

An Investigation into the design of Advanced Certificates in Education on Mathematical Literacy teachers in KwaZuluNatal

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Abstract

The aim of this paper is to describe an ongoing study into the design of two Advanced Certificates in Education in Mathematical Literacy (ML) offered by two Higher Education Institutions in the KwaZuluNatal (KZN) province in South Africa. Mathematical Literacy is a relatively new subject that has been introduced into the grade 10, 11 and 12 school curricula as an alternate to Mathematics. Mathematics and ML are two distinct subjects with different objectives. There is thus an urgent need to train pre-service teachers and re-skill in-service teachers to teach ML competently in schools, and not to treat ML as a less sophisticated version of Mathematics. This paper looks at the design of the two qualifications and the results of the students who studied for the qualifications.

Introduction

All learners in South Africa have a choice of either Mathematical Literacy or Mathematics for their last three years of schooling. As ML is a relatively new addition to the curriculum, studies on the effectiveness of programmes targeting teacher training are imperative. By comparing and contrasting in-service programmes offered by two Higher Education Institutions (HEIs), methods, strategies and results are brought to light and evaluated. Because of the pressing need to have qualified and effective ML teachers in the classroom, the KZN Department of Education (DoE) tasked two HEIs to deliver Advanced Certificates in Education (ACE:ML) programmes throughout the province. The in-service teachers, who were prospective students, were identified by the DoE and the HEIs, therefore, had no part in specifying mathematics ability, other than the entrance requirements for the qualification. Each programme spanned two years' of study, and extended to a third year, when students were given an opportunity to repeat modules if they had failed to reach the Universities' required standards. The centres dictated by the DoE were in rural, peri-urban and urban areas.

The study described in this paper focuses on approximately 2 200 in-service teachers who have studied ACE:ML on a part-time basis over a period of two years with either of the two HEIs operating in KZN. The method of the broader study (which is preliminary at present) will follow an explanatory mixed method approach where quantitative data on the students' demographics and performance will be collected and analysed to identify any particular trends relating to uptake and success in these programmes. Module templates (providing information about the learning outcomes, modes of delivery, assessment strategies and module evaluation requirements), learning materials and tutor training guides will be analysed to provide information about the nature and design of the two ACE programmes. A questionnaire consisting of closed questions as well as a limited number of open ended items will be sent out to all current students, drop outs and graduates of the programmes. The purpose of the questionnaire will be to gather data about the teachers' perceptions of the effectiveness, relevance and utility of the two programmes as well as to solicit suggestions on

how the models of delivery could be improved. Semi-structured interviews will also be conducted with samples of students from each programme to triangulate the data.

ACE programmes from all South African HEIs are currently being placed under the spotlight. According to the November 2010 Draft Policy on the Minimum Requirements for Teacher Education Qualifications selected from the Higher Education Qualifications Framework (HEQF), ACEs will have to be restructured into either Advanced Diplomas in Education (ADE) at National Qualifications Framework (NQF) level 7 or Advanced Certificates in Teaching (ACT) at NQF level 6 (Department of Higher Education and Training, 2010). The quandary HEIs are presented with is that the HEQF is under review and there is speculation as to the breadth and depth of content and pedagogical content knowledge that should be included in the proposed qualifications.

Literature overview

Steen (2003) has written extensively about Quantitative Literacy in the United States. He is of the opinion that learners need to be flexibly prepared for life and to this end he suggests teaching a blend of numeracy, mathematics and statistics. De Lange (2003) posits that being mathematically literate has differing definitions depending on the needs of the community; however, in his description of a balanced mathematical literacy curriculum he identifies topics similar to those in the South African NCS, soon to be superseded by an adjusted curriculum:

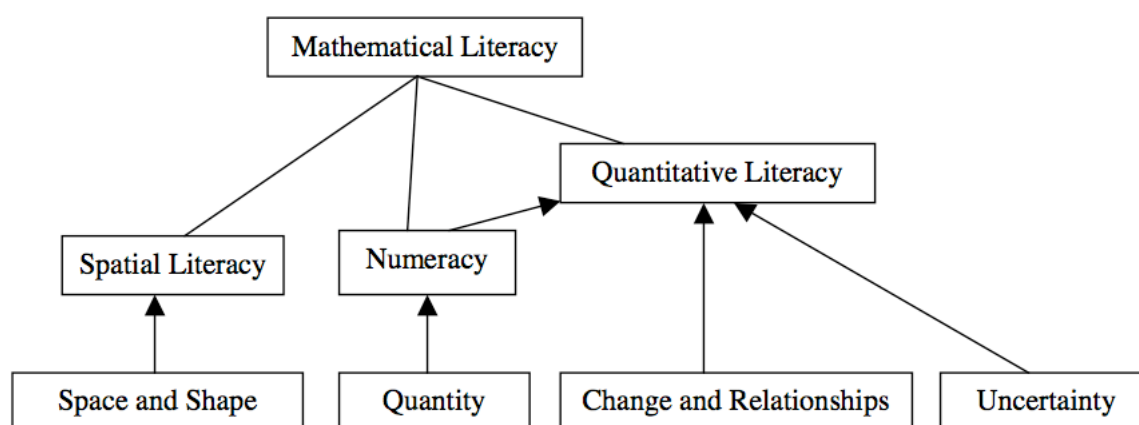


Figure 1: Jan de Lange's (2003) conception of a balanced Mathematical Literacy Curriculum

Adler, Pournara, Taylor, Thorne and Moletsane (2009) surveyed the field of mathematics education in South Africa and one of their conclusions was that learning science and mathematics (and, in this instance, mathematical literacy) for teaching is not a simple matter. Many initiatives have not made the required impact on teaching or learner performance. They suggest examining the practices of teacher education with respect to "breadth and depth of domain knowledge; subject content and pedagogy" (p.39)

Schmidt, Cogan and Houang (2011) report on the Teacher Education and Development Study in Mathematics (TEDS-M), an international comparative study of teacher education. The researchers in the TEDS-M study assessed mathematical content knowledge, general pedagogy and mathematical pedagogy as they identified these as three key areas associated with teacher preparation. Although the TEDS-M study focused on the preparation of future teachers, the opportunities to learn are similar to those of in-service teachers who are facing

the challenges of a new content area. The TEDS-M study revealed that there is little agreement among HEIs in the United States as to what constitutes teacher preparation, possibly because there is no shared vision of what a highly trained teacher should know (Schmidt et al., 2011). The situation in South Africa with teacher training for ML is similar as there was an urgency to train a massive cohort of teachers before the learning area was implemented in schools, even though the implementation was phased in over three years. HEIs developed programmes in isolation, and perhaps without due regard for Adler et al.'s caveat concerning both breadth and depth of mathematics content. The TEDS-M study further revealed that achievement is related to curricular differences in terms of content cover. Data gathered in the TEDS-M study indicated that the mathematical content offered in teacher training courses was positively related to professional competencies. In the comparison of the two ACEs in this study the majority of modules were ML content-based as professional competencies were deemed to have been acquired through previous teaching experience.

Curriculum contrasts

The requirements for entry to ACE: ML for University A recommended that students have at least a pass for mathematics standard grade at Senior Certificate level, a category C (M+3) teaching qualification at NQF level 5 and at least three years' teaching experience. Similarly, University B required an approved initial teacher education qualification or diploma of at least three years' duration and specified that the prospective students should have at least attempted mathematics at Senior Certificate level. In reality 42% of the 1 048 students studying ACE: ML in KZN from University A and 31% of the 691 students from University B had either no mathematics or failed mathematics in their senior certificate examination.

The curriculum for University A consisted of four 30-credit modules. Three modules focused on ML content and were divided into grade levels – grade 10, grade 11 and grade 12 ML content knowledge. The coherence of the curriculum was addressed by using a commercial ML textbook to underpin the curriculum content. The fourth module was designed as an ML pedagogical module that linked content and context. General pedagogy was deemed to be an aspect of recognition of prior learning (RPL) as the teachers all had a minimum of three years' teaching experience. The emphasis was on reskilling the teachers in a new subject area.

In contrast the curriculum at University B consisted of eight 16-credit modules. The ML content knowledge was covered in four modules that were horizontally aligned to ML curriculum learning outcomes – number and number relationships, functional relationships, space and shape, and data handling. The faculty developed their own study material and utilised school textbooks as supplementary material. There was one module devoted to the ML pedagogical aspects of teaching mathematics and mathematical literacy, while another was a research module designed to improve the teachers' reflective practices. In addition, there were two general pedagogy modules, studied by all ACE students in the faculty regardless of the ACE discipline, and two generic research modules –theory and practice of research.

The ML content modules from both HEIs were devised as a combination of content and context. For example, the one grade 11 examination that was perused was set in the context of a game reserve and the mathematical content. In one question a map was given of the park and a sub-question was,

“Having watched the elephants at the Hapoor water hole for a while, you realise that it is 17:50 and the game gate closes at 18:30. Sketch on the map the shortest route out of the park estimate the distance in km and calculate how long it will take you if you stick closely to the given speed limit of 40km/h.”

Other contextual questions included calculations concerning cell phone billing, loans, interest rates and house renovations. The balance between content and context was similar in all the ML content modules at both institutions.

In both universities delivery was through a cascade method of training tutors to teach students throughout the province. The tutors at University A attended a central block of training then went into the field to tutor on Saturdays whereas University B utilised a mixed delivery approach of block sessions and Saturdays. For both ACE programmes modules were delivered over a semester and there was continuous assessment through assignments and tests throughout the semester. In both programmes all modules, except the practical research module at University B, were summatively assessed with an examination. Class marks contributed towards the final examination mark.

Coherence

The statistical data from the study are in the process of being analysed but a few interesting preliminary results are emerging.

The first investigation was to plot the coherence of the curricula according to Steen and de Lange’s recommendations. As the South African NCS seems closely aligned to de Lange’s diagram both curricula cover all aspects recommended, even though the University B curriculum is horizontally aligned along learning outcomes whereas the University A is vertically aligned according to grades.

The correlation among the pass rate performance of the students in the three ML content modules at University A ranged between 0.751 and 0.826. Correlation was deemed to be significant at the 0.01 level in a two-tailed test. The correlation of the performance in the mathematical pedagogy module as compared with that of the content modules ranged from 0.712 and 0.769. This indicates that if a student achieved well in one of the four modules, there was a strong possibility that the student would also achieve in the other three modules – and vice versa.

At University B the correlation among the performance in the ML content modules ranged from 0.676 to 0.807; however, the correlation was not as strong between the content modules and the ML pedagogical module (minimum correlation was 0.634), the reflective practice research module (minimum correlation was 0.415), and even less between the content modules and the general pedagogy modules (correlation ranged between 0.385 and 0.567). These correlation statistics imply that students who did well in any one of the ML content modules, performed well in the others. However students who did well in the content modules may not have done well in the general pedagogic modules or the research module, and vice versa. Thus, these statistics indicate that different skills are required for mathematical content, general pedagogy and reflective practice. Thus Schmidt et al.’s (2011) recommendation is strengthened – that mathematical content knowledge, general pedagogy and mathematical pedagogy should be included in teacher training as they focus on different skills.

Further research is required to ascertain whether the two programmes have made an impact on ML teaching in KZN. The objective of the larger study is to investigate teachers' efficacy in the classroom.

Correlation between students' ACE and school leaving results

An interesting aspect of the data collection was the link between the students' achievement in mathematics in the Senior Certificate examination and the probability of passing either qualification in the minimum time period of two years. As all the students, registered at both institutions, were in-service teachers with more than three years' experience, they had all written either Mathematics Higher Grade or Mathematics Standard Grade, or had no Mathematics in their final school examination. Their senior certificate symbol for mathematics was converted to a scale variable ranging from zero (No mathematics or failed mathematics at Senior Certificate level) to 7 (a B-symbol for Higher Grade mathematics at Senior Certificate level).

At both institutions there was a high correlation between the students' mathematics point in the senior certificate examination and their propensity for completing the qualification in the minimum time period. In University A the correlation was 0.805 and in University B the correlation was 0.883. The fact that some students had left school many years before did not appear to affect the data. Not surprisingly, this indicates that a measure of mathematical ability is a prerequisite for success in ML modules.

Conclusion

In this paper we have looked at the composition and student results of two ACE: ML programmes that have been delivered in KZN. It appears that if students are able to achieve well (or vice versa) in a module focusing on ML content from one learning outcome or grade, this is a reliable indication that they will be able to show good progress (or poor) in modules focusing on other learning outcomes or grades. In this study it appears that the students' ML content knowledge was fairly constant over all learning outcomes and grades in both programmes. Those students who achieved in one content module generally achieved in the other content modules as well.

Another outcome of the study is the positive correlation between mathematics marks in the school leaving examination and the students' achievement in the ACE programmes. Results suggest that despite intervening years, school mathematics marks are a strong indicator of success in completing an ML qualification successfully in the minimum time period. Further interviews are planned with the students which may triangulate this supposition.

The expedience and urgency of the delivery of ACE:ML qualifications throughout the province precluded including more than curriculum content knowledge in the ML content modules of both curricula. There is ongoing uncertainty and debate about the extent of mathematical depth required to become an effective ML teacher. Should students who studied ML in their senior certificate examination be excluded from training to become ML teachers? If not, what depth of mathematical knowledge should they explore, considering that they do not have a pure mathematics background? However, if ML learners are excluded from ML teacher training, how will South Africa populate schools with ML teachers if the pool of prospective teachers is limited to those who studied pure mathematics successfully at school?

Both international and national research has indicated that teacher efficacy is a result of balanced teacher training. The implication is that the areas of ML content knowledge, general pedagogy and ML pedagogy should be included in ML teacher training curricula. The issue of the breadth and depth of domain knowledge has not been addressed; however, it is a pertinent issue to discuss during the forthcoming qualifications recirculation process.

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