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TECHNOLOGICAL SKILLS A CHALLENGE IN PRESENTING MATHEMATICS TO MODERN LEARNERS: AN EMPIRICAL STUDY OF FORMER CISKEI AND TRANSKEI IN THE EASTERN CAPE

Agyei Fosu

Department of Pure and Applied Mathematics
Faculty of Science, Engineering and Technology
Walter Sisulu University
Private Bag XI, Mthatha 5117
Eastern Cape, South Africa

Abstract

In order to popularize mathematics, which is a critical subject for the success of 21st century technology-based economies, we need teachers/educators that are always sharpening their skills and tapping into modern students' affinity for all things technological. In this study, we present empirical evidence to back how the lack of technological skills among mathematics teachers in the former Ciskei and Transkei homelands of the Eastern Cape (EC) is somehow hindering them from effectively tapping into the above-mentioned affinity, so that the teachers' lack of technological expertise is preventing an effective presentation that could arouse the interest of today's students in this important subject. This quantitative investigation was conducted in 120 high schools in former Ciskei and Transkei homelands in the Eastern Cape Province, considered

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economically the poorest and one of the underperforming provinces when it comes to national matriculation results. Purposeful sampling was employed to select a sample of 120 respondent high school mathematics teachers. Data were collected through questionnaires. It was found that the technological skills and competences of the educators in using technology as a medium to present this critical subject were far from satisfactory. The study highlights the need for the EC Department of Education to prioritize technological skill and technological competence development training by providing mathematics educators in the region with the tools that are necessary for them to teach the subject with success by effectively tapping into students' affinity for technology.

This study has highlighted and presented data to back how the lack of technological skills among high school mathematics teachers in an underdeveloped region in South Africa has resulted in a low rate of incorporating technology into their classroom teaching. This lack of skill among the teachers is thus poorly delivering what students need to learn in order for them to prepare to participate in the current technology-based economy.

Introduction

Researchers such as Gardner [11], Wagner [29] and others have expressed a great concern with the approaches or methodologies used by our schools, largely the product of the 19th century industrial society. Classroom teaching must equip students with digital age literacy for the 21st century.

Due to the rapid development and expansion of information and communication technologies, new forms of learners/students are emerging (whom I term modern day students/learners). Most students (including rural students) have access to smart phones and laptops, and they come to class knowing how to use the latest technology (or example, using their smart phones or laptops to retrieve information from the internet (ASTD 2008)).

Unfortunately, most current schools still use the 19th century system of teaching mathematics by writing on chalkboards. This method does not always bring out the beauty and the vast application of the subject. The

troubling aspect for these researchers is that most of our current teachers, being products of such schools, are themselves not well equipped with the skills necessary for the 21st century. This has been confirmed in the studies of Stuart and Tatto [24], Tatto [25] which highlighted the lack of emphasis on information technology and computer training in most teacher education programs.

Because of this antiquated approach to teaching mathematics, most of today's students, would have like to see technology in all things, are going to be discouraged from developing any interest in the subject. Instead, they will consider it as boring and abstract, thus developing a negative attitude toward the subject. This point that modern students like to see technology in all their learning has been highlighted by many researches (Chen and Chen [4], Fulton [9], Zhi-Ting [32]). For instance, Zhi-Ting [32] mentioned that the use of technologies in the 21st century digital age to facilitate learning and engage learners has become a universal phenomenon. These challenges, if left unaddressed, will have far-reaching consequences not only for the country's education system but also for the type of skilled learners that will be produced and for the economic growth of the country. This is because lack of numerical competences (Jenkins [13]) has a negative effect on employment and economic development in this century. In the 21st century economies, companies, one of the key engines for economic growth, depend on technology to present, record and analyze data to increase productivity and to analyze markets. With competition among emerging economies to attract investors to establish these much needed companies in their countries, one of the resources which will put any country in an advantageous position will be availabilities of the required skilled workers (Burkhardt et al. [3]). Similarly, the recent calls from the South Africa department of education to find ways to attract students into the field of mathematics (Department of Basic Education 2012) have stressed the need for educators to become more creative in teaching this important and critical subject which is needed for the success of 21st century technology-based economies.

To be able to equip modern students with these skills and also to attract them into the field of mathematics, there must be a supply of educators that

are constantly sharpening their own technological competence. Such are the teachers who will be able to build creative and meaningful content that will appeal to modern students by tapping into the students' affinity for technology. When used correctly, technology can help to create and present information to students in innovative and engaging ways. For instance, calculators, standard software programs and the internet can be used effectively to enhance instruction in a number of ways. These include allowing students to perform complex calculations more quickly, organizing data efficiently for tables and graphs, and presenting processes and findings more clearly (Willard [31], Hopkins [12]).

As a result of educators fulfilling the seventh role described by Killen ([14], p. 367), they need to tap into the modern students' affinity for technology. Also, because of the rapid evolution of technology, the technological competence and skills of educators must be regularly updated and supplemented by additional training.

Several studies in mathematics (Fricke et al. [8], Roux [15], Themane et al. [26], Machaba [16], Badugela [2]) have been conducted in South Africa. But the focus has always been concentrated on curriculum implementation and classroom variables such as teaching resources and textbooks that could influence performance. The focus has never been on equipping educators with skills that would prevent them from presenting lessons which could impact negatively on successful learning.

In light of the above, it is necessary that this type of research be carried out to check the technological competence and skills among mathematics teachers in the teaching of this critical subject.

The primary objective of this study is to provide a better understanding of how the lack of technological skills poses a formidable challenge confronting mathematics educators as they seek to present their critical subject to modern learners.

Background

Under South Africa's policy of apartheid, land was set aside for black

people in self governing territories. Ciskei and Transkei was designated as two homelands for Xhosa-speaking people. Some of the major towns that were in the two homelands are Whittlesea, Alice, Balfour, Peddie, Dimbaza, KingWilliam'sTown, Zwelitsha, Mdantsane and Middledrift (for Ciskei); and Butterworth, Mthatha, Cofimvaba, Bisho, Engcobo, Libode, Lusikisiki, Maluti and Dutywa (for Transkei). The two regions are underdeveloped in infrastructure and are characterized by high levels of unemployment, poverty and crime which impact negatively on the economy. Different types of schools, such as village, farm, township and town schools, exist in the regions, with a large number of village schools in the former Transkei being over-populated with learners who belong to single headed households or have no parents (Thobeka [27]). Quality education is therefore seen to be important to the economic development of the two regions because of the positive contribution it could make to address unemployment, alleviate poverty and facilitate growth.

As noted by Nussbaum ([22], p. 152), education converts people's existing capacities by developing internal capabilities of many kinds. This formation, in addition to being valuable in itself and a source of lifelong satisfaction, is pivotal to the development and exercise of many other human capabilities (Unterhalter [28, p. 186], Meyer [18]). This formation thus serves as a basic necessity of the highest importance in addressing disadvantage and society's functioning in a way that central to dignity, equality, and opportunity.

Problem statement

For teachers to fulfill their roles effectively, they must not only have the required knowledge and qualification. It is also essential that teachers must have the skills to make lesson contents meaningful to students. As highlighted by Ertmer [6], embracing and using knowledge in teaching and learning by teachers will happen only if it is consistent with their existing pedagogical beliefs. But many of our teachers earned their degrees at a time when technology in education was at a very different stage of development

than it is today (Stuart and Tatto [24], Tatto [25]). A study to determine technological skills as a challenge facing mathematics educators of the former Ciskei and Transkei in the Eastern Cape province of South Africa to present mathematics to modern day students is conducted. The results of the study could have significant implications towards delivering quality education in the Eastern Cape province of South Africa. Quality education is a tool for improving the standards of living in a society and the stability of a country.

Questionnaire to assess the technological skills of the teachers

Welman and Kruger [30] are of the view that the nature of information or evidence required would determine the choice of the qualitative or quantitative research technique. The purpose of this study is to investigate the technological skills of mathematics teachers in former Ciskei and Transkei Homelands in presenting mathematics to today's students.

Quantitative technique was deemed appropriate for this study and the following questions guided the design of the questionnaire:

• Their gender.

• The year they obtain their teaching qualification.

• How long they have been teaching mathematics in grade 10, 11, 12.

• If they have a personal Laptop, tablets or a mobile phone with Google android, internet access and if their students also have this type of mobile phone with internet access as well.

• Since they started teaching, whether they have received any training in technological skills, like internet usage, Microsoft Word, Excel, PowerPoint, Geogebra, and how to incorporate them into everyday lessons from the department of education or if they have taught themselves.

• Since they started teaching, if they have ever searched on the internet for demonstrations on some mathematics topics and then either shown it to their students or done the demonstrations with their students in class using

their personal Laptop, Tablet or cell phone; and, if so, how their students felt about the experience.

• Since they started teaching, if they have ever referred their students to search on Internet for a mathematical problem or solution.

• If they know about Geogebra and have ever asked their students to use it to plot a graph.

About the survey and the participants

It should be noted that the study is primarily aimed at eliciting the technological skills possessed by mathematics teachers in a rural area to present mathematics to modern students who have an affinity for technology and access to technology-smart phones.

Participants were selected due to their teaching post location, targeting specifically those teaching in the towns in the former Ciskei and Transkei Homelands which were chosen for the study.

Research Methodology

Quantitative research was deemed appropriate for this study. Purposeful sampling was employed to select a sample of 120 high schools from the database of EC Department of Education of high schools in former Ciskei and Transkei homelands. The use of such sample technique depends on the subjective judgment of the researcher to only approach those people who, in his or her opinion, are likely to have the required information and be willing to share it (Welman and Kruger [30]). A questionnaire was developed and sent to ask the mathematics teachers, specifically those teaching grade 10-12 in the chosen schools, about their skills in some basic computer end-user programs, as well as mathematics programs like Geogebra, and how frequently they use these programs to engage students. In the letter that was attached to the questionnaires, respondents were assured of the confidentiality of their responses by highlighting to them that their names or the names of the schools would not be mentioned (this increasing the

likelihood that reliable information would be provided by the respondents). A total of 114 questionnaires were eventually returned, but only 109 of these were deemed usable because only those had answered all the questions. Descriptive statistics were used in the study.

Discussion and Findings

With the implementation of the National Curriculum statement in 2003, South Africa joined the global initiative that both developed and developing countries have been engaging in to revise curriculum to take into account the knowledge and skills needed in a globalizing 21st century economies (Gadebe [10]). In addition, this implementation moved us from an emphasis on learning content to specific outcomes and from the memorizations of facts to the demonstration of outcomes. This places a great responsibility on teachers to improve or develop their skills of presenting lessons which will make content and applications more meaningful to students.

In defining the seven roles of teachers, Killen ([14], pp. 366-367) stated clearly in the 1st, 2nd and 7th roles that the teacher should be well grounded in the knowledge, skills, know about the different approaches to teaching and learning and how these may be used in ways which are appropriate to the learner and context. For modern learners, one of the approaches to teaching and engaging them in a learning environment is the incorporation of technology in daily lessons. This can be done either by using it as a teaching aid in the classroom or by giving assignments which require them to search for information on the internet for instance (and, by so doing, possibly encountering some demonstrations, applications on the topic, etc.). This suggests that an adequate provision of continuous professional training to teachers to sharpen their skills and appropriate technological competence is of paramount importance if the development of capacities for poverty reduction in modern learners' is to be achieved. This argument is supported by Mallows and McNeill ([17], p. 5), who assert that, in order for teachers to address needs more effectively, they need to upgrade their skills and subject knowledge.

As it is evident that educators are a crucial resource to quality education, it is therefore important for management within the department of education to identify gaps that exist in between educators' actual skills and educators' required skills. Thereafter, continuous professional training can be used as a tool to focus on these gaps to enhance not only future performance, but also stimulate development of these educators. Flippo [7] defined the word "training" as "an act that involves growing the knowledge and skill level of an employee in order to perform a specific job". Teaching is a complex practice that requires an interweaving of many kinds of specialized knowledge, therefore requiring teachers to apply complex knowledge structures across different cases and contexts (Mishra et al. [19], Spiro and Jehng [23]).

Faced with this difficulty, a major question arises: how can teachers integrate technology into teaching? Mishra and Koehler in [20] explained that at the core of good teaching with technology are three core components: Content Knowledge (CK), Pedagogy Knowledge (PK), and Technological Knowledge (TK), as well as the relationships that exist among them (for more information about this and the relationship between them (see Mishra and Koehler [20, 21]). Mishra and Koehler further defined for us the core components of PK as the teachers' deep knowledge about the processes and the methods of teaching and learning, whereas CK is the teachers' knowledge about the subject matter being learned or taught. They explained TK as the teachers' technological knowledge to apply productively (which is always in a state of flux because of ever-changing technology). By correctly relating these three core components as suggested by Mishra and Koehler, one is led to their successful integration.

The results of the current study provided some interesting information regarding the teacher's technological skills and training received from the department.

Table 1A. Gender of the participants

Gender	Number of teachers	Percentage
Male	96	88.07
Female	13	11.93

Table 1B. Year in which participants obtained their teaching qualifications

Year	Number of teachers	Percentage
1973-1989	47	43.12
1990-2006	38	34.86
2007-2015	24	22.02

Table 1C. Experience (N = 109)

Years	Number of Teachers Teaching Grade 10	Percentage	Number of Teachers Teaching Grade 11	Percentage	Number of Teachers Grade 12	Percentage
1-5	29	26.61	40	36.70	40	36.70
6-10	43	39.45	34	31.19	46	42.20
11 and above	37	33.94	35	32.11	23	21.10

Table 2A. Technological skills and training received from the department (N = 109)

Training in	No. training	%	Self taught	%	Training from department	%
Microsoft Word 2007	38	34.86	59	54.13	12	11.01
Microsoft Word 2010	50	45.87	57	52.29	2	1.83
Microsoft Excel 2007	103	94.50	3	2.75	3	2.75
Microsoft Excel 2010	107	98.17	2	1.83	-	-
Powerpoint	100	91.74	9	8.26	-	-
Internet	57	52.29	43	39.45	9	8.26
Geogebra	109	100	-	-	-	-

Table 2B. Teachers having Laptops, Tablets and Cell phone with internet access

	Yes	%	No	%
Laptops	21	19.27	88	80.73
Tablets	13	11.93	96	88.07
Cell phone with internet and believe students also have	107	98.17	2	1.83

Table 3. Usage of technology to engage students

	Yes	%	No	%
Ask students to use Geogebra to plot graph	-	-	109	100
Search demonstration and shown to students	-	-	109	100
Ask students to check Internet for problem or solution	3	2.75	106	97.25

Without a doubt, the results validate what these authors (Flippo [7], Mallows and McNeill [17]) said: when one has acquired the right qualification or trained in a subject, the developed competencies allow the individual to make sense of, and hence have the confidence to participate in, the teaching of the subject. On the other hand, teachers who do have a proper skill in technology will have only limited ability to communicate and deal with students in that respect.

The challenge highlighted in Table 2A- The percentages of no training (34.86%, 45.87%, 94.50%, 98.17%, 91.74%, 52.29% and 100%) is the lack of technological skills training among the teachers, which one justifiably can say has resulted in not or under utilizing technology (as seen in Table 3) in their daily teaching, thus hindering their ability to effectively tap into and use today's students affinity for all things technological. A classical example is the lack of basic skills of the majority of the teachers in Geogebra, a math software used for plotting graphs which can be downloaded and run on any phone with Google's android. Most of the teachers and students have mobile phones (as confirmed by the teachers from Table 2B) with this application, so it is not a problem if schools do not have computer labs with internet access. However, none of the teachers who responded knows anything about Geogebra. In particular, none of the respondents has ever used this

application to demonstrate how to plot a graph, and none has ever asked students to use this program to plot a graph.

Conclusion and Recommendations

An especially sad aspect of the challenge identified from Tables 2A and 3 arises because most of these students from high school will either enter university to further their education or enter the job market to look for work. These two fields require readiness of the matriculants to utilize technology to interact with the world around them. How can our teachers be tasked with the responsibility of preparing and equipping students with these skills when they themselves are not well equipped?

These problems need to be addressed by encouraging Eastern Cape Department of Education to provide teachers with additional training in information technology and expertise in being a computer end-user, as well as providing teachers with internet access and encouraging them to the use technology when engaging students.

More research work needs to be done to check the attitude of the high school mathematics teachers towards the integration of technology into the traditional way of teaching mathematics in high schools.

Limitations of the Study

The study only focused on mathematics teachers of the former Ciskei and Transkei homelands in the Eastern Cape, thus making it a regional-specific study. Mathematics teachers from other former homelands of South Africa, which were outside the targeted geographical area, were excluded due to time and financial constraints.

As a result of the former apartheid reign, the level of development within all the nine provinces existing in South Africa are similar in the sense that the previously considered to be “White areas” are well developed compared to the “Black locations”, poorest and underdeveloped, as characterized by high levels of unemployment, poverty and crime.

Hence, generally it can be assumed that similar situations exist in other former homelands.

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