**Case Study:**

**A Triadic Model for Development and Dissemination of Pedagogic Innovations**

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**Introduction**

Indenting inert educational systems with firmly entrenched practices is a complex task. Alternate programs demand new structures, resource materials, teaching strategies, instruments for assessment, mechanisms for dissemination and pilot trials. Such wide scale changes can not be affected in isolation from the key players: the students and the teachers who cannot but operate within the academic and administrative framework of the organization.

At University of Delhi, teaching of undergraduate courses is delegated to several constituent colleges, all prescribing a common course of study and terminal examination. Teaching programs operate within the dyadic framework of traditional lecture and laboratory. These place few cognitive demands on the student. Periodic changes in curriculum do occur. However, the locus of reform is invariably the content. Rarely is an effort made to embed the curriculum in what may be perceived as good pedagogical practice and evolve effective methods of instruction. Although these problems are not unique to our system, they are more serious because unlike developed countries where periodic waves of curriculum innovation have been enabled by well-deliberated policy initiatives, in India there are abysmally few institutional reviews or funding programs for research in education at the tertiary level. Then, most teacher innovations tend to be on a limited scale and rarely constitute a comprehensive course package to merit attention. Inasmuch as import of curriculum packages, resource materials, experimental kits and equipment, however proficient, cannot fill the lacunae in individual programs, indigenous solutions become imperative.

**Theoretical Framework**

There are essentially three steps in curriculum development. These entail:

1. **Innovation**: getting from an idea to the concrete curricular product which could be an instrument for teaching, a teaching strategy or a complete curriculum;
2. **Accommodation**: getting all the stakeholders to formally endorse and accept the innovations as part of the formal curriculum; and last but not the least,
3. **Assimilation**: getting the teachers to implement curriculum innovations in letter and in spirit in the actual classroom.

This triadic model (Jolly, 2002) proposed for a learning organization follows closely the process of cognitive change in a learning individual. As is well known, each of the above evolutionary stages brings its characteristic challenge and necessitates development of unique instruments and process skills.
Elaboration

Student Projects as Instruments for Innovation
Since the initial stages of our work that began from the confines of a single classroom, we have used student projects as tools for curriculum development and pedagogic innovation. Guiding students has also provided a tremendous opportunity to us, as teachers, for lifelong learning.

Context: Although the scope of investigations is unlimited, we have looked for student project ideas from within the existing curriculum or such frontier areas that ought to be included in the formal curriculum (Jolly et. al., 1987.) To make a beginning, we targeted the existing laboratory programs, identifying three major lacunae:

- there are few well crafted setups for demonstration of physical phenomena which can help students visualize the physics they are learning and enhance qualitative understanding;
- there is a lack of emphasis on reproducing the result of a physical measurement quantitatively to a sufficient accuracy; this is responsible for diminution of skills and consequent loss of confidence in the use of hands; and
- the measurement techniques are outdated and do not reflect the technological advances in instrumentation or exploit befittingly the potential of microelectronic devices and microcomputer-based technologies.

As an end product, the projects have attempted to generate ideas and resource material to fill these shortcomings.

Development of effective teaching-learning strategies: Projects provide the perfect framework for constructing a learning environment where the process of discovery is, both, hands-on and minds-on. A post hoc analysis of the project activities suggests that the model of learning that has evolved is one of cognitive apprenticeship (Collins, Brown, and Newman, 1989). In the initial stages the teacher, like an expert craftsman, models the problem, provides coaching and scaffolding to the student who moves forward through a sequence of increasingly complex tasks. As the student learns to negotiate these tasks entirely by herself, the teacher gradually fades out. By carefully balancing teacher guidance and self-paced inquiry, we have tried to ensure that open-ended projects, in addition to enhancing procedural and conceptual skills of students, also yield outputs utilizable by the formal system.

Development of Resource Materials: The know-how from student projects has led to formulation of a radically different laboratory curriculum (Jolly, 1994). The salient features of this course are its modular structure; introduction of familiarization exercises, laboratory tutorials and group discussions designed to enhance procedural and conceptual skills; and implementation of modern day measurement techniques. Iterative improvements on traditional physical measurement setups have also led us to develop indigenously a comprehensive low-cost microcomputer-based laboratory with appropriate data-acquisition hardware, software and curricular materials (Jolly, 1997; Jolly, Verma and Raghavan, 1999). An important requirement of most projects is development of hardware. The students whose projects involve a component of electronics instrumentation are required to package their working circuits and contribute these to the project laboratory for use by others. Considerable effort is expended in perfecting soldering skills, planning component layout, chassis mounting, art work and finally, in testing, debugging and
calibrating. Students learn to optimize aspects such as the overall cost, technical features, ease of use, aesthetic appeal and robustness. The final designs conform to the blueprint accepted by the whole group so that work produced by different student groups can ultimately be branded together as a commercial prototype.

**Accommodation of Pedagogic Innovation**

The federal structure of our university and inherent democracy in discourse, in principle, gives the teaching community immense power to set its own academic agenda. Evidence shows that whenever a sufficiently large number of college teachers want a change in curriculum, endorsement by the formal system follows intrinsically. Then, before any major curriculum reform meeting, we have found it expedient to circulate background papers, hold discussions with teachers in individual colleges, conduct teacher training programs and use feedback to fine tune proposals. Such grass root level canvassing has played an important role in the formal adoption of the new laboratory curriculum for the honors program in Physics. However, acceptance of new curricular ideas invariably depends on a diverse set of factors. It is often because a change is long overdue; no other concrete alternative proposal is available; on academic grounds it would be politically incorrect to reject the ideas put forward. Indifferent acceptance can, however, cause significant distortions in what is proposed. In the case of new undergraduate laboratory curriculum, despite the training programs, we found many teachers systematically put aside all the novel features on which the pedagogic success of the course depended. Without the innovative units, techniques and teaching strategies, the curriculum accepted in principle, stood defeated on ground.

It is relatively easier to usher changes in curriculum where teachers who develop the alternatives have the freedom to implement these in the class. At the undergraduate level where teaching is distributed over a large number of colleges, the dynamics of diffusion of innovation are complex.

**Classroom Research as an Instrument for Assimilation of Innovation**

Effective transfer of pedagogic innovation from the local and well-defined environs of the developers' laboratory to the widely differentiated ambience of actual classrooms is the most difficult stage to negotiate. Assimilation of educational innovation depends critically on teachers' understanding of how the specific instrument is to be employed. Then rather than concentrate on propagating merits of use of specific instruments, it is necessary to address the root cause of the impediment; the teacher’s epistemological beliefs about the process of teaching-learning itself.

We have found routine short duration teacher training programs to be singularly unsuccessful in affecting a deep-rooted change in perspective. Using insight gained from our work with students, we have floated a unique training program that aims to build a community of thinking teachers who can commingle the roles of curriculum developers and education researchers. It does so by introducing them to current findings of physics education research and its methodology by directly engaging them in a classroom research project (Jolly, 2000.) It also provides a hands-on introduction to select innovative instructional strategies that have been successful the world over.

**Context:** While the scope of classroom research is all encompassing, the program deliberately keeps the teacher’s classroom projects time bound, limited in scope and thus, sharply focused.
After an initial introduction to what classroom research is, the participants are asked to form a collaborative group, design a single concept based instrument to collect data on students' learning of a single topic and administer it to large sample populations of students from across the university at the most opportune moment during instruction. This exercise provides the context for reading about earlier research where it exists (McDermott and Redish, 1999.) The challenge lies in designing a suitable instrument, analyzing students' responses, looking for patterns in students' thinking, interpreting these and making suggestions on how students' learning difficulties could best be overcome. To ensure quality, each collaborative group is required to produce a report and present the findings of the classroom research at a Seminar.

Achievements: This program has been fairly successful in, one, sensitizing teachers to need for reflecting on their teaching practices; two, focusing their attention on pedagogic issues. It has also led to development of new instruments for objective assessment of learning outcomes and generated a wealth of research-based data on patterns of student’s learning through specific studies. More importantly, the program has catalyzed the formation of teachers' collaborative groups and a community of teacher learners, significantly large in number. This network has successfully permeated classrooms across the university as concept tests have been administered to large populations of students across many colleges. Even teachers who have not been active participants in this program have out of curiosity provided access to their classrooms. Training in the methodology of classroom research has empowered the participating teachers to undertake research-based curriculum innovations using their own classroom for data collection and field-testing of ideas. We hope the endeavor would lead to sustained action research by the collaborative network. It is the latter that can impact the praxis of instruction.

Summary

The model proposed herein is essentially cyclic (Figure). It provides a mechanism for implementing the process loop for curriculum innovation, accommodation, and assimilation into the actual classroom. This entails

- identifying select lacunae in domain knowledge in the existing courses;
- initiating student projects for developing, one, a better understanding of the domain; two, resource material for new areas of instruction; and three, a new ethos in teaching-learning with greater emphasis on innovation and active mental engagement;
- identifying select lacunae in the pedagogic content of the existing courses;
- initiating teachers' classroom research projects for, one, sensitizing teachers to need for reflecting on their teaching practices; two, developing new instruments for objective assessment of learning outcomes; and three, establishing processes for large-scale development of research-based curriculums.

While experiments in education reform are long drawn and difficult to validate, the necessary steps outlined in this study have provided us milestones against which efforts can be evaluated.


Investigating:
Student Projects/
Classroom

Identifying gaps:
Domain Knowledge/
Pedagogic Knowledge

Developing
End Product

Integrating

Evaluating

Non Formal Inputs

Extending and Enhancing Existing

**Figure:** Model of Curriculum Reform:
Process Loop for Curriculum Innovation and Accommodation