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Students Perceptions on the Relevance of High School Mathematics in University Education in South Africa

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***Abstract*—**In this study we investigated the relevance of high school mathematics in university education. The paper particularly focused on whether the concepts taught in high school are enough for engineering courses at diploma level. The study identified particular concepts that are required in engineering courses whether they were adequately covered in high school. A questionnaire was used to investigate whether relevant topics were covered in high school. The respondents were 228 first year students at the Central University of Technology in the Faculty of Engineering and Information Technology. The study indicates that there are some topics such as integration, complex numbers and matrices that are not done at high schools and are required in engineering courses at university. It is further observed that some students did not cover the topics that are in the current syllabus. Female students enter the university less prepared than their male counterparts. More than 30% of the respondents in this study felt that high school mathematics was not useful for them to be able to do engineering courses.

***Keywords*—**High school mathematics, university education, SPSS package, students' perceptions.

I. Introduction

THE motivation for this study is as a result of the poor performance of university students in the area of engineering and mathematical sciences. Most students at university struggle with almost all courses which require mathematical background. Some students fail to complete their courses due to repeated failure of courses that require basic mathematical concepts. Some students have resorted to completely changing their intended degree programmes due to these difficulties. In this study we investigate the relevance of high school mathematics to the university courses. We also expose the gap that exist in the current mathematics syllabus in high schools in South Africa. Some institutions of higher learning have resorted to pre-degree programmes such as the Extended Curriculum Programme (ECP) and science access. These models are used to prepare students for higher learning. We discuss the problems in teaching, learning, mathematics syllabus deficits, assessment design failures and gaps between high school and universities in other countries.

In South Africa mathematics is considered a difficult subject and only a few people do it, there is a perception that being able to do mathematics is more of ability than effort [1]. Leadership in schools play an important role in the teaching of mathematics taught in schools [2]. Initial teacher education has an impact on the teaching of mathematics. The development of teacher training to achieve positive results might take a decade or more [3]. South African teachers are not ready to use computers in schools in the teaching of mathematics [4]. The problem of teaching and learning mathematics in South African high schools need urgent attention as it fails to offer the relevant concepts required for further study. South Africas education system is a national disaster that is essentially dysfunctional [5].

Students do not understand basic mathematical concepts, they use imitative reasoning or recalling facts; there is a tendency by students learning mathematical algorithms which prevents them from understanding the underlying mathematical concepts [6]. Mathematical concepts deficits occur in pupils early stages of learning [7]. Mathematics is taught for long hours and the way how it is presented makes students dislike it [8]. The study of mathematics learning has shown that word problems are shunned by many students yet form the most important aspect of understanding mathematics. Students also fail to relate the application of mathematics to other subjects [9].

Learning difficulties can be brought about by the use of English language as a medium of instruction, use of indigenous language also lack proper terminology and inability to compete internationally [10]. There are serious gaps in mathematical knowledge content in primary school teachers [11]. Learning is also hampered by socio-economic hardships such as poverty, illness, poor living conditions and poor diet [12]. Male students perform mathematics better than female students in Africa, the reason for this remain unknown [13]. School mathematics is too rigorous than what everyday life and workplaces demands [14]. Mathematical activities are not linked to learning concepts [15] Changes in the South African school system created a need for the retraining of teachers [16].

Mathematics learning in high school need to have elective topics to enable students to choose areas which they can tackle and according to their backgrounds [17]. Students assessment method in mathematics do not consider students diverse backgrounds, it does not warn students what they should expect, does not consider gender in cases where boys perform better than girls or vice-versa [18].

Mathematics is a core subject in schools all over the world, the knowledge acquired at lower levels is required in level above it and beyond [19]. Mathematics is compulsory in all primary and secondary schools in Kenya and is used to select students to access university education [20]. In the UK the

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students choosing to do A level mathematics at GCE level have decresed [21]. In North Carolina in the US, there is a High Schools That work (HSTW) programme that addresses the issue of gaps between schools and colleges in mathematics and science [22].

II. Methodology

In this study, a questionnaire was used to 228 respondents, who are first year students in the Faculty of Engineering and Information Technology at the Central University of Technology. The respondents were asked to answer questions about how the mathematics curriculum at high school helped them to be able to do courses in Faculty of engineering at diploma level. The choice of respondents was based on the fact that they were accepted in the Faculty of engineering based on merit and that they were all taking mathematics I as their first mathematics course in the faculty. This was a suitable target group for this study because they were most likely to remember the details of their experience in high school.

The questionnaire consisted of seven questions which covered the following aspects; gender, respondents time at university, respondents department, respondents mathematics type (Mathematics or Mathematical literacy), whether it was respondents choice to do the type of mathematics they did, respondents matric mathematics mark range, whether doing mathematics at high school was useful in their engineering courses and whether certain topics that are necessary in the courses in engineering were covered in high school by the respondents, the following topics were considered; differentiation, Integration, complex numbers, matrices, geometry (particularly circle geometry), indices and logarithms, factorization, addition/subtraction and multiplication of fractions without using calculators, long division and mensuration (areas, volumes, perimeters).

The students performance in their first assessment was also analysed and how they tackled certain problems in this test. The students responses were then compared to their performance in the test. This was done by identifying how students performed certain questions in which they acknowledged that they were covered in high school. A comparison was also performed in those questions that they stated that were not adequately covered in high school.

In this study we used SPSS to analyse the data and make conclusions. The methods used in teaching these methods in schools is not investigated in this paper, it is claimed that students use imitative reasoning [6]. We also believe that early introduction of the use of calculators in addition of fractions, long division and multiplication negatively affects these operations in algebra.

III. Findings

In this section the findings of the study are presented in the form of bar graphs, tables and pie charts. The illustrations are shown below in Figs. 1-14 and Tables I-XIII. The findings show the gender distribution from the study, how long students have repeated their mathematics course, distribution in respondents respective departments, the type of mathematics taken by respondents in high school, whether it was the respondents choice to take the mathematics type they chose, the respondents matric mark distribution and whether their high school mathematics helped them in their studies.

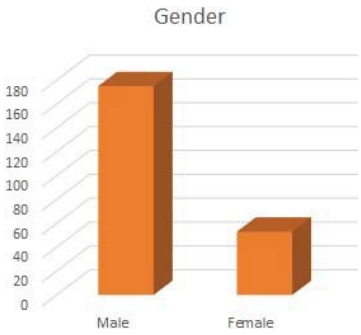

Fig. 1 Respondents gender distribution

TABLE I
Frequency Distribution Table for Respondents Gender

Gender	Male	Female	Total
Frequency	175	53	228
Percentage	76.8	23.2	100

In Fig. 1 and Table I, it is shown that there were a total of 228 respondents of which 76.8% are male and 23.2% are female in the faculty of engineering and information technology who were taking Mathematics I as one of their courses. It is also observed that the engineering faculty attracts more male students than males. It is not known why males perform better in sciences than females.

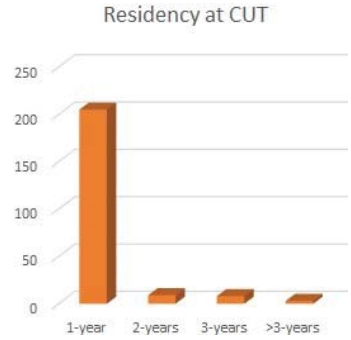

Fig. 2 Respondents residency at CUT

TABLE II
Respondents Frequency Distribution for Residency at CUT

Tme at CUT	1 yr	2 yrs	3 yrs	> 3yrs	Total
Frequency	205	9	8	6	228
Percentage	89.9	3.9	3.5	2.6	100

In Fig. 2 and Table II, the bar charts and the frequency distribution table shows respondents time of residency at the university. 89.9% of the students were in their first year at university and more than 10 students where repeating

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Mathematics I for two or more years. 10% of the students who were doing mathematics I were repeating the course and 2.6% repeating more that two times. This shows that there is a deficit in high school mathematics that is required in engineering mathematics. In this study the number of students who were expedted to pass Mathematics I was not expolred.

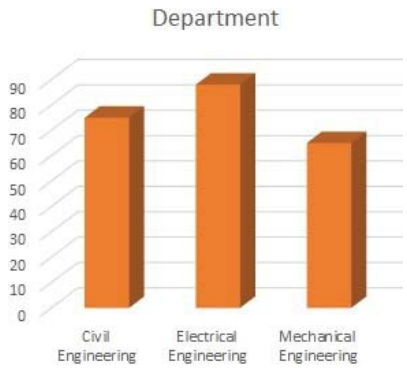

Fig. 3 Respondents department at CUT

TABLE III
RESPONDENTS FREQUENCY DISTRIBUTION FOR DEPARTMENT AT CUT

Department	Civil Eng.	Elect Eng.	Mech Eng.	Total
Frequency	75	88	65	228
Percentage	32.9	38.6	28.5	100

Fig. 3 and Table III show the respondents' departments. The electrical engineering department attracted more students than any other department with 38.6% followed by the civil engineering department with 32.9%. The mechanical engineering department had the least number of students with 28.5%. In this study the respondents were not asked why they chose to study in these departments. This trend can be attributed to the job market demand in South Africa.

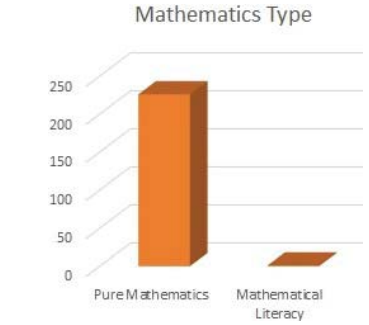

Fig. 4 Respondents choice of mathematics type

TABLE IV
RESPONDENTS FREQUENCY DISTRIBUTION FOR CHOICE OF MATHEMATICS TYPE

Math Type	Math	Math. Lit	Total	Missing	Total
Frequency	226	1	227	1	228
Percentage	99.1	0.4	99.6	0.4	100

Fig. 4 and Table IV show the type of mathematics chosen by the respondents and whether it was their own choice or not. 99.1% did mathematics and not mathematical literacy which is in line with the recruitment criteria. In South Africa these two types of mathematics are offered in high school with most schools preferring to do mathematical literacy. In this study this assertion could not be assertained due to the fact that most studnets who were admitted in engineering had done mathematics only.

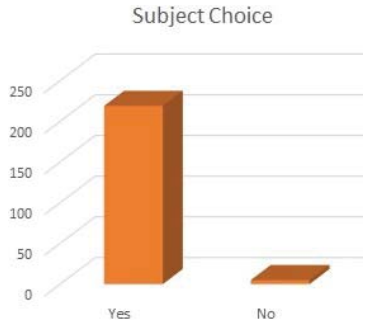

Fig. 5 Respondents response on whether it was their own choice or not

TABLE V
RESPONDENTS FREQUENCY DISTRIBUTION FOR WHETHER IT WAS THEIR CHOICE OR NOT

Subject Choice	No	Yes	Total	Missing	Total
Frequency	5	219	224	4	228
Percentage	2.2	96.1	98.2	0.4	100

Fig. 5 and Table V shows the respondents' response whether it was their own choice to choose this type of mathematics. 96.1% agreed that they chose to do the type of mathematics they did at their own accord. There are reports that some schools in South Africa are imposing the type of mathematics to be done.

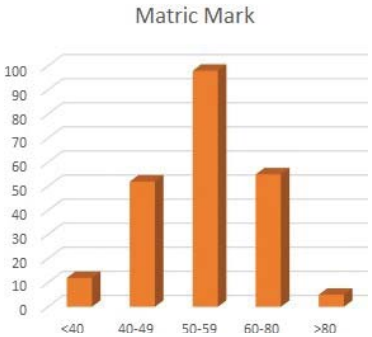

Fig. 6 Respondents high school (matric) mathematics mark

TABLE VI
RESPONDENTS FREQUENCY DISTRIBUTION FOR MATHEMATICS MARK

Matric Mark	<40	40-49	50-59	60-79	>80	Total
Frequency	12	52	98	55	11	228
Percentage	5.3	22.8	43	24.1	4.8	100

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Fig. 6 and Table VI shows the respondents' matric mathematics mark, 28.1% of the students were accepted in these three departments with a mathematics mark of less than 50%. It was also noted that 4.8% of the respondents obtained a mark more than 80% and 5.3% had a mark less than 40%. This trend also explains why some students struggle to pass Mathematics I.

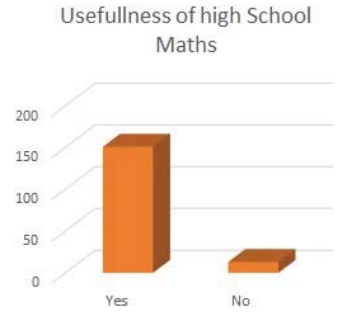

Fig. 7 Respondents opinion on the usefulness of high school mathematics in engineering

TABLE VII
RESPONDENTS FREQUENCY DISTRIBUTION FOR USEFULNESS OF HIGH SCHOOL MATHEMATICS IN ENGINEERING

Math usefulness	No	Yes	To some extent	Total
Frequency	13	151	64	228
Percentage	5.7	66.2	28	100

In Fig. 7 and Table VII, the data shows the repondents' response whether doing this mathematics was useful to them or not. It is also noted that 33.7% of the students indicated that mathematics at high school did not help them in their courses in engineering. This shows that there are some gaps in the mathematics syllabus in high school.

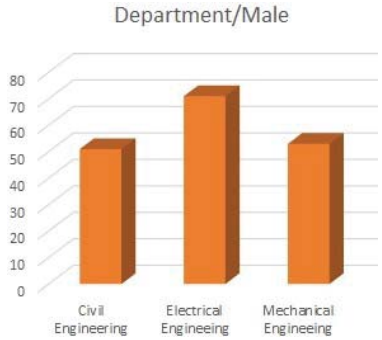

Fig. 8 Male respondents department

TABLE VIII
RESPONDENTS FREQUENCY DISTRIBUTION FOR MALE STUDENTS IN DEPARTMENTS

Department/Male	Civil Eng.	Elect Eng.	Mech Eng.	Total
Frequency	51	71	53	175
Percentage	29.1	40.6	30.3	100

Fig. 8 and Table VIII shows that the electrical engineering department attracts more male students than any other department. Civil and Mechanical departments have almost the same number. All departments in this study attracted many male students as compared to the female students. More than 70% of male students are attracted to both Electrical and Mechanical engineering departments.

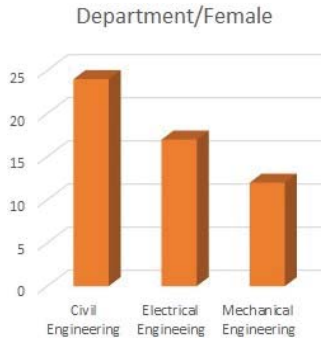

Fig. 9 Female respondents department

TABLE IX
RESPONDENTS FREQUENCY DISTRIBUTION FOR FEMALE STUDENTS IN DEPARTMENTS

Depart./female	Civil Eng.	Elect Eng.	Mech Eng.	Total
Frequency	24	17	12	53
Percentage	45.3	32.1	22.6	100

In Fig. 9 and Table IX shows that the Civil engineering department attracts more female students than any other department. Mechanical has the least female students. There were only 56% of female students who were attracted to the Electrical and Mechanical departments.

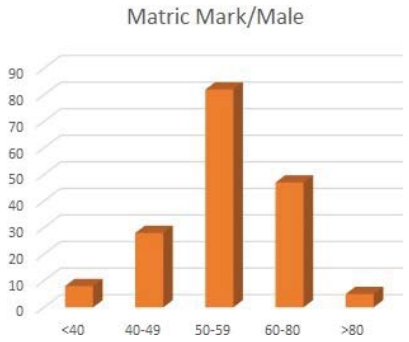

Fig. 10 Male respondents high school (matric) mathematics mark

TABLE X
RESPONDENTS FREQUENCY DISTRIBUTION FOR MALE MATHEMATICS MARK

Matric Mark	<40	40-49	50-59	60-79	>80	Total
Frequency	8	28	82	47	5	170
Percentage	4.6	16	46.9	27.6	2.9	100

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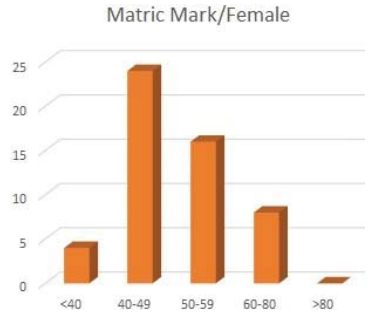

Fig. 11 Female respondents high school (matric) mathematics mark

TABLE XI
RESPONDENTS FREQUENCY DISTRIBUTION FOR FEMALE MATHEMATICS MARK

Matric Mark	<40	40-49	50-59	60-79	Total
Frequency	4	24	16	8	52
Percentage	7.5	45.3	30.2	15.1	100

In Fig. 10 and Table X male respondents performed better in high school mathematics that female respondents as shown in Fig. 11 and Table XI. It is evident that more female students with a mark between 40 and 49 were accepted than their male counterparts. Table X shows that only 20% of male students were accepted with a mathematics mark of less than 50%, while over 50% of females were accepted with a mathematics mark of less than 50%.

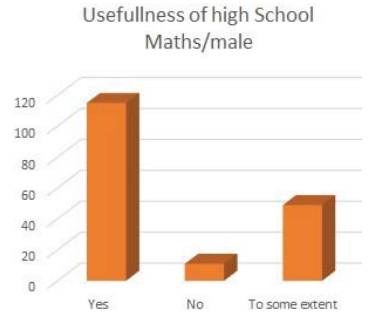

Fig. 12 Male respondents response on the usefulness of high school mathematics in engineering

TABLE XII
MALE RESPONDENTS FREQUENCY DISTRIBUTION FOR USEFULNESS OF HIGH SCHOOL MATHEMATICS

Usefulness	No	Yes	To some extent	Total
Frequency	11	115	49	175
Percentage	6.3	65.7	28	100

TABLE XIII
FEMALE RESPONDENTS FREQUENCY DISTRIBUTION FOR USEFULNESS OF HIGH SCHOOL MATHEMATICS

Usefulness	No	Yes	To some extent	Total
Frequency	2	36	15	53
Percentage	3.8	67.9	28.3	100

In Fig. 12 and Table XII show that most male respondents

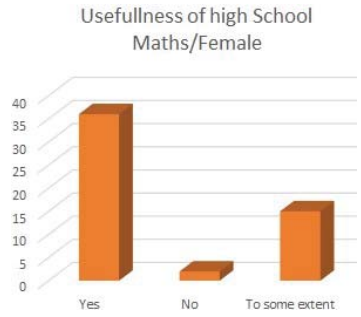

Fig. 13 Female respondents response on the usefulness of high school mathematics in engineering

agreed that high school mathematics was useful in their engineering studies, while more female respondents had the same perception as shown in Fig. 13 and Table XIII. 28% in both male and female respondents agreed that high school mathematics was not that useful in their engineering courses. In this study we observe that a considerable percentage of both male and female respondents agreed that high school mathematics was not very useful for them to be able to do engineering courses.

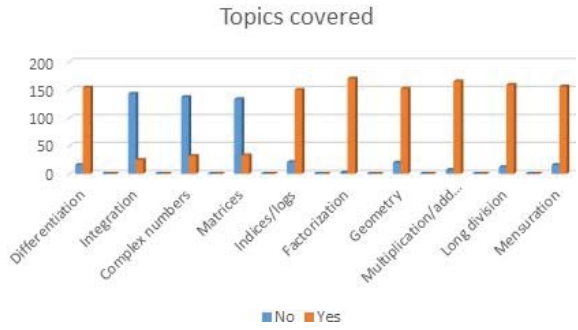

Fig. 14 Respondents mathematics topics covered in high school mathematics

Fig. 14, it is shown that the topics such as integration, complex numbers and matrices were not covered in high school as all other topics. It is still observed that some topics that are supposed to be covered were not covered. Among these topics Geometry, mensuration and long division are among those that were not fully covered.

A. Results and Discussion

In this section we analyse the results that were collected from questionnaires. We focus on the research questions of the relevance of high school mathematics (National school certificate NSC). We address the issues of the respondents choices in the two types of mathematics offered in high school; mathematics and mathematical literacy. We also investigated their performance in mathematics at high school and whether their mathematics syllabus helped them to be able to do courses in engineering at diploma level. In this study we investigated whether the respondents covered certain mathematics topics that are required for them to be able to do engineering courses. There were 228 respondents in this study. The respondents were all the first year students in the Faculty of Engineering and Information Technology (FEIT) who were

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doing Mathematics I. These respondents were accepted in the departments of civil, electrical and mechanical engineering at diploma level. Most of their courses require basic mathematics. The following results were obtained and we display it in the form of frequency distribution tables and bar charts.

From the findings in the previous section there were a total of 228 respondents of which 76.8% were male and 23.2% were female in the faculty of Engineering and Information technology who were taking mathematics I as one of their courses. This faculty attracted more male students than females. This result show that female students are still fewer than their male counterparts in engineering sciences.

The respondents time of residency at the university doing mathematics I and which departments they belonged to was analysed. More than 89% of the respondents were in their first year at university and more than ten students where repeating Mathematics I for two or more years. The electrical engineering department attracted more students than any other engineering department. This shows that most students who get into the engineering faculty like to be electrical engineers. Civil engineering and Mechanical engineering attract far less number of students. The Civil engineering department attracted more female students than any other department in the Faculty. The electrical engineering department attracted more male students than any other department in the Faculty.

The respondents choice of mathematics type (Mathematics and Mathematical literacy) and whether it was their own choice or not to take the type they did. 99.1% did mathematics and not mathematical literacy which is in line with the recruitment criteria. The requirements for accepting students in engineering does not accept mathematical literacy. 96.1% agreed that they chose to do the type of mathematics they did at their own accord. 3.9% of the respondents had no choice but to take the type of mathematics as dictated by their former schools.

The respondents mathematics matric mark range and whether doing this mathematics was useful to them or not was analysed. More than 25% of the respondents were accepted in these three departments with a mathematics mark of less than 50%. More than 30% of both male and female respondents indicated that high school mathematics was not that useful to them. Female students enter the university less prepared than their male counterparts. This is shown by the fact that male respondents had higher matric mathematics marks than female respondents. More than 20% of the male respondents were accepted with a mark of less than 50% and more than 50% of the female respondents were accepted with a matric mark less than 50%. These figures suggest that females are likely to struggle to complete their studies than their male counterparts. This might be viewed as the so called affirmative action, allowing more females in engineering. This might have negative impact on the part of females. This explains why some students struggle to complete mathematics I on time. Those who pass this course by marks close to 50% find themselves failing to pass mathematics II and III. 33.7% of the respondents indicated that mathematics at high school did not help them in their courses in engineering. This points to the fact that the mathematics syllabus in high schools need to be revised. The syllabus need to address prerequisite topics for engineering.

Respondents indicated that the topics such as integration, complex numbers and matrices were not adequately covered in high school. Some respondents indicated that they covered these topics. This indicates the existence of different school syllabus systems. Some respondents indicated that some topics that were supposed to be covered were not, Among these topics geometry, mensuration and long division are among those that were not fully covered. This explains why some students who were accepted at university lack basic mathematical concepts.

IV. Conclusion

There are more male students enrolled into engineering studies than female students. The reason for this imbalance is not known. A considerable number of students repeat Mathematics I due to failure attrbuted to the deficit in high school mathematics. The students' distribution in the departments in engineering is affected by their high school perfomance in mathematics especially across gender. Most students agreed that they chose mathematics instead of mathematical literacy and they did this at their own accord. The students' matric mark affected their acceptence in the engineering faculty. The usefullness of high school mathematics affected their perfomance in the engineering with some of them acknowledging that it was not that useful. It was also observed in the study that most female students were accepted with less that 50% mathematics mark compared to their male counterparts who most of them had more than 50% in their mathematics mark. This means that female students join the university less prepared than their male counterparts. The mathematics school syllabus need to be revised to meet university engineering requirements. The high school mathematics syllabus does not include necessary topics, these iclude integration, complex numbers and matrices. The study also indicated that some topics which are in the syllabus were not fully covered, these include geometry, long division and mensuration. Entry requirements for engineering students need to be revised to improve excellence in this area.

References

[1] Mutodi P, Ngirande H, *The influence of students perceptions on mathematics performance. A case of a selected high school in South Africa*, Mediterranean Journal of Social Sciences, 5, pp431-445, (2014).

[2] Loyiso C., Jita, *Instructional leadership for the improvement of science and mathematics in South Africa*, Procedia Social and Behavioural Sciences, 9, pp851854, (2010).

[3] T. E. Mabila, S. E. Malatje, A. Addo-Bediako, M. M. M. Kazeni, S. S. Mathabatha, *The role of foundation programmes in science education: The UNIFY programme at the University of Limpopo, South Africa*, International Journal of Educational Development, 26, pp 295-304, (2006).

[4] Mofokenga L. S. P, Mjia A, *Teaching mathematics and science using computers: How prepared are South African teachers to do this?* Procedia Social and Behavioural Sciences, 2, pp16101614, (2010).

[5] Letseka M., *The Illusion of Education in South Africa*, Procedia-Social and Behavioral Sciences, 116, pp48644869, (2014).

[6] Bergqvist E, *Types of reasoning required in university exams in mathematics*, Journal of Mathematical Behaviour, 26, pp348370, (2007).

[7] Spaull N, Kotze J, *Starting behind and staying behind in South Africa The case of insurmountable learning deficits in mathematics*, International Journal of Educational Development, 41, pp13-24, (2015).

[8] Simkins C, Spaull N, in: *Mathematics outcomes in South African schools: What are the facts? What should be done?* 2013, The Centre for Development and, Johannesburg, South Africa, ISBN: 978-1-920653-13-2.

[9] Gebremichael A. T, Students perceptions about the relevance of mathematics to other subjects In: *Proceedings of the Frontiers in Mathematics and Science Education Research Conference (FISER14)*, 1-3 May 2014, Famagusta, Cyprus, pp71-78, (2014).

[10] Ismail W. R, Mustafa Z, Muda N, Abidin N. Z, Isa Z, Zakaria A. M, N. R. M. Suradi, N. J. Z. Mamat, R. M. Nazar, Z. M. Ali, N. M. Rafee, N. Majid, S. H. Jaaman, M. Darus, R. R. Ahmad, F. A. Shahabuddin, A. S. Rambely, U. K. S. Din, I. Hashim, H. Ismail, A. G. Ahmad, M. S. Md. Noorani, S. N. M. Ramli, M. I. Azlan, *Students Inclination towards English Language as Medium of Instruction in the Teaching of Science and Mathematics*, Procedia Social and Behavioural Sciences, 18, pp353360, (2011).

[11] H. Venkat, N. Spaull, *What do we know about primary teachers mathematical content knowledge in South Africa? An analysis of SACMEQ 2007*, International Journal of Educational development, 41(2015) pp121-130, (2015).

[12] T. Bush, R. Joubert, E. Kiggundu,J. Van Rooyen, *Managing teaching and learning in South African Schools*, International Journal of Educational Development, 30, pp162168 (2010).

[13] A. Dickersona, S. McIntosha, C. Valenteb, *Do the maths: An analysis of the gender gap in mathematics in Africa*, Economics of Education Review, 46 pp1-22, (2015).

[14] J. Gainsburg, *School mathematics in work and life: What we know and how we can learn more*, Technology in Society, 27, pp1-22,(2005).

[15] K. Akeayapong, K. Lussier, J. Pryor, J. Westbrook, *Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?*, International Journal of Educational Development, 33, pp272282, (2013).

[16] M. Makgato, *The challenges of teaching and learning technology subject at schools in South Africa: A case of INSET teachers in Mpumalanga Province*, Procedia-Social and Behavioural Sciences, 116, pp36883692, (2014).

[17] X. Yang X, *Senior secondary students perceptions of mathematics classroom learning environments in China and their attitudes towards mathematics*, The Mathematics Educator, 15, pp66-80, (2013).

[18] Gao M, *Classroom assessments in mathematics: High school students perceptions*, International Journal of Business and Social Science, 3, pp63-68, (2012).

[19] A. Murugan, L. Rajoo, (2013), *Students perceptions of mathematics classroom environment and mathematics achievement: A study in Sipitang, Sabah, Malaysia*, ICSSR-E-Journal of Social Science Research, e-ISSN-2289-4977.

[20] B. N. Githua, *Secondary school students perceptions of mathematics formative evaluations and perceptions relationship to their motivation the subject in Nairobi and rift valley provinces, Kenya*, Asian Journal of Social Sciences and Humanities, ISSN-2186-8492, (2013).

[21] S. Bevins, M. Brodie, E. Brodie, A study of UK secondary school students perceptions of science and engineering. In: *European Educational Research Association Annual Conference*, Dublin, 7-10 September 2005.

[22] L. C. Miller, J. Mittleman, *High Schools That Work and college preparedness: Measuring the models impact on mathematics and science pipeline progression*, Economics and Education Review, 31, pp1116-1135, (2012).

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