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A BIBLIOMETRIC ANALYSIS OF THESES AT THE SCHOOL OF NUCLEAR AND ALLIED SCIENCES, UNIVERSITY OF GHANA, LEGON

BY

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Abstract

The purpose of the study was to analyse the Master of Philosophy and the Doctor of Philosophy theses publications by postgraduate students at the School of Nuclear and Allied Science (SNAS), University of Ghana from (2008 - 2016) using the INIS database as the source of data. The study used the bibliometric method. The purposive sampling technique was used to retrieve four hundred and fourteen (414) theses records from a population of five hundred and thirty eight (538) theses records published in Ghana. The International Nuclear Information System (INIS) database and the search query language (country:Ghana AND recordtype:Thesis/Dissertation) were the main instruments used in retrieving the data before extracting them onto Microsoft excel spreadsheet for analysis. The major findings of the study revealed that the yearly publication trend of graduate student theses at SNAS showed a constant rise and fall in the number of theses published over the period. There was also a big gender gap with male students dominating their female counterparts with (300 or 79.71%) counts. The most frequently used keyword assigned by the indexer (subject specialist) was radiation protection with (189) counts. It is recommended that SNAS should gain autonomy from the University of Ghana, the parent University as it will enable it to run its academic programs by itself, take decisions that will benefit its smooth running and management in the long run and also help to accelerate the plans already in place for a nuclear power plant to be added to the energy mix for Ghana.

Keywords: Bibliometrics, Theses, Postgraduates, International Nuclear Information System, International Atomic Energy Agency, School of Nuclear and Allied Sciences, Ghana Atomic Energy Commission Library, Bibliography

1. INTRODUCTION

1.1 Background to the study

The application of Bibliometrics has been in existence since the days of Gross and Gross (1927), where the means of scholarly communication was mainly through non-electronic resources such as books, theses and journals. This has changed with the arrival of Information and Communication Technology (ICT) to include digital or electronic resources. The use of Bibliometrics as an evaluation tool enables Library and Information scientists (LIS) to conduct studies on theses and dissertations, databases, online journals and institutional repositories.

Academics play an important role in the research process. For instance, they play a pivotal role in guiding students to undertake an independent academic study and finally come out with the findings of their thesis which helps to fill the research gap. These theses do not just end up on the shelves of these academic institutions but sometimes can be found on online databases, institutional repositories and even published in online journals.

In the words of Alemna (2016), "Academics all over the world place emphasis on research and publications, not only because it is presumed that research enriches both teaching and the learning process as well as contributing to the body of knowledge, but also because it is a major determinant of institutional prestige" (p. 4).

Due to information overload, academic institutions and their staff, students, library and Information scientists (LIS), researchers, Governments and Policymakers are therefore not always aware of the means by which scholarly materials are published and shared.

Based on supporting literature and practical experiences, "Bibliometrics is ideal for librarians to develop and provide innovative services for both academic and administrative university staff. In doing so they made sure to actively participate in the development of new strategies and in fostering innovation". (Gumpenberger, Wieland and Gorraiz, 2012).

In Sri Lanka, Dilani (2015) argues that librarians can respond to the research demands of students by analysing bibliographic citations in theses through the use of citation analysis. This is a commonly used bibliometric method worldwide which is a useful tool for collection management.

In Austria, the International Nuclear Information System (INIS) secretariat offered bibliometric services to the Physics Section of the International Atomic Energy Agency (IAEA) by analysing the topic 'muon tomography' (IAEA, 2017). Assessing research output and impact using bibliometrics has now become a common phenomenon worldwide.

1.2 School of Nuclear and Allied Sciences (SNAS), University of Ghana

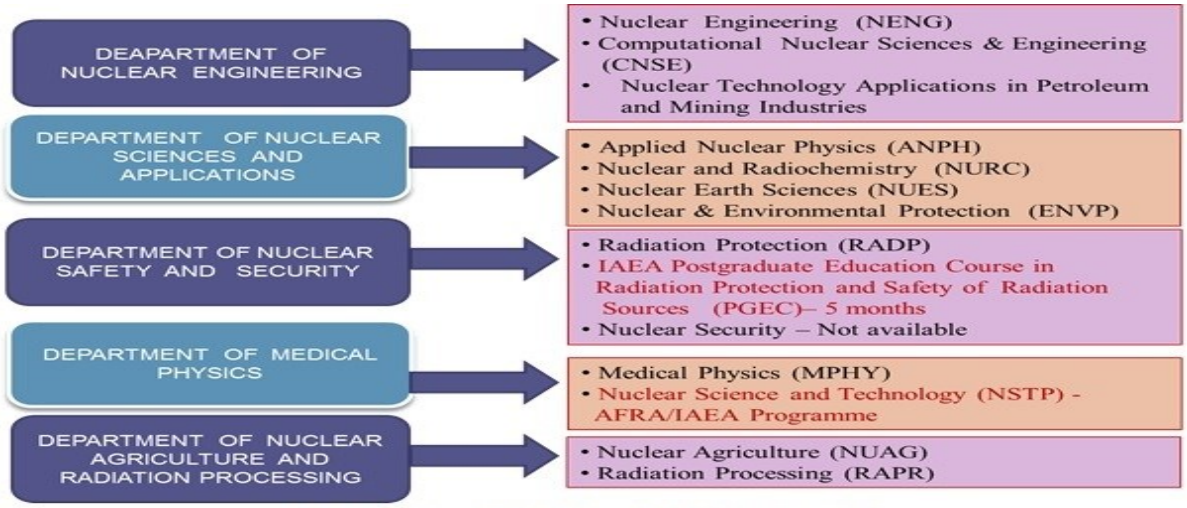
The IAEA's General Conferences of 2002, 2003 and 2004 all adopted a resolution on nuclear knowledge which was meant to address the usefulness of nuclear knowledge management, calling for greater concern as well as making the International Atomic Energy Agency and its Member States to step up their activities and efforts in this important area (IAEA, 2007).

These knowledge management initiatives became paramount during that period since according to the IAEA (2007), "A large number of veteran nuclear professionals including engineers, researchers, and professors are reaching their retirement ages. At the same time, the younger generation appears to be losing interest in nuclear technology, which they do not consider as attractive or challenging as it was in the past. These factors are causing a situation that threatens to jeopardize smooth and effective technology transfer giving rise to the looming risk of a shortage of knowledgeable workforce in the future" (p. 1). In response to this threat Ghana in 2005 declared its intention to train and develop nuclear scientists and engineers to meet the manpower requirements for the peaceful development and use of nuclear energy and technology in Ghana and the rest of Africa during the 117th IAEA Board of Governors meeting in Vienna, Austria (IAEA, 2007).

The training of nuclear scientists started in 2006 with the establishment of the School of Nuclear and Allied Science (SNAS) jointly by the Ghana Atomic Energy Commission (GAEC) and the University of Ghana (UG) with support from the International Atomic Energy Agency (IAEA), Vienna, Austria. In 2009, SNAS was officially upgraded to a Regional Centre of Excellence for professional and higher education in Nuclear Science and Technology and now called the African Regional Cooperative Agreement for Research Development and Training related to Nuclear Science and Technology (AFRA)/IAEA. In October 2011, SNAS was again designated as the IAEA Regional centre for training in radiation protection. Since the 2014/2015 academic year, SNAS has been under the College of Basic and Applied Sciences when the collegiate system was adopted (University of Ghana, 2014). SNAS currently has five

(5) established departments offering 14 programmes. This is illustrated in figure 1 below.

Figure 1: Departments and Programmes offered at SNAS



Adapted from: Serfor-Armah, Y. (2015, p. 11)

1.3 International Nuclear Information System (INIS)

INIS was established in 1970 and it is one of the biggest repositories containing over 4 million published literature on the peaceful uses of nuclear science and technology. INIS constitutes a very remarkable example of global cooperation under IAEA auspices (Savic, 2017).

INIS is currently operated by the IAEA in collaboration with 154 members who are made up of 130 countries and 24 international organisations who all come together to contribute and share nuclear literature in their member states and organisations.

1.4 Ghana Atomic Energy Commission (GAEC) library

The GAEC Library exists to support the teaching, learning and research activities of the commission and SNAS. It serves as a resource base for information in nuclear science and technology in Ghana. The library is the designated International Nuclear Information System (INIS) centre for the country and therefore responsible for fulfilling article **2.3.1** of the INIS members' rights, privileges and responsibilities namely the collection, selection, description, categorization, indexing, abstracting and related preparation, of items of literature published within its national boundaries (or organizational confines if an international body) and submission to the INIS Secretariat in Vienna in accordance with the definitions, rules,

procedures, formats, and guidelines set forth in the 'IAEA/INIS Reference Series' and associated INIS Circular Letters (IAEA, 2000).

1.5 Statement of the Problem

To fulfil the nuclear sector manpower requirements of the country SNAS was established in 2006 to train nuclear scientists in Ghana and the rest of Africa. Several academic research works have been undertaken by over five hundred (500) postgraduate students who have graduated from the programmes offered at SNAS over the period.

Also, the GAEC library which is the mandated national Internal Nuclear Information System (INIS) centre has also been collecting, processing and forwarding relevant inputs on nuclear sciences and applications within Ghana to the INIS secretariat in Vienna, Austria for onward transmission to the INIS database. Some of the inputs processed by the GAEC Library include the theses from SNAS which rank among the top best globally in terms of input contribution and quality.

A review of the literature shows that several bibliometric studies have been conducted by various researchers to evaluate research outputs in several research and academic institutions. Some of these include (Agyeman and Bilson, 2015; Kankam, 2014; Tsafe and Aliefo, 2008; Fosu and Alemna, 2006).

Bibliometric studies aid in policy evaluation and the review of research output. This may explain the reason why the Research Excellence Framework (REF) was established in 2014 to secure the continuation of a world-class, dynamic and responsive research base across the full academic spectrum within the United Kingdom higher education (REF, 2014).

SNAS by virtue of being a centre of excellence has continuously trained high calibre Nuclear Scientist both in Ghana and Africa for the past decade. However no study available has attempted to investigate the research output of postgraduate students at SNAS since its inception a decade ago. It is against this background that this study attempts to analyse the bibliographic data of Master of Philosophy (M.Phil.) and Doctor of Philosophy (Ph.D.) theses publications by postgraduate students at SNAS, University of Ghana from (2008 - 2016) using

the INIS database as the source of data in other to identify the research output, measure enrolment and identify areas of research.

1.6 Objectives of the Study

The main objectives of the study are:

1. To identify the number of graduate student theses by year.
2. To identify the academic qualifications awarded.
3. To identify the gender distribution of graduate students.
4. To identify the distribution of graduate student theses by academic department.
5. To identify the subject coverage of graduate student theses.
6. To identify the page range, figures and tables and citations found in theses by graduate students.
7. To identify the most frequently used keywords assigned by the indexer (subject specialist).

1.7 Theoretical Perspective

This study will use Pritchard's (1969) Bibliometrics theory. According to Carrizo-Sainero (2000), "the conceptual and theoretical foundations of the science of Bibliometrics rely on the following hypotheses:

(a) Bibliometrics finds its epistemological roots in Bibliography;
(b) Bibliometrics, as applying Bibliography, constitutes a factor of measurement and evaluation of information sources and
(c) Bibliometrics consists in a method, or set of methods, that can be employed to evaluate research" (p. 1).

1.7.1 Pritchard's Bibliometrics Theory

The theoretical foundations of bibliometrics was laid by notable pioneers such as Gross and Gross (1927), Lotka (1926), Bradford (1934), Zipf (1949) and Garfield (1955). However its usage and practice of what is now known as bibliometrics can be traced back to the earlier model of Hulme (1923) called "Statistical Bibliography". Bibliometrics was however first used by Pritchard (1969) in a publication titled "Statistical Bibliography or Bibliometrics" in the "Journal of Documentation". He reiterated that the term "Statistical Bibliography" was clumsy,

not very descriptive, and could be confused with statistics itself or bibliographies on statistics. He proposed a new term called Bibliometrics which he referred to as "the application of mathematics and statistical methods to books and other media of communication" (p. 2).

The bibliometric model has been tested and used extensively in diverse disciplines and has become a basic instrument used in evaluating research performance. Tague (1988) is of the view that bibliometrics has been heralded as the theoretical basics of information science. It is not surprising that Pritchard (1969) in the conclusion of his publication entitled "Statistical Bibliography or Bibliometrics" by indicating that the term BIBLIOMETRICS was going to be be used fully in every study that aims at quantifying the processes of written forms of communication and it will be quickly in the information science field. It is not surprising that today bibliometrics has become a widely used research approach to quantify various forms of publications.

Regarding this study, the variables of the bibliometric theory are as follows:

(a) Bibliography - The bibliographic details of M.Phil. and Ph.D. theses publications from SNAS, University of Ghana from (2008 - 2016) indexed in the INIS online bibliographic database.

(b) Measurement and evaluation - Review of theses publications by postgraduate students of SNAS, University of Ghana from (2008 - 2016) using data from the INIS online bibliographic database to get the results or outcomes from the study.

(c) Method or a set of methods - The bibliometric method. The bibliometric model was therefore appropriate for investigating the study.

2. LITERATURE REVIEW

In the view of Agyeman and Bilson (2015), "Bibliometrics, also known as scientometrics is a a research technique in library and information science that applies quantitative analysis and statistics to describe publication patterns in any field of knowledge" (p.2).

Thomson Reuters (2008) also defines bibliometrics as "the application of quantitative analysis and statistics to publications. It is used in research performance evaluation especially in university and government laboratories and also by policymakers, research directors and administrators, information specialists and librarians, and researchers themselves" (p.2).

Several studies have been conducted to investigate theses and dissertations of students from academic institutions in different parts of the world.

In India, Kavitha and Sivaraj (2014) reviewed 106 Ph.D. theses in commerce at the Periyar University, India from 1989 - 2012. Their research findings revealed that out of 106 Ph.D. theses submitted during the period, the year 2009 recorded the highest number of theses with 21 (19.81%) counts and the lowest number of theses submitted was 1 (0.94%) counts in 1993, 1999, 2002 and 2004. Theses submitted during the period by male and female students were 80 (75.47%) counts and 26 (24.53%) respectively. The total citation count for the 23 year period i.e. 1989 - 2012 was 1951 citations. The most preferred subject area for undertaking the Ph.D theses in commerce was marketing with 26 (24.53%) counts.

In another study in India, Mishra, Gawde and Solanki (2014) quantitatively analysed 55 Ph.D. theses in english submitted between 1975 - 2007 at Vikram University. The outcomes of their research findings revealed that the highest number of theses was submitted in 1991, 1996 and 2002 with 5 (9.09%) counts each. Male researchers dominated their female counterparts with 30 (55%) counts and 25 (45%) counts respectively which confers with the findings by Kavitha and Sivaraj (2014). Their findings further revealed that all theses used a combined citation total of 5399 and 51 - 100 references was the highest with 30 (54.55%) counts.

Rarely has any bibliometric analysis been done on theses publication in the nuclear science and technology field using the INIS database as source of data. However directly related to this study is the quantitative analysis of theses at the Instituto De Pesquisas Nucleares - São PAULO Brazil by Santos et.al. (n.d.). These theses were analysed using the INIS/ETDE (Energy Technology and Data Exchange) manual as the data source. The results of their study revealed that the theses spread through 33 subject categories with material science having the highest number of theses (243).

In France, Salmi, Gana and Mouillet (2001) studied the patterns of French medical theses between 1st January 1993 and 31st December 1997 using a random sample from 36 Universities with data extracted from the CD-ROM Doc-Thèse. The results of their study showed that out of the 300 theses included in the study 238 (79.3%) were from medicine, 43 (14.3%) from surgery, and 19 (6.4%) from biology. Also, a total of 51 theses (17.0%) resulted

in publication. They also discovered that almost all the French medical theses were not made available to the scientific community.

Sudhier and Kumar (2010) analysed 168 biochemistry Ph.D. theses awarded at the University of Kerala, India. Their research findings showed that the highest number of Ph.D. theses was awarded during 1993 with 16 theses. The page distribution of the Ph.D. theses showed that theses with the highest number of pages ranged from 151 - 200 pages with 70 (41.66%) counts. With regard to the gender distribution of Ph.D. theses females dominated with 89 theses as against their male counterparts with 79. This finding is in direct contrast to the findings by Kavitha and Sivaraj (2014) and Mishra, Gawde and Solanki (2014). With the distribution of citations in theses, 201 - 300 citations was the highest with 55 (32.74%) counts.

In a bibliometric study in Sri Lanka, Angammana and Jayatissa (2015) studied postgraduate theses in Library and information science at two educational institutions namely University of Kelaniya and University of Colombo, Sri Lanka using the bibliometric research technique. For this study 70 theses were analysed comprising 50 theses submitted for the Master of LIS degree (MLS) of the University of Colombo and 20 theses submitted for the Master of Social Science in LIS (MSSc) of the University of Kelaniya. It was revealed that there was a total of 4,901 citations. The most cited information source was books with 1921 (39.20%) whiles the least cited information sources were pamphlets with 5 (0.10%) counts.

Suma and Sudhier (2013) investigated 137 doctoral dissertations of CSIR-National Institute of Interdisciplinary Science and Technology (NIIST) from 2001 to 2010. The findings of their study revealed that the highest number of theses was submitted in 2007 with 21 (15.33%) counts whiles the lowest number of theses was submitted in 2003 with 4 (2.92%) counts. There was a total of 33,263 references with an average of 242.79 per thesis. The subject distribution of the theses revealed that Chemistry was the most researched area with 107 (78.10%) counts.

Ezema (2016) studied scholarly communication behaviour in language research theses in Nigeria with the aim to strengthen the collection development policy in linguistics research. Using bibliometric and informetric indicators, a total of 87 theses and dissertations submitted from 2005 to 2014 at the Department of Linguistics and Nigerian Languages, University of Nigeria, Nsukka were examined. The major findings from the study was that 2009 recorded the highest number of theses with 12 (13.8%) counts whiles 2005 recorded the lowest number

of theses with 6 (6.9%) counts. There was also a total of 5084 bibliographic references that were extracted from the theses with an average of 58.4 citations per theses.

Sam and Tackie (2007) analysed (67) Master of Arts dissertations from the Department of Information Studies, University of Ghana from 1998 to 2004 using the citation analysis approach. The findings of their study revealed that the most cited material were books and monographs with 969 (43.8%) counts. This was followed by journal articles with 550 (24.9%) counts whiles unpublished materials was the least cited material with 4 (0.2%) counts. The most common research area among graduate students was information technology followed by evaluation of information services. On the other hand reading habits was an inactive research area. From the study the authors are of the view that citation analysis is a helpful tool for evaluating the use of library materials, with implications for collection management and development.

In another study in Ghana, Fosu and Alemna (2006) analysed Masters dissertations which focused on studying the University of Ghana Balme Library from 1998 - 2005. The goal of the study was to find out whether the management of the Universities Library had carried out the suggestions from the various dissertations submitted. Their analysis looked at the form, type and year of dissertation, subject and whether it was written by Balme Library staff or not. The findings from their study indicated that the suggestions in the dissertations had not been carried out by the library because management was not even aware of the findings and suggestions made in these dissertations. The researchers put across some suggestions to help overcome the problem. This included the need for staff of the Balme Library to supervise some of such dissertations or, failing this, and/or the need for the management of the library to, at least, be made aware of studies and recommendations relating to the Balme Library.

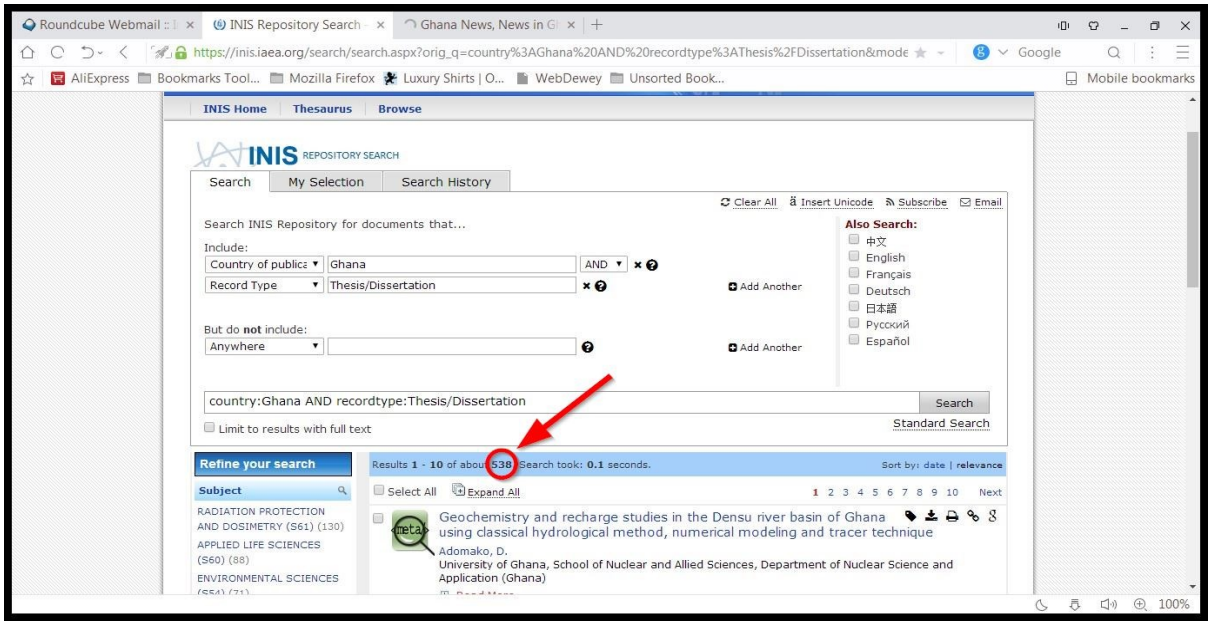
Imoro (2017), undertook an in-depth bibliometric analysis of the citation patterns of Ph.D. theses submitted to the University of Cape Coast from 2005 to 2016. The theses were obtained from the Africana section of the Sam Jonah Library. The findings of his study revealed that male students dominated their female counterparts with 28 (80.0%) and 7 (20.0%) of the Ph.D. theses respectively. Also, Ph.D. theses within the range of 201 - 300 pages were the highest with 17 (48.60%) counts. Agriculture was the most researched subject area with 11 (31.4%) counts. A total of 6,458 citations were analysed with the citation range of Ph.D. theses within the range of 101 - 200 dominating with 17 (48.6%) counts. Again the majority (73.3%) of

journals cited by Ph.D. students could be accessed through the Sam Jonah Library's subscribed online databases. The study points out that even though usage of these databases were high among Ph.D. students, there was the need for greater awareness and training in the use of these databases.

3. METHODOLOGY

The study used the bibliometric method to statistically analyse and obtain data on the M.Phil and Ph.D. theses publications by graduate students theses at the School of Nuclear and Allied Sciences, University of Ghana from 2008 - 2016 using the INIS database as the source of data. It combined both the descriptive and evaluative bibliometric approaches. For this study, the population was all theses published in Ghana and indexed in the INIS database. The population for the study was five hundred and thirty eight (538) theses records. This is illustrated in figure 2 below.

Figure 2: Population for the study



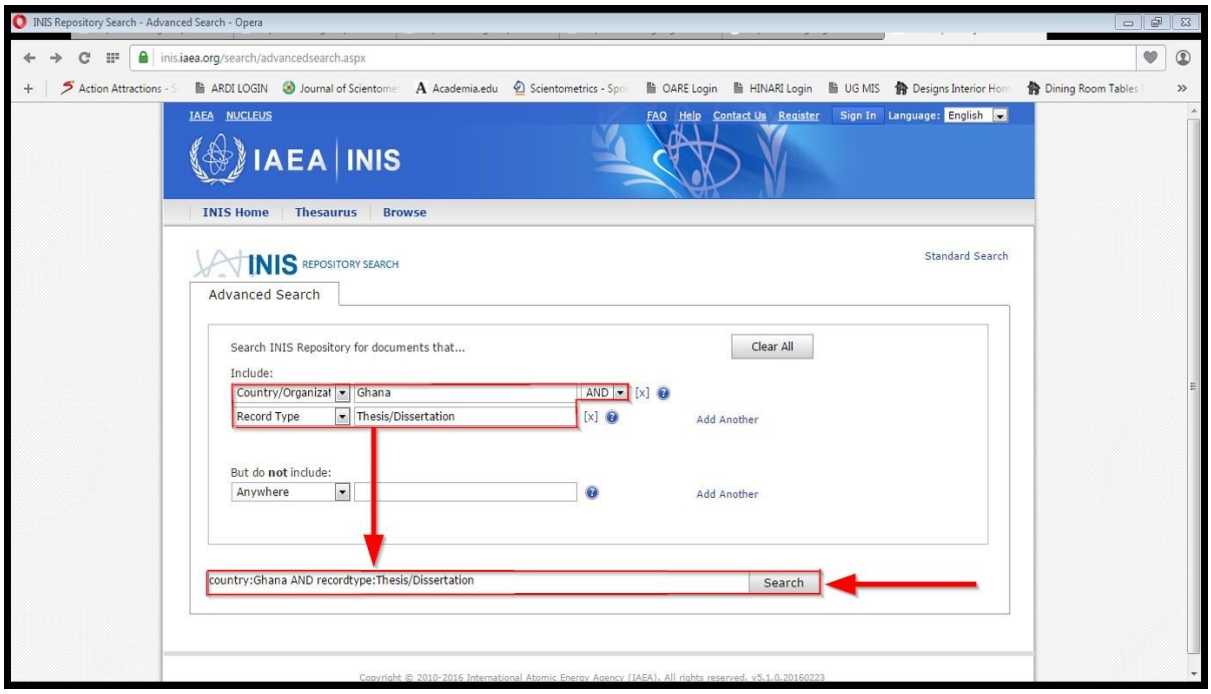
Source: International Nuclear Information System (INIS) repository search

The sample size for the study was four hundred and fourteen (414) theses indexed in the INIS database. These constituted the theses publications from SNAS that were indexed in the INIS database. The study used the purposive sampling technique. The justification for this sampling technique was that some of the theses publications from the population (538) were not

published at SNAS and since the researcher knows the specific sample to use from the population i.e. theses publications from SNAS, the sampling technique used allowed the researcher to identify and retrieve (414) theses publications from SNAS which were available on the INIS database to answer the research questions.

The INIS database and a search query language were the main data collection instruments used for data collection in the study. The INIS database is an online bibliographic database which contains information on all aspects of the peaceful applications of nuclear science and technology. In retrieving the relevant records for the study, the advanced search page was selected from the INIS advanced search page. Using the query builder tab the Country of publication was first selected from the list box and Ghana typed into the corresponding box. Then in the same interface add another was selected to generate a second list box before selecting Record Type and then Thesis/Dissertation after which the search button was then clicked to display the search results. After going through the steps above the search query language to retrieve the required records and answer the research questions was as follows: **country:Ghana AND recordtype:Thesis/Dissertation.** This is illustrated in figure 3 below.

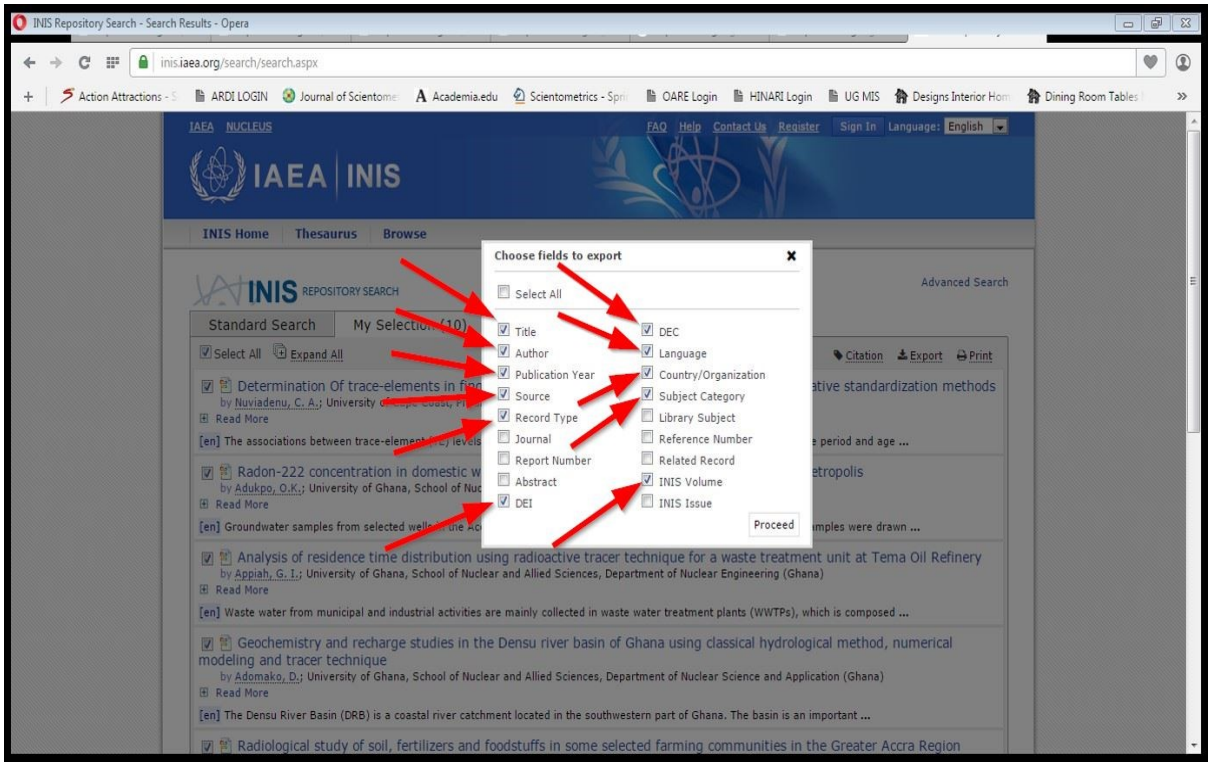
Figure 3: Search query language



Source: International Nuclear Information System (INIS) repository search

After the search results were generated the records were selected and the selection button clicked on. The export button was selected next which brought up a drop down menu to choose the format in which to export the records. Microsoft excel spreadsheet was the preferred format for downloading the data. Bibliographical access points that were taken into account before exporting the data into microsoft excel spreadsheet were as follows: title, author, publication year, source, record type, subject category, country/organisation, descriptors (DEI and DEC), country/organisation, subject category and INIS volume. The records were then downloaded and verified to ensure that all the theses records were published in Ghana and at the SNAS, University of Ghana. Records that did not meet the criteria were excluded from the analysis. This then become the master list for the analysis. The bibliographic access points chosen and the exporting of data to Microsoft excel is illustrated in figures 4 and 5 below.

Figure 4: Bibliographic access points chosen



Source: International Nuclear Information System (INIS) repository search

Figure 5: Exporting of data to Microsoft excel

Source: International Nuclear Information System (INIS) repository search

The master list in Microsoft excel spreadsheet were then analysed, presented and illustrated using descriptive statistics such as frequency, graphs and charts. Based on the research questions, the worksheets created from the master list included year of publication, qualification, gender, department, subject, qualification and subject, figures, pages, tables, references and descriptors.

4. FINDINGS AND DISCUSSION

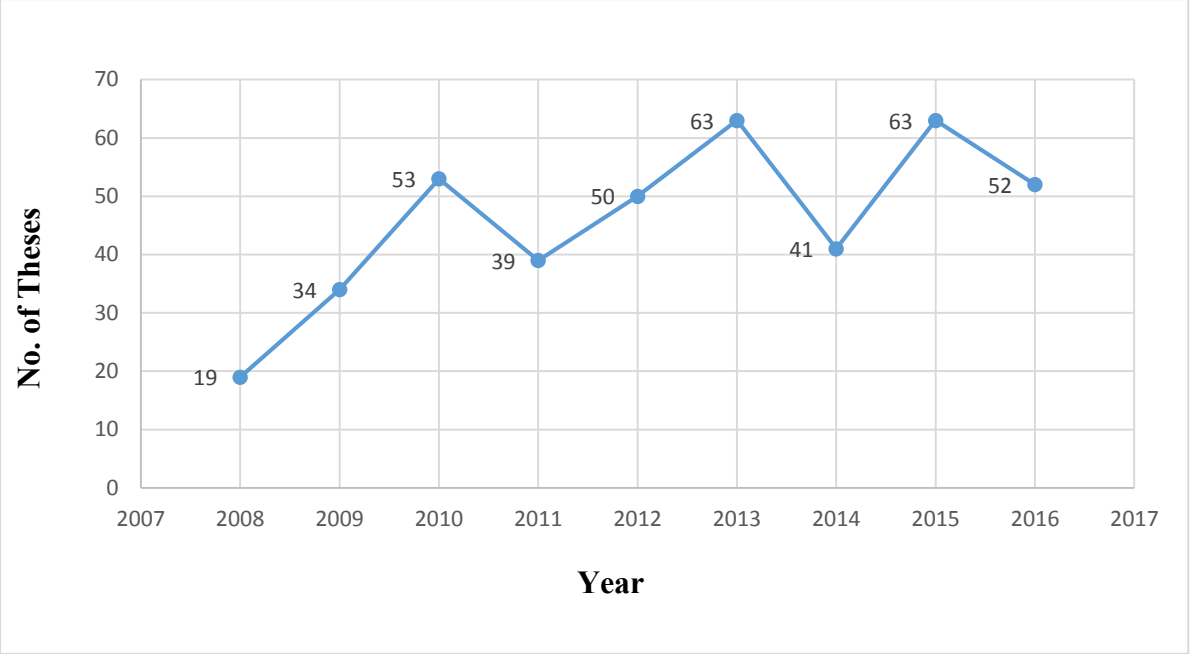
This section provides the analysis of the data and the presentation of the findings of the statistical and quantitative approach using the bibliometric method to analyse the M.Phil. and the Ph.D. theses at SNAS, UG from (2008 - 2016) using the INIS database.

Connaway and Powell (2010) are of the view that "Statistical analysis, or "statistics," is concerned with the development and application of methods and techniques for organizing and analyzing data (usually quantitative) so that the reliability of conclusions based on the data may be evaluated objectively in terms of probability" (p.261).

4.1 Number of Graduate Student theses by year

Figure 6 shows the yearly analysis of theses publications by graduate students from SNAS.

Figure 6 - Distribution of theses by year



Yearly analysis of publications enables one to understand the direction, growth and fall of such publications over a period. From figure 6 above, the yearly analysis of theses shows that the highest number of theses publications were in the years 2013 and 2015 with 63 (15.21%) counts each. This was followed by 2010 with 53 (12.80%) counts, 2016 with 52 (12.56%) counts, 2012 with 50 (12.07%) counts, 2014 with 41 (9.90%) counts, 2011 with 39 (9.42%) counts, 2009 with 43 (8.21%) counts and 2008 with 19 (4.58%) counts. The average number of theses for each year was 46.

In a bid to find out the yearly publication trend of graduate theses, the findings depicts a constant rise and fall in the number of theses published over the period (2008 - 2016). The number of theses increased from (19 to 53) from (2008 - 2010) and then decreased from (53 to 38) from (2010 - 2011). It again increased from (39 to 63) from (2011 - 2013) and then decreased from (63 to 41) from (2013 - 2014). Finally there was another increase from (41 to 63) from (2014 - 2015) before a decrease from (63 to 52) from (2015 - 2016).

This finding on the constant rise and fall in the number of theses concurs with the findings of Kumar, Sah and Singh (2013) who found out that in both Kumaun University and Delhi University the distribution pattern of doctoral theses was uneven from 2000 to 2004 showing increasing trends and then decreasing trends.

Again, findings by (Aliyu and Abba, 2009; Ezema, 2016; Tsafe and Aliefo, 2008; Bohra and Devi, 2015; and Mahapatra and Sahoo, 2004) have also shown a similar trend in the rise and fall in the number of theses published each year from the respective institutions that they investigated.

This trend in the constant rise and fall in the number of theses published each year may be attributed to the yearly increase in the academic user fees for prospective students by the University of Ghana (UG) which might have affected enrolment thereby contributing to the trend seen in figure 6.

Another reason could be that due to the yearly increment in the academic user fees charged by the University of Ghana (UG), prospective students/ nuclear scientists who want to build their profession in the nuclear field through reading nuclear science programs choose to enrol in Universities in Ghana offering similar nuclear related programs with less expensive academic fees.

Another reason could be that prospective students might have applied for admission and scholarship from Universities outside of the country to pursue nuclear related programs since they cannot fund the programs on their own by enrolling at SNAS due to the yearly increment in the academic user fees charged by the University of Ghana. Furthermore this could also be due to the fact that programs in the sciences by nature are expensive on their own in comparison with programs in the humanities and the yearly increment in academic user fees charged by the University of Ghana makes them even more expensive.

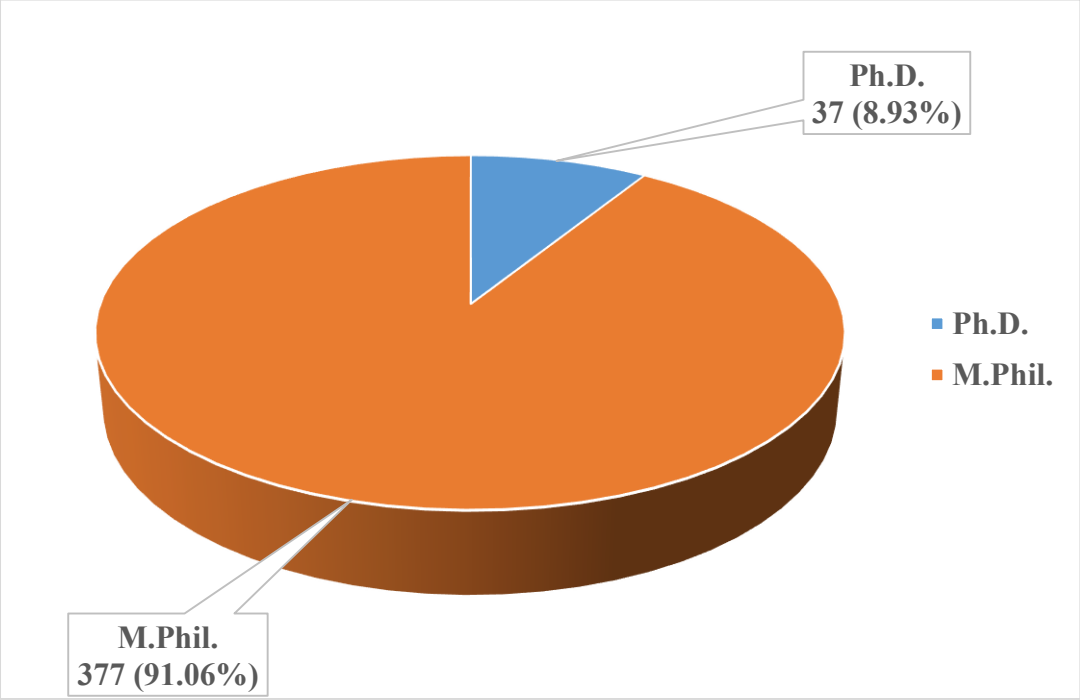
4.2 Academic qualifications awarded

The researchers wanted to know the type of academic qualification awarded and the yearly trend of theses qualifications.

4.2.1 Type of academic qualification

Figure 7 shows the type of academic qualifications that were awarded at SNAS.

Figure 7 - Type of academic qualification



The findings (Figure 7) above reveals that a total of 414 academic qualifications were awarded over the period (2008 - 2016). These academic qualifications were postgraduate qualifications namely the Ph.D. and the M.Phil. M.Phil. accounts for the highest number of theses with 377 (91.06%) counts followed by the Ph.D. with 37 (8.93%) counts.

The big difference between the M.Phil. and Ph.D. theses could be attributed to the fact that the entry level requirement in becoming an Assistant Scientific Officer is having a master's degree in a nuclear science related academic program and as such established technicians and technologists who want to upgrade themselves in the nuclear science profession as well as students looking to start a career in the Scientific Officers rank, enrolled to pursue the M.Phil. and this might have accounted for the high number of M.Phil. theses.

On the other hand, the low numbers in the Ph.D. theses could be due to the fact that for some years now, the University of Ghana has chosen to make Ph.D. programs at its institution to be full fee paying an option which is very expensive than the regular option since the government

provides no subsidy for this option thereby making the fees to be very high. Due to this, prospective students who might have qualified to gain admission to pursue these Ph.D. programs are left disappointed since it is only the rich and those who can afford to pay these high fees who enrol in these programs thereby accounting for the low numbers over the period.

Another factor for the low numbers in the Ph.D. theses could be attributed to the fact that while students offering similar Ph.D. programs in Ghana spend three years to complete, students at the University of Ghana rather spend 4 years and this might have made prospective students to opt for the other institutions due to the period involved.

4.2.2 Type of academic qualification awarded by year

Table 1 shows the type of academic qualification that was awarded each year.

Table 1 - Type of academic qualification awarded by year

Year	Ph.D	Percentage (%)	M.Phil	Percentage (%)	Count
2008	-	-	19	5.03	19
2009	-	-	34	9.01	34
2010	3	8.10	50	13.26	53
2011	4	10.81	35	9.28	39
2012	-	-	50	13.26	50
2013	4	10.81	59	15.64	63
2014	10	27.02	31	8.22	41
2015	7	18.91	56	14.85	63
2016	9	24.32	43	11.40	52
Total	**37**	**100.00**	**377**	**100.00**	**414**

The findings (Table 1) above shows that M.Phil. theses in the year 2013 had the highest number of awards with 59 (15.64%) counts. This was followed by the year 2015 with 56 (14.85%) counts, 2010 and 2012 with 50 (13.26%) counts each, 2016 with 43 (11.40%) counts, 2011 with 35 (9.28%) counts, 2009 with 34 (9.01%) counts and 2008 with 19 (5.03%) counts.

The Ph.D. theses on the other hand had the year 2014 having the highest number of awards with 10 (27.02%) counts. This was followed by the year 2016 with 9 (24.32%) counts, 2015 with 7 (18.91%) counts, 2013 and 2011 with 4 (10.81%) counts each, 2010 with 3 (8.10%) counts and 2008, 2009 and 2012 recorded no Ph.D. award.

The findings showed the non-availability of Ph.D. awards in 2008, 2009 and 2012. For the non-availability of Ph.D. awards in 2008 and 2009 this could be as a result of the fact that Ph.D. programs take about 3 to 4 years to complete. For the year 2012 the non-availability of Ph.D. awards might be as a result of no graduate student completing the program in that academic year. Again, from the findings the researchers also agree with the findings by Kumar, Sah and Singh (2013) that universities should encourage and motivate students for doing Ph.D. programs since the young generation are not much interested in doing Ph.D. after completion of the Masters degree.

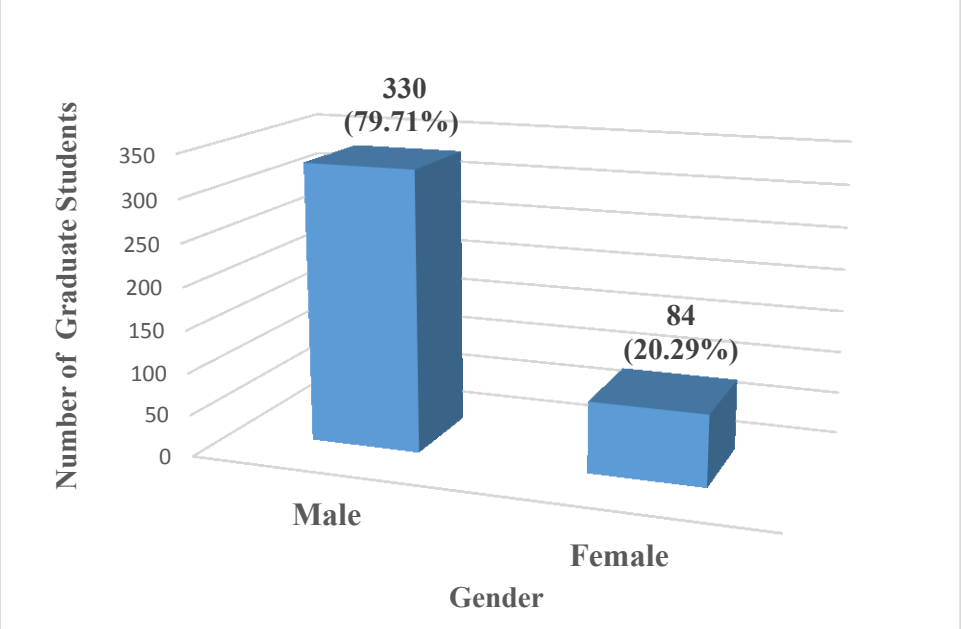
4.3 Gender distribution of Graduate Students

The researchers wanted to know the gender distribution of graduate students, gender distribution by year and the gender distribution by academic qualification.

4.3.1 Gender of Graduate Students

Figure 8 shows the gender distribution of graduate students at SNAS.

Figure 8 - Gender distribution of Graduate Students



From the findings in (figure 8) above, the analysis of theses by gender at SNAS revealed that out of the 414 theses published, males had 330 (79.71%) counts with their female counterparts having 84 (20.29%) counts which was almost four times the number of male graduate students.

The gender gap can be as a result of the fact that the general admission of students into nuclear sciences and application programmes is skewed towards males than females. The subject area involves the application of mathematics and due to the weak foundation in mathematics starting from the pre-school days through to adulthood, mathematics as a subject is an area females in the Ghanaian society are less likely to pursue than their male counterparts thereby accounting for the low numbers of female postgraduate students in the nuclear sciences field.

This findings on the gender distribution of graduate students in the current study is consistent with the findings of Bohra and Devi (2015); Kavitha and Sivaraj (2014); Mishra, Gawde and Solanki (2014); Kumar, Sah and Singh (2013) and Ramachandran (2012) who all reported that the majority of the male students were more than the female students in their respective studies investigated.

4.3.2 Gender Distribution by year

Table 2 shows the gender distribution of graduate students at SNAS by year.

Table 2 - Gender of Graduate Students by year

Year	Male	Percentage (%)	Female	Percentage (%)	Total
2008	17	5.15	2	2.38	19
2009	29	8.78	5	5.95	34
2010	45	13.63	8	9.52	53
2011	31	9.39	8	9.52	39
2012	33	10.00	17	20.23	50
2013	53	16.06	10	11.90	63
2014	34	10.30	7	8.33	41
2015	53	16.06	10	11.90	63
2016	35	10.60	17	20.23	52
Total	**330**	**100.00**	**84**	**100.00**	**414**

The findings (table 2) above shows that the highest number of male graduate students was in 2013 and 2015 with 53 (16.06%) counts. This was followed by 2010 with 45 (13.63%) counts, 2016 with 35 (10.60%) counts, 2014 with 34 (10.30%) counts, 2012 with 33 (10.00%) counts, 2011 with 31 (9.39%) counts, 2009 with 29 (8.78%) counts and 2008 with 17 (5.15%) counts. For females, 2012 and 2016 had the highest number of graduate students with 17 (20.23%) counts. This was followed by 2015 and 2013 with 10 (11.90%) counts, 2011 and 2010 with 8 (9.52%) counts, 2014 with 7 (8.33%) counts, 2009 with 5 (5.95%) counts and 2008 with 2 (2.38%) counts.

4.3.3 Gender distribution by academic qualification

Table 3 shows the gender distribution of graduate students at SNAS by academic qualification.

Table 3 - Gender distribution of academic awards

Gender	Ph.D.	Percentage (%)	M.Phil.	Percentage (%)	Total
Male	32	86.48	298	79.04	330
Female	5	13.51	79	20.95	84
Total	**37**	**100.00**	**377**	**100.00**	**414**

The findings (table 3) indicates that male graduate students awarded with Ph.D. awards were 32 (86.48%) counts whiles female graduate students were 5 (13.51%) counts. For M.Phil. awards male graduate students had 298 (79.04%) counts whiles their female counterparts had 79 (20.95%).

This finding could be due to the fact that Female students were more interested in pursuing the M.Phil. programs rather than the Ph.D. programs as they consider the M.Phil. programs to be less rigorous than the Ph.D. programs. Hence after completion of the M.Phil. program most of these females don't aspire to pursue the Ph.D. programs in the future.

It could also be due to the fact that prospective female students might be burdened with raising up children by the time they might aspire to pursue a Ph.D. program hence the difficulty in combining school with parenting which thereby creates the disparity between themselves and their male counterparts.

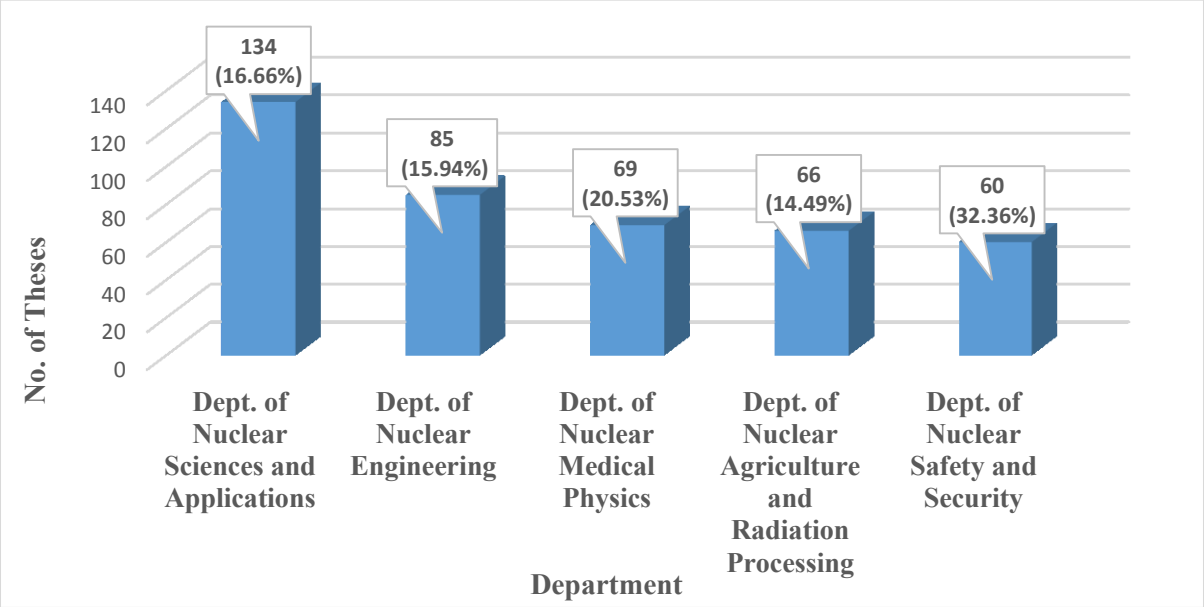
4.4 Distribution of theses by academic department

The researchers wanted to know the distribution of theses by academic department, frequency distribution of departments with regard to gender and distribution of departments with regard to M.Phil. and Ph.D. theses.

4.4.1 Number of theses by academic department

Figure 9 shows the distribution of theses by academic department.

Figure 9 - Theses count by academic department



The findings (figure 9) above shows that the Department of Nuclear Sciences and Applications had the highest number of Theses with 134 (33.68%) counts. This was followed by the Department of Nuclear Engineering with 85 (20.53%) counts, Department of Medical Physics with 69 (16.6%) counts, Department of Nuclear Agriculture and Radiation Processing with 66 (15.95%) counts and the Department of Nuclear Safety and Security with 60 (14.49%) counts. The high enrolment of postgraduate students at this department may therefore be attributed to the broad nature of this department and its importance in nation building.

The IAEA (n. d.) states that the Department of Nuclear Sciences and Applications is a more diverse department which spreads across a number of significant socio-economic sectors such as health, food and agriculture, environment, water resources and industry. The IAEA (n. d.) further reiterates that in each of the socio-economic sectors, Scientists from the IAEA together with experts from Member States work together in meeting their development needs through Nuclear science, technology and innovation. The high enrolment of postgraduate students at this department may therefore be attributed to the broad nature of this department and its importance in nation building.

4.4.2 Frequency distribution of departments with regard to gender

Table 4 shows the distribution of department with regard to gender.

Table 4 - Distribution of academic department by gender

Department	Male	Percentage (%)	Female	Percentage (%)	Total
Dept. of Medical Physics	59	17.87	10	11.90	69
Dept. of Nuclear Agriculture and Radiation Processing	41	12.42	25	29.76	66
Dept. of Nuclear Engineering	74	22.42	11	13.09	85
Dept. of Nuclear Safety and Security	47	14.24	13	15.47	60
Dept. of Nuclear Sciences and Applications	109	33.03	25	29.76	134
Total	**330**	**100.00**	**84**	**100.00**	**414**

Table 4 shows the frequency distribution of departments with regards to gender. For male graduate students the majority, 109 (33.03%) counts were in the Department of Nuclear Sciences and Applications. The rest in descending order are 74 (22.42%) were in the Department of Nuclear Engineering, 59 (17.87%) were in the Department of Medical Physics, 47 (14.24%) were in the Department of Nuclear Safety and Security and 41 (12.42%) were in the Department of Nuclear Agriculture and Radiation Processing.

For female graduate students the majority, 25 (29.76%) counts were in the Department of Nuclear Sciences and Applications and Department of Nuclear Agriculture and Radiation Processing respectively. The rest in descending order are 13 (15.47%) were in the Department of Nuclear Safety and Security, 11 (13.09%) were in the Department of Nuclear Engineering and 10 (11.90%) were in the Department of Medical Physics.

4.4.3 Distribution of departments with regard to M.Phil. theses

Table 5 shows the distribution of departments with regards to M.Phil. theses.

Table 5 - Distribution of department with regard to M.Phil. theses

Department	(M.Phil.) Count	Percentage (%)
Dept. of Nuclear Sciences and Applications	119	29.70
Dept. of Nuclear Engineering	77	20.98
Dept. of Nuclear Agriculture and Radiation Processing	64	17.43
Dept. of Medical Physics	63	17.16
Dept. of Nuclear Safety and Security	54	14.71
Total	**377**	**100.00**

Table 5 shows the distribution of departments with regards to M.Phil. theses. The majority, 119 (29.70%) counts of graduate students were in the Department of Nuclear Sciences and Applications. The rest in descending order are 77 (20.98%) were in the Department of Nuclear Engineering, 64 (17.43%) were in the Department of Nuclear Agriculture and Radiation Processing, 63 (17.16%) were in the Department of Medical Physics and 54 (14.71%) were in the Department of Nuclear Safety and Security.

4.4.4 Distribution of departments with regard to Ph.D. theses

Table 6 shows the distribution of departments with regard to Ph.D. theses.

Table 6 - Distribution of departments with regard to Ph.D. theses

Department	(Ph.D.) Count	Percentage (%)
Dept. of Nuclear Sciences and Applications	15	40.54
Dept. of Nuclear Engineering	8	21.62
Dept. of Medical Physics	6	16.21
Dept. of Nuclear Safety and Security	6	16.21
Dept. of Nuclear Agriculture and Radiation Processing	2	5.40
Total	**37**	**100.00**

Table 6 is the distribution of departments with regards to Ph.D. theses. The majority, 15 (40.54%) counts of graduate students were in the Department of Nuclear Sciences and Applications. The rest in descending order are 8 (21.62%) were in the Department of Nuclear Engineering, 6 (16.21%) were in the Department of Nuclear Safety and Security and Department of Medical Physics respectively and 2 (5.40%) were in the Department of Nuclear Agriculture and Radiation Processing.

4.5 Subject coverage of theses

The researchers wanted to know the number of theses by subject and the subject coverage of academic qualifications.

4.5.1 Number of theses by subject

For the analysis of the subject coverage of postgraduate theses the INIS/ETDE (Energy Technology Data Exchange) subject categories and scope descriptions (ETDE/INIS joint reference series no. 2) were used (IAEA, 2002). According to the (IAEA, 2002) the INIS/ETDE

"defines the subject categories and provides the scope descriptions to be used for categorization of the nuclear literature for the preparation of INIS input by national and regional centres. Together with volumes of the INIS Reference Series and ETDE/INIS joint reference series it defines the rules, standards and practices and provides the authorities to be used in the International Nuclear Information System" (p.3).

In analysing the subject coverage of theses, some of the records had more than one subject category assigned in which case the first subject category was used in the analysis. Table 7 shows the distribution of theses by subject.

Table 7 - Number of theses by subject

Subject Areas	**Count**	**Percentage (%)**
Applied life sciences	82	19.80
Environmental sciences	61	14.73
Radiation protection and dosimetry	61	14.73
Radiology and nuclear medicine	54	13.04
Specific nuclear reactors and associated plants	51	12.31
Geosciences	29	7.00
Chemistry (inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry)	28	6.76
Engineering	13	3.14
Isotopes and radiation sources	12	2.89
Materials science	5	1.20
General studies of nuclear reactors	4	0.96
Management of radioactive wastes and non-radioactive wastes from nuclear facilities	4	0.96
Nuclear physics and radiation physics	4	0.96
Particle accelerators	2	0.48
Biomass fuels	1	0.24
Instrumentation related to nuclear science and technology	1	0.24
Mathematical methods and computing	1	0.24
Petroleum	1	0.24
Total	**414**	**100.00**

The findings (Table 7) revealed that the subject coverage of postgraduate theses at SNAS was spread across 18 subject areas. Applied life sciences was the most researched subject area by postgraduate students with 82 (19.80%) counts. This was followed in descending order by environmental sciences and radiation protection and dosimetry with 61 (14.73%) counts each,

radiology and nuclear medicine with 54 (13.04%) counts, specific nuclear reactors and associated plants with 51 (12.31%) counts, geosciences with 29 (7.00%) counts, chemistry including inorganic, organic, physical, analytical chemistry and radiochemistry and nuclear chemistry with 28 (6.76%) counts, engineering with 13 (3.14%) counts and isotopes and radiation sources with 12 (2.89%) counts.

Others are materials science with 5 (1.20%) counts, general studies of nuclear reactors, management of radioactive wastes and non-radioactive wastes from nuclear facilities, nuclear physics and radiation physics all with 4 (0.96%) counts each, and particle accelerators with 2 (0.48%) counts. The least most researched subject areas were biomass fuels, instrumentation related to nuclear science and technology, mathematical methods and computing and petroleum with 1 (0.24%) counts each.

The preference for applied life sciences could be attributed to the fact that Ghana's nuclear research focus is geared towards agriculture since it is one of the major engines of growth whereby the country gets a substantial amount of foreign exchange earnings.

This finding corroborates with the findings of Agyeman and Bilson (2015) in another study using the INIS database where they argued that the high publication count in the area of applied life sciences was expected because agriculture continues to be the main-stay and backbone of the Ghanaian economy and like other developing countries a lot of human and material resources are channelled into that sector.

This finding is also contrary to the findings by Santos et.al. (n.d.) who analysed theses published at the Instituto De Pesquisas Nucleares - São PAULO Brazil using the INIS/ETDE (Energy Technology and Data Exchange) manual as the data source and found out that the theses spread across 33 subject categories with material science having the highest number of theses with (243).

The finding is also dissimilar to the findings by Kademani, Kumar, Sagar and Kumar (2006) who revealed in their study that Indian Nuclear scientists contributed 23,033 of publications to the subject area of physics.

4.5.2 Subject coverage of academic qualifications

Table 8 shows the subject coverage of Ph.D. theses.

Table 8 - Subject coverage of Ph.D. theses

Subject Areas	**Ph.D.**	**Percentage (%)**
Environmental sciences	9	24.32
Specific nuclear reactors and associated plants	8	21.62
Radiology and nuclear medicine	5	13.51
Applied life sciences	4	10.81
Geosciences	3	8.10
Radiation protection and dosimetry	3	8.10
Engineering	2	5.40
Isotopes and radiation sources	2	5.40
Chemistry (inorganic, Organic, Physical, Analytical Chemistry, Radiochemistry and Nuclear Chemistry)	1	2.70
Total	**37**	**100.00**

The findings (Table 8) shows that the Ph.D. theses was limited to a few subject areas. Environmental sciences was the most researched subject area with 9 (24.32%) counts. This was followed by specific nuclear reactors and associated plants with 8 (21.62%) counts, radiology and nuclear medicine with 5 (13.51%) counts, applied life sciences with 4 (10.81%) counts, geosciences and radiation protection and dosimetry with 3 (8.10%) counts each and engineering and isotopes and radiation sources with 2 (5.40%) counts each. The least most researched subject area was chemistry including inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry with 1 (2.70%) counts.

The preference by Ph.D. students in doing research in environment sciences could be due to the fact that the environment continuous to be impacted negatively in areas such as illegal mining, pollution of water bodies, air and land pollution, indiscriminate logging etc. and through the use of nuclear techniques their research findings could go a long way to help curb the problem.

Table 9 is the subject coverage of M.Phil. theses.

Table 9 - Subject coverage of M.Phil. theses

Subject Areas	**M.Phil**	**Percentage (%)**
Applied life sciences	78	20.68
Radiation protection and dosimetry	58	15.38
Environmental sciences	52	13.79
Radiology and nuclear medicine	49	12.99
Specific nuclear reactors and associated plants	43	11.40
Chemistry (inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry)	27	7.16
Geosciences	26	6.89
Engineering	11	2.91
Isotopes and radiation sources	10	2.65
Materials science	5	1.32
General studies of nuclear reactors	4	1.06
Management of radioactive wastes and non-radioactive wastes from nuclear facilities	4	1.06
Nuclear physics and radiation physics	4	1.06
Particle accelerators	2	0.53
Biomass fuels	1	0.26
Instrumentation related to nuclear science and technology	1	0.26
Mathematical methods and computing	1	0.26
Petroleum	1	0.26
Total	**377**	**100.00**

The findings (Table 9) revealed that the M.Phil. theses was spread across a large number of subject areas. Applied life sciences was the most researched subject area with 78 (20.68%) counts. This was followed by radiation protection and dosimetry with 58 (15.38%) counts, Environmental sciences with 52 (13.79%) counts, radiology and nuclear medicine with 49 (12.99%) counts, specific nuclear reactors and associated plants with 43 (11.40%) counts, chemistry including inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry with 27 (7.16%) counts, geosciences with 26 (6.89%) counts, engineering with 11 (2.91%) counts, isotopes and radiation sources with 10 (2.65%) counts and materials science with 5 (1.32%) counts.

Others are general studies of nuclear reactors, management of radioactive wastes and non-radioactive wastes from nuclear facilities and nuclear physics and radiation physics with 4

(1.06%) counts each and particle accelerators with 2 (0.53%) counts. The least most researched subject areas were biomass fuels, instrumentation related to nuclear science and technology, mathematical methods and computing and petroleum with 1 (0.26%) counts each.

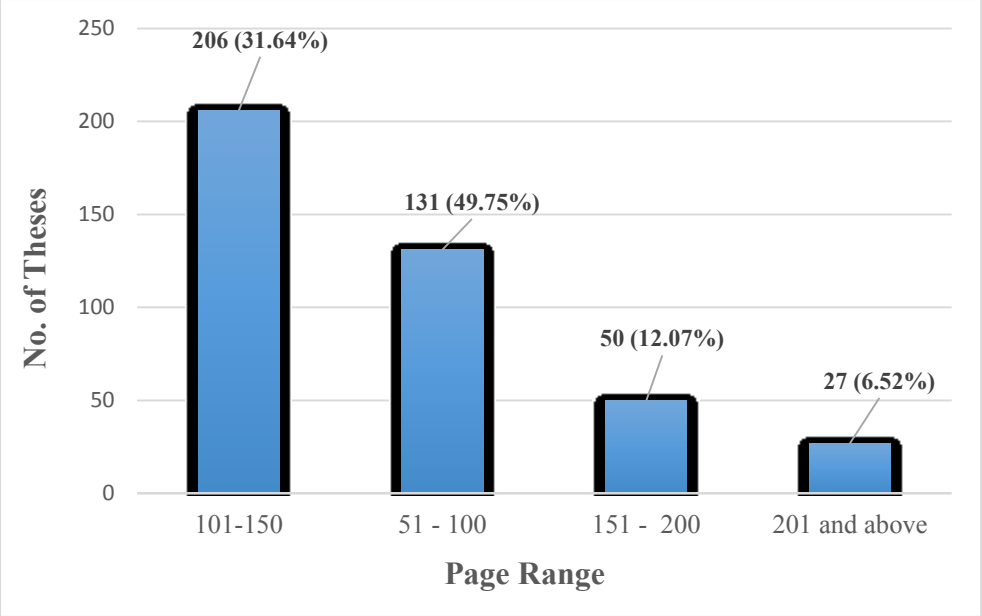
4.6 Page range, figures, tables and citations in theses

The researchers wanted to know the page range, figures, tables and citations in theses by postgraduate students of SNAS.

4.6.1 Page range

In determining the page range of postgraduate theses, all the page numbers of the 414 theses records retrieved from the INIS database were grouped into page ranges of (51 - 100, 101 - 150, 151 - 200 and 200 and above pages). Figure 10 shows the page range of theses.

Figure 10 - Page range of theses



From the analysis the findings (Figure 10) above shows that the page range of theses with 101 - 150 pages was the highest with 206 (49.75%) counts. This was followed by theses with the page range of 51 - 100 pages with 131 (12.07%) counts, page range of 151 - 200 pages with 50 (12.07%) counts and the least been theses with 201 and above pages with 27 (6.52%) counts. The total number of pages for all the postgraduate theses was 51,403 pages with an average of 124.16.

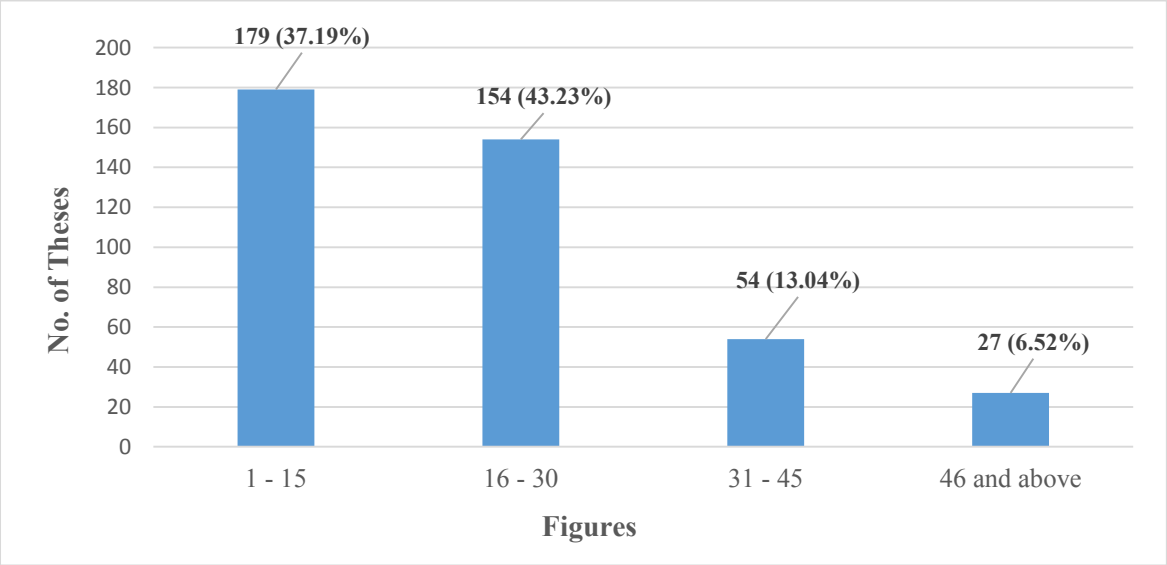
For theses within the range of 101 - 150 pages the high theses count could be due to the fact that the requirement by the school of graduate studies, UG for the number of pages for an M.Phil. thesis is up to a maximum of 150 pages and since the M.Phil. theses accounted for the majority of theses 377 (refer to section 4.3.1) this could explain why the page range of (101 - 150) was the highest.

On the other hand for theses within the range of 201 and above pages the low figures could be due to the fact that the requirement by the School of Graduate Studies, University of Ghana for the number of pages for a Ph.D. thesis of Ghana is more than 200 pages and since the Ph.D. theses accounted for the minority of theses 37 this could explain why the page range of (201 and above pages) was the lowest.

4.6.2 Figures

The figures in the 414 theses records retrieved from the INIS database were analysed by grouping them into ranges of (1 - 15, 16 - 30, 31 - 45 and 46 and above figures). Figure 11 shows the figures found in theses.

Figure 11 - Figures found in theses

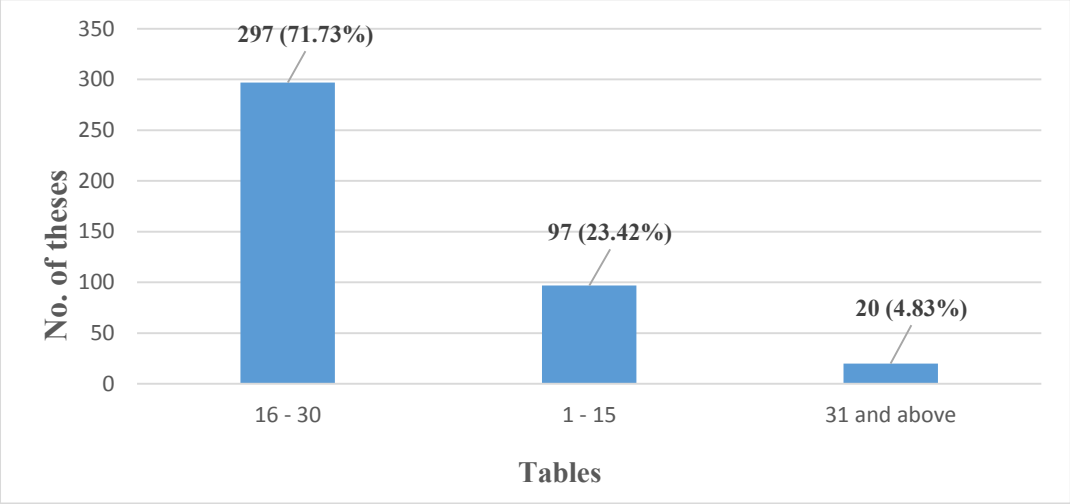


The findings (Figure 11) above revealed that theses with figures within the range of 1 - 15 were the highest with 179 (43.23%) counts. This was followed by theses with figures within the range of 16 - 30 with 154 (37.19%) counts, 31 - 45 figures with 54 (13.04%) counts. Theses having 46 and above figures were the least with 27 (6.52%) counts.

4.6.3 Tables

In analysing the tables in the 414 theses records retrieved from the INIS database, they were grouped into ranges of (1 - 15, 16 - 30 and 31 and above tables). Figure 12 shows the tables found in theses.

Figure 12 - Tables found in theses



The findings (Figure 12) above revealed that theses with tables within the range of 16 - 30 were the highest with 297 (71.73%) counts. This was followed by theses with tables within the range of 1 - 15 with 97 (23.42%) and theses with tables within the range of 31 and above been the least with 20 (4.83%) counts.

From the findings (figures 12 and 13), an important finding observed was that the higher range of tables (16 - 30) had a higher number of theses (297) than the higher range of figures (1 - 15) with 179 theses. This preference could be due to the fact that postgraduate students prefer tables since they are able to organise raw data better for scientific research than figures.

4.6.4 Citations

This section looks at the number of citations used in theses by year and the range of citations used in M.Phil. and Ph.D. theses.

4.6.4.1 Number of citations used in theses by year

The yearly breakdown of citations by year shows that theses published in 2010 used the highest

number of citations with 5,477. This was followed by theses published in 2015 with 5,173 citations, theses published in 2013 with 4,821 citations, theses published in 2016 with 4,601 citations, theses published in 2012 with 4,205 citations, theses published in 2014 with 3,832 citations, theses published in 2011 with 3,362 citations, theses published in 2009 with 2,527 citations and 2008 using the least number of citations with 1,650 citations. The total number of citations in the 414 M.Phil. and Ph.D. theses by postgraduate students was 35,648 citations with an average of 86.10 citations. The findings are shown in table 10 below.

Table 10 - Citations used in theses by year

Year	No. of theses	No. of citations	Average citations per theses
2008	19	1,650	86.84
2009	34	2,527	74.32
2010	53	5,477	103.33
2011	39	3,362	86.20
2012	50	4,205	84.10
2013	63	4,821	76.52
2014	41	3,832	93.46
2015	63	5,173	82.11
2016	52	4,601	88.48
Total	**414**	**35,648**	**86.10 (Average)**

The findings (table 10) revealed that year 2010 had the highest number of citations with 5477 citations and this could be attributed to several factors among which are the number of theses published, the availability of information sources for the research topic and the subject area in which the program was done.

4.6.4.2 Range of citations used in M.Phil. and Ph.D. theses

In analysing the range of citations in the 414 postgraduate student theses records retrieved from the INIS database, they were grouped into ranges of (1 - 50, 51 - 100, 101 - 150, 151 - 200 and 201 and above citations). Table 11 shows the range of citations in M.Phil. and Ph.D. theses.

Table 11 - Range of citations in M.Phil. and Ph.D. Theses

No. of Citations	M.Phil.	Percentage (%)	Ph.D.	Percentage (%)
1 - 50	113	27.29	3	8.10
51 - 100	167	40.33	7	18.91
101 - 150	59	14.25	7	18.91
151 - 200	28	6.76	11	29.72
201 and above	10	2.41	9	24.32
Total	**414**	**100.00**	**37**	**100.00**

From (Table 11) above, M.Phil. theses, citations within the range of 51 - 100 recorded the highest number of postgraduate theses with 167 (40.33%) counts. This was followed by theses with citations within the range of 1 - 50 citations with 113 (27.29%) counts, theses with citations within the range of 101 - 150 citations with 59 (14.25%) counts, theses with citations within the range of 151 - 200 citations with 28 (6.76%) counts and theses with citations within the range of 201 and above citations with 10 (2.41%) counts.

On the other hand for Ph.D. theses, citations within the range of 151 - 200 recorded the highest number of theses with 11 (29.72%) counts. This was followed by theses with citations within the range of 201 and above citations with 9 (24.32%) counts, theses with citations within the range of 51 - 100 and 101 - 150 citations with 7 (18.91%) counts each and theses with citations within the range of 1 - 50 citations with 3 (8.10%) counts.

From the findings it was observed that the Ph.D. theses used a higher citation range than the M.Phil. theses. This difference could be as a result of the fact that the Ph.D. programme is a more rigorous academic programme than the M.Phil. programme as it takes a longer period twice the M.Phil. programme to complete and students are also likely to consult more literature sources in doing their theses write-up which requires more pages than the M.Phil. programme.

4.7 Frequently used keywords assigned by the Indexer

According to Feather and Sturges (2003), a keyword is “a word that succinctly and accurately describes the subject, or an aspect of the subject, discussed in a document” (p. 341). The winfibre plus software was used by the subject specialist to describe each research topic when indexing and abstracting theses to be forwarded to the INIS secretariat for onward transmission into the INIS database.

The keywords were assigned by the indexer through reading the title of the research topic, abstract, research objectives and the methodology. Out of the 414 theses retrieved from the INIS database, a total of 4960 keywords were assigned by the indexer with an average of 11.98 keywords per thesis. Table 12 shows the most frequently used keywords assigned by the indexer.

Table 12 - The most frequently used keywords assigned by the Indexer

No.	Keywords	Frequency	No.	Keywords	Frequency
1	radiation protection	189	32	phantoms	29
2	radiation doses	125	33	uranium	29
3	ions	108	34	irradiation	28
4	water	86	35	iron	27
5	doses	80	36	natural radioactivity	27
6	Ghana	71	37	pollution	27
7	neutron activation analysis	68	38	tin	27
8	risk assessment	66	39	water quality	27
9	public health	63	40	m codes	26
10	safety	58	41	occupational safety	26
11	man	57	42	cobalt	25
12	recommendations	54	43	ground water	25
13	Gharr-1 reactor	53	44	thorium 232	25
14	quality control	51	45	mines	24
15	absorption spectroscopy	49	46	monte carlo method	24
16	radiation monitoring	49	47	comparative evaluations	23
17	patients	47	48	heavy metals	23
18	computerized simulation	46	49	ionizing radiations	23
19	quality assurance	45	50	ph value	23
20	gamma radiation	42	51	potassium 40	23
21	sorption	40	52	soils	23
22	dose rates	39	53	environment	22
23	occupational exposure	39	54	neoplasms	22
24	personnel	39	55	radiation hazards	22
25	therapy	38	56	radiotheraphy	22
26	dosimetry	36	57	reactor cores	22
27	trace amounts	36	58	neutrons	21
28	cobalt 60	31	59	plant breeding	21
29	evaluation	30	60	potassium	21
30	gamma spectroscopy	30	61	standards	21
31	hazards	29	62	accidents	20

No.	Keywords	Frequency	No.	Keywords	Frequency
63	biomedical radiography	20	112	calibration standards	11
64	health hazards	19	113	computerized tomography	11
65	radon	19	114	contamination	11
66	elements	18	115	flow models	11
67	flame photometry	18	116	in vitro	11
68	gas chromatography	18	117	ionization chambers	11
69	moisture	18	118	mathematical models	11
70	radiation sources	18	119	radioactive materials	11
71	safety standards	18	120	radioactive waste disposal	11
72	sediments	18	121	safety analysis	11
73	uranium 238	18	122	sample preparation	11
74	calibration	17	123	thermal hydraulics	11
75	gold	17	124	water pollution	11
76	personnel monitoring	17	125	cat scanning	10
77	radurization	17	126	concretes	10
78	storage life	17	127	diagnostic techniques	10
79	geochemistry	16	128	emergency plans	10
80	high-purity ge detectors	16	129	finite difference method	10
81	isotopes	16	130	images	10
82	management	16	131	mining	10
83	neutron flux	16	132	multi-element analysis	10
84	nutrients	16	133	productivity	10
85	plants	16	134	radiation dose distributions	10
86	shielding	16	135	radioisotopes	10
87	thermal neutrons	16	136	safety culture	10
88	brachytherapy	15	137	salinity	10
89	heat transfer	15	138	thermoluminescent dosimetry	10
90	rivers	15	139	thickness	10
91	waste disposal	15	140	transients	10
92	x-ray fluorescence analysis	15	141	ultraviolet spectra	10
93	food	14	142	waste management	10
94	hospitals	14	143	abdomen	9
95	photon beams	14	144	beryllium	9
96	radiation accidents	14	145	cassava	9
97	carbon	13	146	chest	9
98	hydrology	13	147	chlorine	9
99	mammary glands	13	148	coastal regions	9
100	residues	13	149	concentration ratio	9
101	surface waters	13	150	cultivations techniques	9
102	chlorine	12	151	density	9
103	drinking water	12	152	external beam radiation therapy	9
104	iaea	12	153	fertilizers	9
105	metals	12	154	finite difference method	9
106	reactor safety	12	155	head	9
107	regulations	12	156	minerals	9
108	activity levels	11	157	morphological changes	9
109	aquifers	11	158	multi-element	9
110	bacteria	11	159	nuclear medicine	9
111	boreholes	11	160	pesticides	9

No.	Keywords	Frequency	No.	Keywords	Frequency
161	polymerase chain reaction	9	182	optimization	8
162	radiology	9	183	organic chlorine compounds	8
163	reviews	9	184	pelvis	8
164	rocks	9	185	physical properties	8
165	s codes	9	186	planning	8
166	solutes	9	187	radioactive waste management	8
167	tissue cultures	9	188	radon 222	8
168	vegetables	9	189	reactivity	8
169	absorption	8	190	residence half-time	8
170	air	8	191	scattering	8
171	alara	8	192	steady-state conditions	8
172	collimators	8	193	tailings	8
173	diagnosis	8	194	temperature distribution	8
174	distribution functions	8	195	titration	8
175	epithermal neutrons	8	196	training	8
176	fishes	8	197	turbulent flow	8
177	highly enriched uranium	8	198	urban areas	8
178	icrp	8	199	water cooled reactors	8
179	image scanners	8	200	watersheds	8
180	magnetic resonance	8	201	x-ray equipment	8
181	nitrogen	8			(truncated)

The findings (table 12) above shows the most frequently used keywords assigned by the indexer (at least occurring 8 times and above). The top ten most used keywords assigned by the indexer was radiation protection with (189) keywords. The rest is radiation doses with (125) keywords, ions with (108) keywords, water with (86) keywords, doses with (80) keywords, Ghana with (71) keywords, neutron activation analysis with (68) keywords, risk assessment with (66) keywords, public health with (63) keywords and safety with (58) keywords.

The high frequency for the keyword (radiation protection) could be attributed to the fact that SNAS is designated as the IAEA Regional centre for training in radiation protection since October 2011 and this might have drawn interest from several postgraduate students from home and abroad who enrolled at SNAS to undertake research studies on the subject matter (radiation protection) thereby accounting for it been the most frequently indexed keyword by the indexer (subject specialist).

This finding is dissimilar to the findings by Kademani, Kumar, Sagar and Kumar (2006) who used a scientometric approach to study dimensions of nuclear science and technology research

in India from 1970 - 2002 using the INIS database and found out that the most frequently assigned keyword by the indexer was gamma radiation with (4076) keywords.

6. CONCLUSION AND RECOMMENDATIONS

The researchers provide an overview of the main research results, draw conclusion from the key findings and then offer a set of recommendations based on those main research findings.

6.1 Conclusion

The study analysed M.Phil. and Ph.D. theses publications by graduate students at SNAS, UG from (2008 - 2016) using the INIS database as the source of data. It is important that authorities from the University of Ghana, GAEC and the IAEA address issues emanating from the study which are affecting the running of the graduate school especially with regards to enrolment, academic degrees and gender inequality. Also, these recommendations would benefit the GAEC library tremendously and make it better placed to be more resourced to provide for the needs of its users including the academic faculty members and students at SNAS. Finally the activities of INIS will also be greatly enhanced and the visibility of the database greatly improved as well.

6.2 Recommendations

With regard to the outcomes of the study, the following recommendations are made:

6.2.1 Gaining autonomy from the University of Ghana

The findings revealed that there was a constant fluctuation in the number of theses published at SNAS over the period. There were many Master of Philosophy (M.Phil.) theses published with few Doctor of Philosophy (Ph.D.) awards. Most of the academic faculty were trained at SNAS. Besides the laboratories and equipment used for practical training are also provided by GAEC. SNAS also has its own accommodation for students in place. It is therefore recommended that SNAS gains autonomy from the UG, the parent University by becoming an autonomous University. This will enable SNAS to run its own academic programs and take decisions that will benefit its smooth running and management in the long run. It will also help SNAS to accelerate the plans already in place for a nuclear power plant to be added to the energy mix for Ghana. Again SNAS could also introduce non-science related programs in the future which could also boast enrolment. Autonomy will also help it to have control over the

fees charged for the various academic programs and thereby making it reasonably affordable for the general public which will boost enrolment. Again, this will also benefit prospective Doctor of Philosophy (Ph.D.) students who previously couldn't afford to pursue the program and also help to curb the loss of human resource expertise in the field. Finally, establishing an autonomous university would also help SNAS to collaborate better with the Nuclear Regulatory Authority (NRA) in fulfilling its mandate as a regulatory authority as SNAS would therefore become a centre to train personnel and issue certification as well as to create awareness and increase sensitization on nuclear safety, security, safeguards and radiation protection.

6.2.2 Introducing Nuclear and Allied Sciences programs at the undergraduate level

To promote interest in the Nuclear and Allied sciences programs and meet the manpower needs of the country, SNAS could introduce undergraduate programs in Nuclear and Allied sciences field at the bachelor's degree level. Relevant programs such as petroleum engineering, electrical and electronics engineering, computer engineering, materials engineering, civil engineering and mechanical engineering could be rolled out to add to the existing programs offered at SNAS. This could serve as an entry point for those interested in pursuing a career in the field and would go a long way to boost interest in the subject area at a lower academic level than what exists currently at the M.Phil. and the Ph.D. levels. Having these undergraduate programs will also help to increase enrolment at SNAS as well as increase the number of theses/dissertations records that Ghana processes and forwards to the INIS secretariat for input into the INIS database which will also improve the countries worldwide visibility in the nuclear sciences field.

6.2.3 Women empowerment and gender equality

The findings revealed that the ratio of female students who pursued the M.Phil. and the Ph.D. programs at SNAS was not encouraging. It is therefore recommended that women should be made to play a more active role in the Nuclear Science field by encouraging them to pursue postgraduate programs within the field as well as teaching. Preference should also be given to females who don't meet the cut-off point for the program in-take. Also organizing regular sensitization campaign programs, debates and quizzes especially in female dominated high schools and also at the Junior High School level to educate them on the subject area will also help to bridge the gender gap in the long run.

6.4.4 Undertaking Research

There are about 67, 294 theses and dissertations publications that have been added to the INIS database from member states and organisations. However there is rarely any research that has been done by these member states and organisations to analyse these theses and dissertations publications sent to the INIS database. It is therefore recommended that INIS liaison officers from member states and organisations undertake bibliometric studies on theses and dissertations publications from their various centres thereby contributing to the body of knowledge on bibliometric studies particularly in the field of nuclear science and technology worldwide.

6.4.5 Removing Copyright Obstacles

Due to copyright requirements, electronic copies of theses published at SNAS are sent to the digitization section of the Balme Library, University of Ghana for onward upload unto the Universities institutional repository before the links to these documents are added to the GAEC digital library. The GAEC library however sends the abstract of theses published at SNAS to the INIS secretariat in Vienna, Austria for onward submission to the INIS database. Users of INIS who find a preferred theses published at SNAS have to search the GAEC online digital library for links to the full text. This make accessibility to information cumbersome and complex. There is therefore the need for SNAS to gain autonomy which will benefit the GAEC library in having autonomy to be able to send the full text theses to the INIS database and also upload them directly onto its digital library to serve its user needs more efficiently.

6.4.6 Training of Indexers (Subject Specialist)

The subject specialists at the GAEC library who process records for Input onto the INIS database have to take advantage of training programmes such as the INIS training seminar and nuclear knowledge management programmes organised by the IAEA. This will practically help them to improve and develop their indexing skills better.

6.4.7 Resourcing the GAEC library

An academic library cannot serve the needs of its faculty and students better without a well resourced library. SNAS has relied more on the Balme library at the University of Ghana as it is currently under the University. If SNAS gains autonomy from the University of Ghana it will help to shift the central focus onto the GAEC library as the institutional library thereby

helping the library to get the necessary resources required to operate as the Institutional library and provide for the needs of its users including the academic faculty members and students at SNAS.

6.4.8 Areas of future research

The study analysed M.Phil and Ph.D. theses publications at the SNAS, UG from (2008 - 2016) using the INIS database. Nevertheless, further studies could be done in the future to find out the preferred bibliographic forms for referencing theses by students at SNAS, UG. This study adopted the bibliometric method using the INIS database as source of data. It will be very interesting to subject this study to a manual document counting approach to compare the research findings. Also, it could be of interest in studying knowledge management practices at SNAS and GAEC.

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