In Focus…

Can the Ideal of the Development of Democratic Competence Be Realized Within Realistic Mathematics Education? The Case of South Africa

Cyril Julie

As is the case in any country there is a constant search to improve the mathematics offerings presented to school-goers in South Africa. The activity surrounding this search was intensified after the attainment of democracy. The primary aim of this search was to establish a mathematics curriculum that would result in productive learning and the mastery of the goals set for the curriculum. These goals are predetermined and are embedded within the country's ideological intent of its school educational endeavors. Explicitly it is stated that school education should be a mechanism to contribute towards the development of "a participating citizen in a developing democracy [who has] a critical stance with regard to mathematical arguments presented in the media and other platforms" (South African Department of Education, 2003, p. 9). This goal was already proffered during the struggle for liberation against apartheid and encapsulated in the alternative school mathematics program during the latter periods of that struggle. The alternative mathematics curricular movement found expression in People's Mathematics (PM). People's Mathematics was an independent development in South Africa during a particular historical moment but shared commonalities with the varieties of Critical Mathematics Education (Skovsmose, 1994; Frankenstein, 1989). It differed from other varieties in that it adopted the stance of critique but also emphasized action against those practices which inhibit human possibility.

The broad umbrella goals of People's Mathematics were "political, intellectual and mathematical

Cyril Julie obtained his doctorate in Mathematics Education and Computer-Based Education from the University of Illinois at Urbana-Champaign. He teaches courses at undergraduate and graduate level in Mathematics Education at the University of the Western Cape. He is currently involved in a major project related to the development of research capacity building in Mathematics Education in Sub-Saharan Africa. His major research centers around the application and modeling of school mathematics and the relevance of school mathematics for students in grades 8 to 10.

empowerment" (Julie, 1993, p. 31). It is with these goals in mind that Realistic Mathematics Education (RME) was found a viable approach to school mathematics with which the People's Mathematics movement could "live." The particular characteristics of RME that PM found useful were:

(a) It has a Lakatosian research program nature (Gravemeijer, 1988). Being such a research program there was some certainty of sustainability due to Lakatos's notion of strong research programs fulfilling their predictions.

(b) The retention of the integrity of mathematics through RME's vertical and horizontal mathematization (Streefland, 1990).

(c) The centrality of applications and modeling in RME (De Lange, 1987).

(d) The seamless integration of the history of mathematics and educational contexts from extra-mathematical domains (De Lange, 1987).

(e) Mathematics curriculum development that is continuous and not of a once-off tinkering nature.

(f) A curriculum development research methodology that is classroom-based and action-oriented (Gravemeijer, 1994) with an accompanying reporting strategy of research findings that is understandable to practitioners.

In terms the umbrella goals enunciated above in RME fulfilled the mathematical and intellectual ideals ((b) and (d)) of PM but not the political. This does not imply that contexts of an overt political nature are not included in the RME program. For instance, in the following activity (De Lange & Verhage, 1992) around national budgets and military expenditure, the overt political dimensions are clearly discernable.

> In a certain country, the national defense budget is $30 million for 1980. The total budget for that year was $500 million. The following year the defense budget is $35 million, while the total budget is $605 million. Inflation during the period covered by the two budgets amounted to 10 per cent.

A. You are invited to give a lecture for a pacifist society. You intend to explain that the defense budget decreased over this period. Explain how you would do this.

B. You are invited to lecture to a military academy. You intend to explain that the defense budget increased over this period. Explain how you would do this.

What is not clear from these and other similar activities is how these activities are to be used in classrooms or how and whether there are follow-up activities that take the intent of the activities beyond the purely mathematical. The political empowerment ideal within People's Mathematics implied a movement beyond this purely mathematical treatment of issues of political import. This begs the question of where does the political reside in mathematical activity?

The political find expression in at least three areas of mathematical activity. They are all within the arena of the applications and modeling of mathematics. The first of these is akin to the activity of De Lange and Verhage above. What is added to this is opportunity for overt reflection on those issues that relate to inequality and discrimination on the basis of race, sex, social class and economic developmental level of countries. This is aptly illustrated by the following activity (Frankenstein, 1989, p. 140):

Review the comparisons made in the following three tables and write briefly about the connections among the data in each table and any conclusions and any questions you have about the given information. (Note: Only one table is given here.)

Median incomes of full-time workers by occupation (persons fourteen and above)

Major occupation group	1976 income ($)	
	Women	Men
Professional and technical workers	11,081	16,296
Non-farm managers & administrators	10,177	17,249
Sales workers	6,350	14,432
Clerical workers	8,138	12,716
Operatives (including transport)	6,696	11,747
Service workers (except private household)	5,969	10,117

A second area where the political is overtly present is during the model construction process. When a mathematical model is constructed, interpretations and translations take place. The given reality situation from outside of mathematics is stripped down to make it amenable for mathematical treatment, and the resulting mathematical model is more a mathematical representation of a stripped-down version of the situation. In essence, there are three domains involved in mathematical model making. These are the extra-mathematical reality, the consensus-generated reality domain, and the intra-mathematical domains. The characteristics of these domains are summarized in Figure 1.

Extra-Mathematical Reality Domain	Consensus-Generated Reality Domain	Intra-Mathematical Domain
Issues of a technical, physical, financial, social, political, environmental, and so forth nature are at stake. Issues are complex and under a variety of influencing factors.	Issues are stripped of some of the influencing factors. Consensus is reached based on purposes and interests.	Mathematical procedures and ideas are developed and used. Mathematical conclusions are reached.

Figure 1. The translation of reality issues through different domains.

It is during this process of translation that issues of interests, ideological preferences and power are at stake and contestations manifest themselves. These contestations occur prior to the subjucation of the issue for which a mathematical representation is to be constructed to mathematical treatment. They occur between the domain of the real and that of mathematics. The resolution of conflicts, interpretational variances, and interests render a different reality. This reality is realized through consensus and hence the postulation of a consensus-generated reality domain as outcome of deliberations on differences, interests, and intentions. It is within the consensus-generated reality domain that ideological intentions are explicitly revealed. A resulting mathematical model is always a product of its consensus-generated domain and thus different and non-equivalent models might result for the same phenomenon.

Lastly, the political rears its head during the final phase of the modeling process when the adequacy-of-fit of the model to the reality situation is considered. Here the issue is whether the derived mathematical conclusions should be accepted or not. Consider, for example, the mathematics of voting. In this instance a

dictatorship is defined as "[a member] in [a voting set] A is called a dictator in A if and only if {x} is a minimal coalition" with a minimal coalition "a subset of K…if and only if K is a winning coalition and no proper subset of K a winning coalition" (Steiner, 1968, p. 189, 184). From this definition, if the results of a general election in a country is such that a political party has a majority such that they need to form no coalition with any other party to carry an issue, then that political party, and by implication, the government of the day, is a dictatorship, at least mathematically. For example, for the South African 2004 election, the African National Congress (ANC) commanded that 69.75% of the parliamentary seats and a two-thirds majority was needed to carry any decision. Thus, according to the mathematical definition of a dictatorship, South Africa is under the dictatorship of the ANC. However, the lived experiences in South Africa are such that this is not the case. Here then it is clear that mathematical conclusions and lived experiences might at times be in conflict and for all intents and purposes it is sometimes wiser to be guided by lived experiences rather than by the dictates of mathematical conclusions.

One of the features that stand out in modern school mathematics curricula in terms of the goals that are offered is the development of democratic competence. This competence is an individual's (and a collective's) ability to make sound judgments about those issues which structure and steer the affairs and practices of humankind. The judgments are about the appropriateness or not of the development and implementation of the mechanisms that guide these affairs and practices. These mechanisms are profoundly driven by worldviews on issues such as race, gender, and class differentials and generally the kind of world that is envisioned. During the model construction process issues of this political nature come into play and hence the need for democratic competence as stated. Further, as enunciated above, part of this competence is a considered skepticism towards being convinced through mathematical argumentation. Democratic competence is normally captured in the definition of Mathematical Literacy as, for example, given below for the Programme for International Student Assessment (Organization for Economic Co-Operation and Development, 2003, p. 24):

> Mathematical literacy is the individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with

mathematics in ways that meet the needs of that individual's life as a constructive, concerned, and reflective citizen.

A question that can be asked is whether the goal of the development of democratic competence can be realized within the Realistic Mathematics Education framework. What was indicated above is that RME falls short as a paradigm in this regard. It does allow for reflection on issues of a political nature but remains at an awareness and conscientization level. It does not allow for a consensus generation phase in model-construction. Neither does it explicitly allow for the questioning of mathematical conclusions in relation to lived and other experiences. It is suggested that RME needs to be broadened to incorporate at least these three issues in order to contribute more to the goal of development of democratic competence. In doing so there is a need to move beyond awareness and conscientization. This "moving beyond" is what Ellis, a leading South African and internationally recognized cosmologist, suggested about 20 years ago. He stated:

> …the only true basis of freedom is a realistic vision of the alternative possibilities for change before us. Mathematical studies can sometimes help us in understanding what these alternative possibilities are. But such an understanding is quite valueless unless it affects our actions. An understanding of the causes of any social wrong, which does not lead to some corrective action to right that wrong, is meaningless. (Ellis, 1974, p. 17)

Democratic competence is thus about an individual's (or collective's) capacity to interact with mechanisms which affect their lives and those of society and to act where such mechanisms are to the detriment of humankind. Where these mechanisms have a mathematical base, or where they can be explained and understood through mathematical means, necessitates that schooling in mathematics be called upon to provide the spaces for such interactions and actions.

REFERENCES

de Lange, J. (1987). *Mathematics, insight and meaning.* Utrecht University: Utrecht, Netherlands: OW & OC.

de Lange, J., & Verhage, H. (1992). *Data visualization.* Pleasantville, New York: Sunburst.

Ellis, G. (1974). *On understanding the world and the universe.* Professorial Inaugural Lecture, University of Cape Town, Cape Town, South Africa.

Frankenstein, M. (1989). *Relearning mathematics: A different third R – Radical maths.* London: Free Association Books.

Gravemeijer, K. (1988). *Een Realistisch research programma.* In K. Gravemeijer & K. Koster (Eds.), *Onderzoek, ontwikkeling*

en ontwikkelingsonderzoek (pp. 106–117). Utrecht University, Utrecht, Netherlands: OW & OC.

Gravemeijer, K. (1994). Educational development and development research in mathematics education, *Journal for Research in Mathematics Education*. 25(5), 443–471.

Julie, C. (1993). People's mathematics and the applications of mathematics. In J. de Lange, C. Keitel, I. Huntley, & M. Niss (Eds.), *Innovation in maths education by modelling and applications* (pp. 31–40). Chichester: Ellis Horwood.

Organisation for Economic Co-operation and Development (OECD). (2003). *The PISA 2003 assessment framework—Mathematics, reading, science and problem solving knowledge and skills*. Retrieved November 23, 2004 from http://www.pisa.oecd.org/

Skovsmose, O. (1994). *Towards a philosophy of critical mathematics education*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Steiner, H. G. (1968). Examples of exercises in mathematization in secondary school level. *Educational Studies in Mathematics*, *1*, 181–201

South African Department of Education. (2003). *The national curriculum statement: Mathematical literacy*. Pretoria, South Africa: Government Printers.

Streefland, L. (1990). *Fractions in realistic mathematics education: A paradigm of developmental research*. Dordrecht, Netherlands: Kluwer Academic Publishers.