International Journal of Innovation and Research in Educational Sciences
Volume 2, Issue 6, ISSN (Online): 2349–5219

The Mix of Physics, Chemistry and Biology: Preference and Performance of Distance Education Students in Science

Wisdom Harrison K. Hordzi
Institute for Educational Development and Extension;
University of Education, Winneba; Box 25, Winneba
Email: wisdomhordzi@gmail.com or wisdomhordzi2@yahoo.com

Abstract **– In Ghana one of the subjects that students dread is science. This most often prevents many students from boldly opting for science courses and thereby denying them of the opportunity to acquire basic scientific knowledge that they need for day-to-day activities. However, the general impression is that Biology is more manageable than Physics and Chemistry. Meanwhile, all diploma students and few Post Diploma students of University of Education, Winneba distance education programme offer science courses. This study was initiated to find out which component of the science programme (Physics, Chemistry and Biology) appeals more to the distance education students and their performance in science in general. To do this, course contents of three science courses of second semester of 2013/2014 academic year were analysed to find out how much of Physics, Chemistry and Biology each course contained. Also, examination items were analysed to find out how many questions covered each of the three subject areas. The performance of students for Section C items were also analysed to find out how students fared in relation to the three subject areas. It was realized that 50% of one course was made up of Biology while in the other two 25% of each one contained Biology topics. Similarly, Biology items prominently featured in Sections A and B of the examination papers of the courses more than Physics and Chemistry. Students generally, preferred Biology items in Section C than Physics and Chemistry. However, the general performance in the three courses was low and students did not perform any extraordinarily for the Biology items compared to Physics and Chemistry. The impression is that Biology topics in the various courses encouraged students to take part in the science courses. However, there is the need for science course tutors on the distance education programme to use more friendly methods to encourage students to like Physics and Chemistry topics as well.**

Keywords **– Biology, Chemistry, distance education, Physics, Science**

I. INTRODUCTION

The world is experiencing global explosion of knowledge which is driven by science and technology (S & T). Science and technology takes its root from enterprising manpower well endowed with basic scientific knowledge. This suggests that for a country to progress scientifically there is the need for the educational sector to train people who are scientifically smart. However, it seems globally the young people of today are not all that interested in pursuing Science and Mathematics programmes in school. This has been attested to by a number of authors. For example, [1] and [2] observe that despite the fact that students who take science, or science and mathematics are able to pursue further scientific education and scientific careers; the decline in the number of science-based students as a proportion of all students eligible for higher education in the US and several European countries raises concerns about the economic future and the scientific literacy of the population of these countries. Also, [3] observes that students' increasing reluctance to choose science courses in their final years of secondary education has serious adverse implications for the health of scientific endeavour and the scientific literacy of future generations.

The endorsement of positive attitudes to science, scientists, and learning science, which has always been a constituent of science education, is increasingly a subject of concern [3]. Related to that are the factors affecting the attitudes of young people to science. Some of the identified factors affecting students' attitudes to science are gender, personality, structural variables, and curriculum variables. Further, [4] considers sex as the most probable variable affecting students' attitudes to science. Other reporters such as [5], [6], [7], [8], [9] and [10] submit that males have more positive attitudes to science than females. On the other hand, [11] as well as [12] found no statistically significant gender differences between male and female interest in science.

According to [13], the term "interest" refers to preference to engage in some types of activities rather than others. They further espoused that an interest may be regarded as a highly specific type of attitude such that when one is interested in a particular phenomenon or activity, one is favourably inclined to attend to it and give time to it. Thus, if students are interested in science they will give a lot more time to it than other subjects.

A further gloomy picture was presented by [14] concerning the lack of interest in Science and Technology (S & T) courses by young people in the world. For instance, they stated that lack of interest in S&T studies, and the possible hostility or disenchantment with S&T seem to be more pronounced in many highly developed countries than other parts of the world. According to them the rich countries such as USA, Canada, Western Europe, Australia and Japan seem to have such challenges, while such trends are to a less extent found in economically less developed countries of Asia, Africa, Oceania, and Latin America.

Considering the submissions of [14], one can easily conclude that the problem of lack of interest by students in

science in Africa is not a serious problem. However, in Ghana one of the subjects that students dread is science. This most often prevents many students from boldly opting for science courses and thereby denying them the opportunity to acquire basic scientific knowledge that they need for day-to-day activities. Obviously, this development has negative implications for national development, because development is intricately related to science and technological advancement of a nation.

Despite the fact that a lot of students try to avoid science and technology courses, many programmes in the Ghanaian Universities involve science in one form or the other. For example, all Diploma Students and few Post Diploma Students of University of Education, Winneba Distance Education Programme offer science courses. This means that as a diploma student on the programme one is obliged to pass two science courses alongside other courses in order to obtain Diploma in basic Education. Similarly, students offering quasi specialization in science on the Post Diploma Bachelor of Education in Basic Education (BEd) Programme are expected to pass all their science courses alongside other courses in order to be awarded the BEd in Basic Education degree. The Diploma science courses are Integrated Science courses. These causes are made up of Physics, Chemistry and Biology topics. On the other hand the Post Diploma degree science courses are mixed in nature. One course is purely Biology; another is also purely Physics, while another course is made up of Chemistry and Biology topics. One other course is made up purely of Agricultural Science topics and the last course is Science Methodology course.

Despite the fact that majority of Ghanaian students including the distance learners develop some form of phobia for science it baffles one's understanding to be faced with the seeming general impression that Biology is more manageable than physics and chemistry. If that is true then in the case of Integrated Science which is made up of Physics, Chemistry and Biology for the distance education students, majority of them will show a lot more preference for Biology questions during examinations. But is that the situation? There is no documentary evidence to that effect. Hence, this study was designed to find out which aspect (Physics, Chemistry and Biology) of the science programmes do the distance education students pursuing Basic Education Programmes of the University of Education, Winneba show preference for and how they perform in science.

The specific objectives of the study were to find out:

- how Physics, Chemistry and Biology topics of three science courses for the distance learners are represented in the course books,
- how fairly are Physics, Chemistry and Biology topics distributed across the various end-of-semester examination questions of the three courses,
- which type of questions in terms of Physics, Chemistry and Biology do students prefer most during examinations,
- how students performed in science questions they select along the line of Physics, Chemistry and Biology during second semester examinations.

The study was guided by the following research questions:

- How fairly were Physics, Chemistry and Biology topics distributed across the curriculum and in the question papers of the end-of-semester examination of the second semester of 2013/2014 academic year?
- Which type of questions in terms of Physics, Chemistry and Biology did students prefer most during the examinations?
- How did students perform in Biology related questions compared to Physics and Chemistry to encourage them to study science?

The null hypothesis was that there were no differences between students' scores of each question.

II. METHODOLOGY

This study was basically an analysis of the contents of three science courses and scores of candidates in an end-of-semester examination. On a large scale the study design adopted descriptive research approach.

The population covered Diploma levels 100 and 200 as well as Post Diploma 1 science students of the distance education programme of Centre for Distance Education (CDE); Institute for Educational Development and Extension (IEDE); University of Education, Winneba (UEW). The study did not include Diploma Level 300 students because they did not do any science course during the semester. Also, Post Diploma 2 students were not included because they did not do any science content course which involved Physics, Chemistry and Biology.

The sample comprised 746 Diploma Level 100; 281 Level 200 and 452 Post Diploma 1 science students who wrote the end-of-second semester examination in the science courses and had their scripts marked. Therefore, the total sample size was 1479 students. More or less the purposive or accidental sampling was used because candidates whose scores were included in the analysis were those whose scripts were marked and the marks recorded and analyzed. However, the researcher did not have any influence on the distribution of the scores.

The main instruments used were the course books of three science courses for both diploma and post diploma students; and the end-of-semester examination question papers for the three courses and the corresponding marking schemes. The questions were set by the researcher and moderated by a peer. Each of the papers comprised three sections each. These were section A, B and C. Section A of each paper was made up of 15 compulsory multiple choice items, whereas Section C of each paper also contained 4 essay type items of which candidates were to answer any 2. The number of items for section B differed for each course. However, section B items were also compulsory. Section B of Integrated Science for the Basic School Teacher 1 and Integrated Science for the Basic School Teacher 2 each contained 10 short answer items, while that of Basic Chemistry and Health contained 9 short answer items. The total mark for Sections A and B was 15 marks each respectively, whereas that of Section C was 30 marks. Thus, in all, a candidate was expected to make 60 marks in the end-of-

semester examination in each paper. However, analysis of examination scores was restricted to Section C items along the line of contents of Physics, Chemistry and Biology.

Corresponding marking scheme for each of the three courses was prepared by the Chief examiner who happens to be the researcher. These were mechanical marking schemes. Before the marking started the Chief Examiner together with the assistant examiners went through the marking schemes and agreed on common answers that should be accepted. This served as a standard for all the examiners for each course to use. Each item in Section C scored a maximum of 15 marks. Thus, for each item in Section C, students could score between 0 and 15 marks.

In order to find out how much Physics, Chemistry and Biology topics were contained in each of the three science courses of the semester, the researcher analysed the contents of the three course books. Also, the contents of the end-of-semester examination items were analysed. The researcher went further to analyse the performance of candidates in the essay items in Section C of the question papers of each of the three courses.

Two examiners each marked the scripts of Integrated Science for the Basic School Teacher 1 and Basic Chemistry and Health. The Chief Examiner coordinated the examiners by taking them through the marking scheme, where all examiners as well as the Chief Examiner agreed on common points in the marking scheme that merited scores. For a practice, before the actual marking started, five photocopied answer scripts for each course known as dummies were given to each examiner to use for experiment. The scores obtained from the dummies from each examiner for each course were discussed for the examiners to know where they went wrong. This exercise also helped in identifying possible correct answers that were not included in the marking schemes so that they could be included. The examiners marked the examination scripts according to the accepted marking schemes. The marking exercise took 9 days and examiners were not to leave the venue for this number of days so that if there were any new developments all examiners would get the information and did things in common.

In order to ensure that each examiner was marking according to the marking scheme, the Chief Examiner sampled marked scripts and did a second marking. The scores obtained by the Chief Examiner should have scores in the range of plus or minus 3 maximum of that of the assistant examiner. Any examiner who was not performing according to the standards set were either asked to re-mark or stop marking and scripts re-allocated to someone else who could do it well. The Chief Examiner marked the scripts for Integrated Science for the Basic School Teacher 2.

Frequencies and percentage frequencies of the analysis of the course books and the distribution of Physics, Chemistry and Biology questions determined were used to draw bar charts. Scores for each of the items in Section C for each candidate were imputed into the computer and analysed using Statistical Package for Social Sciences (SPSS) version 20. Also, means, standard deviation, and student t-test were determined by using the SPSS. The unpaired t-test was used to compare the differences in the scores of each question. The results were then commented upon and discussed.

III. RESULTS

Analysis of course books and end-of-second semester science examination questions

a) Analysis of course books

The results for the analysis of course books are presented in Table 1. There are four (4) units in each of the course books. In the case of Integrated Science for the Basic School Teacher one, 25% was about Physics, 50% about Biology and the other 25% about Chemistry. For Integrated Science for the Basic School Teacher two, 50% covered Physics, 25% for Biology and another 25% for Chemistry. The course book for Basic Chemistry and Health had three units made up of Chemistry topics whereas the fourth unit was made up of Biology topics. Thus, in all 25% of the course book was made up of biology topics and 75% made up of chemistry topics (Table 1). There was no Physics topic for this course book.

Table 1: Analysis of course books

Subject Area	DBE123: Integrated Science for the Basic School Teacher 1	DBE243: Integrated Science for the Basic School Teacher 2	SCB 421: Basic Chemistry and Health
Physics	25.0	50.0	0
Chemistry	25.0	25.0	75.0
Biology	50.0	25.0	25.0

b) Analysis of end-of-second semester science examination questions

From Fig. 1, 60% of the fifteen objective items from Section A, 70% of the short answer items from Section B, and 50% of the four items from Section C of Integrated Science for the Basic School Teacher 1 were from Biology topics. For Integrated Science for the Basic School Teacher 2 (Fig. 2), Physics and Biology recorded 40% each for Section A items, Biology topics recorded 60% of the items for Section B, and Physics recorded 50% whereas Biology and Chemistry each recorded 25% of the items for Section C. Furthermore, 73.33% of Section A items of Basic Chemistry and Health, 88.89% for section B and 75% for section C covered Chemistry topics (Fig. 3).

b) Analysis of end-of-second semester science examination questions

International Journal of Innovation and Research in Educational Sciences
Volume 2, Issue 6, ISSN (Online): 2349–5219

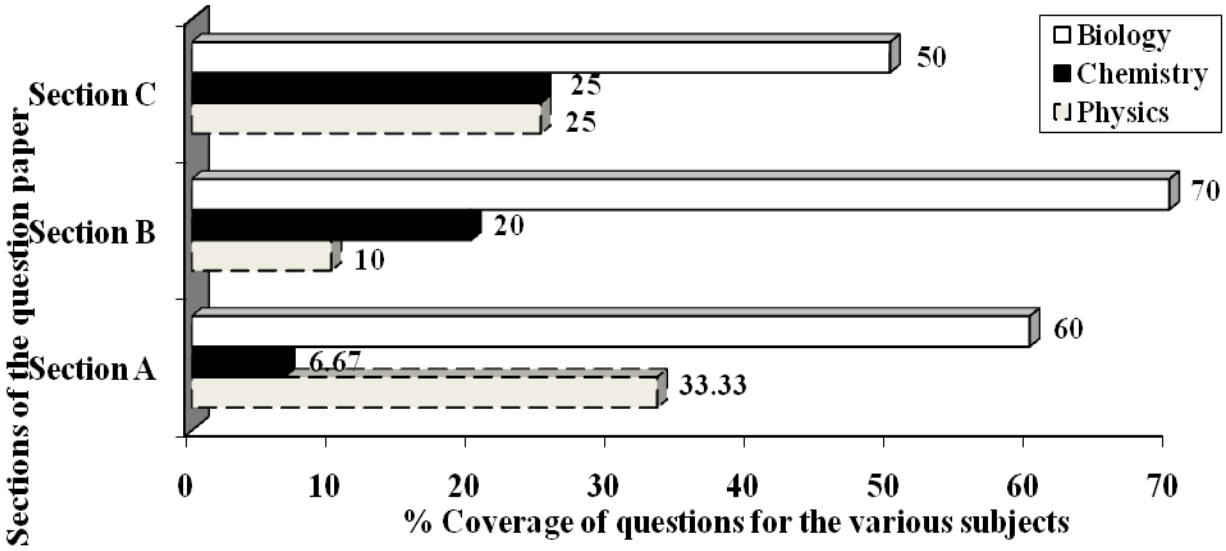

Fig.1. Coverage of questions for DBE 123: Integrated Science for the Basic School Teacher 1

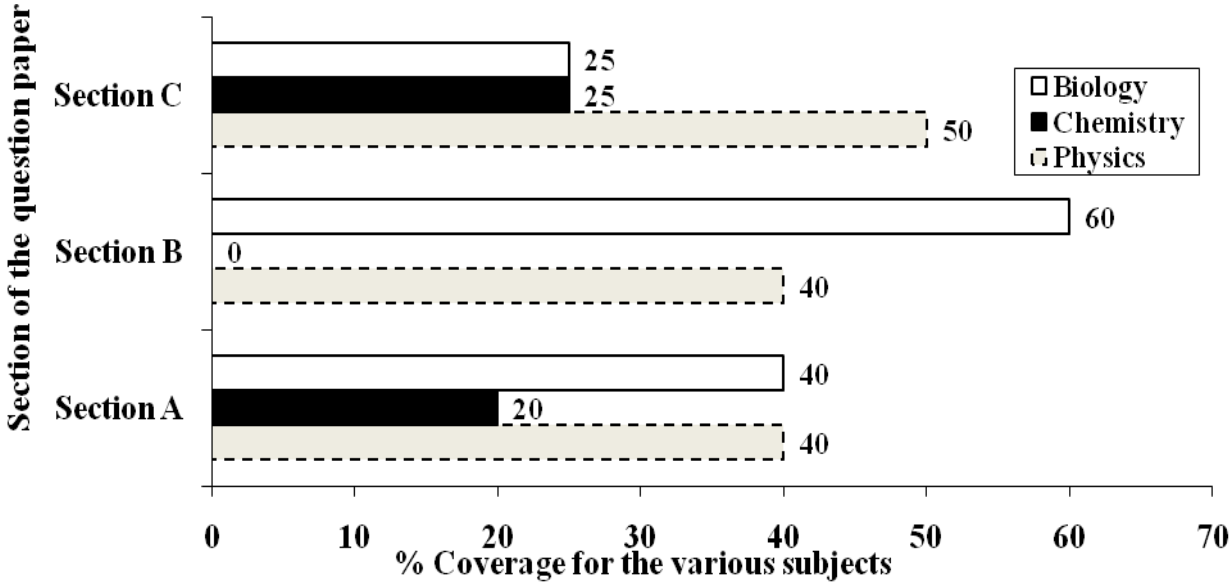

Fig.2. Coverage of questions for DBE 243: Integrated Science for the Basic School Teacher 2

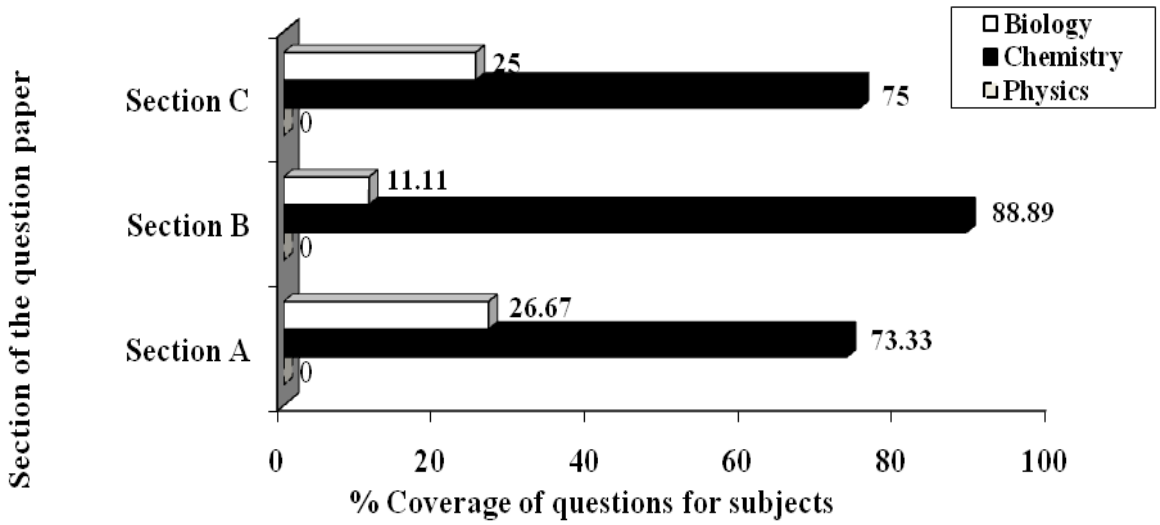

Fig.1. Coverage of questions for SCB 421: Basic Chemistry and Health

Analysis of the performance of candidates for Section C items of science courses in the end-of-second semester examinations

Results of Section C questions in Integrated Science for the Basic School Teacher 1 have been presented in Table 2. The reliability for the four items for Integrated Science for the Basic School Teacher 1 was 0.72 for Cronbach's Alpha. The highest subscribed item was item 2 (571 candidates = 38.27%) which was based on Biology topics, but it was the item with the worst performance (mean of 3.31). The second highest subscribed was item 1 (425 candidates = 28.49%) based on Physics topics. This item recorded the second highest performance with a mean of 5.24. The least subscribed item was item 3 (211 candidates = 14.14%) which also covered biology topics, with the best performance (a mean of 7.69). The differences between the scores of each item were significant at 0.05 (t = 36.28, df = 424; t = 24.86, df = 570; t = 26.36, df = 210 and t = 22.83, df = 284) (Table 2).

Table 2: Performance in Integrated Science for the Basic School Teacher 1

Item No.	Subject area	N	%	Mean	S. D.	t	df	Sig. (2-tailed)
1	Physics	425	28.49	5.24	2.97	36.28	424	.000
2	Biology	571	38.27	3.31	3.18	24.86	570	.000
3	Biology	211	14.14	7.69	4.24	26.36	210	.000
4	Chemistry	285	19.10	3.97	2.94	22.83	284	.000

In the case of Integrated Science for the Basic School Teacher 2 (Table 3), the reliability for the items was 0.89 for Cronbach's Alpha. For this course also, item 1 which covered Biology topics was the most subscribed by candidates (258 candidates = 45.91%) and with the second best performance (mean of 5.08). The best performance was in item 3 (mean of 5.57) which was the third highest subscribed item (113 candidates = 20.11%). This item covered Chemistry topics. The differences between the scores of the various items were significant at 0.05 (t = 32.62, df = 257; t = 15.62, df = 120; t = 14.93, df = 112 and t = 10.59, df = 69).

Table 3: Performance in Integrated Science for the Basic School Teacher 2

Item No.	Subject Area	N	%	Mean	S. D.	t	df	Sig. (2-tailed)
1	Biology	258	45.91	5.08	2.50	32.62	257	.000
2	Physics	121	21.53	3.45	2.43	15.62	120	.000
3	Chemistry	113	20.11	5.57	3.96	14.93	112	.000
4	Physics	70	12.46	4.27	3.37	10.59	69	.000

Results of the performance of candidates in Basic Chemistry and Health have been presented in Table 4. Here a reliability of 0.86 for Cronbach's Alpha was recorded. The highest subscribed item was item 1 (338 candidates = 37.43%) which covered Chemistry topics. This item recorded the second best performance (mean of 7.75). The second highest subscribed item was item 4 (275 candidates =3045%), which covered Biology topics but with the worst performance (mean of 5.94). The least subscribed was item 3 (96 candidates =10.63%), which covered chemistry topics but with the best performance (mean of 8.30). The differences between the scores for the various items were significant at 0.05 (t = 44.29, df = 337; t = 37.25; 193; t = 28.37, df = 95, and t = 33.39, df = 274).

Table 4: Performance in Basic Chemistry and Health

Item No.	Subject area	N	%	Mean	S. D.	t	df	Sig. (2-tailed)
1	Chemistry	338	37.43	7.75	3.22	44.29	337	.000
2	Chemistry	194	21.48	6.40	2.39	37.25	193	.000
3	Chemistry	96	10.63	8.30	2.87	28.37	95	.000
4	Biology	275	30.45	5.94	2.95	33.39	274	.000

IV. Discussion

Analysis of the course books reveals that it is Integrated Science for the Basic School Teacher 1 that Biology dominated (50%) while Physics (50%) dominated Integrated Science for the Basic School Teacher 2. On the other hand, Chemistry dominated (75%) Basic Chemistry and Health course book. These revelations show that the dominance of any particular subject for the three courses is course dependent.

Since Biology dominated Integrated Science for the Basic School Teacher 1 course book it is not surprising to find out that 60% of the multiple choice items from Section A, 70% of the short answer items from Section B, and 50% of the four items from Section C came from Biology topics. Similarly, once Physics topics dominated Integrated Science for the Basic School Teacher 2 book, it was expected that Physics questions should dominate also. However, Physics and Biology recorded the same percentage coverage (40%) for Section A items, while Biology topics recorded the highest percentage (60%) of Section B items. The expected happened when 50% of Section C items covered Physics topics. As expected, Chemistry items dominated the questions for Basic

Chemistry and Health (73.33% for Section A, 88.89% for section B and 75% for Section C). Therefore, the only departure from expectation was Section B of Integrated Science for the Basic School Teacher 2 where Biology items dominated instead of Physics. The findings also point to the fact that Section C which is the main focus of this study followed the norm such that majority of the test items covered the subject areas that dominate the three courses. This is in the right direction so that one can actually deduce the right subject area orientation of the distance learners. It is said that interest is a powerful motivator [15], which differs from most other motivational concepts by its content specificity [16]. Therefore, the choice of questions depending on the coverage of subject area will suggest the interest areas of students so far as Physics, Chemistry and Biology are concerned.

Analysis of the items in Section C shows that in the case of Integrates Science for the Basic School Teacher 1 and Integrated Science for the basic School Teacher 2, items covering Biology topics were the highest subscribed. However, the best performances were not recorded for these items that were the highest subscribed. In the case of Integrated Science for the Basic School Teacher 1, the best performance came from item three (a mean of 7.69), which was least subscribed and the item came from Biology topics, whereas in the case of Integrated Science for the Basic School Teacher 2 the best performance also came from item three (mean of 5.57), which covered Chemistry topics. In the case of Basic Chemistry and Health the highest subscribed item was a Chemistry item (item one) which recorded the second best performance, whereas item four which covered Biology topics was the second highest subscribed with the worst performance (mean of 5.94). On the other hand item three which was the least subscribed recorded the best performance (mean of 8.30). Therefore, the performance in an item does not have anything to do with how many people subscribe to it. However, the fact that the differences between the scores for each item were significant at 0.05 probability suggests that the distribution of the scores were not due to chance but represents the actual performance of the students.

The findings suggest that though the distance learning students generally preferred Biology items to Physics and Chemistry items that does not necessarily mean that they also performed very well in them. It is possible that they went for items covering Biology topics because they could better relate with issues in Biology than issues in Physics and Chemistry. Thus, Biology appears to be popular with the distance education students of University of Education, Winneba. This finding agrees with views of other writers who asserted that compared to other science subjects, Biology enjoys the most popularity among students ([17] and [18]). Generally, many people find Biology to be more interesting than the Physical Sciences. This is attested to by [19] that among 17-year-old students who elected to study science for their matriculation examination, 72% found the study of Biology interesting, whereas only 48% found the study of Physics interesting. Furthermore, [20] report that in England and Wales Biology is much more popular than Physics. Therefore, the findings in this study are just depicting the world trend.

In another explanation, [21] observe that one of the reasons that students show disinterest in science is the lack of relevance of formal science education to the lives, needs, and interests of many students, especially females. This concern is even more relevant for many students in developing countries, who feel that school science is like a foreign culture because of the fundamental differences between the culture of Western science and their indigenous cultures [21]. According to [22] and [23] teaching students what they want to know can be a very beneficial pedagogical strategy because positive relationships have been reported between interest and a wide range of learning indicators. Interest plays a role in learning through its contribution to students' connection with the content (affective response) and maintaining that connection for sufficient time to be able to learn (persistence) [24]. Taking cues from these assertions it can be said that in this study students might have found physics and chemistry as not too relevant to their needs, hence their interest in Biology more than the other two subject areas. On the other hand the foundations of the students from lower levels of education could also be a factor. This is because in the case of diploma students the two courses are compulsory. Therefore, majority of the students might be non-science students who did not like science. However, since they must pass it before a diploma can be awarded to them they might be more interested in a subject area that they consider easier to learn, hence their interest in Biology items more than Physics and Chemistry items. This is in consonant with the observation of [25] that interest in science appears to be aroused at an earlier age than interest in other curriculum areas, suggesting that primary science experience might be important for future students' long-term interest in the subject.

A factor also to consider in this study is the curriculum. The curriculum is an imposed one not taking into consideration the interests and ability of the students. However, teaching students what they want to know can be a very beneficial pedagogical strategy. For example, adults seem to be more interested in Human Biology because they are more concerned with health issues. A number of researchers point it out that older pupils show interest in Human Biology ([26], [13] and [27]). The increased interest in Human Biology among adolescents is probably due to the approach of puberty and the related increasing interest in one's body. This is because this appeals to their needs. However, curriculum developers and teachers often lack the necessary knowledge on which to base teaching which is responsive to students' genuine interests and informational needs [28]. Though the distance education curriculum of University of Education, Winneba is geared towards training the distance learning students to teach at the Basic School level in Ghana a deliberate effort to include topics that can appeal to adults more and at the same time serve the purpose would have been a useful thing to arouse the interest of the learners.

Representing reality in the form of an object to clarify a concept is one way of simply allowing someone to see for

herself/himself the characteristics of this object [29]. It is also a known fact that learning activities that enhance practical work, problem solving, and investigation hinge on the appropriate use of teaching aids which in turn elicit discussions [30]. Information is appropriately acquired through our five senses. There is interdependence between the information that learners gather through the different senses and how they learn and remember it ([31] and [32]). However, on large scale, the distance education students of University of Education, Winneba are only taken through the contents in the course books without any practical work. As such, abstract concepts in Physics and Chemistry that the students cannot easily relate to can scare them off. Perhaps that is also one of the reasons why they did not show much interest in Physics and Chemistry components of their examination papers.

Despite the fact that the distance learners seem to be interested in Biology items more than items from Physics and Chemistry, they did not necessarily perform very well in them. This shows that though Biology is a reading subject and appeals to more people who do not like subjects with calculations, it does not necessarily mean that Biology is an easy to pass subject because it is full of terminologies and technicalities, which may not be easily substituted. The Section C results also show that the performance in the three courses is an average one where the best performance ranges between mean of 5.57 and 8.30 out of 15 marks for each question. This may further point to lack of interest in science by the learners. It is documented evidence that a negative attitude to a subject leads to lack of interest, while a positive attitude to science leads to a positive commitment to science that influences lifelong interest and learning in science (Simpson & Oliver, 1990).

V. CONCLUSION

From the findings of this study, it can be concluded that the distance education students of University of Education, Winneba prefer biology items to items from Physics and Chemistry. However, they did not perform very well in their preferred items. This suggests that preference does not necessarily mean that one can do well in what is preferred. It can also be concluded that the students generally did not perform well in the three courses, pointing to the age-old disinterest in science. This calls for a deliberate effort on the part of the authorities of the University of Education, Winneba to put mechanisms in place to encourage their distance learners to show more interest in science subjects. It may not be out of place if topics that can appeal to the needs and interests of the learners are infused into the curriculum. It is also suggested that science course tutors on the distance education programme should use more friendly methods to encourage students to like Physics and Chemistry topics as well.

REFERENCES

[1] Dearing, R. (1996). *Review of Qualifications for 16-19 Year Olds*. London: Schools Curriculum and Assessment Authority.

[2] National Commission on Mathematics and Science Teaching for the 21st Century (2000). *Before it's too late.* Washington, DC: US Department of Education.

[3] Trumper, R. (2006). Factors Affecting Junior High School Students' Interest in Biology[1]. *Science Education International 17*(1): 31-48

[4] Gardner, P. (1975). Attitudes to science: A review. *Studies in Science Education, 2*: 1-41.

[5] Menis, J. (1983). Attitudes towards chemistry as compared with those towards mathematics among tenth grade pupils (aged 15) in high level secondary schools in Israel. *Research in Science & Technological Education, 1*: 185-191.

[6] Sjøberg, L. (1983). Interest, achievement and vocational choice. *European Journal of Science Education, 5*: 299-307

[7] Weinburgh, M. (1995). Gender differences in student attitudes toward science: A Meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching, 32*: 387-398.

[8] Francis, L., & Greer, J. (1999). Measuring attitudes towards science among secondary school students: The affective domain. *Journal of Research in ScienceTeaching, 35:* 877-896

[9] Jones, G., Howe, A., & Rua, M. (2000). Gender differences in students' experiences, interests, and attitudes towards science and scientists. *Science Education,84*: 180-192.

[10] Sjøberg, S. (2000). Interesting all children in 'science for all'. In R. Millar, J. Leach & J. Osborne (Eds.), *Improving Science Education*. Buckingham: Open University Press

[11] Selim, M. & Shrigley, R. (1983). The group-dynamics approach: A socio-psychological approach for testing the effect of discovery and expository teaching on the science achievement and attitude of young Egyptian students. *Journal of Research in Science Teaching, 20*: 213-224.

[12] Kahle, J. & Meece, J. (1994). Research on gender issues in the classroom. In D. Gabel (Ed.), *Handbook of Research on Science Teaching and Learning*. New York: Macmillan.

[13] Tamir, P., & Gardner, P. L. (1989). The structure of interest in high school biology. *Research in Science & Technological Education, 7*(2): 113-140.

[14] Sjøberg, S., Schreiner, C. & Stefansson, K. (2004). The voice of the learners: International perspectives on S&T based on the ROSE project. *Proceedings of the XIth Symposium of IOSTE: Science and Technology Education for a Diverse World - dilemmas, needs and partnerships*. Lublin: Poland.

[15] Deci, E. L. (1992). The relation of interest to the motivation of behavior: A self-determination theory perspective. In Renninger, K. A., S. Hidi, and A. Krapp, editors. *The Role of Interest in Learning and Development.* .Hillsdale, NJ: Lawrence Erlbaum Associates.

[16] Krapp, A. (2002). An educational-psychological theory of interest and its relation to SDT. In Deci, E. L. and R. M. Ryan, editors. *Handbook of Self-Determination Research* . Rochester, NY: University of Rochester.

[17] Baram-Tsabari, A. and A. Yarden. (2005). Characterizing children's spontaneous interests in science and technology. *International Journal of Science Education 27*:7803–826

[18] Murray, I. and M. Reiss. (2005). The student review of the science curriculum. *School Science Review 87*:31883–93.

[19] Tamir, P., Levine, T, Lewy, A., Chen, D., & Zuzovsky, R. (1988). *Science Teaching in Israel in the Eighties.* Jerusalem: Hebrew University, Israel Science Teaching Center.

[20] Spall, K. Barrett, S., Stanisstreet, M., Dickson, D. & Boyes, E. (2003). Undergraduates' views about biology and physics. *Research in Science & Technological Education, 21*: 193-208.

[21 Aikenhead, G. S. & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching, 36*(3): 269-287.

[22] Pintrich, P. R. & Schunk, D. H. (2002). *Motivation in education: theory, research, and applications* (2nd ed.). Upper Saddle River, NJ: Merrill.

[23] Seiler, G. (2006). Student interest-focused curricula. In K. Tobin (Ed.), *Teaching and learning science: A handbook* (Vol. 2). Westport, CT, US: Praeger.

[24] Ainley, M., Hidi, S., & Berndorff, D. (2002). Interest, learning, and the psychological processes that mediate their relationship. *Journal of Educational Psychology, 94*(3): 545-561.
[25] Ormerod, M. & Duckworth, D. (1975). *Pupils' Attitudes to Science.* Slough: National Foundation for Educational Research.
[26] Osborne, J. and S. Collins. (2000). *Pupils' and parents' views of the school science curriculum* London: King's College, London.
[27] Stawinski, W. (1984). *Development of students' interest in biology in Polish schools. Interests in Science and Technology Education 12th IPN Symposium*. Kiel: Germany.
[28] Baram-Tsabari, A., Sethi, R. J., Bry, L. and Yarden, A. (2010). Identifying Students' Interests in Biology Using a Decade of Self-Generated Questions. *Eurasia Journal of Mathematics, Science & Technology Education*, 2010, **6**(1): 63-75. Retrieved from www.ejmste.com on 23rd January, 2015.
[29] Romiszowski, A. (1968). *The selection and use of teaching aids*. London: Kogan Page.
[30] Mamokhele, J. M. (2002). *An analysis of the use of teaching and the implications for and learning Mathematics in QwaQwa Phase one schools (South Africa).* Master of Arts Thesis presented to Concordia University, Montreal, Quebec, Canada
[31] Van Rooyen, H. and Van der Merwe, C. (1996). Teaching Media. In M. Jacobs and N. Gawe (Eds.), Teaching-learning dynamics: *A participative approach,* (237-279). Johannesburg: Heineman
[32] Spencer, K (1988). *The psychology of educational technology and instructional media*. London: Routledge.
[33] Simpson, R. & Oliver, J. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education, 74*: 1-18.

AUTHOR'S PROFILES

Dr. Wisdom H. K. Hordzi

Hordzi is a Senior Lecturer at the Centre for Distance Education; Institute for Educational Development and Extension; University of Education, Winneba. He has been a science teacher for the past 27 years. He holds PhD and MPhil in Zoology with specialty in Entomology from the University of Cape Coast, Ghana; Post Graduate Diploma in Distance Education from Indira Gandhi Open University, BSc (Hons) in Biology from University of Cape Coast, Diploma in Education and Chartered Institute of Marketing Certificate in Marketing. He has been working as a lecturer with the University of Education, Winneba since 2002. His interest areas of research are use of local materials in preparation and teaching of science, Pollination Biology, HIV/AIDS, Distance learners and study of science and Innovation in science education. He has a number of publications in science, HIV/AIDS, distance education and Innovation.