Teaching Mathematics in Open Distance Learning (ODL): Does it make a Difference with Teaching in the Traditional Approach?

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Abstract: *Teaching mathematics through open distance learning (ODL) has been a challenge to mathematics educators due to the nature of communication with learners and material delivery during instruction. Traditionally, mathematics was taught mainly through face-to-face interaction and the learners were able to interact with materials provided and also interact among themselves in the classroom. Some critics of ODL doubt whether ODL modes can impart adequate mathematical critical thinking and solving problem skills to learners as has been considered in the traditional approach. In this paper, as a case study, we look at the performance of one mathematics module offered through ODL and determine whether the module offered was to the expected quality. A sample of 50 student-teachers' examination results in the module written in year 2010 was analyzed on the six levels of the Bloom's taxonomy in the cognitive domain and the set exam evaluated in the same levels of the taxonomy. The findings showed that while the general performance was averagely good, most students performed well in lower levels of cognitive domain while performing poorly in the higher levels. These findings indicated that while students had a general good average score in the module, they had not achieved adequate knowledge in higher levels important for critical thinking and problem solving required for a mathematics student-teacher in a teacher training programme. It was believed by the researcher that current modes of module delivery were not adequate enough to prepare mathematics student-teachers become competent in higher levels in cognitive achievement. It was concluded that current ODL modes of delivery in mathematics did not make any significant difference with the traditional approach of face-to-face mode of instruction to improve performance in the subject. It was recommended that current ODL modes of the module delivery at UNISA and also other maths modules be improved and renovated by involving current technologies, to conduct research on effective online programmes, and to equip regional centers with enough learning resources for easy access to learners.*

Key words: mathematics, ODL, teaching, quality, technology, online programmes.

INTRODUCTION

Teaching through (ODL) modes has been regarded as a promising and practical strategy to address the challenge of widening access to education for many people. ODL is considered to offer the curricula appropriate for learners and addressing their needs and interests. On the African continent where resources are scarce and higher education provision is low, ODL has been accepted as a viable, cost effective means of expanding education provision without costly outlay in infrastructure (Pityana, 2009). ODL has also been credited for increasing more participation in higher education and is seen as an educational delivery mode which is cost-effective without sacrificing quality (*ibidem*). The later on quality has been an issue of debate in offering effective and quality mathematics programmes and on whether the current modes in ODL were able to enable the learner to acquire adequate mathematical knowledge and skills. Low achievement in mathematics has been of concern worldwide and the challenge faced by mathematics educators was to find out whether ODL modes could be used for effective teaching and learning against the traditional approach of face-to-face interaction. With current technologies, mathematics can be taught through many different forms such as in electronic texts, video conferencing, computer assisted programs, etc where physical groupings may not be necessary. While in some other subjects, ODL modes like electronic texts have been reported to provide the opportunity for learners to establish communicative relationships among learners where they were able to reflectively co-construct their knowledge by engaging in open and critical discourse (Maor, 1998, 1999; Taylor *et al*., 1999), very little research had shown such outputs in mathematics, science and technology (Mashharawi, 2000; Gilmer, 2001; Tobin, 2001; Open University, 2011). While mathematics seems not to be more advantaged in ODL technologies like in other subjects as found out by some educators, ODL has become known as a veritable vehicle of access to educational opportunities for a substantial proportion of the population all over the world and is evident that traditional educational systems are not capable of eradicating mass illiteracy on the African continent and in developing nations elsewhere (Agbelekawe, 2010). The success of ODL programmes was reported to be realized for many years where resources were made available to support these programmes (Perraton, 2000).

At UNISA, mathematics modules like other modules in various subjects are offered through ODL; the module materials (that also include instructions and orientation to the materials) are put on the website. Hardcopies of study materials are also sent by post to candidates who may not access Internet. The candidates contact their module lecturers through email, telephone and fax. There are also arrangements for discussion classes in the regional centers where candidates have to meet their module lecturers at least two times in one academic year for discussion. In the regional centers there are also tutors who have to be in contact with the candidates for consultations. UNISA also has Satellite Broadcasting (SB) and Video Conferencing (VC) facilities at the main campus from where lectures can be delivered to candidates situated in different places. Currently also there is a *MyUnisa forum* at UNISA website where lecturers can discuss with their candidates online.

Like in many other institutions elsewhere, UNISA has the task to provide quality programmes through ODL and especially in mathematics where low performance in the subject has been widely reported. Despite a general view that mathematics was failed in many places, some mathematics modules at UNISA have shown a good average performance for few years back.

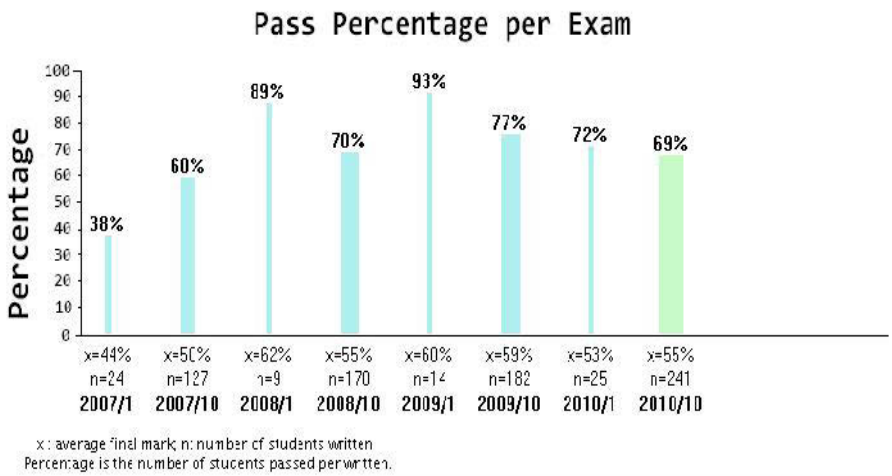

Figure 1: Pass percentages for LADMMM6 for the past three years

In this paper, the module considered, “Teaching and Learning Mathematics in Diverse Classrooms *(LADMMM6)* has shown good average performance for the last three years as indicated in Figure 1. These results indicated that most students were passing the module with an average of 50% and above.

These results put a picture that the programme was offering quality programme to student-teachers. Despite these seemingly good results, there were concerns that teachers’ knowledge in the subject was not adequate for effective teaching in schools and as a result many students failed the subject. It was then the intention of the researcher to investigate the performance in the subject by looking into performance at different levels in the cognitive domain and make a reflection on the modes of the course delivery. The researcher adopted the Bloom’s (1956) cognitive taxonomy of educational objectives to categorize the levels of the exam set and performance of student-teachers in these levels. In recent years different taxonomies have been developed in cognitive levels for different mathematics activities. For example, these levels categorize different level forms such as memorization, performing procedures, communicating understanding, solving non-routine problems and conjecture, generalization and proof (Porter, 2008) or memorization, procedures without connections, procedures with connections, and doing mathematics (Stein *et al.*, 2000). While this categorization seems to suit well in some of illustrated mathematical examples, the complexity in these levels is that some questions suit a particular level according to the argument set by the assessor in the solution process of the problem tackled and at the same time could also suit the other level with convincing arguments. It also becomes difficult to apply these developed taxonomies in the construction and evaluation of the mathematics exam because of the overlaps in the developed levels. The same overlaps have also long been noted in the Bloom’s taxonomy. The researcher however, found it more proper to use the Bloom’s taxonomy rather than other developed taxonomies because Bloom’s taxonomy was clearer to use in the evaluation of both the set exam and candidates’ scores in the exam.

METHODOLOGY

This study aimed at finding out the nature of performance in the mathematics modules offered at UNISA through ODL with a case example, with the intention of a further study on a larger sample. The premise made in this paper was that quality of the programme should be reflected by a good performance in all levels of the cognitive domain and vice versa. A total of eight mathematics modules for student teachers for senior phase and further education and training are offered by the Department of Teacher Education each year at UNISA for B.Ed, B.Ed Honours degrees and PGCE certificate. One PGCE module, “Teaching and Learning Mathematics in Diverse Classrooms (LADMMM6)” for in-service teachers in primary schools, marked by the researcher in year 2010 was selected at random for study.

A sample of 50 student-teachers’ results in this module were selected at random for study. This number was about 21% of students who wrote the paper and was considered to be representative sample of the module. The 2-hour exam had six questions and an evaluation of the exam in the six levels of the Bloom’s cognitive domain i.e. knowledge, comprehension, application, analysis, synthesis and evaluation was done. Also the student-teachers’ scores in these levels were analyzed. The performance of students in mathematics module under study was related with delivery modes in place at UNISA and linked these with a possible effect to the quality of mathematics programmes offered.

RESULTS

The exam paper consisted of 6 questions and these were found to be in five out of six levels of the Bloom’s taxonomy, i.e. knowledge, comprehension, application, synthesis and evaluation. The analysis level was not included in the set exam. Constructed questions carried the following weightings: knowledge (21%), comprehension (48%), application (10%), synthesis (13%) and evaluation (8%) as indicated in Table 1 below. The weighting of the exam paper showed that the lower cognitive levels of knowledge and comprehension carried 69% of total marks and higher levels (application, synthesis and evaluation) carried 31%.

The overall average performance of 50 student-teachers was 47% and the average scores in the five levels were 54% (knowledge), 55% (comprehension), 31% (application), 38% (synthesis) and 17% (evaluation), (Table 1, Figure 2, and Figure 3).

Table 1: Student-teachers' performance in *LADMMM6* module

Student	Knowledge Q1.1,1.2,3.1,5.2 (out of 21%)	Comprehension	Application Q3. (out of 10%)	Synthesis Q6.1,6.2 (out of 13%)	Evaluation	Total score (%)
		Q1.3, 2.1,2.2,2.3,4.1,5.1,5.3 (out of 48%)			Q4.2 (out of 8%)	
1	18	44	9	9	1	81
2	17	40	8	10	0	75
3	6	5	2	1	1	15
4	9	44	5	4	1	63
5	10	40	1	0	0	51
6	11	41	2	2	1	57
7	8	37	3	3	0	51
8	13	36	4	5	0	58
9	10	9	3	3	1	26
10	9	4	1	0	2	16
11	10	43	3	1	1	58
12	8	37	4	2	0	51
13	16	40	9	10	1	76
14	2	3	3	2	1	11
15	11	46	3	2	0	62
16	3	5	5	3	1	17
17	19	27	9	10	1	66
18	15	27	4	6	0	52
19	6	25	1	0	0	32
20	14	8	8	10	6	46
21	15	44	5	4	8	76
22	9	37	1	0	0	47
23	10	42	6	5	1	64
24	8	41	5	5	1	60
25	3	33	1	1	1	39
26	18	32	1	0	1	52
27	17	25	9	10	8	69
28	19	43	8	10	1	81
29	18	5	5	5	8	41
30	13	8	2	1	2	26
31	9	9	1	1	2	22
32	16	45	4	8	8	81
33	17	42	3	2	1	65
34	5	2	2	1	0	10

35	5	8	1	0	0	14
36	17	3	1	0	0	21
37	8	31	2	0	0	41
38	9	11	8	10	0	38
39	16	45	9	10	0	80
40	9	8	5	3	0	25
41	14	29	4	2	0	49
42	8	7	1	0	0	16
43	7	45	1	1	0	54
44	16	43	8	10	2	79
45	8	44	1	0	0	53
46	17	9	7	5	1	39
47	15	43	6	5	1	70
48	10	2	1	0	1	14
49	6	9	5	5	1	26
50	7	9	2	1	1	20
Total Ave. Score	11.28	26.3	4.04	3.76	1.34	46.72
	0.537142857	0.547916667	0.31076923	0.376	0.1675	0.4672
Score (%)	**53.71428571**	**54.79166667**	**31.0769231**	**37.6**	**16.75**	46.72

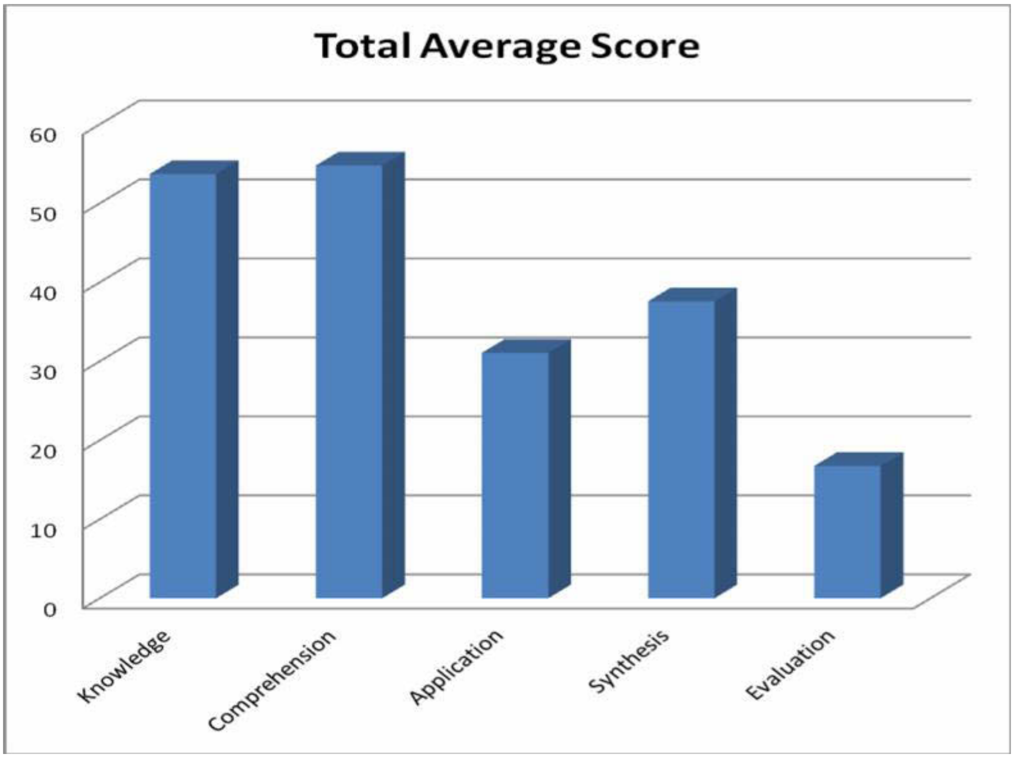

Figure 2: Pass percentages for LADMMM6 for the five different cognitive levels

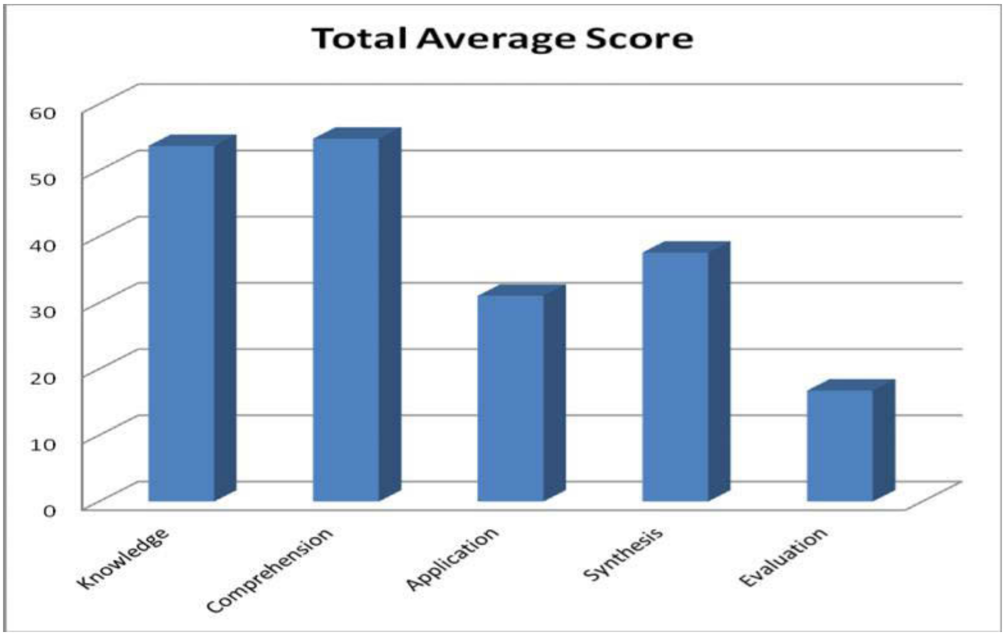

Figure 3: Distribution of scores in the Bloom's taxonomy

These findings show that most students performed well in the two lower levels of knowledge and comprehension and performed poorly in the three higher levels of application, synthesis and evaluation. The analysis on knowledge and comprehension levels show almost normally distributed scores indicating that many candidates scored well in these levels, (figures 4(a) and 4(b).

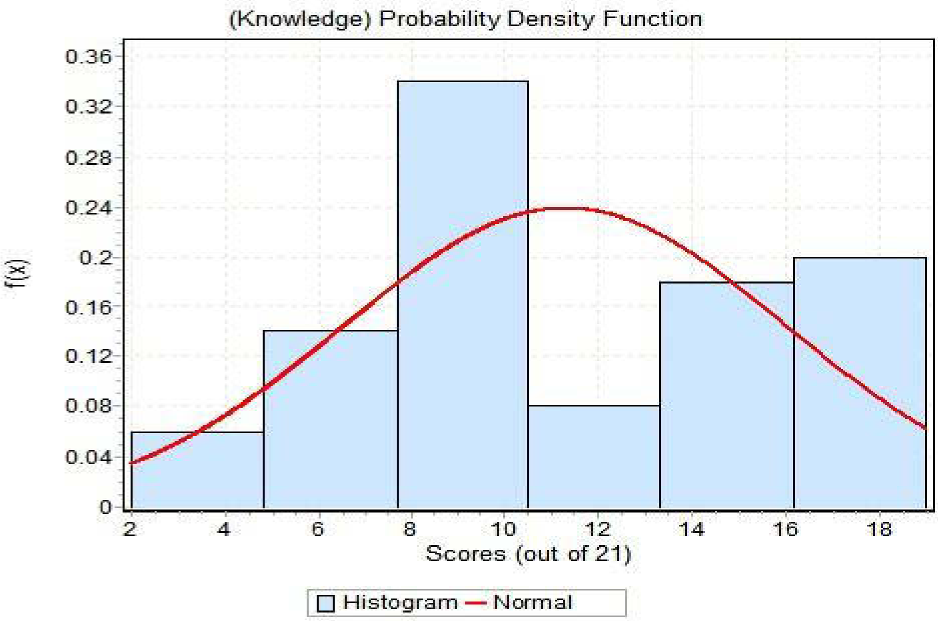

Figure (4a): Distribution of scores in knowledge

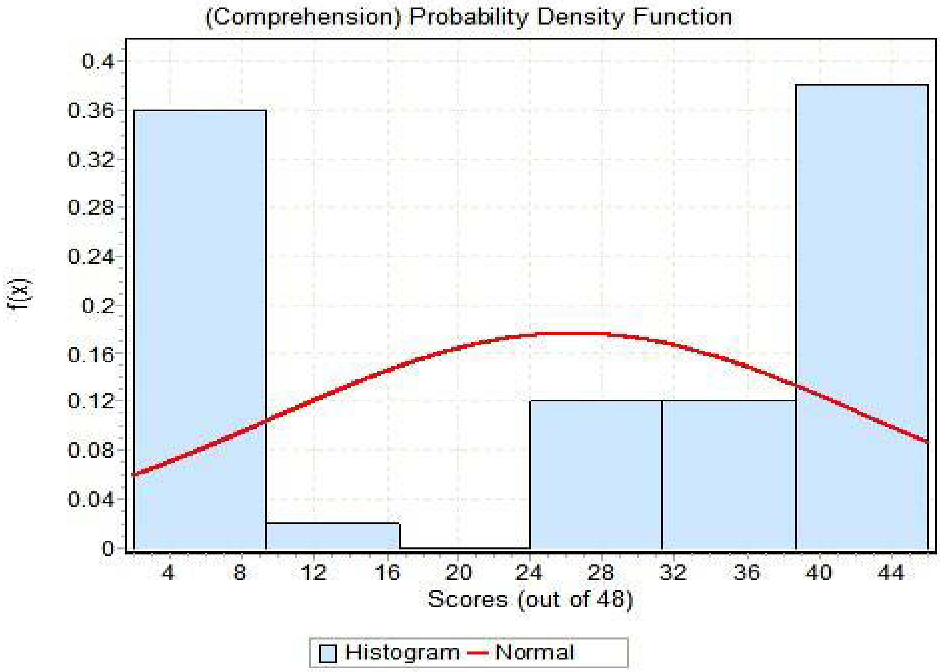

Figure 4(b): Distribution of scores in comprehension

However, the analysis on application, synthesis and evaluation showed positively skewed scores indicating that few students scored better in these levels, (figures 4(c), 4(d) and 4(e)).

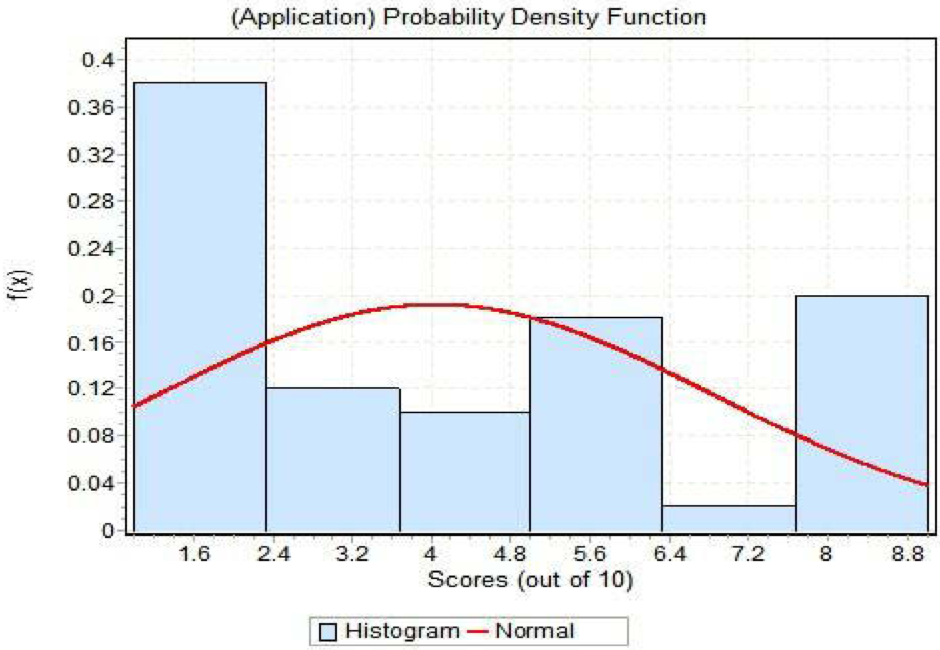

Figure 4(c): Distribution of scores in application

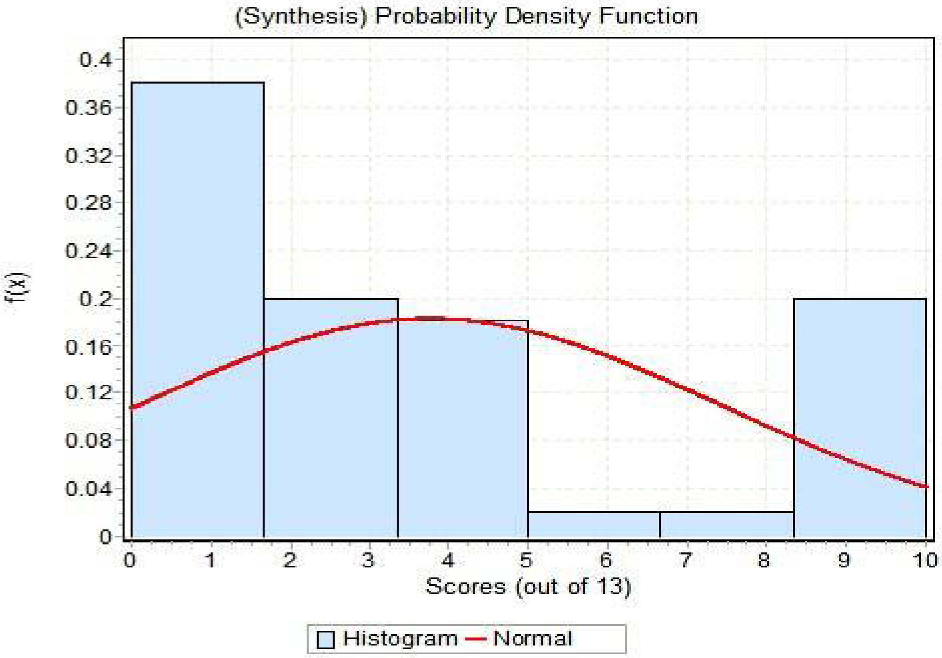

Figure 4(d): Distribution of scores in synthesis

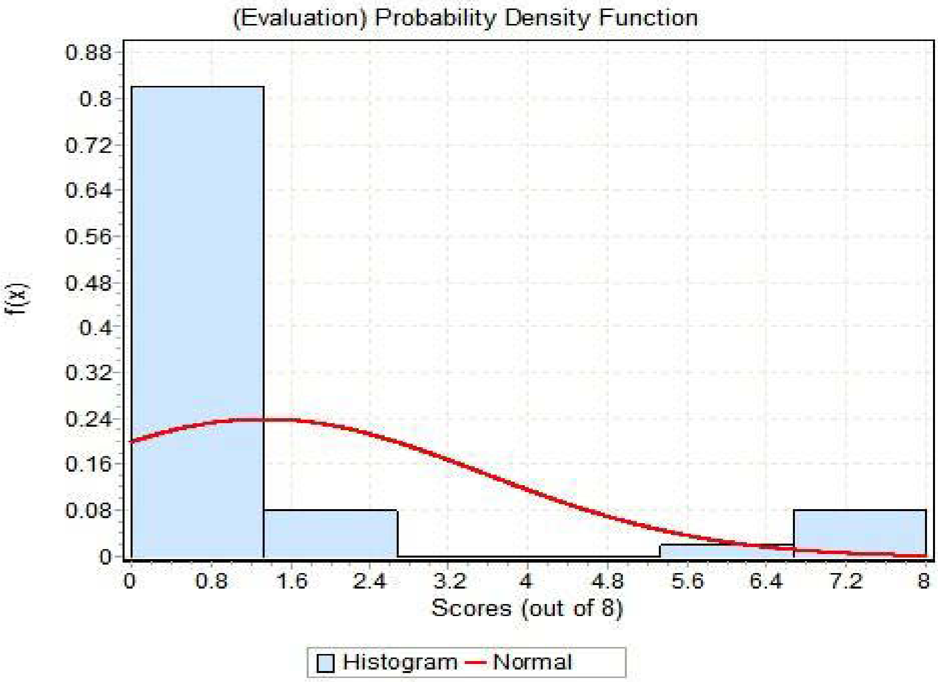

Figure 4(e): Distribution of scores in evaluation

A deeply skewed distribution score in evaluation level show that candidates performed very poorly in this area. These findings can be interpreted as student-teachers being more knowledgeable in the lower cognitive levels than in the higher ones.

DISCUSSION

The overall average score of 69% in the examination for all student-teachers in the year 2010 indicated that the candidates performed well in the subject. And with a recorded performance of 50% and above in the module for the past 3 years, it tended to portray the quality of the module offered. Furthermore, an average score of 47% in the sample of 50 students used in this study was an indication of a fairly good score in the module. However, the analysis indicated that these students performed well in the lower levels of the cognitive domain, i.e. knowledge and comprehension and failed in higher levels of application, synthesis and evaluation. The analysis showed that fewer students performed well in the higher levels while many performed poorly. These findings indicated that student-teachers with such performance lacked critical and problem solving skills required by learners. The knowledge level enabled learners to recall mathematical rules, procedures, formulas and facts. From the study findings, the questions on knowledge level required student-teachers to state things like the importance and significance of doing mathematics as well as on how mathematical modules could be used to develop particular concepts in mathematics. In the comprehension part, student-teachers were able to make descriptions of their understanding of conceptual and procedural knowledge in mathematics, and also why the traditional computation of maths were different from the 'doing' of maths. At the comprehension level, student-teachers were required to have knowledge of expressing mathematical knowledge from one form into the other and vice versa, and being able to make an interpretation of these. Knowledge in these two levels of knowledge and comprehension did not provide learners with critical and problem solving skills necessary to tackle mathematical problems in higher levels of cognitive domain. Student teachers' knowledge in these levels enabled them to translate and interpret information in comprehension problems but unable to move well into another level of application and above and present the solution process into appropriate component forms. The lack of knowledge in application was found in student-teachers' inability to solve Polya problem. In Polya's solution process, the candidate was required to show an understanding of the problem by identifying the shaded quadrilateral of which the formula to calculate its area was non-existent, then devise a plan, carry out a plan and then look back to the process to determine the solution. All these steps needed the candidate to use the knowledge on triangles and rectangles to discover, plan and solve the problem; the knowledge essential in the application level.

The question in synthesis level that required the candidates to develop a mathematics lesson plan was performed better than the question in application level. In this question the candidates were to present assumed or previous knowledge in the area selected, develop anticipated outcomes of the lesson involving knowledge, skills and attitudes, introduction, conclusion and development of the worksheet. In this type of the question, the candidates were to plan, design, organize and propose different methods and strategies in developing the lesson plan, the knowledge that was essential in the synthesis level. The reasons for the candidates' good performance in this level than in application were not immediately known to the researcher though the assumption could be that many of the candidates might have been practicing in the schools (without teaching qualifications) and were able to obtain the knowledge and skills of lesson planning through their daily activities in the classrooms.

Also the failure by the candidates in the evaluation level to identify assessment strategies in mathematics classrooms by displaying an understanding of why mathematical algorithms and different problem solving methods did not form a major part of classroom assessment was an indication that the candidates lacked knowledge in this level. In this level, the candidates were to display their arguments, make a justification of these and then defend their arguments. Poor performance in these higher levels was an indication that learners lacked critical and problem solving skills (obtained in higher cognitive levels) necessary to solve real life problems and lack of these does not indicate quality in the module offered. Though the evaluation of exam paper written by the candidates found that the analysis level was not included in the questions set, there was little possibility that candidates would have done any far better in this level compared to performance in the lower levels. The candidates' performance in the analysis level was thus comparable to the lower performance in the higher levels analyzed.

Poor performance of mathematics teachers (related to poor performance of students for many years) in many countries prompted teacher training institutions to evaluate their student subject matter and pedagogical knowledge as well as methods of training in these institutions (Bukova-Güzel, 2010). ODL delivery modes are a challenge to the traditional approach involving face-to-face classroom interaction that dominated mathematics ways of instruction for many years and evaluation of current mathematics delivery modes in ODL becomes necessary. The perceptions by some mathematics educators that the use of concrete interactions with study materials in the classroom where learners interacted with each other was the best approach to impart mathematical knowledge to learners (Abrams and Haefner, 2002) can only be changed if quality mathematics programmes were offered through ODL.

Mathematics modules at UNISA are mainly offered through course materials sent to students who communicate with lecturers by emails, telephones and cell phones. The planned discussion groups and use of tutors in the regional centers are occasional and not well planned to reach majority of learners. The centers should also be equipped with other mathematics programs that have been found to be effective in teaching and learning such as mathematical, geometer sketchpad, crocodile, MATLAB and others (Liu, and Kaino, 2007; Kaino, 2007, 2008, 2011). To strengthen offering of mathematics modules at UNISA, some research tools such as COLLES should also be used to investigate the quality of online learning environments for effective teaching of modules (Taylor and Maor, 2000). The UNISA centers are also based in the country and students outside have no such facilities as regional centers and tutors for consultations. UNISA's many learners have no access to Internet with adequate access to email connection. The challenge will also be on the use of video conferencing and MyUnisa facilities currently available. There are high expectations that such facilities could improve student achievement in the subject compared to the prominent traditional approach that has not succeeded to improve student performance in mathematics.

CONCLUSION

Despite an overall good performance in the module (LADMMM6) as also reflected in the past 3 years, student-teachers performed poorly in the higher levels of the cognitive domain, indicating that critical thinking and problem solving skills were not attained by these candidates for effective teaching of mathematics in schools. The seemingly good performance reflected in average scores in the module cannot be considered as an offering of a quality mathematics programme. Though the findings on this module cannot be generalized to reflect the performance in other maths modules offered at UNISA, the performance in analyzed levels indicated that current ODL modes of delivery in mathematics did not make any significant difference with the traditional approach of face to face mode of instruction to improve performance in the subject. It may be possible to improve performance in the subject by involving current technologies in maths instruction, conduct research on effective online programmes, and equip UNISA regional centers with enough resources to deliver these programmes for easy access to learners.

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