences in market wage rates. Killingsworth (1983, p.110) described methods for evaluating elasticities at mean values of wages and hours worked in labor supply functions.

3. What are the net changes in household labor supply as a result of participation in technical and vocational education?

This research question is a twist of question 2. The focus in this question, however, in on the effects of investment in technical and vocational education on household labor supply. One household member's increase in income from work in the labor market becomes another household member's non-labor income. In this way, increases in the labor supply of one household member may be offset by decreases in the labor supply of another household member.

While noting the substantial problems with the comparability and anomalous findings of studies using the static labor supply model, Killingsworth's (1983, Tables 3.1 through 3.5) review of empirical studies reveals important influences of household members' income on the labor supply behavior of other household members. One obvious implication is that studies of the labor

market effects of investment in technical and vocational education must take into account income contributed by all members of former participants' households. The net effects of investment in technical and vocational education on aggregate employment and hours worked will probably be more modest if household behavior is considered rather than merely individual behavior.

4. IS PARTICIPATION IN TECHNICAL AND VOCATIONAL EDUCATION POSITIVELY ASSOCIATED WITH POSITIVE TASTES FOR WORK IN THE LABOR MARKET?

Technical and vocational educators frequently assert that technical and vocational education improve work attitudes and commitment to paid employment over leisure. The influence of technical and vocational education on these attitudes and commitment often is assessed, however, through analysis of responses to questionnaire items requiring former participants to express their feelings about paid employment. Such an approach relies on descriptions of how former participants might react in the labor market or how they respond to abstract situations. This approach fails, though, to examine the decisions that people actually make about their labor supply. As we know, intentions, convictions, and responses to hypothetical situations can be quite different from actual behavior. We might bluster and swagger that we would shoot to kill a robber in our home without hesitation, but we might be paralyzed with fear and moral hesitation if we actually confront an invader.

Shifts in taste for work in the labor market are revealed in two ways through the theory of labor supply. First, a positive substitution effect is evidence of increase of, or at least maintenance of, utility through production of more income by taking advantage of a greater market wage rate. Second, differences in labor supply of individuals who face the same market wage rates can only be accounted for through differences in the position of their utility functions along the budget constraint. One person may prefer more work (and, more income and, therefore, more consumption of goods and services) than another person who faces the same market wage rate merely because consumption may be more valued than leisure.

Evidence of differences in taste for market work among people facing the same market wage rate is investigated by inclusion of variables in labor supply functions that measure characteristics of individuals other than fundamental labor supply parameters such as the market wages rate and non-labor income. Some of these variables might be descriptive demographic factors such as sex, race, or marital status. However, inclusion of variables that measure participation in education for work would also allow estimation of differences in utility while holding constant the market wage rate and non-labor income.

As with each of the four questions, answering this question competently and unequivocably requires determination of whether observed differences in labor market behavior between participants and non-participants in technical and vocational education are due to the investment in technical and vocational education or to existing differences between participants and non-participants. Of course, a true experiment, with random assignment of subjects to treatment conditions, is required to separate these competing effects.

Some researchers have concluded that randomized clinical trials are necessary to determine the effects if investments in technical and vocational education (Ashen-

felter & Card, 1985, p.648; LaLonde, 1986). These arguments have persuaded the United States Department of Labor to conduct classical experiments of participation in 20 local training programs funded through the Job Training Partnership Act. Such experimentation, however, raises substantial ethical issues and is costly. Methods are available to minimize bias in data summarizing the outcomes of non- experimental interventions (see, e.g., Heckman & Hotz, 1987) which might find fruitful application to evaluations of investments in technical and vocational education.

Synthesis

A synthesis of expected employment outcomes of technical and vocational education implied by labor supply theory can be derived from these four research questions. First, we expect that participants in technical and vocational education should have higher market wage rates than non-participants. Second, substitution effects should outweigh income effects among participants in technical and vocational education. Third, the expected employment outcomes of technical and vocational education are tempered in the aggregate by the compensating effects of household income improvements on the labor force behavior of other household members. And, fourth, by examining specific economic and behavioral markers of preferences for labor market rather than abstract and psychological measures, it is possible to directly assess whether participation in technical and vocational education yields greater preferences for work, income, and consumption over leisure.

Summary

In response to a lack of a theoretical basis to guide evaluations of technical and vocational education, we have extended microeconomic theory of demand for leisure to clarify the expected outcomes of technical and vocational education. The nature, characteristics, and imperfections in labor markets were reviewed. The influence of opportunity costs of leisure, wealth, and consumer preferences for leisure on labor supply decisions was outlined. We synthesized four expected outcomes of investment in technical and vocational education which are implied from labor supply theory.

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Retention and Transfer of Teaching Competencies from Training to Practice – A Case Study and the Implications on its Findings.

T. R.V. Subrahmanyan and N.R. Bhat

ABSTRACT

This paper refers to the major findings of a case study undertaken by Prof T. Subbarao and Prof. TB Adhikari investigating how teaching competencies are developed in technical teachers and to what extent these are retained and transferred in their own settings. In the background of these findings, their implications are critically examined covering issues relating to in-service training programmes such as selection of competencies, laboratory approach to training, provision of learning resources, approaches for behaviour modification, implementation strategies and instrumentation for assessing impact. The paper concludes with a useful discussion on principles which may guide the teacher trainers in successfully identifying, designing and implementing in-service programmes with focus on enhancing retention and transfer of competencies from training to practice.

Introduction

The Technical Teachers Training Institutes (TTTIs) in India have been organising various long and short term courses for inservice teachers of Polytechnics. The congruence of the intended objectives of such courses with the outcomes realised in actual practice has not been thoroughly investigated. There is a general feeling that competencies developed during such courses may not be sustained and used by the participants in their institutions over longer period of time. This has become a matter of concern for technical teacher trainers requiring critical examination. Towards this end, a study was undertaken by Prof. T Subbarao and Prof. TB Adhikari to investigate how teaching competencies are developed in technical teachers and to what extent these are retained and transferred in their own settings. A brief reference to the major findings of this study is first made and these are critically examined in the light of findings of other researches and experiences of the authors to get an insight into the various issues involved.

Case Study Methodology

The methodology adopted was a combination of naturalistic enquiry and a case study undertaken in three phases involving conduct of a two week training programme on 'Improving Teaching Skills' in three identified competencies viz. Questioning, Using Assignments and Class room Testing at TTTI Madras, with a follow-up in two stages. The training programme was conducted from July 27 to August 7, 1987 and was attended by 12 participants from the

Southern and Eastern Regions of India. The first follow-up was spread over a period of about four months from September to December 1987 during which the participants attempted to use the acquired competencies according to an action plan drawn-up by them during the training programme. At the end of this period, each participant was required to send a self-report feedback on the extent of his use of the three competencies.

The second stage follow-up involved visiting five participants (2 from the South and 3 from the East) by the research team. This included observation of lessons, discussions with the participants, their students and peers and a study of the instructional setting. A variety of appropriate tools were used to collect information necessary for this study in the different stages.

Major Findings

Congruence between intended and realised processes

The training programme used the adult learning mode. The processes included lecture-demonstration/discussions followed by workshop and review sessions and simulated practice. In the case of questioning, the cycle was repeated, starting from eliciting behaviour to more complex behaviours for involving individual students in the generation of higher order thinking. A step-ladder approach from progressive differentiation to integrative reconciliation of component skills and concepts in an increasing order of complexity was adopted. In the case of the other two competencies, one cycle each was carried out, keeping the composite competency in view. Minor departures from the time table, such as interchange between topics to meet certain external exigencies were made, which is normal in such training programmes. The faculty reported that the training programme was conducted as planned and expected of them.

Regarding the transactions, the participants reported their liking for each of the components of the training programme. Most of them found the theme presentations, class participation and self feedback from video replay as very useful, while some felt that observing performances of others and actual practice in presentation were not so useful. Many reported difficulty with developing appropriate assignments, although they liked the theme presentation and discussion. They did not report much difficulty in developing competency in the other two areas.

The researchers, however, observed that modelling and simulated practice were positively shaping the participants' overt behaviour more than anything else. They found the participants struggling hard in practising questioning skills, although the participants did not report much difficulty in this area. No variation was noted between the intended and realised processes, indicating that the training programme was conducted as planned.

Congruence between intended and realised outcomes of training

The primary objective of the training programe was to develop/enhance competencies in the three areas to a level, satisfactory enough to retain and transfer them to normal class room teaching.

In respect of the competency of questioning, the participants achieved levels above what was expected by them and the faculty. With regard to using Assignments and Class-room Testing, the competency growth was positive, but below the expected

level, as perceived by the faculty. The participants could not write higher level instructional objectives and higher order class room questions, which, however, did not deter them from developing competency in questioning.

The participants, however, perceived that they have achieved in all the three competency areas, as expected by themselves. The standard of performance expected by the faculty was not shared by the participants in the case of Using Assignemtns and Class room Testing. However, the faculty agreed that appropriate models should have been provided in these two areas for enhancing the outcomes.

Congruence between planned implementation and execution

The participants used the competency of questioning in their class-room setting to the extent planned, resulting in enhanced student participation in the teaching learning processes.

The use of Assignments and Class room Testing were below target (planned), often modified to meet local contingencies. Testing was confined to the end-of-unit tests only and was not integrated with every lesson. Institutional and teacher factors seemed to have inhibited the use of these two competencies, while it was not so with questionning. The participants also had opined in their end-of-course feedback that opportunity to use these two competencies in the polytechnics was rather limited, although they agreed that they were beneficial for improving student performance.

Extent of retention and transfer

The level of retention of the cognitive and skill aspects of the three competencies gained in the training programme was observed to be fairly satisfactory. The transfer to the real situation was seen to be significant in the case of Questionning. It was, however, marginal in respect of Using Assignments and Class-room Testing due to various factors.

Implications on the Findings

Selection of Competencies

There is a consensus among researchers that in-service training programmes succeed when they are need-based (Hutson 1979). The selection of competencies for training is therefore crucial in in-service programmes. The selection has to be made based on an assessment of competency deficits and developmental needs in the practice situation.

In reality, however, such an assessment of training needs is often difficult. The clientele system of TTTIs does not have suitable mechanisms for this purpose to provide information on training needs. In the absence of such systematic information, the selection of competencies for the case study was made on the basis of assumed needs and not expressed needs. The three competencies, namely Questionning (Q), Using Assignments (A) and Class-room Testing (T) were chosen because they are used/expected to be used by teachers in their job and do not demand use of facilities and support services which are difficult to get in the participants' institutions.

The case study findings indicate that the selection of Q was legitimate in view of the significant success achieved both in terms of gain during training and transfer during the follow-up. In the case of A and T, however, the success achieved was only marginal both during training as well as during follow-up. There can be several explanations for this.

–Q is easier to use, while A and T involve additional investment of time and energy in both pre-and post-tutorial phases of teaching

–Q has low risk for students and enjoyable, while A and T tend to be evaluative of individual students.

–Q is private (within the class), with no record being kept for individual performance, whereas A and T are more public

–Q is less coercive, does not violate the ligitimate norms of group behaviour in public and is demonstrated to be utilitarian in the privacy of class-room performance (Etzioni, 1973)

–A and T are used as an act of compliance to external needs, whereas Q is internalised on account of private acceptance, congruent with a teacher's value system, without having to lose part of one's identity (self image) in public (Kolman, 1961).

These observations indicate that while the selection of competencies for training is to be based on identified needs of the clientele system for enhancing success of a training programme, factors inherent in the competencies and the practice situation favouring/hindering their use are also to be considered while designing in-service programmes.

Laboratory Approach to Training

During the last two decades or more, pedagogy has tended to become a laboratory-based field of study with emphasis on practice for competency training (Berliner, 1985). There is considerable evidence to show that when a laboratory set up for practice of competencies with self-feedback was provided, acquisition of competencies is more effective and transfer is significant. (e.g. OECD Project, 1987). The effectiveness of practice is seen to depend largely on whether significant teacher/student interaction patterns observed in natural settings can be replicated through modelling and simulation (Ornstein, 1985). Further, there is a need to use suitable observational instruments during practice to focus on critical specific behaviours to enhance the effectiveness of the models used (Kindswatter & Wilen, 1977). The feedback available based on objective evidences through such instruments has considerable catalystical value for bringing about change (Berquist et al, 1977).

In the case study, for competency Q, the component skills and their heirarchy were identified and a laboratory approach for practice with self-feedback was provided. Models for questioning were built-in in the theme presentations and micro-teaching strategies were used for practice. Video playback with feeback using suitable observational instruments was employed during training. In the case of A and T, after theme presentations, the participants were provided opportunities to prepare assignments and class room tests and the outputs were reviewed by the course faculty. Modelling/simulation was not possible, as on-the job interaction patterns could not be replicated in the training situation. This was also because component skills of A and T could not be easily identified and delinked from content. For the same reasons, feedback was restricted only to faculty review and observational instruments could not be used to provide self-feedback.

The case study findings indicate that the gain in respect of Q exceeded expectation and the competency was even strengthened after 4 months in the follow-up phase. In respect of A and T, the gain was below expectation and transfer during follow-up was

not significant. The laboratory approach to training adopted for Q seems to provide an explanation for this finding.

It is therefore indicated that for enhancing the success of in-service programmes both in terms of gain as well as transfer, a laboratory approach to training with practice involving modelling and simulation and opportunities for self-feedback through use of suitable observational instruments seems to be appropriate.

Provision of Learning Resources

There is evidence to show that teacher perceptions of importance and difficulty of use of new practices affect transfer (Guskey,1988). There is resistance to use competencies requiring additional investment of time and energy in the pre-and post-tutorial phases of teaching, even though they are seen as important in the context of curricular changes. Provision of suitable learning resources or work books to serve as teacher and student support materials when curricular changes are brought about is seen to facilitate the use of competencies required for implementing the changes (e.g. KELT Project, 1982-84).

In the case study, Q was easier to use and was perceived as useful by teachers for improving teaching. Although A and T are also seen as useful for improving teaching, there was considerable resistance to use them, in view of the hindering factors like extra time demand and extra effort/energy demand on their part both in pre-and post-tutorial phases of teaching. Further the participants were seen to experience considerable difficulty in identifying appropriate assignments and preparing class-room tests and expressed concern regarding the institutional constraints which may hamper transfer of these competencies in actual class room situations. The follow-up showed that factors such as inadequate time, insufficient facilities for typing and duplication hindered the effective use of A and T, while Q, where such hindering factors were not operating, the transfer was significant. Resistance in A and T for transfer could have been reduced, if suitable packaged learning resources incorporating the needed assignments and class room tests are provided to teachers so that these can be appropriately used with the students under their guidance.

These observations indicate that provision of suitable learning resources incorporating the materials needed for using new competencies, particularly when they demand considerable investment of time and energy for their use, and orientation of teachers to adopt them is likely to promote better transfer of these competencies.

Behaviour Modification Approaches

Training, instead of 'empowering' teachers to take charge of their lives through clinical supervison, often restrains them through fine tuning in doing more of the same better (Smith, 1986). This fine tuning is generally in the areas of knowledge and skills relating to the various competencies, while transfer of competencies requires changes in the temperament and attitudes of teachers, involving behviour modification. In in-service programmes, behaviour modification is seen to occur, when a learner-empowering approach with concern for person is deliberately introduced in the training, as it helps the participants to internalise the various competencies (Kelman, 1961). The participants are to be seen as resources for change and improvement and not targets for change. The strategies used should promote self-critical awareness, self-understanding, willingness to change and internalisation of change. Andragogical principles such as self-

directed enquiry, provision of use of experiences, making one's own decisions and working for them are important for bringing about behavioural changes in in-service programmes (Kowalski, 1984).

In the case study project, the andragogical principles mentioned were adopted during training and a positive attitude among participants towards the components of the training programme was evidenced. In the case of Q, a learner-empowering approach with a step-ladder development strategy, alternating between concern for the content and concern for the learner was deliberately used. In the case of A and T information-disseminating approach with built-in practice, group guidance and faculty feedback was employed. It was seen that the extent of transfer of Q was significant and the participants used it widely for improving class room climate and motivation. In the case of A and T, although the transfer was marginal, some individual observations are interesting. One participant, who had a relatively lower self-concept of teaching ability, but gained most in the training phase, was found to use a large number of student-centred class assignments to promote thinking by the students. Two other participants, who had a higher self concept and reluctant to share power with the students in the training situation were seen as friendly and exhibited some concern for students' well-being, although they strongly held that their basic style had not changed due to training, presumably because such new habit was internalised and they were unaware of it. This indicates that considerable attitudinal changes needed for transfer had taken place, eventhough it was pronounced in the case of Q because of deliberate introduction of empowering strategies.

These observations indicate that in in-service training programmes, transfer seems to be facilitated by adopting andragogical principles and incorporating approaches to 'empower' the individuals to deal with changes and related problems.

Implementation Strategies

Research evidence is available for the fact that a programme and its plan for implementation, if explicit and developed in collaboration with the practice institute and participants, the probability of success of the programme in terms of acquisition and transfer of competencies is higher (Hutson, 1979). This is because of the commitment that will be ensured, as, otherwise, the competencies developed may not be utilised, even if they are seen as legitimate and useful. Further, if the use of new competencies conflict with existing practices and norms in the real situation, transfer may be hindered. Therefore there is a need to make the use of new competencies legitimate through needed infrastructural support and administrative approval. This is corroborated by the success of the KELT Project, where the new competencies required for teaching were used, because of the support provided by a specially designed work book and the state level approval of the new curriculum (KELT Project, 1982-84).

In the case of the case study project, although the training programme was not drawn up in consultation with the practice institutions and the participants, each participant developed a plan of action for implementing the competencies back in his own institution taking into account the constraints and restraints. The participants were also made aware that the plan prepared by them would be followed-up by the investigators to get administrative support for utilisation by writing to the Principals of the

institutions and getting their approval for all the phases of the project. It was found that the participants mostly met the targets planned and they made appropriate efforts to keep to their plans to the extent those were feasible within local constraints.

These observations seem to indicate that in-service programmes tend to succeed in terms of both gain in the competencies and their transfer, if the programmes and plans for implementation are developed in collaboration with the practice institute and the participants, taking into account the opportunities and barriers in the practice situations and obtaining necessary policy support. A plan for follow-up developed in consultation with them is also a helpful factor in promoting transfer.

Instrumentation for Assessing Impact

Instrumentation is an important factor to assess the impact of a training programme from the point of view of sustaining and transfer of the acquired competencies. Some of the tools that can be used are self-report of the participants; observations, discussions and interviews with participants in the practice context during the follow-up. The date obtained from various sources in the practice context are to be triangulated and compared with the participants' pre-training performance for assessing the impact of training.

In the case study project a self-report questionnaire was adopted during follow-up Phase I and observation, discussion and interviews were used as tools in the second follow-up phase. The self reports obtained generally indicate that participants are satisfied with the implementation of plans they developed during training. However, the information gathered from other sources shows that while the transfer of Q was appreciable, A was used sparingly and T was used to a limited extent mainly for unit testing. It appears that over time a teacher, when successful, internalises the competency and tends to forget any uncomfortable experiences encountered. Thus self-report may be a defence mechanism to preserve his status as a self-directed adult and may not reveal the true picture.

The above observations indicate that a variety of instruments are needed for assessing the impact of training programmes for retention and transfer of competencies acquired. Self-report as a tool may not be a reliable measure for the purpose and if used, the information obtained should be checked against data obtained using other tools during the follow-up and triangulated to enhance the reliability of the conclusions drawn.

Retention and Transfer of Competencies

Retention and transfer of compentcies from training to practice is an aspect which needs further examination, in view of the fact that the ultimate test of any in-service training programme is its use on the job.

Forces affecting transfer

In terms of the findings of the case study, it is evident that there are helping and hindering forces that affect transfer from training to practice, provided that training has adequately equipped the participants with the competencieis and also helped them to retain and use them during clinical practice in the training itself.

The following Table 1 suggests many forces with bi-polar effects, indicating how they favour or hinder transfer from training

TABLE 1. Forces Helping or Hindering Transfer Process Competencies and Component Skills in Teaching and How they affect class room etc., teaching skills

No.	Forces	When		Skills used in study			Skill suggested by trainees		
		Hel-ping	Hin-drg	Ques-tng.	Cls. Assgnmt.	Cls. rm. testg.	Chalk Bd. Use	Demon-stns.	Guidnce & Counslng.
1	Enjoyability during use	High	Low	F	?	U	?	F	?
2	Teacher Freedom (alternative forms available	High	Low	F	?	?	F	U	F
3	Extra time demand	Low	High	F	U	U	F	U	U
4	Extra effort/energy demand	Low	High	F	U	U	?	U	U
5	Appropriateness or usability throughout the year/course	High	Low	F	?	U	F	F	F
6	Structural dependence on content	Low	High	F	U	U	U	U	F
7	Visibility of teacher performance	High	Low	F	U	U	F	F	?
8	Availability for later inspection	Low	High	F	U	U	F	F	F
9	Risk of student being evaluated	Low	High	?	U	U	F	F	?
10	Dependence on student need-base	Low	High	F	U	U	F	?	U
11	Influence of organizational norms & realities	Low	High	F	?	U	F	U	?
12	Need for infrastructural support	Low	High	F	F	?	F	U	F
13	Need for administrative backing	Low	High	F	?	U	F	U	?
14	Mode suitability for learning by grownups	High	Low	F	F	U	F	F	?
15	Ease of identification of components (subskills)	High	Low	F	U	?	F	?	U
16	Time-lag in feedback	Low	High	F	U	U	F	F	F
17	Generalizability of modelling simulation	High	Low	F	U	U	F	U	U
				33	9	3	30	16	19

F–Favourable; U-Unfavourable; ?–cannot be decided when the force is in-between high and low

(The scores above are based on taking F as 2, ? as 1, and U as 0 and adding them up for each of the component skills. It can be seen that transfer can be most with questioning and least with class tests.)

to practice. The list is open for alterations and additions. The table indicates an assessment of the three competencies of Questioning, Using Assignments and Class room Testing that were used in training, in terms of the hindering or helping forces to estimate their transfer possibilities. A similar analysis is made for three other competencies viz. Chalk board use, Class room demonstration, and Counselling and guidance which the participants suggested for inclusion in further programmes of training.

IMPLICATIONS FOR TRAINING

It can be seen from Table 1 that forces that affect transfer are mostly inherent in the task itself for some of the competencies and the analysis provides some ideas for adopting suitable training strategies to enhance transfer in such cases by trying to minimise the effect of hindering forces and strenthening that of favourable forces.

For example, the 'Risk of student being evaluated,' which is somewhat a hindering factor for Q can be be brought down by affecting the personality and characteristics of teachers (person factor) to dilute the evaluative efforts in the class room and promote learning by students. The effect of 'Extra time and effort demand', which is an unfavourable factor for A can be overcome to a large extent by providing the needed instructional learning resources and orienting the teachers to use them during training.

'Teacher freedom' for use of T can be raised by providing the teachers with multiple sources to find test items and ready-made tests, thus enhancing the possibility of transfer.

Teacher behaviour factors

A teacher is regulated by context, content, process and his own personality (Person) and all these factors affect transfer of competencies from training to practice. It is useful to consider how the various forces affecting transfer influence/are influenced by the four factors. Table 2 below provides a perspective of these forces from this point of view.

IMPLICATIONS FOR TRAINING

In a training situation, the person (participant) is the proximal factor ready at hand for influence and the context is a distant one, hard and slow to reach by the training institute. Content and process factors come in between.

Again, more the factors and greater the intensity of their potency in affecting transfer, less the actual transfer or the sustained use of a competency from training to practice.

Taking all these into consideration, the ranking given in Table 2 seems to point to strategies and tactics as to where to start training for transfer. Rank 1 goes to 'Ease of identification of component skills in a competency' and rank 17 to 'Teacher freedom'. This approach seems to hold promise in meeting the challenge of transfer from training to practice.

Conclusion

The above discussion is intended to help in broadly identifying a set of principles for successfully planning, designing and implementing in-service programmes to enhance retention and transfer of competencies from training to practice. An analysis of the forces influencing transfer indicates that process competencies are crucial elements in transfer, supported by those in handling the context, the content and oneself as a teacher (person). A teacher training institute may probably exert itself most in the process transfer area and do what is essential for the retention of competencies in other areas.

Table 2

Bi-polar forces as they affect or being affected by context, content, process, and person (teacher)

No.	Forces	Affecting/Affected by				
		Context	Content	Process	Person	Rank *
1	Enjoyablity during use		x	xx	x	13
2	Teacher Freedom	x	xx	xx	xx	17
3	Extra time demand		x	xx		6
4	Extra effort / energy demand		x	xx		7
5	Appropriateness or usability throughout	xx		xx		9
6	Structural dependence on content		xx	x		5
7	Visibility of teacher performance		x	xx	xx	14
8	Availability for later Inspection		x	xx		8
9	Risk of student being evaluated			x	xx	3
10	Dependence on student need-base	xx	xx	x		16
11	Influence of organizational norms/realities	xx		xx	xx	12
12	Need for infrastructural support	xx	x	xx		15
13	Need for administrative backing	xx		xx		10
14	Mode suitability for learning by grown-ups		xx	xx		4
15	Ease of identification of components			xx		1
16	Time-lag in feedback	x		x	x	11
17	Generalizability of modelling/ simulation			xx	xx	2

x - somewhat affecting/affected by

xx - significantly affecting/affected by

* indicates how to sequence training for ease of transfer from rank 1 to 17 in terms of hindering/ helping forces.

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Improvisation and Students' Performance in Introductory Technology in Junior Secondary Schools in Anambra State of Nigeria

OKEKE C.C.

ABSTRACT

The author refers to the shortage of trained teachers and suitable equipment to teach the course on Introductory Technology recently introduced in the Junior Secondary Schools of Nigeria. He emphasizes the need to use both improvisation and actual manipulation of equipment in teaching this subject effectively and attempts to validate this view by undertaking a study on the effectiveness of these approaches in the Nigerian setting. The paper reports the findings of such a study and recommends measures to improve Introductory Technology teaching and learning in Junior Secondary Schools in the country.

Introduction

Teacher resourcefulness is, perhaps, most crucial in the area of Introductory Technology where most of the gadgets presently available are imported. This is apparently compounded by the newness of the subject in the secondary school curriculum as well as the paucity of teachers who have relevant orientation to teach the subject effectively. But since technology has to do with problem-solving in response to human needs, its practical orientation stands out clearly. It thus logically follows that a theoretical approach to the teaching of technology will not only be counter-productive, but may also be attitudinally frustrating to students.

The objectives of Introductory Technology, according to Bamiro et al (1983) include:

- To provide pre-vocational orientation for further training in technology;
- To provide basic technological literacy for every day living; and
- To stimulate creativity.

Based on the above objectives, it necessarily follows that extensive use has to be made of equipment both by the teacher and the students. Students have to be provided the requisite practical knowledge and skills to enable them to acquire technological literacy as well as have pre-vocational orientation for further training in technology. Considering the number of students enrolled in each class (on an average 30 students), it appears a truism to state that no amount of imported material can go round the students without some form of improvisation by teachers and students. Improvisation implies making use of alternative material resources by the teacher and students to facilitate instruction. The generation of such alternatives is usually as a result of shortfall in supply or non-availability of requisite instructional materials. For clarity, local production which compares favourably with an imported one does not necessarily consitute improvisation. For example, factory-produced and school carpenter produced drawing tables

having the same specifications are not different. But when a foam is used to make a model of a building or an object, in a Technical drawing class, improvisation is implied.

The Problem

The need to lay a sound basis in science and technology for our young students is incontrovertible. It is the primary responsibility of teachers to stimulate students' interest via purposeful activities. As Ohuche (1986) puts it:

> If technology is to be harnessed for our national development and play an important role in our way of thinking, our way of reasoning, our way of living, then we must start early to provide appropriate help to our young ones. The young child must begin early to absorb from his environment experiences which will bring home to him the importance of technology as well as those which challenge him to aspire to future functioning as a technologist.

Since it is characteristic of young pupils to be curious and exhibit exploratory propensity, it is the teacher's responsibility to harness such characteristics to improve the instructional quality. One of his primary functions is:

> "to help all those who will become scientists and technologists to see science as more than a collection of facts or a game of getting the right answer, but as a field demanding the highest qualities of creative insight and imagination", (ASE, 1981).

The above underscores the importance of instructional materials in science and technology teaching. It is only through the effective use of such materials that children can manipulate, explore, and possibly invent. Introductory Technology as a new subject is faced with both the problem of requisite equipment and materials for instruction as well as qualified teachers to impart the required knowledge. Considering the large student enrolment in each class, the problem gets more compounded. This makes improvisation of learning resources necessary. Already, teachers are being improvised since there is dearth of requisite manpower for Introductory Technology. This has been reported by Eze (1986) from his survey of Anambra, Bendel, Benue, Borno and Gongola States' secondary schools. Moreover, the few imported equipment appear to lack local expertise for their operation.

Furthermore, available literature on improvisation in the sciences appears merely prescriptive (Bologun, 1982; Bomide, 1985). Such an approach does not seemingly provide a strong substratum for making predictions because of the doubtful fidelity of such suggestions. Without actually trying out the suggestions, it would be difficult to establish their efficacy and, consequently, make a prognosis of their application and results.

Consequent upon these short-comings, it has been thought desirable to look at some areas of Introductory Technology - technical drawing and applied electricity-with a view to determining what could be improvised to teach the topics therein and subsequently applying the materials so improvised in actual teaching to establish their efficacy.

The Purpose

The purpose of this study included:

1. To establish the effectiveness or otherwise of improvised materials for introductory technology teaching and learning;

2. To establish the direction of students' attitude to improvisation.

The significance:

Education for technological self-reliance pre-supposes that the students should be equipped with the capacity to explore, manipulate, invent or discover as well as make acceptable generalisations based on observed phenomena. Knowledge so acquired should be transferable and utilised for the solution of human problems. As a sequel, therefore, an orientation in improvisation of materials for teaching Introductory Technology will, hopefully, enable both teachers and students to see technological problems as issues that require environmental resolution. By using materials which have been so improvised, complex problems would seemingly have practical and simple solutions.

In this study, it has been established that the students taught by means of improvisation performed significantly better in terms of achievement and attitude to technology. Such revelations have some pedagogic implications which have been discussed.

Scope and Delimitations:

The study covered three out of the five educational zones of Anambra State. The Zones involved in the study included Awka, Enugu and Onitsha. Two secondary schools in each zone participated, and three Junior Secondary students were the subjects. Technical Colleges in these Zones were excluded. Topics for the lessons were selected from technical drawing and applied electricity.

Hypotheses

Based on the purpose of this study, the following hypotheses were formulated:

1. There is no significant difference between the performance (knowledge of basic facts and actual manipulative performance) of students whose teachers exposed them to improvisation and of those not so exposed.
2. Students taught through improvisation do not develop a more positive attitude to Introductory Technology than those not so taught.

Review of Related Literature

Introductory Technology is one of the pre-vocational subjects introduced in the Nigeria's 6-3-3-4 education system. The student is expected to acquire some basic skills in this subject on completion of the J.S.S. programme. Thereafter, he can function on his own, become employed, or even continue his education at a higher level. Primarily, therefore, the course is expected to inculcate in the student some basic skills and at the same time enable him to develop both positive interest in and attitude towards Introductory Technology. To achieve these, well thought-out combination of methods and materials is needed on the part of teachers.

Disappointingly, some recent studies on the teaching of basic sciences reported poor instructional approach which has been attributed, in part, to nonavailability of sufficient instructional materials, teachers' inability to make models or encourage their students to do so (Momodu, 1977). Poor performance of students in the basic sciences has also been attributed to poor teaching.

Thus, Obuba (1984) writes:

> "In the last five years, more candidates have been failing core Science subjects such as Mathematics, Physics, Chemistry and Biology....Education experts blamed the poor performance on bad teachers,

among other factors. They also warned that the imbalance in the core sciences needed to be corrected before Nigeria could dream of having technology muscle".

Since both Science and Technology has much in common in terms of experimentation and manipulative performance, any instructional approach in these areas devoid of practical orientation may not yield reasonable dividends. Students should be exposed to problem-solving experiences through the methodology of openness to enable them to retain and transfer their knowledge in a variety of situations. Studies by Toney(1968) and Ray (1960) attest to the above contention.

UNESCO (1981), reporting on the "Development of Content, Method and Materials for Science and Technology Education" observed, inter alia:

> "Teaching methods in science and technology education must be designed to close the gap between theory and practical work..... Teaching methods or instructional systems which enable the learner to engage himself in creative or divergent thinking, problem-solving and self-learning, and to the new avenues of communication, productive work and technological innovation, through such methods as simulation games, project work, should be promoted. Closer attention should be paid to the learner's participation in experimental and practical activities, and teaching methods must be flexible and more adaptable to anticipate a changing future..... More utilisation of media, printed and audio-visual teaching materials should be encouraged as well as active utilisation of locally available material resources....."

The use of equipment whether factory-produced or improvised for science and technology teaching is imperative. In the case of Introductory Technology, it was remarked by Abdullahi (1982) that:

> The course cannot be taught without equipment, because it is essentially practical. The theory is minimal and largely consists of simple explanations or descriptions of how certain simple results are to be obtained with tools and equipment.

On the attitude to Introductory Technology, the result of an earlier study has not been encouraging (Unachukwu, 1986). Students' attitude to Introductory Technology was reported to be just on the average. On attitude and achievement, while some conflicts of views have been reported, there appears to be some consensus that there is a reciprocal relationship between the two (Aiken, 1970). Thus, an improved attitude towards a subject would suggest an improved performance therein.

Design

Post test only equivalent groups design was utilised for the study. This design is reputed as one of the most effective in minimizing the threats to experimental validity (Best, 1981). The subjects utilised for the study were in three groups, and arrangement was as follows:

Group A R X_1 O_1
Group B R X_2 O_2
Group C R — O_3

R stands for random assignment;
X stands for treatment; and
O stands for test administered after the treatment.

Subjects

The subjects involved 730 Junior

randomly selected secondary schools in three educational zones in Anambra State. Out of this number, a sample of 570 students was drawn on the basis of proportional representation. This represented 78% of the population.

There was random assingment of the subjects into treatment groups A and B and control group C. Each group was made up of 190 students. Group A was involved in improvisation by both the teacher and students and in manipulation of the materials. Group B saw only the teacher demonstration using only the available equipment in the workshops and improvisation was absent. Group C which formed the control group was taught by the regular classroom teacher.

Organisation for Instruction

Six final year N.C.E. (Technical) student teachers who have been exposed to the various areas of Introductory Technology were provided six weeks orientation in improvisation techniques.

Each teacher was assinged to teach both groups A and B, while the regular class teacher taught group C (control class). The activities of the six teachers were supervised and coordinated. The duration of each lesson for all the groups was the same. The difference lay on the application of instructional materials.

The attitude scale was administered both before and after the treatments, while the achievement test was administered only at the end of the treatments which lasted for ten weeks. The test items were based on the objectives and content of work covered during the period. The areas covered included:

- Drawing equipment and materials
- Geometrical construction
- The atomic structure
- Basic ideas of electricity and magnetism

There were three periods of 40 minutes duration each of Introductory Technology lessons per week.

Treatments

Treatment Group A students were involved in both improvisation and manipulation of equipment under the teacher's direction and active involvement. Students were encouraged to engage in a series of workshop activities involving observation, explanation, improvisation and manipulation of equipment. They were encouraged to work individually and in groups to resolve common problems. Pre-and post-workshop discussions in content areas and workshop practice results also featured.

Treatment Group B students observed teacher demonstrations and manipulation of the available equipment. No efforts were made by the teacher to motivate the students to improvise the required instructional materials. Theoretical information of workshop procedures and expected results were given as part of a normal lesson.

The Control Group C had no special treatment, rather the students were taught by the regular class teacher of Introductory Technology. Most of these teachers, as has been reported earlier in this paper, are not qualified for their assignment, and therefore, seem ill-equipped.

Instrumentation

An "Achievement Test" and an "Attitude to Introductory Technology Scale" were the two instruments employed for data collection. The achievement test comprised twenty multiple choice and five performance - based items.

The performance test required the students to observe, improvise, manipulate equipment, record their observations and draw conclusions.

With regard to the "Attitude Scale", there ware 48 items. The response to the items was based on a five-point scale of: strongly agreed (5), agree (4), not sure (3), disagree(2), and strongly disagree(1). The maximum score in this scale stood at 240.

Establishing Validity and Reliability

For the achievement test, the researcher used a table of specifications to ensure that the test items were representative of the various areas taught, relative to the objectives of the course. Furthermore, the test items were placed at the disposal of professional colleagues and measurement experts for criticisms, suggestions and modifications. The final form of the test was as a result of the scrutiny.

The Attitude Scale was pilot-tested by the researcher using 40 Form Three students from four schools whose students were not involved in the experiment. Data obtained were analysed by applying the split-half technique as well as the Spearman - Brown prophecy formula. This yielded a reliability coefficient of 0.80. On the basis of the foregoing, the researcher considered the instruments appropriate for the study.

Data Collection and Analysis

Both the achievement test and the attitude scale were administered as earlier stated. Data so collected in each case were collated and analysed to test the hypotheses formulated.

Hypothesis One

There is no significant difference between the performance of students whose teachers exposed them to improvisation and of those not so exposed.

Analysis of Variance (ANOVA) for the one-way lay-out was the statistical tool employed here.

TABLE 1

One-way Analysis of Variance for test results.

Source of Variation	*df*	*Sum of Squares*	*Mean Squares*	*F*
Among Groups	2	3781.5	6980.75	
Within Groups	567	87644.8		44.57
Total Variation	569	101426.3	154.60	

$P < .01$

From Table 1, it is seen that there is a significant difference in the performance of the three groups ($F = 44.57$, $P < .01$).

However, as can be seen from Table 2 post-hoc comparison (least significant difference) indicates that while significant differences exist between A and B and between A and C, there is no such difference between B and C.

TABLE 2

Post-hoc Comparision of Means (LSD):

Groups	*N*	*t - value*	*df*	*P*
A × B	380	6.2	378	< .05
A × C	380	7.1	378	< .05
B × C	380	0.96	378	< .05

Hypothesis Two

Students taught through improvisation do not develop a more positive attitude to Introductory Technology than the students not so taught.

This hypothesis was analysed by means of Analysis of Covariance.
Table 3 illustrates the analysis.

This hypothesis embraces three sub hypotheses, namely:

a) that there are no differences among the adjusted means;
b) that there is no linear relationship between the two variables and the adjustment provided by the analysis of convariance; and
c) that the treatments do not influence the covariate.

From the results (F=14.151; F=361.228; and F = 6.253; P < .05), significant difference exists between the attitude of students in Groups A and B. In fact, the subjects in group A proved superior ($\bar{x}$ = 185.8) to those in group B ($\bar{x}$ = 180) in terms of attitude to Introductory Technology. In other words, the two treatments had differential effects on the two groups.

Discussion

Some of the observations on these findings will now be discussed These are:

- There is apparent lack of improvisation of instrutional materials in the area of Introductory Technology in our secondary schools.
- The quality of Introductory Technology teaching in our schools is seemingly poor.
- Introductory Technology teaching and learning can be improved upon through teacher resourcesfulness. Student and teacher improvisation as well as student manipulation of instructional materials appear more productive of learning.
- Attitude to Introductory Technology

TABLE 3

Analysis of Covariance of Treatment Effect on attitude towards Introductory Technology :

Source of Variation	*Sums of Squares and products*				*Deviations from Regression (Adjusted for Regression)*		
	df	X^2 *(Pre-test)*	*XY*	Y^2 *(Pre-test)*	SSy^2	*df*	*MS*
Methods within Treatments	1	3069.449	–1054.42	362.96			
Error within Treatments	378	185550.156	115564.078	147093.586	75118.135	377	2819.624
Total	379	188619.606	114509.658	147455.781	77937.759	378	
Adjusted Methods							
(Adjusted Treatment)					2819.624	1	2819.624

F (.05; 1,377) = 14.151;
F (.05; 1,377) = 361.228;
F (.05; 1.378) = 6.253

appears facilitated by active student involvement in the classroom activities through improvisation and manipulation of equipment.

For a teacher to be able to improvise or teach students to do so, it is presupposed that he understands both what to teach and the type(s) of equipment required to teach the subject. But teacher quality in the area of Introductory Technology is reportedly poor and this is reflected in the teaching of the subject. Thus, in Anambra State, Nduanya et al (1986) reported that out of 362 Secondary Schools offering Introductory Technology, there were 445 teachers none of whom was actually qualified to teach the subject. Furthermore, the work of Eze (1986) reported earlier stands in place here. This situation, perhaps, explains why the performance of students taught by the regular class teachers (C group) and those taught only through

teachers' demonstrations (group B) performed poorly. And in the words of Neff (1966), "If a teacher has never been afforded the opportunity to learn the meaning of objectivity, how does he subject his own biases, prejudices, and convictions to impartial evaluations? It is only the teacher who cultivates an attitude of objectivity is more likely to cultivate similar traits in his students". Neff's dictum possibly explains the state of Introductory Technology teaching in our Secondary Schools today.

That the students who were actively involved in improvisation and manipulation of equipment performed significantly better both attitudinally and in terms of achievement suggests the dire need for sound teacher preparation as well as providing opportunities to students to observe, explore, manipulate and make generalisations based on observed phenomena. It is this type of opportunity that will, perhaps, ' stimulate creativity' in the students. Poor instructional approach in the basic sciences has been attributed, in part, to non-availability of sufficient instructional materials and teachers' inability to make models or encourage their students to do so (Adesoji, 1976; Momodu, 1977).

However, if Introductory Technology must be meaningfully taught and the objectives realised, the active involvement of the learners becomes imperative. The performance of students in group A seemed to vindicate the observation by UNESCO and the remark by Abdullahi (1982) that Introductory Technology "cannot be taught without equipment....."

Since there seems to be a reciprocal relationship between attitude and achievement, the improved attitudinal change recorded by students in group A appears to have justified the students' improved performance in the achievement test.

Recommendations

Based on the foregoing, the following recommendations have been made:

— If the objectives of Introductory Technology are to be met, teachers must be specially prepared for their assignment. The practice of deploying science and other teachers to teach the subject holds no promise. Since this problem seems to assume national dimensions, a purposeful and aggressive policy at the national level is recommended. Polytechnics and Universities of Technology should be provided some financial grant to mount special programmes and prepare teachers for Introductory Technology.

— While the present government effort to provide Schools with Introductory Technology equipment is commendable, the near absence of teachers who have the where-withal to manipulate the equipment and possibly influence students positively appears to make such effort not effective. Priority should, therefore, be given for staff development of Introductory Technology teachers.

— Both teacher and student improvisation and manipulation of instructional materials are very indispensable during Introductory Technology lessons. Efforts should be directed towards production of suitable instructional materials in the subject to provide for improvisation and manipulation tasks, both by teachers and students.

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Ph.D. Education and Australia's Industrial Future: An Agenda for Reform*

J.G. SEKHON

ABSTRACT

The paper reports a study investigating the issue of responsiveness of Ph.D. education to the needs of industry in Australia. It articulates the important factors which contribute to the inadequacies of Ph.D. education as a preparation for a career in industrial research and suggests directions for reform. The perspective presented is Australian, but the conclusions and recommendations have a validity beyond the shores of Australia.

Aim of the Study

The general intent of the research reported here (Sekhon, 1985) was the formulation of educational proposals for doctorate industrial mathematicians in Australia. The aim was to provide an empirical basis for informed professional judgements on both the ends and means of Ph.D. education of mathematicians, scientists and engineers for industry.

Catalyst for the Study

There were, in the main, two considerations that caused this enquiry. The first was the health of the Australian economy. The entire range of economic indicators not only paint a sorry picture of Australia's technological performance, but underline a general adverse contrast with its major industrial competitors. Thus, the pressure and logic of economic strategy that Australia must increasingly diversify to high technology science-based industries lent a sense of urgency to the study.

The second consideration that spurred the study was the clear perception that the future of Australian industry is being directly threatened by the conjunction of the small number of Ph.D. mathematicians graduating from our universities and the exceedingly small number that elect to enter industry.

The numbers of science and engineering Ph.D. and other doctorates have declined over the period 1973-1985. The number of Ph.D. and Higher doctorate graduations in engineering was 105 in 1973, 88 in 1979, and 76 in 1985. The corresponding numbers for science were 441; 336; 366 (ASTEC 1987).

Further, Australia differs from other highly industralised countries, in having, in proportional terms, a low concentration of Ph.Ds in industry. On an average, 55 percent go to government research establishments and the higher education sector. About one

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in three move overseas. A mere 12 percent accept positions in industry. This is not in the best interest of national research and development effort.

The serious falling-off in industrial research and the relative decline of the manufacturing sector in Australia is a compound of shortcomings in the structure and attitudes of industry.

However, at the heart of our problems is the availability to industry of highly trained ability, for progress in industrial research and development depends crucially on the supply of able minds.

Hence the low incidence of mathematics Ph.Ds in industry led us to enquire into the possibility of misdirection in the structure of Ph.D education of mathematicians. The aim at all times has been not to level strictures, nor to assign blame, but rather to determine information that may be of interest to those responsible for making our campuses more productive environments for higher learning.

Evidence Gathered

The principal methods used to assemble the body of evidence were questionnaire and interview surveys. The data were collected through the administration of 1100 mailed questionnaires on an Australia-wide basis. The overall response rate was 41 per cent. The questionnaire and interview surveys set out to evaluate the climate of opinion regarding Ph.D education for non-academic employment. Three separate questionnaires, specifically contextualised to three main groups, were sent.

The study explores the attitudes and views of:450 employers of Ph.D graduates as well as the attitudes and opinions of 200 PhDs. Together they put forward, from strikingly different perspectives, the point of view of the consumer of doctorate education.

Employers were asked, for instance, what kinds of graduates does industry need? Are they happy with the end products of doctorate education? What are their expectations and perceptions of industrial mathematicians? What changes do they desire in doctorate education?

Similar questions were also put to PhD employees in industry. They were asked to assess the effectiveness of PhD education as a preparation for research careers in industry. To what extent did their doctoral education equip them to meet the special requirements of successful industrial practice? From the vantage of hindsight, what reforms or modifications do they desire in the design and implementation of PhD education?

The study also examines the attitudes and views of faculty and, in so doing, presents the producer' point of view. 450 academics were asked to indicate the extent of their collaboration with industry, the degree of sensitivity of their institutions to the needs of industry, and the elements in PhD education which should be emphasised and those that should be soft-pedalled.

Findings of the Study

The study has shown that research in industry is very different from research conducted in an academic setting. Industrial research is characterised by team effort, by time and financial constraints and by projects which cannot reflect one's own interests.

Given that the aims and approach in industrial and academic research are quite different, the question has seldom, if ever, been faced squarely, as to whether the present format of PhD education, designed to serve one purpose-namely, to produce initiates to

academia-can reasonably be expected to serve another. Hence, an important question addressed by academics was: what kind of PhD education should be provided to produce the kinds of graduates that industry needs?

Questions such as these have not been accorded anything like adequate attention in discussions of higher education. As far as we can tell, this is a pioneering study. The detailed analysis of the questionnaires has identified a continuum of opinion across a range of issues.

An important finding of this study is:

The degree of satisfaction for the majority of employers is only moderate.

To a significant proportion of employers, PhD education was of dubious value. The employer's criticism of the university product is that the latter is too academic, too distant from industrial reality, barely interested in problems of importance to industry and seeing his (her) future in a university or government research establishment.

The overall views of research laboratory managers suggest that there are grounds for satisfaction in the level of pure, mathematical knowledge in Ph.D. graduates. The inadequacies, however, are in attitudes and skills as well as the breadth and flexibility in professional interests. The disenchantment of executive managers stems from deficiencies in four particular areas:

- an enthusiasm for the aims and problems of industry;
- ability to adapt to priorities in industrial research where projects are all aimed at economic endpoints, with defined objectives in time and budgets;
- ability to communicate; and
- ability to participate effectively in team research.

The research has indicated that there is a strong and articulate recognition in the majority of responses of the following four factors which induce a trained incapacity towards the industrial research scientist role.

Dissertation Subject

There is considerable disposition to push students into fields of study which are of special interest to the supervisor. Seldom may dissertation topics be regarded as contributing to themes of direct interest to industry. PhD graduates display little willingness to contemplate migration into fields other than those of their research degrees.

Student's Supervisor

A student's development and attitudes to research are very dependent on his particular apprenticeship to his supevisor. The student internalises the values and role model of the supervisor. How he goes about research and how he regards his research task persist from his PhD experience.

Insularity of the Candidate

The general pattern of preparation suggests insularity of the PhD candidate from personal contact with industry. The experience of doctoral education rarely conveys to the student any idea of the scope and challenge of industry, nor any appreciation of its ethos.

Double Requirement

Most universities require from their doctoral students theses which must at one and the same time be original and substantial. This double requirement can too easily produce triviality at book length, more and more about less and less, the exhaustive and exhausting exposition of next to nothing.

Implications for Policy and Practice

The study has put forward a number of recommendations which provide a framework of strategy to guide broad courses of action for the achievement of desired ends, namely,

- to reduce the discrepancies in the responsiveness of PhD education to the needs of industry;
- to attract a higher proportion of PhDs into research careers in industry, and to enhance the quality of their role performance; and
- to promote the innovative and research capacity of industry.

Higher education and industry are interdependent: changes in any one influence the other and both have an interest to secure the best possible doctorate education. Accordingly, a number of recommendations are addressed to employers and academics alike. In the important and challenging area of preparation of PhD mathematicians for industry, both industry and higher education sector have singular opportunities of becoming catalysts of change.

Structure of Australian Industry

Given Australia's geographical isolation and the widespread distribution of her small population, by the standard of most other industrial countries, industrial firms are small. Expenditure on industrial research and development has been parsimonious in comparision with other countries. Together with the high levels of protection and the heavy concentration of manufacturing industry in large foreign firms, this has a pernicious influence on the nation's research and development enterprise.

We wish to avoid making detailed recommendations in the alleviation of these difficulties as they lie outside the ambit of this particular study, save to make one observation.

Education is assuming the role of the key parameter in the treatment of many of our social, economic and industrial problems. However, the education of highly skilled engineers, economists, scientists and mathematicians in any one nation will not, of itself, create economic growth. The thrust and direction of policies in relation to expenditure on industrial research and development, degree of foreign ownership and defensive strategies of protection need to be carefully reassessed.

Availability of Trained Human Resources to Industry

The application of new developments in science and technology is almost certainly the single most important method of increasing the productivity and competitiveness of Australian industry. The lack of an adequate infusion of PhD graduates into industry is, therefore, a major contributory cause of deep-seated malaise affecting the manufacturing industry.

There are considerable impediments to the flow of a strong stream of PhD graduates into industry and commerce, not the least of which are management attitudes as well as rewards, responsibilities and career opportunities.

The use of mathematics is still in some respects a pioneer activity in many industrial situations and there is a great deal of suspicion and prejudice on the part of management towards graduates of the highest intellectual calibre.

Salary and employment structures do not fully recognise and reflect the value and contribution of PhD graduates: indeed, their

contribution is attenuated as many have been employed on lower level support work.

The willingness of PhD graduates to enter industry and of employers to recruit them and use them to full effect must be regarded as problematic unless there is a major transformation of employers' attitudes and practices.

If Australian industry is to arrest the flight from itself of highly qualified manpower, as indeed it must, it will have to take increasing notice, through close study and observation, of how PhD graduates are used and rewarded in American, British, and European industry and seek to apply the lessons to itself.

Industry, too, will have to make a determined effort not only to project an attractive image of itself but also to disseminate the conviction that a research career in industry can be professionally rewarding. It must not only pay premium salaries, but strive to offer conditions of employment which are no less secure and congenial than those offered by its rival bidder - the higher education sector.

We therefore recommend:

(a) that managers and directors take necessary stepts to acquaint themselves with the prevailing practices and attitudes in American, British, and European industry concerning deployment of highly trained research personnel;

(b) that employing organisations appraise their salary and career structures to ensure that they adequately recognise and reflect the value of the contribution of mathematicians, scientists and engineers within their enterprises; and,

(c) that employers appreciate and act upon the fact that the only sure way to induce PhD graduates to opt for research careers in industry is to make them see such a career as more satisfying in terms of likely rewards, responsibilities and career prospects than the alternative.

Higher Education Sector

However, not all the balame for the small proportion of PhDs found in industry or for the distrust and suspicion in which they are held by employers can be laid at the door of industry itself.

The fault lies partly with higher education. Hill, Johnston and Smith (1983) indicate that higher education cannot be acquitted of responsibility.

Interest in industrial or commerce employment is abysmally low ... This may reflect a traditional lack of interest by Australian industry in higher graduates. But even more it reflects that research training appears (particularly for full time students) to orient them away from industrial employment.

The universities of Australia cannot be complacent about the quality and nature of provision of PhD education for those wishing to enter industry. There are many PhDs whose working careers have borne little, if any, relation to the subject of their theses, however potent the contribution of research training has been to their intellectual development.

Historically, the PhD degree was established to provide a formal education in Australia for the future staff of universities. The pattern of provision has remained unchanged, despite a period of unprecedented financial stringency being experienced by the higher education system, when more and more PhD graduates are compelled to seek

employment in settings outside the blissful groves of 'Academe'.

Thus, it may be questioned whether the traditional PhD is the most appropriate form of education for all students at this time. Are we educating for an age which has perhaps gone?

Respondent after respondent has made it plain to us that there is insufficient appreciation of the need for a new kind of doctoral graduate with a new kind of preparation, bearing in mind the distinctive needs of industry.

Our findings indicate that the traditional PhD format does not match the needs of modern industry at all well. This tells adversely not only on the ability of industry to attract and hold graduates with PhD qualifications, but also on the degree of confidence which employers are prepared to repose in their recruits, both actual and prospective.

Hence, the scale of support for postgraduate training, primarily for academic research, should be reviewed, and alternative forms of PhD training more closely orientated to the requirements of industry should be developed as a matter of transcending importance.

Teachers

The rigidity of the Australian PhD system derives in part from inbreeding, for inputs into universities are in large measure selected from their outputs.

The single most influential factor during PhD candidature is the student's supervisor. The attitudes that a PhD graduate brings to the corporate sector are unintentionally implanted during the candidate's apprenticeship to his supervisor, whose influence is often a disincentive to pursue a research career in industry.

There is one essential, indispensable qualification for a person who intends to educate another and this is that he himself should be educated. The proponents of educational reform are quick to acknowledge, as do we, that any substantial and lasting improvements in the PhD education of mathematicians, scientists and engineers for industry would be dependent to a significant degree on the quality of the teaching force. The way the supervisors have been trained, the extent of their responsibilities and the attitudes they hold in relation to mathematics, science and engineering in industry are all crucial factors in the educational process of PhD industrial mathematicians, scientists and engineers.

The quality of the teaching force is a decisive determinant of the effectiveness of the PhD education of industrial mathematicians, scientists and engineers.

To counteract the tendency of universities to train towards academic achievement as an end in itself, it is recommended that universities should:

(a) promote a greater degree of interaction and collaboration between themselves and industry;

(b) give ready recognition to work in industrial laboratories for higher degrees;

(c) employ a panel of supervisors, some from industry and some from academia; and,

(d) encourage the selection of a research project which reflects a confluence of academic and industrial interests.

Part-time or Sandwich Study

The Finniston (1980) Report has urged that postgraduate training for engineers

should either follow full-time experience, or be a mixture of academic and industrial training. This is widely accepted as an ideal, but there are practical problems in obtaining the release of first-class people from industry to return to full-time research training.

The evidence seems to suggest that industry is reluctant to release people for more than a few weeks at a time, and individuals making progress in their careers similarly do not wish to be absent for any longer periods. Indeed, one employer remarked:

> *Few companies can afford to release first class talent for research training leading to the award of a PhD, when results are bound to be speculative.*

Valuable as the opportunity for full-time study is, it seems that it ought not to be regarded any longer as the norm for post-graduate work, especially where a thesis is required. The opportunity to qualify for a PhD by part-time study needs to be retained both in fairness to individuals and in the interest of gaining more recruits to industrial research.

The alternation of academic study and practical experience in industry- the sandwich scheme - is an arrangement, provided it is properly integrated, which for some students is most fruitful and conducive to the fuller development of their powers. This interaction of academic study and practical application serves to illumine and stimulate each other. Hence, the extension of the sandwich principle to doctoral studies deserves primary consideration.

As the campus is not a true copy of industry, periods spent in an industrial research laboratory can be of great value to a PhD candidate. How the experienced applied mathematician attacks his problems, what mathematical method he uses, what judgements he brings to bear, his way of thinking - these are positive elements in the mode of education of PhD industrial mathematicians which are not to be underestimated. As a result of his experience, the student will emerge with a much clearer idea of the mathematician's role in industry.

There is scope for some initiatives in supporting the availability of part-time PhD education. One is the extension by employers of the half-time, half-pay approach to enable more people to do part-time study leading to a PhD degree. Higher education institutions should also play their part by recognising work in industrial laboratories or government establishments for higher degrees.

In this connection, the lead given by the Council for National Academic Awards (CNAA) (1983) in the United Kindom is most salutary. The CNAA's scheme for the award of the PhD provides the opportunity for candidates working or studying outside the university sector to obtain the degree on a full-time or part-time basis or a mixture of these two modes of study. There are no residential requirements.

One rather radical suggestion offered by a respondent was the establishment of an Open Postgraduate University so that PhD studies may be completely pursued outside the university environment. The subject is sufficiently important, in our view, to warrant more detailed study by higher education, industry and government.

As part of an armoury of measures we recommend that:

(a) the extension of the sandwich principle to PhD education deserves primary consideration;

(b) the opportunity to qualify for a PhD degree by part-time study should be made available;

(c) flexible arrangements should be developed to make it easier for persons in employment to pursue PhD education; and,

(d) the possibility of using industrial research laboratories (or government research establishments) as training ground to acquaint PhD students in applied mathematics with the ethos of industry should be explored.

Student's Thesis Topic

There is considerable disposition to push students into fields of study which are of special interest to the supervisor. The discipline-oriented emphasis in the present PhD pattern puts a premium on intensiveness, which in turn inevitably leads to 'tunnel-vision'.

It would add to the quality and significance of the work done by PhD candidates if their dissertation subjects could be regarded as contributing to themes of direct interest to industry.

The research projects should be problem-oriented. The formulation and analysis of a practical problem, including an appreciation of the constraints upon its solution, the consideration of alternative solutions and the specification of a fundamental, economic and satisfactory solution - these involve imagination and inventiveness and the development of skills as much as, if not more than, making significant original solutions in the traditional dissertations.

For these reasons, we recommend that the research topic should be jointly determined by academic and industrial interests.

To ensure that research degree projects would be concerned with real problems met in industry, we believe that consideration should be given to the development of linked-award schemes in which studentships are attached to substantive research projects in non-academic surroundings. The success of the Cooperative Awards in Science and Engineering (CASE) Scheme in the United Kingdom persuades us to recommend that:

an industry-oriented postgraduate support scheme modelled on the UK CASE Scheme be established.

Apart from linking the research with industry and the prosecution of research of practical value, such a scheme would not only influence positively the motivation and attitude of PhDs towards mathematics in industry, but would help to convey to the student the ethos of industry.

Supervision

The success of the measures we are advancing hinges importantly on the availability of competent supervision.

To ensure adequate, competent supervision of a research project which is chosen by an academic in conjunction with an industrial partner, the sole supervisor pattern could be profitably replaced with a group of two or three supervisors, each of whom can offer rather different skills and experience to the student.

The panel should comprise faculties whose disciplines impinge on the research project as well as advisers from the collaborating establishment.

Group Research

The Swinnerton-Dyer (1982) Report suggests that:

a number of research reports put together for publication should be sufficient to warrant the award of a Ph. D.

This suggestion flies in the face of traditional, accepted practice and perhaps portends a revolutionary change. However, given the importance of team research in industry, we warmly commend the idea for consideration that the PhD may be awarded for publication of a series of papers, describing solutions to problems of importance to industry, instead of for a single thesis.

Course Work

The research reported here has indicated the need in industry for a broader and less specialised education than the traditional PhD. Indeed, many respondents were hospitable to the view that PhD education, with a bias towards the American model, could do much to elevate the quality of research in the corporate sector.

At present, formal courses in PhD degree programmes are rather rare in Australia. And yet, what is at the base of preference for the American version is less emphasis on "independent work" and more stress on assessed taught courses. Perhaps we can take a leaf out of the American book.

Education-Industry Interaction

A recurring theme in this study was the importance of a better mutual understanding of the industrial and academic milieu through the (full-time) placement of staff in each other's environment for extended periods.

There is plainly a need for improved interaction. To this end, we recommend that:

(a) The possibility should be actively explored of implementing in Australia counterparts of the University of Oxford Study Groups with Industry.

b) The Higher Degree Advisory Committees should be restructured to aim for an equal representation from industry. Those who employ PhDs have knowledge of their use in industry, and therefore must accept a fuller share of responsibility in the determination of policy in this area in the national interest; and,

c) The appointment of PhD industrial scientists and engineers as coadjutant faculty members should be encouraged. They are best placed to assist with the planning, mounting and conduct of doctorate education to meet industry's needs.

Concluding Comment

Few of the measures we are advancing will be easy to implement. But it is hoped that they are sufficiently compelling to invite co-operation and constructive effort from those persons and institutions best placed to strengthen the nation's economy.

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Management of Polytechnics : A Case Study

M. Adithian, V.P. Puri and K.B. Raina

ABSTRACT

The paper reports the findings of a case study of a polytechnic to bring out the methodology adopted by it for planning and implementing courses and the strengths and weaknesses of the system. It highlights the problems experienced by the management of the polytechnic and issues arising therefrom with a view to create an awareness amongst planners and administrators of polytechnic education of the need to adopt a scientific approach for planning and management of technician education.

Introduction

The polytechnic studied is one of the oldest in the State in the Northern region of India, having been established about three decades ago. The location of the polytechnic is in an urban area of the State. The town in which it is situated is known for its small scale industries which are manufacturing a wide range of popular laboratory scientific instruments and kitchen mixers. It offers five courses leading to diploma in Civil Engineering, Mechanical Engineering, Electrical Engineering, Automobile Engineering and Architectural Assistantship. The first three courses are generalised in nature, whereas the latter two are specialised. The duration of these courses is three years and they are essentially institute-based. The annual intake for all these courses is 330.

In keeping with the industrial development in the state and the country, the polytechnic proposes to diversify its programmes. To start with, it plans to offer a diploma course in Electronics with an annual intake of 40 students. The total annual intake, even after this diversification, would be 330 students only, after reducing the intake in other courses.

Case Study Methodology

Polytechnic education may be viewed as a system, based on "Input-Process-Output" model, designed to achieve certain objectives. The system has to function within an "Environment" which provides "Feedback" to improve the effectiveness of the system. Application of Systems concept enables considering simultaneously all the essential components of a system under consideration, namely : Input, Process, Output, Environment, and Feedback (See Fig. 1). This approach helps in understanding the interactions taking place among these various components for achieving the System's objectives. Hence, for the purpose of the case study, System's Approach has been applied and qualitative methods of naturalistic enquiry such as observation, interviews and document analysis are employed to gather information about various components of the system in relation to the polytechnic studied.

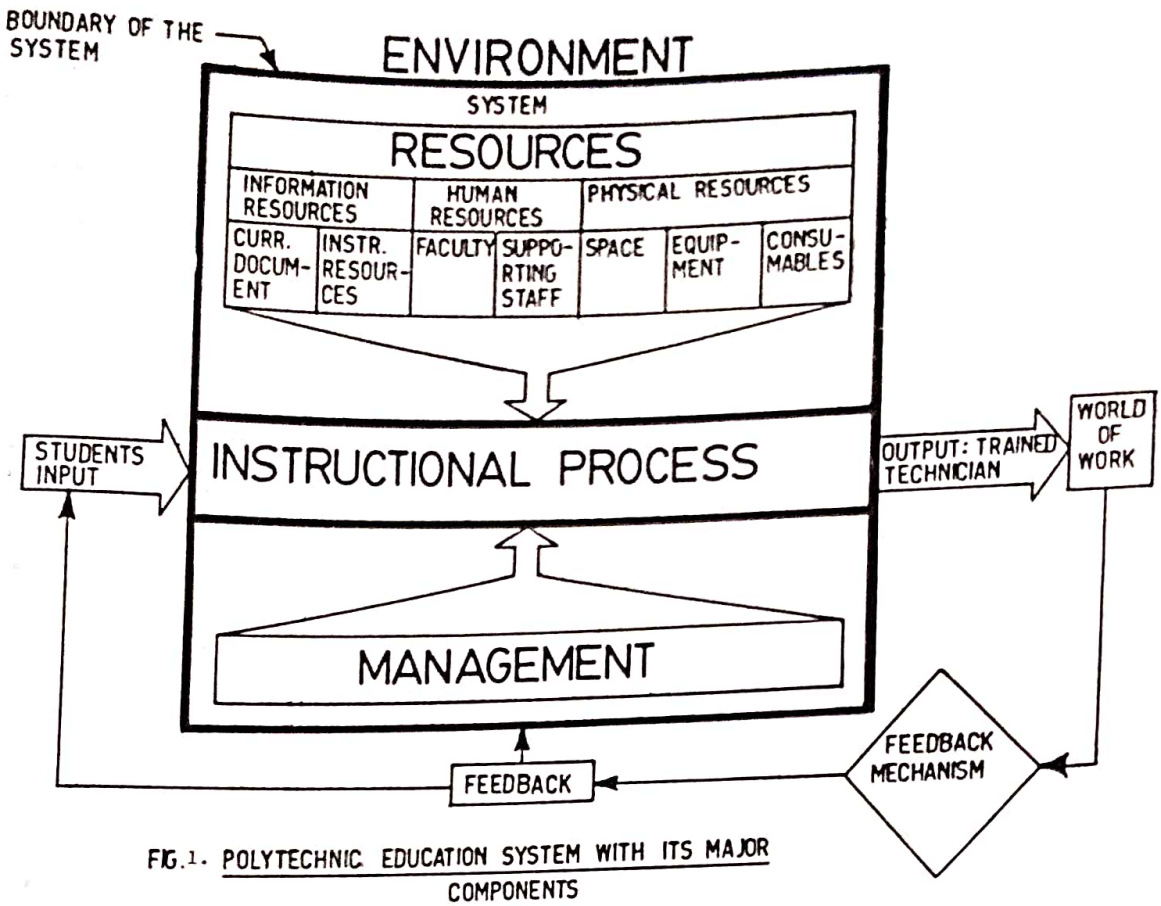

FIG.1. POLYTECHNIC EDUCATION SYSTEM WITH ITS MAJOR COMPONENTS

Output

Output refers to the technicians who pass out of the polytechnic with reference to their numbers, type and quality. The following factors which have a bearing on this component are now considered.

Expansion and Improvement

The polytechnic under study has prepared an integrated development plan for qualitative improvement and for limited quantitative expansion. This plan was formulated under the guidance of the Technical Teachers' Training Institute, Chandigarh, keeping in view the recommendations and requirements of the State Department of Science and Technology, industries and other employers. The factors that influenced the evolution of this plan were:

(a) manpower assessment for meeting additional requirement in conventional industries,

(b) futuristic trends and emerging areas of technology,

(c) the societal needs, and

(d) qualitative improvement of the diploma programmes.

Continuing Education Programmes

In pursuance of National Policy on Education - 1986, the polytechnic has initiated continuing education programmes

by starting part-time diploma courses in Civil, Electrical and Mechanical Engineering for working craftsmen. Another scheme for continuing education proposed to be implemented at the polytechnic is that of special classes for working technicians (Diploma Holders) to enable them to acquire higher qualifications.

Interaction with Employers

Interaction exists between the polytechnic and the potential employers of diploma holders such as Public Works Department (Central and State), State Electricity Board, Board of Apprenticeship Training, Local Bodies and industrial establishments. This interaction is primarily confined to:

(a) official correspondence regarding vacancies for diploma holders,

(b) visits by the Principal, Training and Placement Officer and the polytechnic faculty to employing organizations to obtain feedback about the programmes and courses offered by the polytechnic, and

(c) visits by officials of the employing organizations to the polytechnic for conducting campus interviews for recruitment of diploma holders.

The representatives of industries visit the polytechnic about 6 times a year and about 35 diploma holders are recruited through this process every year. Experts from industry are also involved in academic activities like participation in seminars and in delivering extension lectures for the students and faculty.

Feedback about Passouts

There is no mechanism at the polytechnic to obtain feedback from passed-out students about their performance in the world of work and the suitability or otherwise of the courses undergone by them at the polytechnic. However, training managers periodically provide feedback on the performance of diploma holders employed in their organizations. This information is furnished by training managers quite willingly and readily and is used in effecting improvements in the educational programmes of the polytechnic.

Development Planning

Certain problems and difficulties are experienced by the polytechnic in getting the developmental plans through. The time-gap between the formulation of the plan and its approval by the State and Central Governments is about 2 to 3 years. This is often due to cumbersome governmental procedures and inadequacies in the infrastructure and expertise at the polytechnic and Directorate level.

Input

Input refers to the characteristics of students entering the polytechnic. The minimum qualification prescribed for admission to the polytechnic is a pass in the Matriculation examination (10+) or equivalent. The approximate percentage of suudents entering with 10+ and other higher qualifications are: (10+) – (51%); 10+2 – (20%); Pre-engineering – (15%); others - Higher Secondary Part I, Pass outs of Industrial Training Institutes, Junior Technical Schools etc. – (14%).

Students are admitted to the Polytechnic on the basis of marks obtained by them in the State School Board Final Examination. The reservation of seats for different categories such as Scheduled Castes, Backward Classes, Children of Defence personnel, and backward areas are made as per policies of the State Government and this accounts for nearly 43% of the total number of seats filled.

Instructional Process

This covers aspects such as instruction and curriculum development

Instruction

Instruction takes place in the polytechnic as per the guidelines provided in the Curriculum approved by the Directorate. The polytechnic has, in a limited manner, introduced modern communication media for qualitative improvement of teaching and learning. Technical films for about an hour are shown on five days in a week. About 60 students view these films at a time. However, use of other audio-visual aids by the teachers during instruction is on a limited scale.

Curriculum Development

Regarding the involvement of the polytechnic in curriculum development activities, certain faculty of the polytechnic are identified at the state level as coordinators for design of curricula for new courses as well as for revision and updating of curricula for existing courses. As and when the work of design and revision of curricula is taken up, discipline-wise committees are constituted at the polytechnic level to collect feedback from teachers and use the information so obtained for design and revision of curricula. Polytechnic faculty take part in the Curriculum Workshops organised by the regional Technical Teachers' Training Institute, Chandigarh.

The polytechnic experiences some difficulty in designing the curriculum as well as in its implementation because of heterogenous groups of students admitted with different entry qualifications.

Resources

The polytechnic follows the norms for physical, human and other resources that have been framed by the All India Council for Technical Education and subsequently adopted by the State and deploys them adequataly for meeting curricular and other needs.

Physical Resources

The polytechnic has adequate buildings and space to cater to the needs of instructional processes for the courses presently offered. However, there is an acute shortage of residential accommodation for faculty and students. The polytechnic does not have hostel accommodation for women students. However, accommodation for women students is arranged outside the polytechnic through the courtesey of other institutions.

The polytechnic has the necessary equipment required for imparting training to the students as per guidelines provided in the curriculum and these are adequately utilised. Removal of obsolescence and modernization of equipment in laboratories and workshops are being undertaken in a phased manner, under the scheme of "Integrated Development of Polytechnics" launched by Technical Teachers' Training Institute of the region and funded by the Government of India.

Human resources

RECRUITMENT OF FACULTY

The process for recruitment of permanent faculty at the polytechnic is rather long and takes almost one year and sometimes more to mature. This due to certain procedural formalities that have to be gone through in deciding the qualifications and experience required, advertisement of positions and selection. However, for adhoc appointments at the level of Lecturers, the recruitment is made in a relatively short time by calling candidates through the Employment

Exchange and through advertisement in the press.

The staff patterns existing in the polytechnic is in accordance with the recommendations of the Madan Committee which provides for a 3-tier system, namely Lecturers, Senior Lecturers and Heads of Departments in the ratio of 3 (Lecturers): 1 (Senior Lecturers and Heads of Departments). At the Lecturer's level, the recruitment is through open selection by the State Public Service Commission. Thereafter, at the higher levels, the positions are mostly filled up by promotion on the basis of seniority of service, even though there is some provision for selecting Senior Lecturers and Heads of Departments by direct recruitment. It is seen that there is a perpetual shortage of well-qualified faculty, probably because of less attractive service conditions and limited avenues for career advancement. The problem is seen to be severe in respect of emerging areas such as Electronics, Computer Science.

PERFORMANCE APPRAISAL

The performance appraisal of faculty is based on sincerity and interest of teachers in the class, pass percentage of students in the respective subject, conducting tests regularly and interest shown in co-curricular activities. There is no system of incentives and awards for faculty who show outstanding performance on the academic front. However, good work done by the polytechnic faculty is duly recorded in the Annual Confidential Report of the concerned faculty. Prizes are given for good work done by the faculty in co-curricular activities like making arrangements for Sports, Annual Functions, Cultural Activities, etc.

Teachers are involved in the process of evaluation by asking them to report on their own performance. In addition, evaluation is done by their superiors. Other factors that account for evaluation of teachers are regularity in taking classes, punctuality and discipline in the class, relationship of the teacher with the students and his faculty colleagues. The existing method of evaluation of teachers as indicated above is seen to be working satisfactorily without posing any problems and to some extent it has helped the teachers to identify their deficiencies if any, and attempt to overcome them.

FACULTY DEVELOPMENT

A plan for the development of the faculty is prepared at the polytechnic level. This plan takes into consideration the following factors in assessing the training and developmental needs of the faculty:

- Subject matter updating to meet curriculum and technological changes;
- Improving teaching competency;
- Industrial exposure; and
- Personal growth and development of the faculty.

The faculty are sponsored to different training programmes to meet the requirements arising due to changes in curricula and to avail the benefit of training programmes in their particular areas of interest. But, there is lack of initiative on the part of the faculty to share their newly acquired knowledge and skills with their colleagues through seminars and discussions.

Problems and Issues

The problems and issues concerning the human resource are:

- instability of faculty due to their transfer after they have been trained in a specific area of work,

- sanctioned posts not being cleared by the state finance department, and
- inadequate supporting staff which hampers optimal utilisation of other resources.

Instructional Resources.

The polytechnic procures instructional materials (print and non-print) depending upon the requirements of the courses offered by it. Some of the polytechnic faculty are involved in the preparation of instructional materials in collaboration with Technical Teachers' Training Institute of the region. The utilisation of these resources is limited in the absence of an Instructional Resources Centre facilitating easy access and deployment.

Financial Resources

The polytechnic is provided with adequate financial resources for its development by the State Government. In addition, the polytechnic has been the beneficiary of Direct Central Assistance (DCA) schemes of the Central Government for implementation of new programmes. Although by and large, no difficulty is experienced due to paucity of financial resources in implementing new programmes, yet grants for recurring expenditure and supply of stationery is inadequate.

The funds obtained by the polytechnic are optimally utilized by proper allocation to various heads of expenditure and by re-appropriation of funds in consultation with the Directorate. The submission of monthly reports of expenditure incurred by the polytechnic to the Directorate serves to monitor the expenditure incurred under various heads. The expenditure on account of construction of buildings is regulated through the State Public Works Department; procurement of equipment is done through Controller of Stores; and maintenance of equipment is undertaken by the polytechnic.

Management

Organisational Structure

The organizational structure of the polytechnic is hierarchical with the Principal as the chief executive and the Heads of Departments looking after their respective departments assisted by Senior Lecturers, Lecturers and other supporting staff (technical and non-technical). The present strength of the faculty as against the sanctioned strength (given in brackets) is: Principal-1(1); Heads of Departments - 1 (6); Senior Lecturers - 9(10); Lecturers - 47 (49); Workshop Staff - 19 (20).

In addition to their usual academic responsibilities, the faculty are assigned other responsibilities like training and placement, building-works, electrical maintenance, landscaping, sports, students' club, equipment purchase, etc.

Linkages with Other Agencies

The Principal of the polytechnic serves as a member of the State Board of Technical Education on a rotational basis along with Principals of other polytechnics of the State. During the meetings of the State Board, the Principal gives suggestions for the efficient conduct of programmes, whereever necessary. The Training & Placement Officer serves as the link between the polytechnic and the Regional Apprenticeship Board and other user industries to arrange for industrial training of students and arranging industrial exposure to the faculty, whereever necessary.

The polytechnic prepares development plans and proposals and submits them to the Directorate for its approval. The interaction between the polytechnic and the Directorate of Technical Education consists of sharing

of information through participation in meetings on education and training of faculty and staff, seeking direction and guidance from the Directorate and providing feedback.

The polytechnic interacts with other technician institutions in the State by way of sharing of innovations through Engineering Exhibitions and displays organised as an annual feature, sharing of resources, and developing a spirit of competition through sports and athletic meets. The community wing of the polytechnic has interaction with the community nearby in the form of conducting socio-economic surveys and imparts technical training to rural youth and village artisans in different trades. So far, about 100 youth have been trained by the community wing of the polytechnic. The transfer of appropriate technolgy is effected through two recently established Extension Centres of the community wing of the polytechnic.

Short educational tours are conducted at the end of third, fourth and fifth semesters, and a long educational tour arranged at the end of sixth semester to expose the students to the world of work. In addition, lectures by engineers from industries and visits by students to local industries are arranged during the session.

Awareness to Planned Change

The polytechnic is seen to be alive to the needs for planned change. 'A Master Plan' has been chalked out for all activities which include conducting admission tests, formulation of committees, simplification of purchase procedures, disciplinary action and last, but most important of all, human resource development.

Administration

The affairs of the polytechnic are administered through academic meetings, involving all the faculty, conducted once a month and departmental meetings conducted once a week. The Head of the Department inspects one laboratory or workshop under his charge once a week. In addition, the Principal meets the Heads of Departments once in 15 days to discuss the decisions of the academic meetings and to monitor the progress. There is a General Body Meeting of all the staff including non-teaching staff held once in a month to discuss other issues in addition to academic issues. To ensure scheduled implementation of approved programmes, the principal makes rounds inspecting the polytechnic twice a day. The Heads of Departments are also involved in the implementation of various decisions in their respective departments.

The Polytechnic is also maintaining a record card of each student which gives instant information about a particular student in respect of his academic achievements and his conduct at the polytechnic. This has shown positive results to ensure high quality of performance by the students of the polytechnic.

The institution maintains a calendar of activities prepared for the whole year to ensure that different activities take place at the appropriate time and adequate prior preparations are made. The dates for class tests are fixed in the 3rd, 5th & 7th weeks of the semester. The polytechnic functions on the basis of a working week rather than a calendar week.

The polytechnic is assigned the responsibility of coordinating the admission work for the State, every alternate year. For the conduct of Board examinations, the Principal is the Chief Superintendent of his Centre.

The polytechnic plans for its staff development and training and for other activities and sponsors faculty to participate

in the short term courses and industrial training. The polytechnic strongly interacts with the regional resource system viz. Technical Teachers' Training Institute through promoting use of instructional materials developed, availing the extension services offered in the recently established Quality Improvement Centre and sponsoring faculty to undergo training programmes conducted by the Institute.

Management of Student Affairs

The management of students' affairs is taken care of by different committees, like Students' welfare committee, Hobby clubs, Tutotial groups, etc. The Principal himself lectures to the students on issues concerning moral education. Problems of students like absenteeism are appropriately handled by intimating the parents and issuing a warning to the students concerned. Special assistance is rendered to the Scheduled Caste students by arranging remedial classes exclusively for them as per their needs. In case of any health problems of students, medical attention is arranged for and fellow students attending on the patients are allowed Special Duty Leave for this purpose.

Communication with Students

Principal does not have any difficulty in communicating with any student in the polytechnic. Communication is in the form of circulars, notices on the display board and instructions through faculty.

For instant communication with students directly during working hours in case of any important announcement to be made, internal communication system in the form of loudspeakers has been provided in class-rooms, library, laboratories and workshops.

Monitoring, Evaluation and Feedfback

Following is the status in respect of monitoring, evaluation and feedback of the programmes offered in the polytechnic under study.

Curriculum evaluation

At present there is no on-going mechanism for curriculum evaluation at the polytechnic level. However, the Directorate takes the responsibility of curriculum revision and evaluation in respect of diploma courses offered in all the polytechnics in the State as a whole. The faculty of the polytechnic are actively involved in curriculum evaluation and revision workshops as and when these are organized by the regional Technical Teachers' Training Institute.

Student Performance Trends

Performance of the Polytechnic with regard to the percentage of students passing out during the past three years is as shown in the Table.

TABLE: Pass percentage in the past three years

Year	No. of Students admitted in the polytechnic	No. of students who have passed out in the corresponsing year	Pass percentage
1987-88	369	311*	84.25%
1986-87	366	272*	74.31%
1985-86	339	221*	65.10%

* includes those who are required to reappear and are able to pass the supplementary examination in that year.

Internal Assessment System

It is ensured that class-work and home-work are assessed by the teachers regularly and tests conducted as per schedule. There is a proposal to hold a workshop in the near future in which a bank of assignments and test items will be prepared by a group of experts, which may be used by the faculty for internal assessment. It is ensured that practical exercises and workshop jobs are evaluated at the end of the class itself and feedback given to students.

Examination System

The Polytechnic feels that there is no problem in the present examination system which needs immediate attention or solution. However, it feels that there is lack of administrative infrastructure to conduct examinations and to process the results quickly, which, in its opinion, should be taken up at the directorate level.

The following suggestions have been made by the Principal to improve the existing examination system:

- Computerisation of sessional marks;
- Introduction of objectivity in the question papers; and
- Computerisation of results and certification to be taken up at the Directorate level

There is a feeling that, in the present context, promoting Open Book Examination System is not desirable.

Resource Monitoring

Through inspection visits to departments and classrooms, and interaction with students, the Principal ensures that all resources are made available to departments and classrooms and are utilised properly. Periodical meetings with the concerned Heads of Departments are also held to assess the adequacy and effectiveness of these resources. The reports submitted by the Heads of Departments and faculty are studied to ensure that all these resources are made available and optimally utilised. However, lack of infrastructural facilities to feed necessary data from time to time is seen as a problem with reagard to monitoring of resources or various programmes.

Monitoring curriculum Implementation

Heads of Departments coordinate at the department level to ensure that the curricula in respect of different programmes are implemented as per guidelines in the curriculum document. Inspection of teachers' diary and interaction with Heads of Departments, teachers and students by Principal ensure that the curriculum is implemented effectively.

Monitoring Student and Teacher Performance

The results of the periodical tests and final examinations help to monitor the students' and teachers' performance. In addition, interaction with teachers and students, reports of Heads of Departments, inspection of teachers' diary and visits round the departments help the Principal to monitor the performance of students and teachers.

Evaluation of Individual Departments

Periodical meetings with Heads of Departments, reports of Heads of Departments, interaction with students of individual departments and feedback from employers of the pass-outs from the departments are used to evaluate the performance of individual departments. The percentage of students passing from individual departments is also considered for the purpose. According to the Principal, the feedback from employers

in respect of students passing out from Mechanical Engineering Department of this Polytechnic is quite favourable.

Conclusion

The above case study has highlighted the strengths and weaknesses of the various system components of the polytechnic studied. It is hoped that the findings will create an awareness among the planners and administrators of polytechnic education to base planning and management of technician education on profiles of institutions developed through such case studies employing a systems approach.

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CALL FOR CONTRIBUTIONS

Contributions are invited to the NEXT issue of the Journal on any theme relevant to its objective. These may be sent to the Managing Editor to reach him by JUNE 1990 for this issue.