Research tensions and paradigm shifts in action sciences

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Three contextual kinds of tensions in fieldwork accompanied the rise of Participatory Action-Research (PAR) in the Third World during the 1970s: theory/practice tensions in determining appropriate safeguards for the application of praxis; subject/object tensions and the knowledge required to resolve them in terms of horizontal relationships between actors; and tensions in developing a philosophy of life, since self-objective positions on science were not fulfilling for action researchers. Questions on validity and rigor were also considered. The implications of this quest for knowledge necessary to induce social change invited a discussion of the ontological components of paradigm formation, especially in and for tropical areas. Some educational and academic effects of this work on the sciences are examined in connection with participatory universities and the teaching of mathematics.

Ocurrieron tres clases de tensiones en el contexto del trabajo de campo en el que se aplicó la Investigación-Acción Participativa (IAP) en el Tercer Mundo durante los años 70. Ellas fueron: las de teoría/práctica con el fin de determinar guías apropiadas en la aplicación de la praxis; las de sujeto/objeto y el conocimiento para resolver la tensión en términos de relaciones horizontales entre los actores; y en las del desarrollo de una filosofía de la vida ya que posiciones auto-objetivas sobre la ciencia no eran satisfactorias para los investigadores activos. También se consideraron cuestiones relacionadas con validez y rigor. Las implicaciones de esta búsqueda de conocimientos necesarios para inducir cambios sociales llevaron a una discusión sobre componentes ontológicos de formación de paradigmas, en especial para y en regiones tropicales. Se examinan algunos efectos educativos y académicos de este trabajo sobre las ciencias, en relación con la universidad participativa y la enseñanza de las matemáticas.

When I received your kind invitation to address this Conference, I was also pleasantly surprised to learn that since the 1970s through these international congresses mathematics and mathematicians have been undergoing an intense epistemological transition focused mainly on education, with emphasis on a critical examination of the patterns of transmission of mathematical knowledge to students and resarchers. As I understand it, a considerable group among you has been trying to go beyond the so-called realistic school --whose rather aloof and static view of the discipline mostly limits students/researchers to receiving and retaining what is transmitted to them-- and to adopt instead a constructivist process of epigenesis and sharing with others through trial and error and problem-solving in real life contexts. As you know, in several countries such as Spain, Brazil, Colombia and the United States this effort has evolved to the

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point of proposing the development of a novel discipline called "ethnomathematics", which is again discussed in the present Conference (cf. Powell 2002).

All of this seems to me quite challenging in view of the intention of discarding the incongruent aspects of the dominant positivist or Cartesian paradigm, a task which reached a peak in the wake of the quantum physics revolution of the 1920s (Capra 1982). It also opens the prospect of looking more carefully at disciplines considered "soft", such as sociology, psychology and anthropology in which Gestalt configurations like social and cultural contexts or "foregrounds" as defined by Valero and Skovsmose are central to knowledge building and transmission (Lincoln and Guba 2000; Valero and Skovsmose 2002).

Since the 70s another critical element has been added to this history of periodic waves of change caused by shifting views of the role scientists and knowledge should play. I am referring to the rise of a complex of research techniques and methods in social disciplines called Participatory Action-Research (PAR), with its related streams, including Action Learning. In parallel with the constructivist trend in mathematical education, those of us who have taken part in the participatory rebellion in the social sciences have naturally underlined the importance of cultural, social and environmental contexts. We have also laid stress on strategic work connected with the practicalities of daily life, and on the need to combine diverse disciplines to achieve social transformations in processes labelled as "liberation" and "empowerment" for dispossessed groups and social classes.

With pertinent case studies, already accumulated data and years of experience of this kind behind us, perhaps it is now time for us to become better acquainted with one another and to exchange information about what we have been doing in our respective fields. Therefore it is the purpose of this paper to consider the valuable contribution that you as concerned and activist mathematicians have made to this epistemic configuration and to share with you some of our own insights.

May I say that the self-examination process induced in developing Participatory Action Research was hazardous for us, and that no conscious planning or forethought nor any previous teachings helped us very much in finding suitable solutions to the new problems posed. But it was a most fruitful and even enjoyable experience. We appeared to be involved in a risky mixture of power/ knowledge, for we dared to challenge established ways and rules with heterodox research-and-study techniques in the field, in the classroom and even in the comfort of our armchairs in order to promote changes that are felt necessary both for academia and for society at large. In academia we tried to replace what we felt were ineffective, tautological or empty analytical procedures. In society we also tried to pursue ideals of social justice for ordinary peoples. All of this required an overarching ethical stand, with a generous understanding of situations and a good dose of patience.

In this connection and with particular reference to ethnomathematics, I will devote attention in this paper to three types of tensions that arose during the construction of PAR, namely: 1) in a redefinition of the theory/practice binomial; 2) in the meaning of the subject/ object and knowledge triad; and 3) in the search for a more satisfactory vision of science, Weltanschauung or philosophy of life. I will attempt to furnish some illustrations as we proceed.

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Theory and practice

Common sense and contributions from local and indigenous writers, leaders and sages taught us to be mindful of the relationships between a natural dynamics conception and its expressions in everyday contexts. In the tradition of Western knowledge, this preoccupation has been tied to the venerable notion of praxis, viewed as a tandem combination of theory and practice in which practice is the determinant factor. We had learned from the positivist school that it was proper, indeed expected, to separate theory from practice in knowledge accumulation. Yet in the classroom and in the face of critical sociopolitical situations in the field, this definition fell short. And a contextual application of praxis with appropriate safeguards induced a partial dismantling of the binary Cartesian heritage as irrelevant. Further debunking came when we adopted the concept of "commitment" (engagement) to the social actors we were incorporating into our work or in our classrooms, for we recognized the combined importance of their experiential ("vivencia"), down-to-earth contribution to social change and their knowledge of reality.

These caveats led us to question the trend towards self-objectivity in scientific disciplines, such as pure mathematics and theoretical demography, for scientism and technology, if left to themselves, could produce a mass of redundant information simply biased towards explaning or justifying the status quo and routine procedures. We tried instead the build theory and obtain knowledge through direct involvement, intervention or insertion in processes of social action outside classrooms or offices. With this praxiological approach it was possible to salvage the utopian, activist traditions of sociological and educational founders such as Saint-Simon, Owen and Pestalozzi and to learn from the 19th century subversive movements in favor of literacy, cooperativism, feminism, organized labor.

In more contemporary times, this concern for action and the practical motivated a change in our usual ways of teaching. With Stenhouse and Freire, we insisted on a contextual education-plus-research combination taken beyond the school premises, into the actual communities, where students together with local teachers and leaders could integrate their life-experiences in efforts aimed at transforming existing oppressive conditions.

Since then observed results in several countries have been highly encouraging and have furnished elements for a participatory revision of educational institutions. Ethnomathematics is involved as it emerges from living

contexts. For example, colleagues from Spain and Colombia have found it useful to tie up anthropological knowledge of artisans, work (in tile-and hat-making and tapestry) with quantitative analysis, in a freedom-inducing experience ranging from informal or implicit calculation to formal presentation (Oliveras 1995; Alvis and Páramo 2001). The social and cultural context as well as the logarithms of the actual handiwork were essential for both study and action and for developing necessary symbols for our campaigns-- the exact, proportional designs of the beautiful Zenu hat are a good example (Puche 1984).

In Participatory Action Research we also had to translate statistics into living or practical experience when local peasants and Indians in Colombia needed to know and decide on variables and attributes such as on how many schools were required in their communities, their students space, and expected furniture. Numbers, curves and formulae then acquired a real meaning and lost their threatening image. In working with indigenous groups, an abacus with knots to establish quantities for local market transactions among illiterates was used to bridge the distance between mental or implicit quantification and the formal numbers given by academicians. This led to a collective feeling of assurance, freedom and betterment.

Thus the primacy of practice in daily life as a guide to pertinent knowledge for change was reinforced as we combined quantitative and qualitative approaches. Live, practical mathematics can be turned into a dynamo to further fundamental social transformations. And activist mathematicians and scholars can become fully involved in struggles for social and economic change. Quantities and units, sequences and patterns then acquire a real meaning connected with surrounding realities.

Subject, object and knowledge

In the nascent stage of PAR we were as careful as you have been in your discipline not to extend to the social domain the positivist distinction between subject and object that can be made in the natural sciences. Especially in Action Learning and in pedagogy it seemed counterproductive to regard the researcher and the researched, the teacher and the student, the “expert” and the “client” or “target” as two discrete, discordant or antagonistic poles. Rather, we had to consider them both as persons linked with feelings and thoughts whose diverse views on their shared life experiences should be taken jointly into account. Resolution of this tension to arrive at a subject/ subject horizontal or symmetrical relationship, implied respect and appreciation by individuals for one another,s inputs and by humans for inputs from nature.

This discovery helped us to define what we called “authentic participation” as distinct from manipulative liberal versions then in vogue, as a way of combining different kinds of knowledge, for example, academic erudition and popular wisdom, even in classroom conditions. This in turn enabled us to design and craft novel types of research and teaching tools such as inter-generational dialogue, audiovisual aids, group/ symposium soundings, cultural maps, and the

use of family ("trunk") archives (see bibliography). We also organized "reference groups" with field or outside leaders replacing the university professors who had been our referents during our formative years.

The horizontal resolution of the subject/object tension involved a "systematic devolution" technique for sharing knowledge and research findings with non professionals and untrained pupils, in which the fundamental role of language was acknowledged. We had to change our jargon and ponderous ways of reporting the results of our work, in order to make such results understandable to the ordinary people or students we worked with. We then developed a communication differential according to the participants, level of literacy and/or training.

Of course, it became important to learn to write and to lecture in different styles, voices and in combined columns or "channels", sometimes simultaneously, including multimedia and dramatic productions. Hermeneutics helped in transmitting complex ideas and mathematical notions when the quantitative approach was necessary. Well illustrated interesting textbooks and monographs were produced, some even written by the non-initiated; school curricula were enriched; and the traditional myth about mathematics as something otherworldly was laid to rest.

There are other tried PAR techniques that can also enliven work and study, and others that can be invented or remade according to need or circumstance -- the scope is almost infinite. For this reason, our Scandinavian colleagues have referred to PAR as "discovery and creation" unfolding in a given epigenetic space (Toulmin and Gustavsen 1996, 179).

Participation as a philosophy of life

Field experience had the enchantment of providing involvement with people in their own neighborhoods and communities. Although change processes were slow and multidirectional, they were always a wonder and a fulfilling and emancipatory experience, formative not only for the community leaders but also for the outside researchers, teachers and activists. We saw that it was possible for the scientific spirit to flourish in the most modest and primitive circumstances, that important work did not need to be expensive or complicated.

Consequently, we found little use for scholarly arrogance and self-objective bias, and we learned instead to develop an empathetic attitude towards others, which we called "vivencia", meaning life-experience (Erfahrung). This was also a lesson received through the example of Western scientists like Galileo, who acknowledged the basic formative importance of his contact with Venetian fishermen and shipbuilders, or like Humboldt who adopted the tropical world as the main mandate for his life and work as a scientist.

These and other cases of scientific humility as well as of collective emancipatory attitudes helped us to redefine Participatory Research and Action Learning as "vivencias" necessary for the achievement of progress and democracy, as a set of attitudes and values that would give meaning to our

praxis in the field and in the classroom. From then on, PAR was to be seen not only as a research methodology worthy of attention but also as a philosophy of life that would turn its practitioners into “thinking-feeling” persons (“sentipensantes”). I would expect that a similar “thinking-feeling” experience should be easy to grasp and adopt by ethnomathematicians.

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Once we had dealt with the three-dimensional framework just described and were more sure of what we were doing with PAR, we were able to answer the critics who rightly required us to have and use valid criteria for our work. This was of great scientific and pedagogical importance.

The first problem about validity had to do with the connection between quantitative and qualitative phenomena in research, as mentioned above. We had inherited from the mechanicist or Newtonian paradigm a belief in the primacy of numbers for truth and exactitude. Husserl’s dictum –that behind a digit there lurks a human being-- implied a different, relativistic angle, more related to verisimilitude and approximation than to precision. This depended on the configurations of phenomena, on time-and-space contexts (Gestalt) and on the cultural milieux, much in the way in which we have talked about constructivism. Numbers were not always exact or had different meanings according to the constructs or configurations in question. For example, for West African tribes the number 401 for referring to Orisha deities does not carry our mathematical connotation but a sense of the many (400) plus the unitary possibility of successive additions or deductions. Weeks may not be of seven but four days among Muslims; and for the Maya a cycle similar to our century has only 53 years.

Moreover, my college training in social statistics always broke down on the issue of pertinence. The lack of reliable field data revealed not only a problem of scale but also the nature of the contact between observer and observed (or researcher and researched). To reason, to ask the whys and wherefores of measures and of measured facts was just as important as to calculate. Technology needed formulae to solve problems and propose acceptable results. Moral choice was often involved, even for pure mathematicians and aloof theoreticians who preferred to work in their ivory towers.

Thus, for example, we were fascinated by the way in which pupils in a Colombian town responded to complex phenomena when they were asked to study and propose a local transport system, as the concept of network became evident and it was necessary to measure the flow of vehicles and the intermittency of traffic lights. Mathematics was turned into a living and practical experience in which local vivencias (as defined above) had a role. Similar results were obtained when dimensional phenomena, like space and time, were applied to the study of urban demographic growth.

Unexpectedly and somewhat belatedly for many of us in the Third World, the development of quantum physics triggered an explosion of interdisciplinary

transfers with such contextual --and even ethical-- factors of validity. When Borg's anthropic hypothesis and Heisenberg's indeterminacy principle could not be refuted, even by Einstein, many physicists started to regard sociologists with respect and to find convergence for interpreting the complex and often unpredictable corpuscular world. The same happened with social systems. Biologists, and systemic and chaos theorists followed.

One consequence was emergence of the view that validity was not simply an internal discursive exercise within a probabilistic structure. We could, when necessary, combine quantitative measures with relevant, well prepared and rigorous qualitative and/or ethnographic descriptions. Validity criteria could be derived from sources other than numerical regressions and correlations. Such alternative guidelines could be drawn by common sense, from inductive/deductive analysis of results obtained in practice through personal involvement in processes, and approved by the considered judgement of local reference groups. Even critical evaluations, showing quantifiable trends and projections, could be made just as well in the actual process of fieldwork, such as live soundings, without having to wait for the end of arbitrary prefixed periods.

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Finally, if we were to define PAR work on the basis of quantities and qualities of configurations and constructs, we had to scrutinize the issue of contextuality more carefully and in its full regalia. This focus on context took us closer to the source of scientific paradigms as sociocultural constructs, especially the dominant ones usually of Eurocentric origin which had shaped us professionaly in the universities.

For us, the dominant paradigms were those referred to and inspired by European and North American historical, economic and cultural traditions, namely Descartes's positivism, Newton's mechanicism, and Parsons' functionalism. We posed the following questions: Are these the only paradigms worth considering, and need they be primordial and universal? Is it not possible to conceive of other paradigms, more closely related to diverse cultural milieux? Could we not devise more pertinent and useful paradigms for forgotten and neglected zones and cultures --such as those of the tropics-- whose paramount importance for survival of the world has received marginal attention from science, but should be recognized and scientifically considered?

Many concepts and institutions constructed in the Third World through the orientation or imposition of dominant Eurocentric paradigms have often produced dysfunctional results. This explains the dismal failure of many development projects and the disorienting effects of the developmentalist discourse itself. We in the peripheral countries have often felt like sheep being herded by Western intelligentsia. We have felt that our minds as well as our riches and resources have been and are being colonized and exploited with little respect for local reason, knowledge, and life. It now seems appropriate and

urgent for us to start thinking and acting more independently and critically with regard to the Western heritage imposed on us in the South and to the world at large. The PAR family both in the South and in the North has thus embarked on a serious ontological appraisal of this problem, in an effort that is leading us all into a fruitful phase of joint intellectual production and cooperation with colleagues from diverse disciplines.

What we are doing in this collaborative scientific field is of interest to activist ethnomathematicians and mathematical educators for there are still many elements and factors that need to be interpreted, reinterpreted, integrated or discarded from science in order to explain realities and processes. This may be the paradoxical significance of the imaginary number ("*i*") often used in trying to explain the unexplainable. But it must be an acceptable type of paradox in that its concrete outcomes strongly challenge routine knowledge and sacred institutions. I hope such challenges will be accepted and worked on for the benefit of all.

Of course, we do not want to become xenophobic or self-centered. That would be a mistake, especially in view of the global forces of economic and cultural integration. We in the South have need of stimulating discourse and understanding with our Northern colleagues, in a mutually respectful horizontal, participative atmosphere. A North-South alliance for the advancement of ordinary people everywhere especially the poor and those exploited by savage capitalism is seen as both a moral duty and a scientific and educational opportunity requiring commitment and ready collaboration from us all.

Our work in the South has advanced and matured. Yet the tropics still present unique conditions that have remained largely unknown, and these are primarily of concern to us Southerners as local actors and insiders; they include precapitalist and indigenous communities with their respective knowledge structures and accumulated experiences. Thus context as we understand it in the participatory action approach has a natural function, and can be brought into play in research and teaching in different disciplines, including mathematics.

The resulting alternative paradigms are more open than the Kuhnian categories with their closed circle of self-defensive knowledge guardians and judges upholding improbable universal laws. And in spite of resistance from such people, there is a growing belief that deep changes in scientific vision are necessary for a better world, including better schools and universities. We do not regard this belief as a call to war among paradigms and paradigm holders. On the contrary, as practitioners of Participatory Action Research and Action Learning, we see it as a positive convergence of diverse knowledge systems that provides many possibilities of accumulation, summation and integration of different streams of thought --this is a challenge for intellectual and moral reconstruction. Convergence of this type should only be limited by how useful it is in the sociocultural and environmental context that inspired it, and in producing the positive practical results expected of it in the real world.

Moreover, the values usually associated with dominant paradigms -- consistency, certitude, scope and simplicity-- can be enhanced by such participatory values as social responsibility, altruism and autonomy. The PAR approach is open, plural, practical and interdisciplinary, embracing elements from American-Indian, African and Oriental thought, together with complexity theories, systemic thinking, cosmic outlooks á la Bateson, and Marxist humanism. All of this comes close to a holistic worldview in which mathematicians certainly have a role to play, witness, for example, the early Greek concept of music as a part of mathematics.

This open, holistic paradigm of PAR brings together praxis and ethics, academic knowledge and popular wisdom, the professor and the student, the rational and the existential, the regular and the fractal, the qualitative and the quantitative. It breaks down the subject/object dichotomy. It is founded on the democratic pluralist concepts of otherness, service and justice, upholding toleration of diversity and introducing neglected perspectives of culture, gender, popular classes and pluriethnicity into research and teaching activities.

This open intellectual project likewise leads to the idea of a participatory university, in which the surrounding social communities are included in both learning and teaching, where there is less pompousness and departmental isolation and greater ease and democratic communication, with a more interdisciplinary approach to concrete social problems, and constant contact with the outside world and involvement in its concerns.

I hope there is concurrence on this from all the sciences. Inputs from you as mathematical educators and applied philosophers would greatly strengthen the dynamic development of knowledge for life and social progress that is the goal of Participatory Action Research.

References

Alvis, Victor and Guillermo Páramo. Estudios antropomatemáticos sobre artesanías en Colombia, Bogotá. (Personal communication).

Bateson, Gregory. Steps to an Ecology of Mind. San Francisco: Chandler, 1972.

Capra, Frithof. The Turning Point. New York: Simon and Schuster, 1982.

Fals Borda, Orlando and M. Anisur Rahman (eds.). Action and Knowledge. New York: Apex Press, 1991.

Fals Borda, Orlando. “Participatory (Action) Research and Social Theory: Origins and Challenges”, in Peter Reason and Hilary Bradbury (eds.), Handbook of Action Research, London: SAGE, 2000, Chapter 2.

Kemmis, Stephen and R. McTaggart. “Participatory Action Resarch”, in Norman K. Denzin and Yvonna S. Lincoln, Handbook of Qualitative Research. London: SAGE, 2000, 567-606.

Lincoln, Yvonna S. and E. G. Guba, “Paradigmatic Controversies, Contradictions, and Emerging Confluences”, in N.K. Denzin and Y.S. Lincoln (eds.). Handbook of Qualitative Research. London: SAGE, 2000, 163-188.

Moser, Heinz and H. Ornauer. Internationale Aspekte der Aktionsforschung. Munich: Kösel Verlag, 1978.

Olivares Contreras, M. Luisa. “Artesanía andaluza y matemáticas: un trabajo transversal con futuros profesores”, UNO Revista de Didáctica de las Matemáticas, Universidad de Granada, España, No. 6, octubre 1995.

Park, Peter et. al. Voices of Change: Participatory Research in the United States and Canada. Ontario: Oise Press, 1993

Powell, Arthur. “Ethnomathematics and the Challenges of Racism”, MS, Third International Mathematics Conference, 2002.

Puche Villadiego, Benjamín. “El sombrero vueltiao zenú: fórmula de su tejido”, Revista de Extensión Cultural, Universidad Nacional de Colombia, Medellín, Nos. 16-17, abril 1984, 91-100.

Reason, Peter, and H. Bradbury (eds.). Handbook of Action Research: Participative Inquiry and Practice. London: SAGE, 2000.

Toulmin, M. and B. Gustavsen. Beyond Theory: Changing Organizations through Participation. Amsterdam: John Benjamins, 1996.

Valero, Paola and O. Skovsmose. “Mathematics Education in a World Apart”, MS, Third International Mathematics Conference, 2002.

Whyte, William F. (ed.). Participatory Action Research. London: SAGE, 1991.