PROFESSIONAL DEVELOPMENT OF TEACHER-RESEARCHERS FOR TEACHERS OF COMMUNITY-BASED SCHOOLS IN RURAL TAMIL NADU, INDIA

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INTRODUCTION

We report on our investigation of the utilization of a NYC model of Mathematics Teaching-Research approach to teaching and learning in Tamil Nadu, India. The TR-NYC methodology and the design experiment were presented during epiSTEMe-1 (Czarnocha, Prabhu, 2004). Immediately after the epiSTEMe-1 presentation, outlining the outcomes of the methodology for the integration of practice and theory, the request for such an integration was initiated by Senthil Babu (then in the audience):

"The teaching research aspect will be focused on the teacher volunteers who are in charge of the night schools. These volunteers need to be trained in localized content development of the curriculum of the night schools, aware of the necessity of keeping the contents alive in relation to the political-economic dimensions of the village; be trained in areas that will enable them to intervene in day to day events of the village."

It turned out that many of the villages of the community-based night schools in question were situated in the path of the tsunami in Nagapattinam and Cuddalore region.

Reflection upon the requested task reveals a powerful vision where the TR methods of classroom enquiry into the process of teaching and learning mathematics, are integrated with the Action Research activities in the communities housing the night schools. The vision allows to ponder on the possibilities of social transformation of communities which is in agreement with the learning needs of the children of the communities. Consequently a natural Teaching-Research Question arises:

What is the methodological route to smoothly integrate Mathematics Teaching-Research focused on the improvement of mathematics teaching and learning with Action Research aimed at improving the socio-cultural and economical well being of the community?

The present report describes the organization of the pilot Teaching-Experiment in three different rural communities of Tamil Nadu, and its three stages: (1) Exploratory, (2) Workshop #1-Mathematics and its pedagogy, (3) Workshop #2-Mathematics and Psycho Social Action Research. The report describes the preliminary results of mathematics workshops as well as a possible answer to the stated research question.

ORGANIZATION

Exploratory phase

A grassroots community effort over several years had developed an infrastructure of community-based night schools aimed at changing the significant difference in the expected and actual academic performance of the children in the government run public schools. The teachers of the community-based schools are volunteers, with first-hand experience of both the social and educational circumstances of the children. The expressed need was the strengthening of their own mathematical and pedagogical expertise. The teacher-researchers familiar only with academic environments needed to understand the new experimental territory and to adjust their methods to the existing needs. This was accomplished in the Exploratory phase by

--visits to several community-based night schools observing, taking field notes

--conversation with teachers about the difficulties they faced

--conversations with the coordinators

Workshop #1 Mathematics and its Pedagogy

Three mathematical concepts were selected for the first teaching-research workshop: Signed Numbers, Fractions, and beginnings of algebra. The three concepts formed the basis for exchange of mathematical knowledge and pedagogy. All three topics were hands-on, manipulative-based; the teaching of the content was interactive, engaging the participants to discover, and to reflect upon (a) how they would use the method in their own class, (b) what problems did they foresee, and (c) what problems might be addressed through the approach. Some participants were able to experiment in their own night-schools with members of the team as observers. Data from these mini-teaching experiments thus collected was helpful in further targeting the methods to the needs.

The participants, aware of long-term teaching difficulties experienced in the classroom questioned the efficacy of the methods to increase the rate of the process of learning, and the teaching-research team aware of the knowledge of the field could (i) directly through the manipulatives demonstrate how this efficacy could occur and (ii) through the theoretical linkage between the work of Piaget (Piaget & Inhelder, 1958), Bruner (Bruner, 1966) and Vygotsky (Vygotsky, 1987) demonstrate the theoretical foundation on which was based the increase in the rate of learning.

Workshop #2 Mathematics and Psycho-Social Action Research

The second workshop alternated the techniques of psycho-social action research with TR-NYC to (i) provide an exposure of psychosocial methods, (ii) continue the content and pedagogy exchange and (iii) underscore the importance of teachers' own role as teacher-

researchers. What emerged was an integration (T-A-R), of the psycho-social and the mathematics teaching-research methods, which is theoretically grounded in the concrete-iconic-symbolic developmental theory of concept formation (Bruner 1966).

OUTCOMES OF THE PILOT TEACHING EXPERIMENT

Mathematical Thinking of Community School Teachers.

During the preparatory visit, it was observed that:

- teachers themselves need reinforcement in the basic arithmetic and algebraic skills;
- the environment of the night-schools is extremely student-friendly, however, at the same time the methods and the standards of teaching needed a thorough reorganization.

Teachers were very much taken by the decimal blocks – the manipulatives engaging students in the re-examination of their understanding of the decimal system.

Teacher-Researchers decided to expand the work with manipulatives into signed numbers (two color chips), algebra tiles used to introduce the operations on polynpmials, and operations on fractions, Fractions Grid, (Czarnocha and Prabhu, 2005) – a new approach to operations on fractions designed by VP for students in the Bronx, NYC. The results of the assessment test conducted during the last session revealed the degree of success of the approach as well as major obstacles.

The teaching methodology of signed numbers consisted in the sequence of:

- Introduction of different representation for 0 and for an arbitrary signed number;
- Addition and subtraction done with chips
- Addition and subtraction done with the help of pictures of chips drawn by participants
- Addition and subtraction by imagining the needed collections of chips, which through the internalization-one of the components of reflective abstraction, leads to the mental construction of formal notation.

The final assessment contained the following examples:

$-8 + (+6)$

$7 - (-4)$

$+10 - (+12)$

$(-9) - (-12)$

$-3 - (+2)$

$(+2) - (-4)$

Whereas the examples 1,2,5,6 did not constitute a major problem for the majority of participating teachers, yet problems 3 and 4 did. Analysis of mental operations needed to calculate this example using the method of chips, shows that the two examples required an additional cognitive step, which was not grasped by the majority of participating community teachers. In accordance with the cyclical TR methodology, the next cycle of work needs to start with the refinement of the previous approach taking into account the revealed challenges. The question here is to find an intermediate step, which will lower the mental gap of teachers between the intuitive and formal approach to signed numbers. Or, what additional chip based exercises need to be in place so that the needed transition can be accomplished. One possibility is the deepening preparatory discussion of the different chip representations of a number. Detailed discussion and slides will be presented at the conference.

Moments of Understanding

The Professional Development of Teacher-Researchers integrates the development of mathematical knowledge with the pedagogical knowledge of mathematics teaching. The approach taken in Tamil Nadu's effort was Just-in-Time (Mazur, 1997) development that is the didactical discussions with teachers and their mentors, the Agents of Change. Just-in-Time approach suggests the development of the appropriate knowledge at the time it is needed rather than as a separate preparatory mental effort. This way the abstract knowledge can be immediately connected to particular experience serving, and possibly, manifesting a moment of understanding. Moment of understanding (or "aha" moment), characterized by Wertheimer (1949) as an "insight", is the step in the development of understanding when suddenly, all separate pieces of knowledge turn into a coherent whole with significant explanatory power. Two examples of description of such moments were discussed:

The statement of Einsten from his autobiographical notes (Einstein, 1949)

The hymn of Appar from circa 3000 BC found imprinted in Archaic Tamil in one of the recently discovered Sumerian temples describing, in metaphysical terms the moment of intellectual enlightenment by the scribe of the period (Loganathan, 2004).

Anchoring the theoretical discussion in concrete experience of the participants of PDTR allowed for several moments of understanding taking place during the work.

In particular, the discussion of fraction grid together with the laborious process of fraction development prompted a question, is it possible to speed up the learning process. Starting learning from the bottom of the developmental progression, from the level of elementary actions definitely makes sense, it was asserted, but the time to reach the abstract level of understanding seems to be extremely long and therefore not very useful in the classroom.

This important question facilitated classroom discussion about the role of the intermediate steps in the development of the concept. Two routes of such a development were discussed, the iconic representations of Bruner approach, and the role of appropriate mathematics writing suggested by the considerations of Zone of Proximal Development of Vygotsky. Moreover, bringing in the assertion of Vygotsky that the route towards concept formation can start from the spontaneous level of the learner as well as from the scientific concepts of the upper level of ZPD prompted a sudden realization (the moment of understanding) by an Agent of Change. Reflecting upon their long time effort in bringing the knowledge of community teachers to the appropriate levels, he said: "I understand now the whole process. In the past we knew we had to start from the concrete operations, but we didn't know how to lead the learners to the formal level. Now, the introduction of iconographic drawings as well the possibility of writing instructions, leading to formal symbolism had put the whole previous knowledge in a new light."

One has to underline here that the question of speeding up learning amongst Indian students is of exactly the same nature as the one confronting Vygotsky in formulating the principles of education in post revolutionary Russia of the twenties and thirties. It is his solution to this problem that prompted Vygotsky to assert that development follows instruction rather than instruction following development as the Piagetian theory suggests.

The Principles of Teaching-Action-Research

Teaching-Research and Action Research are methodologies, which have a common goal, namely the change of practice. One might say that Teaching-Research in the classroom is an Action Research project applied to the classroom environment. While Teaching-Research in a classroom investigates and assesses methods to improve learning, Action Research usually focuses on community-based participatory transformation, or bettering of the life of a community. The integration of both is the creation of Teaching-Action-Research methodology, which places the teacher in the simultaneous role of community organizer as well as in the role of the investigator of classroom learning processes in order to improve them.

It was discovered during the Teaching Experiment (2005 – 2006) that integration of the two can be accomplished if both - classroom Teaching-Research and the Action Research psycho-social methods - can be grounded in the developmental approach. The tools employed by the teacher-researchers as well as by the psychosocial action researchers both aimed at (1) creation or recreation of a symbol, and (2) making implicit knowledge explicit. In the case of the teacher-researchers, conceptual development of the fraction concept was anchored in the Fractions Grid, and students were guided through the iconic representations of Bruner toward concept formation and its mastery. In the case of the psycho-social action research the metaphor of a tree or of the community map of the

village allows for the concrete manifestation of hidden problems of the community and through its iconic representation, guides the person towards the development of appropriate concepts needed for the penetrating analysis and mastery of the social situation of the communities. Tree analysis and the community map (Bragin, 2005) are both iconic representations created by the participants. With the tree analysis, participants identify their problems and difficulties with the leaves of a tree and in the ensuing discussion in the group and in the whole team, identify the roots of this tree. With the creation of the community map, participants represent their lived experiences on paper as a community map. Discussion within the group and across the team, clarifies universal nature of those experiences and the "creation/recreation of the symbol". The detailed evidence and artifacts supporting the hypothesis will be presented at the conference.

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