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Mathematics Students' Perception about Professional Development Programmes (PDPs): Case of South African University

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ABSTRACT This study investigated the perception of candidate mathematics teachers about Professional Development Programmes (PDPs). A questionnaire with Cronbach's alpha of 0.87 was used. Simple random sampling was employed to collect data from 182 undergraduate Bachelor of Education (B.Ed) and Postgraduate Certificate of Education (PGCE) University students. Due to the research questions, the researcher employed two types of data analyses thus; (1) partial correlation and analysis of variance (ANOVA) and (2) factor analysis. The analysis was conducted to explore the relationship between two variables, while statistically controlling for (getting rid of) the effect of another variable that might be influencing the relationship. With respect to the current study, partial correlation was carried out to explore the correlation effect after controlling for respondents' tendency to present themselves in a positive light on PDPs. Further analysis using ANOVA was employed to conduct statistical significance. Factor analysis identified set of factors/structures that represented the underlying relationships among a group of related variables. The findings of factor analysis revealed three factors/structures for the emerged measures of PDPs thus: (1) support from mathematics administrators (2) period of time of PDPs and (3) concerns identified by mathematics teachers themselves .The results also indicated significant inter-correlations among variables especially three measures of PDPs.

INTRODUCTION

Background of the Study

Professional development programmes (PDPs) have been embraced by many educational institutions, researchers and theorist around the world (Department of Education 2010). Recent study in South Africa argues that PDPs (in the forms workshops, seminars, conferences and short courses) refer to designed training programmes or activities intended to enhance productivity (Komba and Nkumbi 2008). The motive is evident in current mathematics curriculum documents (Ngala and Odebero 2010**)**. Indeed, research suggests a consideration of questions about PDPs such as: (1) Which models of say, in-service education are in use and how effective are they? (2) How does participating in a project contribute to a teacher's professional learning? (3) What are the supportive and inhibitory conditions for teachers' learning in the implementation of school-led projects? And lastly (4) how can the outcomes of in-service education inform and guide policy and practice?

Even though all of the questions are important, little consensus exists in literature concerning the relationship between university students' (candidate) perception about PDPs in Africa (Ernest 2007). Nonetheless, sketchy report in other regions of Africa gives an indication of PDP's importance. For instance, accounts from East Africa suggest that since independence, the presiding Governments of Kenya (GOK) have all considered in unison the significance of teacher's education not only as a requisite for pre-entry qualification to the teaching profession, but also as a critical criterion for upward mobility for serving teachers (Ngala and Odebero 2010).

In reality, as a policy response, the government, inter alia established numerous teachers training colleges and university education faculties to deal with the emergent 'diploma disease' now reaching epidemic proportions among serving teachers in Kenya (Ngala and Odebero 2010). Unfortunately, the converse is true for South Africa situation, where teacher training colleges have been closed. South African literature suggests that the culture of professional development has been severely affected by the legacy of apartheid education. The former Department of Education and Training (DoET) encountered political resistance to evaluation and appraisal because many inspectors and princi-

pals were viewed as being politically biased, [and] collaborators with the apartheid regime (Mestry et al. 2009). There are two ramifications for South Africa situation; firstly, both past and present studies have noted that to be effective and responsive to current mathematics needs, a professional development programme should be the responsibility of mathematics administrators such as the department of education (Komba and Nkumbi 2008). In particular, it is argued that governments are judged on their performance in the field of schooling by the outcomes learners achieve (Mestry et al. 2009). However, it has been noted that there is still ill-preparedness and inadequate support for mathematics teachers (Komba and Nkumbi 2008). Secondly, current teacher's mindset is that almost anyone, with a knowledge of mathematics and who can recall how they were taught is qualified enough to teach reasonably well (Mestry et al. 2009).

A number of current research suggests that the ill-preparedness and inadequate support have hampered effective/responsive education in Africa, particularly mathematics education in South Africa (Mestry et al. 2009). Due to the aforementioned, research argues that the official pressure for reforms in the teaching of mathematics overlooks a key factor; the psychological foundations of the practice of teaching mathematics, including the teacher's knowledge, beliefs and attitudes (Department of Education 2010). Similar assertion has been claimed by researchers, who suggest that candidate teacher's awareness of PDPs play important role in shaping classroom practice (Mestry et al. 2009). What the foregoing imply is that effective/responsive mathematics teacher and PDPs perspective held by an individual is intricately related (Komba and Nkumbi 2008).

However, despite the overabundance of studies in PDPs much remains to be learnt (Mestry et al. 2009). PDPs among university students, is a prominent problem, and it often goes unreported (Mestry et al. 2009). A number of studies provide detailed account of PDPs including South African literature (Komba and Nkumbi 2008). The most orthodox research in South Africa, in contrast to the objective of the current study, was related to PDPs among in-service teachers (Mestry et al. 2009). In fact, even though, the study was undertaken in the quantitative approach, this in particular excluded in-service teachers undertaking further studies. Perception of university students about PDPs is an important issue which has been significantly underresearched, at least in Africa (Komba and Nkumbi 2008).

Conflicting results from empirical studies that have examined perception/attitude about PDPs have shown weak correlation between the two university student's perception and PDPs (Komba and Nkumbi 2008). Even, those studies which have tried-showed that perception about PDPs has no significant influence on perception of candidate teachers' particularly in-service teachers (Department of Education 2010). Hence, in-service teachers' perception about PDPs may not necessarily affect a discipline such as mathematics. Furthermore, researchers have included a wide variety of practices in their studies and have used different PDPs; making comparison across studies in specific practices difficult (Department of Education 2010). Thus far, review of literature suggests that explicit attempt is not made to link PDPs with the perception of teachers in university, which the present study does - at least in Africa and particularly South Africa.

The current study focuses specifically on candidate (university) teachers (B.Ed and PGCE). While, the B.Ed programme is four year training for candidate teachers, a typical PGCE course in South Africa mainly focuses on developing teaching skills, and not on the subject intended to teach. For this reason, candidates are expected to have a good understanding of a chosen subject(s) – usually to degree level – before training.

Significance of the Study

With reference to the contestations cited in the background of the study, the current study makes two key contributions. Firstly, it is an attempt to develop a link between university student's perceptions about PDPs that is (are) needed after university training. Secondly, few if any empirical data exist on the issue of candidate teachers perception about PDPs in Africa and particularly South Africa, and hence the study would provide further data which is (are) comparable with existing data of different views. Following the research context as well as these key contributions the following research questions emerged.

Research Questions

- What factors influence mathematics candidate teachers' perception about PDP?
- What is the attitude (perception) of mathematics candidate teachers' towards PDPs?
- To what extent is mathematics candidate teachers' perception associated with PDPs?
- What is the factor structure of mathematics candidate teachers' perception about PDP?

METHODS

Due to the focus of the study, three criteria were needed to be specified in order to determine the appropriate sample size, thus; the level of precision, the level of confidence or risk, and the degree of variability in the attributes being measured.

Sample and Sample Size

Recall that the aim of the current study was to examine the association between mathematics candidate teachers' perception of PDP. In view of the aim of the study as well as the research questions, 182 cohorts of candidate teachers pursuing mathematics in either B.Ed programme or PGCE was sampled (*see Background for details of Programme Structure*). Although, statistical tables could have provided useful guidelines for determining sample size, considering three different factors thus; (1) levels of precision (2) confidence level and (3) variability, the approach in the current study in determining sample size was the application of one of several formulas (Tabachnick and Fidell 2001; Yamane 1967). For populations that are large, Yamane (1967) developed Equation 1 to yield a representative sample for proportion;

$$n_0 = N/ 1 + N (e^2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Which is valid where n_0 is the sample size, e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population. In the current study, number of assumptions were considered, accordingly (1) there was a large population (N=334) but that (2) did not know the variability in the proportion that would adopt the practice of PDPs; thus for the two assumptions, p= 0.5 (maximum variability) *(*Yamane 1969: 886). Furthermore, the study desired a 95% confidence level and ±5% precision, where N was population size = 334 students teachers. The resulting sample size is demonstrated in Equation 2:

$$n_0 = \{N/ 1 + N (e)^2\} = \{334/1 + 334(0.05)^2\} = 182 \ldots\ldots (2)$$

Instrumentation involved a simple random sampling using a questionnaire (closed-ended). A self-administered questionnaire yielded a Cronbach's alpha of 0.87; suggesting a high reliability. Due to the research questions, two types of data analyses were employed thus; (1) partial correlation and analysis of variance (ANOVA) and (2) factor analysis.

The analysis was conducted to explore the relationship between two variables, while statistically controlling for (getting rid of) the effect of another variable that might be influencing the relationship. With respect to the current study**,** partial correlation was carried out to explore the correlation effect after controlling for respondents tendency to present themselves in a positive light (perceive) on PDPs. Further analysis using ANOVA was employed to conduct statistical significance. Due to the purpose of question four (see research question 4), factor analysis attempted to identify a set of factors that represented the underlying relationships among a group of related variables**.** In this case, factor analysis was used to explore question 4- what is the factor structure of the mathematics candidate teachers' perception about PDP? In light of using factor analysis, it was important to follow/ satisfy three assumptions.

Firstly and ideally, sample size should be equal or greater than 150 and there should be a ratio of at least five cases for each of the variables, in this case, the sample was 182- satisfied (Yamane 1967). Secondly, factorability of the correlation matrix was the next important item. To be considered suitable for the factor analysis, the correlation matrix showed at least a correlation of r = 0.3 (noting that others were above 0.3- also satisfied (Tabachnick and Fidell 2001). The Bartler's test of spericity was statistically significant at $p< 0.05$, and thirdly, Kaiser-Meyer-Olkin (KMO) value was 0.6- fully satisfied. However, it was certainly not practical to check scatterplots of all variables with all other variables. Research suggests a 'spot check' of some combination of variables (Tabachnick and Fidell 2001) which was inevitably satisfied.

RESULTS OF THE STUDY

The results of the study were analysed and interpreted based on the four (4) research questions. In the meantime, the sampled participants, thus demographics are as discussed. Table 1 shows the sampled demographics. The table revealed that males (24.6%; 45 out of 182) were less than female respondents (74.3%; 136 out of 182). Of the 182 respondents, the least response year group was the B.Ed 4 (11.5%; 21 out of 182), while the most respondents was B.Ed 1 (38.8%; 71 out of 182). The respondents also comprised those from the B.Ed 2 (n = 31, 16.9%), B.Ed 3 (n = 29, 15.8%) and PGCE (n = 30, 16.4%) students (see Table 1). Majority (n = 46, 25.1%) of the respondents are between ages 20 – 22 years. A total of 11 (6.0%) respondents are aged 28 - 30. Others (28, 15.3%) included ages between 23 – 25 years.

Table 1: Demographics of sampled participant

	Frequency	*Percent (%)*
Gender		
Male	45	24.6
Female	136	74.3
Year Group		
B.Ed 1	71	38.8
B.Ed 2	71	16.9
B.Ed 3	29	15.8
B.Ed 4	21	11.5
PGCE	30	16.4
Age		
17-19	41	22.4
20-22	46	25.1
23-25	28	15.3
26-27	19	10.4
28-30	11	6.0
31 or more1	37	20.2

Summary of sample Percentages are valid percentages (n = 182); one non response = 183.

Research Question 1: What factors influence mathematics candidate teachers' (respondents) perception about PDPs? Respondents were asked to rank in order of preference, reasons that would engineer them to undertake PDPs. Results indicated that most respondents reasons for PDPs was because they wanted support from mathematics administrators (N = 181). Others such as significant period of time allocated for such programmes (N = 181) as well as a focus on issues or concerns identified by mathematics teachers themselves motivated the respondents (N = 179) (see Table 2). But, the respondents were least likely to undertake PDPs because of integrate opportunities for mathematics teachers to reflect, discuss and provide feedback (N = 180).

Table 2: Reasons for undertaking PDPs

Descriptive statistics	*N*	*Mean rank*
Focus on issues or concerns identified by mathematics teachers themselves.	179	18
Be as close as possible to mathematics teacher's classroom environment.	179	17
Be extended over a significant period of time.	181	24
Be only supported by mathematics administrators (for example, Department of Education).	181	64
Integrate opportunities for mathematics teachers to reflect, discuss and provide feedback.	180	06
Give mathematics teachers a genuine sense of ownership of the activities and desired outcomes.	180	10
Expect a conscious commitment on the part of each participating mathematics teacher.	181	09
Involve a group of mathematics teachers from a school rather than an individual teacher.	180	12
Involve a mathematics education consultant or "critical friend" in the development of workshop activities.	180	17

Research Questions 2 and 3: What is the attitude of respondents towards PDPs? Using 'focus on issues or concerns identified by mathematics teachers themselves' to measure respondents perception towards PDP, the results are as shown in Tables 3 to 6. The results (see Table 3) indicated that respondents in B.Ed 1 were more likely to have a positive attitude towards PDP, whereas there was little difference between the scores for PGCE and B.Ed 2. Quite notably though was B.Ed 3 and B.Ed 4.

Table 3: Candidate teachers' attitude towards PDP

		Focus on issues or concerns identified by mathematics teachers themselves	
		Yes	*No*
Year Group	B.Ed 1	66	4
	B.Ed 2	31	0
	B.Ed 3	26	2
	B.Ed 4	18	3
	PGCE	28	1
Total		169	10

Meanwhile, analysis of variance showed a significant difference F (4, 177) = 0.518, p< .005 between year of education and attitude towards PDPs (see Table 4).

Table 4: Year of education and attitude towards PDPs

	Sum of square	*df*	*Mean square*	*F*	*Sig.*
Between Groups	.318	4	.080	.518	.000
Within Groups	26.564	173	.154		
Total	26.882	177			

The distribution (see Table 5) of scores shows some interesting variations for view of PDPs by phase of education. For example, while scores for the Foundation Phase (GR-G3) dominated (N = 7; 38.8%), University Mathematics (N = 4; 2.2%) was least likely. The position of high numbers at the extremes is an indication of the strength of feeling towards Foundation Phase education. By contrast, the distribution for University Mathematics indicates a fairly less attitude.

Table 5: View of university students' perception about PDPs by phase of education

Phases		*Frequency*	*Percent (%)*
Valid	Foundation Phase	71	38.8
	Intermediate Phase	49	26.8
	Senior Phase	24	13.1
	FET (G10-12)	10	5.5
	University Mathematics	4	2.2
	All of the above	22	12.0
	None of the above	2	1.1
	Total	182	99.5
Missing	System	1	.5
Total		183	100.0

The scores as shown in Table 6 indicated that males (37) were less likely to have a positive attitude towards PDPs than their female counterparts (108). There are some correlations between age and perception of undertaking PDPs.

Table 6: Overall view of PDPs by gender

		Yes	*No*
Gender	Male	37	8
	female	108	25

There was a positive correlation between age (31 or >) and undertaking PDPs because of focus on issues or concerns identified by mathematics teachers themselves (CIMTT) {Pearson's r (182) = +.14, p <.001} indicating that older teachers were more likely to undertake PDPs due to CIMTT. There was a positive correlation {Pearson's r (182) = +.13, p <.001} which shows that younger teachers (17-19) were likely to choose PDPs because they wanted to be close as possible to classroom environment. A smaller positive correlation {Pearson's r (182) = +.01, p <.001} indicated that younger teachers were again likely to choose PDPs because they expect a conscious commitment on the part of each participating mathematics teacher. Older candidate teachers (31 or more) were as well likely to undertake PDPs because of involving a group of mathematics teachers from a school rather than an individual teacher {Pearson's r (182) = +.16, p <.001}.

Partial correlation was used to explore the relation between race and PDPs, while controlling for gender. A preliminary analysis was performed to ensure no violation of assumptions of normality, linearity and homoscedasticity. Compared to White students {Pearson's r (182) = +.21, p <.0005}, there was a stronger and positive relationship {Pearson's r (182) = +.63, p <.0005} with Black students with high levels of perceived control of PDPs being associated with higher levels of involving a group of mathematics teachers from a school rather than an individual teacher. An inspection of zero order correlation (r = + .87) suggested that controlling for focus on issues or concerns identified by mathematics teachers themselves responses had higher effect on the strength of the relationship between these two variables.

Research Question 4: The 20 items used to measure PDPs was subjected to principal components analysis (PCA) using Statistical Package for Social Sciences. Prior to performing PCA, the suitability of the data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of r = +0.3 and above. The KMO value was 0.87, exceeding the recommended value of 0.6 and Barlett's Test of Spericity reached statistical significance, supporting the factorability of the correlation matrix. PAC revealed the presence of four components with Eigen-values exceeding 1, explaining 31.2 per cent, 17 percent, 6.1 per cent

and 5.8 per cent of the variance respectively. An inspection of the scree plot revealed a clear break after the second component.

Using Catell's scree test, it was decided to retain three components for further investigation. This was further supported by the results of Parallel Analysis, which showed only two components with Eigen-values exceeding the corresponding criterion values for a randomly generated data matrix of the same size. To aid in the interpretation of these three components, varimax rotation was performed. The rotated solution revealed the presence of simple structure, with the components showing a number of strong loadings and variables substantially on only one component. The two component solution explained a total of 50.4 percent of the variance, with Component 1 contributing 23.13 percent and Component 2 contributing 27.30 per cent. The results of factor analysis suggest three (3) factors/structures for the emerged measure of PDPs thus: (1) support from mathematics administrator(s) (2) period of time of PDPs and (3) concerns identified by mathematics. The results of the analysis support the use of the items as separate scales for respondents' perception on PDPs. What this implies is that the results indicated significant inter-correlations among the variables (especially the three measures of PDPs).

DISCUSSION OF FINDINGS

The results revealed several interesting issues. Noting that investigations based on the research questions included; (1) factors influencing mathematics candidate teachers perception about PDPs (2) attitude of mathematics candidate teachers' towards PDPs (3) extent of mathematics candidate teachers' perception associated with PDPs and lastly (4) factor structure of mathematics candidate teachers' perception. In summary, the study showed that factors that influence respondents' perception about PDPs included support from mathematics administrators. Others such as period of time allocated for such programmes as well as a focus on concerns identified by mathematics teachers themselves motivated the respondents.

However, the respondents were least likely to undertake PDPs because of integrate opportunities for mathematics teachers to reflect, discuss and provide feedback. In light of results for discussion, this study suggests that extent of respondents' perception was positively and significantly associated with PDPs. The results (see Table 3) indicated that candidate teachers in B.Ed 1 were more likely to have a positive attitude towards PDPs whereas there was little difference between the scores for PGCE and B.Ed 2. The study noted by using both correlation and ANOVA to show that there are significant difference in the response between phase of education and PDPs. Furthermore, there was significant relationship between year of education and PDPs. Additionally; B.Ed 1 students were more likely to rank PDPs than their counterparts (other year groups). There was correlation between age and perception of undertaking PDPs. The correlation between age and PDPs was because of focus on issues or concerns identified by mathematics teachers themselves, indicating that older teachers were more likely to undertake PDPs. There was a correlation which showed that younger teachers (17-19) were more likely to choose PDPs because of their personal interests and a smaller correlation indicating that younger teachers were also likely to choose PDPs because of expecting a conscious commitment on the part of each participating mathematics teacher. Older candidate teachers (31 or more) were also likely to undertake PDPs, because of involving a group of mathematics teachers from a school rather than an individual teacher. From measures of the variables via partial correlation together with factor analysis, the results indicated that there was a strong, positive effect of professional development on candidate teachers and particularly those concerned with indicators of B.Ed 1.

In fact, there existed a positive relationship of attitude between influencing factors and year group as illustrated (see Fig. 1).

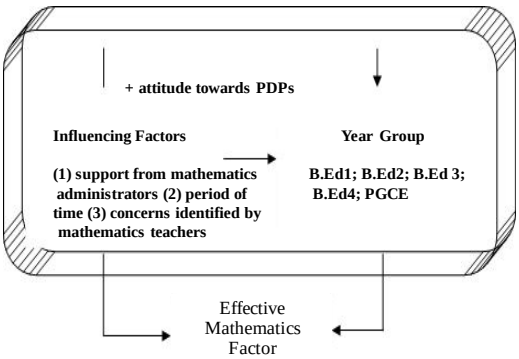

Fig. 1. Attitude of mathematics candidate teachers towards PD

Based on the findings, the summary illustrated in Figure 1, as well as previous studies (see Background), the current study argues that PDPs of candidate teachers determines to a great degree the future of mathematics teachers. This contrasted sharply with earlier study (see Background). Therefore, the key point to improve in educational system is to reform candidate mathematics teacher's education. In light of the findings, the current study argues that the quality of teachers training depends on three factors (1) support from mathematics administrators (2) period of time and (3) concerns identified by mathematics teachers as depicted in Figure 1. The figure suggests that the quality of a teacher depends on the quality of professional development, thus becoming an effective or responsive mathematics teacher continuously after university education. Without well trained, qualified and committed teachers considering the three listed factors, it may be impossible to deliver effective educational systems.

The argument in the current study resonates with previous study, which asserts that to meet the challenges of globalisation, teachers are required to gain the necessary skills and knowledge of support of mathematics (Komba and Nkumbi 2008). However, the current study contrasts with the work of other research (Ernest 2007), but consistent with the notion that mathematics candidate teachers professional development is a tool by which policy makers could use to convey broad visions, disseminate critical information, and provide guidance (Department of Education 2010). This resonates with the fact that instructions provided to teachers during PDPs promote their development in certain areas (for example, use of technology to teach mathematics, subject mastery) (Ngala and Odebero 2010).

CONCLUSION

While, past research considered professional development as the process of improving skills and competencies needed to produce educational results, the current study adds that professional development is a program of activities planned and carried out to promote the personal and professional growth of teachers. Additionally, the study emphasises that mathematics candidate teachers should be aware of the importance of developing themselves strategically in order to achieve their personal goals, school mission and be able to formulate their own professional development plan.

RECOMMENDATIONS

One ramification of the findings is that mathematics teachers may be asked to teach in some fields for which they are ill prepared and receive little support and are not evaluated based on proper criteria to improve their teaching, in this case, PDPs come in handy. In fact, not only novice teachers require guidance in these areas, but there are also veteran teachers whose knowledge of teaching methods should be updated. Thus, professional development programs for teachers should be more than a range of training workshops, meetings, and in-service days. Consequently, development of required professional key qualifications could be supported and enhanced so that mathematics candidate teachers training utilise and enhance the development of authentic learning environments.

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