IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

VOLUME : 6 ISSUE : 6 Print / Issue Publication Date: 10-Jan-2022

ISSN : 2455-2143

DOI : 10.33564/IJEAST.2021.v06i06.002

Indexed In

Google SCHOLAR OPEN ACCESS doi Crossref

WWW.IJEAST.COM

editor@ijeast.com

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)

MULTI-LEVEL STUDENT PEER ASSISTED MENTORING (MSPAM) OF COMPUTER SCIENCE FEMALE STUDENTS AT UNDERGRADUATE

Chalwe Musonda,
University Of Zambia,
School of Natural Science
Department of Computer Science,
Great East Road Campus, Lusaka, Zambia

Monde M.K Kabemba
University Of Zambia,
School of Natural Science
Department of Computer Science,
Great East Road Campus, Lusaka, Zambia

Abstract - The percentage of female students majoring in computer science is much smaller than that of male students. Computer science has one of the lowest shares of women degree recipients among the broader field of Science and Engineering, with reports of only nineteen percent of the computer science degrees in 2016 been awarded to women at University of Zambia. As such, fewer women than men enter the computing profession, leading to a gender disparity in the computing workforce. A number of factors as suggested as contributing to the current state of poor performance of female in the computing field: women lack confidence; negative stereotype; male orientated culture; lack of appropriate role models in the field, self-efficacy, the curriculum is not tailored to suit their interests and many more, that contribute to this disparity. One way to improve the current state of Female in computer science is to mentor female in the computer science at both undergraduate and in industry. The study used mixed methodology to collect data which are observation, interviews, Literature review, asking questions, gathering information and then presenting the facts. This study proposes Multi-level Student Peer Assisted Mentoring (MSPAM) computer science female at undergraduate, an approach to optimize peer mentoring by organizing mentors into levels.

Keywords – Multi-level, Mentor/Mentee, Peer, Computer Science

I. INTRODUCTION

Only a small percentage of computer scientists and computer professionals are female. In the most recent years, both global and local statistics are available, women received a third of the bachelor's degrees in computer science, 27% of master's degrees, and 13% of PhDs. Not only do women make up just 7.8% of computer science and computer engineering faculties, only 2.7% of tenured professors are female (Gries, 1991). Even worse, these numbers seem to be improving only very slowly or even dropping (Leveson, 1989).

However, the concerns arose due to the growing gender disparity in the field of computer science. The field of computing increasingly has developed a gender gap. This gender gap has made the field become more male dominant. With the decline in women pursuing education within the field of computer science and women working in field of computer science, this has brought in lack of diversity in the field of computer science to emerge. The main area of this research paper was to study,

- "What is the structure of student peer mentoring program in Computer Science?"
- "To what extent can we develop the student peer assisted mentoring program in Computer Science program?"
- "How can we integrate Multi-level Student Peer Assisted Mentoring and to what degree does mentoring contribute to academic success?"

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)

The aim of this research was to develop a system that would optimize student peer assisted mentoring of computer science female student at undergraduate. In order to undertake the research, the following objectives were identified:

1. To review the structure of student peer mentoring programs.
2. To develop the student peer mentoring program in computer science program.
3. Propose an integrated multi – level student peer assisted mentoring framework for a 4-year computer science program.

Global statistics

The previous researches demonstrates that, in the United States, the proportion of women represented at undergraduate computer science education and the white-collar information technology workforce peaked in the mid-1980s, and has declined ever since. In 1984, 37.1% of Computer Science degrees were awarded to women; the percentage dropped to 29.9% in 1989-1990, and 26.7% in 1997-1998. (Camp, Tracy, 2001). Figures from the Computing Research Association Taulbee Survey indicate that fewer than 12% of Computer Science bachelor's degrees were awarded to women at U.S. PhD-granting institutions in 2010-11. ("Computing Degree and Enrollment Trends", 2010-2011 CRA Taulbee Survey). According to National Science Foundation, Division of Science Resources Statistics 2021, when looking at the percentage of women earning master's degrees, it peaked around 2000 at 33% and dropped to 27% in 2013. Computer science holds one of the lowest proportion of women holding a doctorate's degree in the field. (Clarke Hayes, Caroline, 2010).

Extensive research conducted by Sax, Linda J.; Lehman, Kathleen J.; Jacobs, Jerry A.; Kanny, M. Allison; Lim, Gloria; Monje-Paulson, Laura; Zimmerman, Hilary B. (2017) in United States shows that the representation of women in the computing field has declined over the past thirty years. Currently, women only make up 18% of graduates with a degree in computer science. In a study based in the United States, "Anatomy of an Enduring Gender Gap: The Evolution of Women's Participation in Computer Science", researchers found an overall decline in women's intent to major in computer science field. They found that by 2011 only 0.4% of women planned to major in computer science compared to 3.3% of men. The study also found, as of 2011, only 15% of women were computer science majors.

Workforce perspective

Women's representation in the computing and information technology workforce has been falling from a peak of 38% in the mid-1980s. From 1993 through 1999, Nation Science Foundation's Scientists and Engineering Statistic reported that the percentage of women working as computer/information scientists (including those who hold a bachelor's degree or higher in an S&E field or have a bachelor's degree or higher and are working in an S&E field) declined slightly from 33.1% to 29.6% while the absolute numbers increased from 170,500 to 185,000. Numbers from the Bureau of Labor Statistics and Catalyst in 2006 indicated that women comprise 27-29% of the computing workforce. (Thomas J. Misa, ed. 2010). (Foust-Cummings, Heather; Sabattini, Laura; Carter, Nancy, 2008). In support of Thomas J. Misa 2010, Laura Sydell 2013, shows that, a National Public Radio report in 2013 stated that about 20% of all U.S. computer programmers are female. In open source fields, only 10% of programmers are women. (Bort, Julie, 2014).

Female bring a different perspective to innovation and problem solving and can ensure that concerns unique to females will not be overlooked. This will ultimately result in products that will be designed to be more representative of all users. Female tend to be social oriented than male, so they can easily mix their technical skills with social and communication skills which are crucial when dealing with Information Communication and Technology (ICT) in a business environment.

Research has been undertaken on the low numbers of women in computer science industry but the majority of this research is focused on “Why are there so few female students applying in Computer Science courses?” putting aside mentorship as the students come in universities.

Success of Mentorship Program

There has been no detailed data about mentorship program existence in universities. During the literature review few trace of data indicate that the mentorship program is either new in the higher education system or not in existence at all. A key aspect of peer mentoring programs is to facilitate the career and/or academic development of the mentee (Allen, Eby and Lentz, 2006). Mentoring can add great richness to the university experience through the valuable dimensions of informal guidance, role modelling, support and encouragement that enriches students’ ongoing undergraduate academic and social development (Barnett, 2008). Mentoring assists in the development of academic and social competence both on the part of the mentor and mentee (Barnett, 2008) and is linked with favorable attitudes and lower attrition (Eby, Durley, Evans, and Ragings, 2006; Eby, Lockwood and Butts, 2006). Even within these limitations, as Jacobi (1991) pointed out in her review of the literature of 1990 on mentorship program, she adds, there is a wide variety of such programs, differing in their methods, focus, and theoretical orientation and this is the situation in Zambian universities. Jacobi also stressed the need for evaluative research “to measure the effectiveness of formal mentoring

programs". The few evaluations that have been reported have focused on either the link between mentoring and academic success as evaluated by Rodger and Tremblay 2003 or on the impact of mentoring on adjustment to university life (Hall 2007). Rodger and Tremblay (2003) in their research found that, students who used the peer-mentoring program gained higher grade point averages than those who did not and that the program worked particularly well for students scoring high in anxiety because they tend to settle as soon as they are enrolled in peer mentoring program of the university. If the untapped potential of women continues to be ignored and under-utilized, this will have an adverse major impact on Zambia's economy in future. Women are needed in Computer Science to ensure that Zambia continues to prosper as a technology hub and remains an attractive Centre for technology companies to locate and remain here.

Mentoring has never being clearly defined and if clearly defined it would have being easy to activate it in our Zambian universities. It is believed that, "*if you are seeing further it's that you are standing on the shoulders of the giants*". Various Scholars have come up with the definition of mentoring in different ways and application. One on one instruction, or mentoring, is one of the oldest form of teaching. Our parents and grandparents are our earliest mentor; later, we may be mentored by or act as mentors to our brothers, sisters, and friends. Mentor programs work because they provide encouragement and guidance to each adolescent or child that participates.

Definitions of mentoring in education should be dependable and appropriate to the educational setting. One of the most apparent problems within the mentoring literature, was the lack of consistency in defining mentorship among organizations and universities that design mentoring programs not only in Zambia, but, outside-developed countries. Conferring to Jacobi (1991) this absence of an operational definition leads to less effective research. Furthermore, peer-mentoring programs appear to define their programs based off older and commonly used business and organizational definitions. Definitions ranged from coach to mentor to career sponsor, or in the context of higher education, peer counsellor. Bierema and Merriam (2002) encompass this entire range by quoting Zey (1984), who defines a mentor as someone "who oversees the career and development of another person, usually a junior, through teaching, counselling, providing psychological support, protecting, and at times promoting or sponsoring".

According to Stephanie (2006), from his literature reviewed, he provided eight different definitions of mentoring: (1) a more advanced or experienced individual guiding a less experienced individual; (2) an older individual guiding a younger individual; (3) a faculty member guiding a student; (4) an individual providing academic advising; (5) an individual who shares their experience with another individual; (6) an individual who actively interacts with another individual; (7) an experienced individual guiding a group of individuals; and (8) an experienced, older individual who guides a younger, less experienced individual via internet resources.

Identified Current Local State of Mentorship program

Peer mentoring programs are an important component in the strategy to increase and maintain the number of female computer science students at undergraduate. Many Universities and Colleges have deficiencies includes lack of a clear definition for mentoring and structuring the program to be used in increasing and maintaining the number of female computer science students.
The percentage of female students majoring in computer science is much smaller than that of male students. Computer science has one of the lowest shares of women degree recipients among the broader field of Science and Engineering, with reports of only nineteen percent of the computer science degrees in 2016 been awarded to females. As such, fewer women than men enter the computing profession, leading to a gender disparity in the computing workforce.

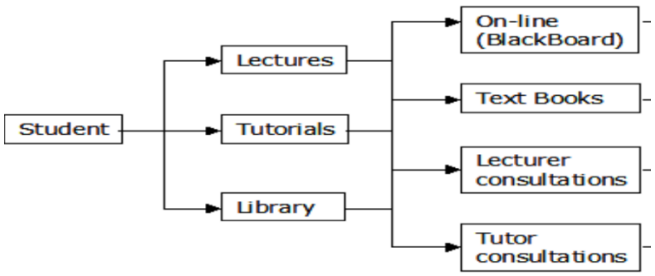
By 2017, The University of Zambia had a total number of 22,598 Students of which 7,231 (32%) were males and 15,367 (68%) were females. (MoHE Annual Census 2017).
Copperbelt University is a public university in Kitwe, Copperbelt province, Zambia. It is the second-largest public university. The *University* has 15,900 *students* and produces an annual average of 1, 500. The total *number of students* in 2017 was 11,900, of which 37% (4, 403) were males and 63% (7,497) were females. (Copperbelt University Website)

Mulungushi University is also a public university in Kabwe, Central Province of Zambia has the student population of 13,500 of which 6,345 (47%) were females and 7,155 (53%) were males. In 2016 there were 900 students who graduated at undergraduate in all disciplines offered by the university, out of the number only 16 graduated from Computer Science of which, 12 male students and 4 females students. In 2017, 20 computer science students graduated, 15 male students and 5 female students. (Mulungushi University Website)

Research suggests that supplemental instruction in the form of peer assisted learning can have a positive effect on student learning (Comgos & Schopes, 1993) and result in improved academic performance (Bidgood, 1992). Programs of this nature have been found to be effective in producing positive differences in student performance and retention rates (Martin & Arendale, 1992). After conducting a research in

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)

Zambian universities, establish that, the universities luck the motivation programs like mentorship more especially to female computer science students. Below is the model of the current situation in Zambian Universities.



Source: Tinto (1997)

Figure 1.2. An example Model of current situation in Zambian Universities

Referring to figure 1.2 above, a student at first level, is exposed to formal educational experience. The female student interacts with the lecturer, tutorials and library, which is formal education supported with limited sources of educational material, she gets the online materials, textbooks from the library and where possible she consult the lecturers who are usually busy most of the time. If we were to produce all-rounder computer scientist female, this model would proof to be incomplete because it looks at formal educational support only, excluding the informal aspect of education of which this research is proposing as multi-level student peer assisted mentoring which goes beyond the formal education experience support.

II. LITERATURE REVIEW

Introduction

Various researcher have discussed on the topic of mentorship, this study has taken a different dimension looked at the value and importance of mentoring programs as a solution for gender disparity. Comgos & Schopes (1993) recommends that supplemental instruction in the form of peer assisted learning can have a positive effect on student learning. Programs of this nature have been found to be effective in producing positive differences in student performance and retention rates (Martin & Arendale, 1992). In Australia, researchers (Calder, 2004; Daley, 2004; Freeman & Kelton, 2004; and Treston, 1999) have examined various student peer-mentoring programs and their findings provide further evidence of the existence of benefits in terms of student performance, retention and satisfaction

Mentorship program is a method that will maintain or close up the low level of women in the Computer Science sector. This is well-documented and researched issue and despite increases in the numbers of women in some of the other stereotypical male industries such as science and mathematics, Computer Science is not following the same trend. For some reason, it has struggled to entice women into the industry, which is in contrast to all other STEM (Science, Technology, Engineering and Mathematics) disciplines (Clarke-Hayes, 2010).

Jenepher Lennox Terrion & Dominique Leonard investigated that, Student peer assisted mentoring in higher education has been regarded as an effective intervention to ensure the success and retention of vulnerable students. Many universities and colleges have therefore implemented some form of mentoring program as part of their student support services. (Jenepher Lennox Terrion & Dominique Leonard, 2007). Corbett C and Hill C, (2015), supports that, student peer mentor might also increase a university student's self-esteem and academic self-efficacy, as well as general satisfaction with their academic program. (Corbett C, Hill C, 2015).

Jacobi's assertion that there is no research on how mentoring actually improves academic achievement is valid. Most of the research and articles on mentoring in higher education draw from the business mentoring literature. (Jacobi, M. 1991). According to Jacobi (1991), it means that mentoring introduced in higher education can help far better than it has done in business circles. Ferrari, (2004), described lack of student peer mentoring program to contributing to gender disparity in computer science at undergraduate.

According to Ralph, (2010) Peer mentoring programs have been widely adopted by universities and colleges as important components of their strategies to enhance the experience of first year students to assist them in making the transition from secondary school to university level. These programs involve senior students mentoring first year students. Using senior students as mentors rather than faculty members takes advantage of their ability to share their own recent experiences as students, and thus the process does not involve the status differences that may exist between faculty and students.

Female's involvement in computer science and related field

Regrettably, computer science was not always the male-dominated industry familiar today. Female had a long history in computing and a very significant presence in the early days when they constituted, almost exclusively, the first programmers and operators of computers.
Ada Lovelace recognized as the first female programmer. Her vision eventually became a reality in the 1940s when there

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)

was a move away from 'number crunching' to the use of symbols and rules, what we acknowledge as a 'programming language' today (Fuegi and Francis, 2003).

During World War II (1939 – 1945), there were two revolutionary computing projects, the 'Colossus' in the United Kingdom and the 'Electronic Numerical Integrator and Computer' (ENIAC) in North America. Both of these projects had women at the forefront, operating the machines. Finding jobs in the computer science field allowed women to find higher opportunities in the workforce. Early programmers on machines such as ENIAC, were mostly women. ENIAC was an electronic digital computer designed to calculate artillery firing tables for the US army, (Frink, Brenda D, 2011). The Colossus project was part of an allied effort to decode messages that were sent by Germany to Japan during the war. Women were recruited to work on Colossus from the Women's Royal Naval Service. (Abbate, 2012).

Another very prominent and pioneering female computer scientist was Grace Hopper who earned her Master's and Doctorate Degrees in mathematics from Yale University before joining the US Navy WAVES (Women Accepted for Volunteer Emergency Service) program in December 1943. She became one of the first programmers of the Harvard Mark I computer, a computer built at Harvard University in 1944 to assist the US navy during World War II. Hopper went on to develop the first compiler for a computer programming language (Bunch and Hellemans, 1993).

Anita Borg is a more recent computer scientist who was a champion for tackling the issue of the under-representation of women in computing. Borg received her Doctorate in Computer Science from New York University in 1981. She co-founded the 'Grace Murray Hopper Celebration of Women in Computing' conference in 1994 to bring the research and interest of women in IT together. In 1997 she established the 'Anita Borg Institute for Women and Technology', a not for profit organization aimed at helping to introduce and retain women into IT (Anita Borg Institute, 2014).

Marissa Mayer is currently one of the most prominent women in the world of computing. Marissa earned a Bachelor of Science degree in symbolic systems and a Master of Science degree in Computer Science with a specialization in artificial intelligence from Stanford University.

Reviewed Structures of Student Mentoring Program

The researcher conducted a review of various mentorship program structures used by different universities outside Zambian. According to the literature reviewed, the following are the structures put in place in different Universities globally. Among the reviewed mentorship programs, looked at Mentorship structure of Texas San Antonio School of medicine, Student Peer Assisted mentoring (SPAM) Conceptual framework and Model of educational aspects of mentoring. Of all the three (3), mentorship structure of Texas San Antorio school of medicine prooved favourable to my study. Because with proposed Multilevel student peer assisted mentoring is done by the 2nd, 3rd and 4th year student of different levels as a mentor and the 1st year student as a mentee whereas Mentorship of Texas San Antonio starts at enrolment where students (mentee) are randomly assigned to students (mentor) and receive mentorship through group and one-to-one which is done by the lecturers and the Head of Section. Below are the details of the structures;

Mentorship structure of Texas San Antonio School of medicine

After reviewing the structure of The University of Texas San Antonio, School of Medicine initiated Veritas, a student-advising program, in 2006 with a goal of enhancing the professional development of medical students by fostering relationships and assisting students to make informed decisions about their careers. Approximately 220 students enter the medical school each year. At enrolment, students are randomly assigned to one of 20 Veritas groups. This assignment occurs with each incoming class so that across the 4 years of medical school, there are total of 44 medical students per Veritas group (11 each of MS1-4 students). Each Veritas group has a faculty mentor (see Fig. 2.5.1 below).

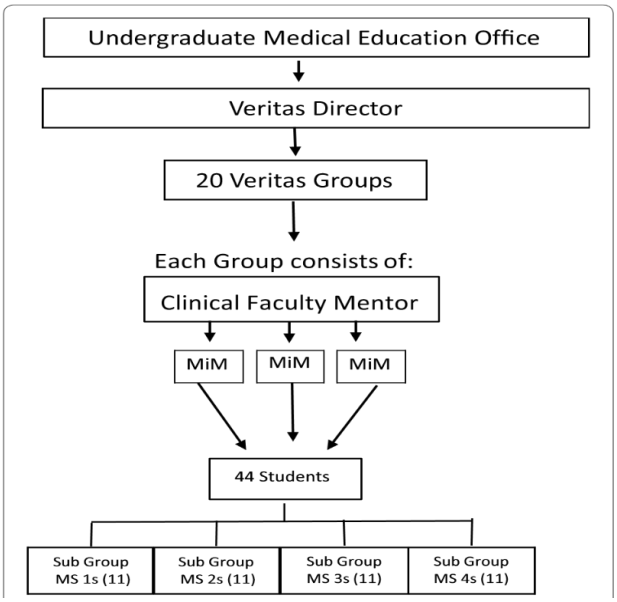


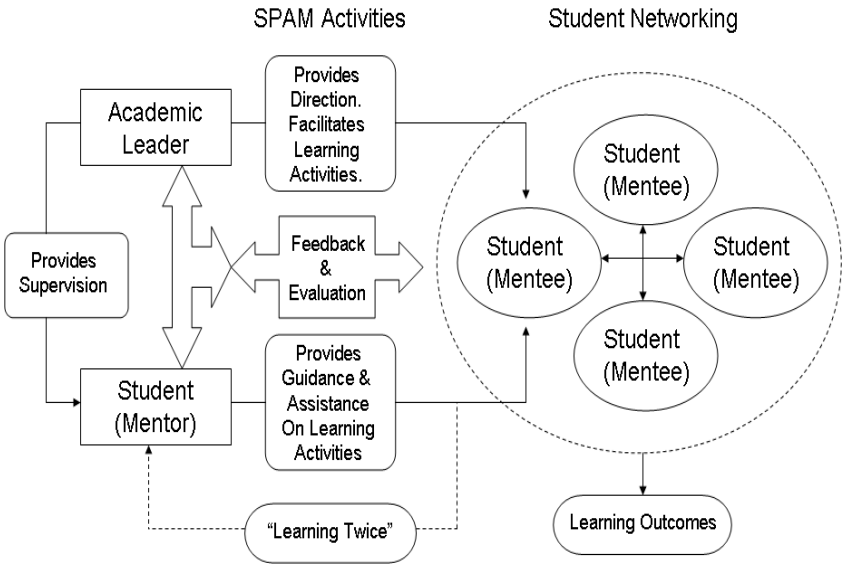
Figure 2.5.1: Mentorship structure of Texas San Antonio School of medicine

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)

Students receive mentorship through group and one-on-one activities. Meetings of subgroups of Veritas students (i.e., MS1s or MS2s classes as shown in fig 2.5.1) occur at least monthly. A subset of meetings are combined so students across classes can share experiences, in addition to choosing a career, study strategies, professionalism, and how to plan for life as a 3rd and 4th year. There are also events for all students within a class year, such as MS4 mock-interview night or MS3 boot camp. At least twice per year, all 48 students in each Veritas group come together for a social event.

Student Peer Assisted Mentoring (SPAM) Conceptual framework

Ross Kirkham and Damian proposed the student peer assisted mentoring conceptual framework; it was not specifically looking at the female computer science student but both female and male in all courses. Student Peer Assisted Mentoring (SPAM) works on two distinct levels one for the student mentees and the other for the student mentors. The mentoring model works for the student mentees because the sessions are conducted in an informal setting and focus on the learning needs of the student mentees. The nature of the approach is proactive rather than reactive and is aimed at providing learning techniques to equip the student mentees with the ability to solve problems not just answer questions. Student mentees are encouraged to ask and discuss their learning needs and to develop good study techniques including the formation of study groups or networks even outside the SPAM program as shown below in figure 2.5.2. (Ross Kirkham, Damian Ringelstein, 2008).



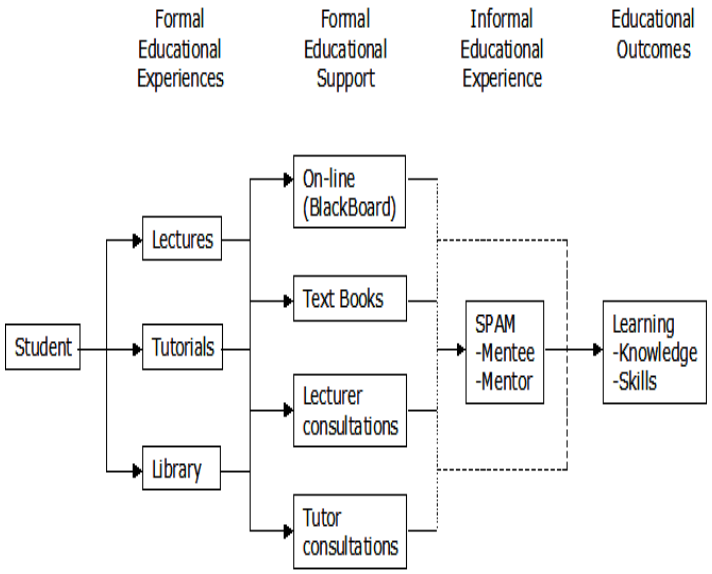
Source: e-JBEST Vol.2, Iss.2 (2008)

Fig 2.5.2. Conceptual framework of the Student Peer Assisted Mentoring (SPAM)

Model of Educational aspects of mentoring

The proposed model looks at the four educational aspects that is formal educational experiences, formal educational support, informal educational experience and educational outcomes. In this model, the mentor is a student, who is in any level of study. Below is the model;

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)



Source: Adapted from Tinto (1997, 615).
Figure 2.5.3 Model of educational aspects of mentoring

With this structure of mentoring approach consisted of one full time academic leader with the support of one sessional academic leader providing supplemental instruction. This is became the nucleus for the development of the Student Peer Assisted Mentoring SPAM program. Two of the students from this initial group became mentors in the following year. Effectively, the two students who had undertaken the SPAM program in the previous year volunteered to act as mentors for students who were having difficulties with understanding the first year in any course and topics. This was the embryonic stage of the student peer-assisted mentoring approach. These mentors were supervised by the academics who acted in the capacity of supervisors. However, the program did not continue in the same format after 1992 due to difficulties in attracting and retaining student mentors. Under the original format, mentors were available at a prearranged time each week, so that students could ask questions about the topics covered by the lectures and discuss problem solving skills for homework. These sessions, were aimed at providing a form of supplemental instruction on a more individual basis than would occur in a tutorial. Students were able to ask questions without any fear of being ridiculed for their lack of understanding of the topic.

The Mentors were required to keep a record of attendance so that the mentored students' academic progress in normal course assessments such as assignments and review quizzes could be monitored. This was particularly useful for monitoring whether the students had gained an understanding of the topic or whether they were still encountering problems. At the end of semester, students were asked if they were satisfied that the mentoring program had assisted their learning and whether their learning requirements had been met. (Ross Kirkham, Damian Ringelstein, 2008).

III. METHODOLGY

Introduction

The study used different methods to collect data which are observation and semi- structured interviews, asking questions, gathering information and then presenting the facts. However, it is also the process of collecting, analyzing, and interpreting data in order to understand a singularity (Leedy and Ormrod, 2001). Using mixed methods that combined both qualitative and quantitative data collection. The strategies used for primary data collection were interviews and the literature reviewed which helped to achieve the second objective.

The analogy of multi-level student peer assisted mentoring is borrowed from the cache memory hierarchy. The purpose of cache memory is to store program instructions and data that used repeatedly in the operation of programs or information that the Central Processing Unit is likely to need next. The cache are divided into blocks that increase the access time and speed and in reference to that analogy, the multi-level student peer assisted mentor would be fast and have speed accessing the mentee who happens to be their fellow students. During the read cycle operations, the access time and speed determines how memory blocks mapped to the cache line, when students interact around the campus they automatically peer mapped in their groups of association. The cache is between the main memory and the processor.

To increase on the efficiency, introducing a small block of high-speed memory called a cache between the main memory and the processor. The operation of cache memory gives full ideas of the Academic leader and the Mentor to mentee operation. Academic leader (lecturer) stands in as a Central Processing Unit and the peer (student) to a mentee (fellow student). The third objective, which was set, achieved on the proposed model, (see figure 3.0) the academic leader happens to be a lecturer and is not considered in the proposed model. In order to reduce the cycle of consultation and the nature of the distance to find the lecturer by the student are shortened instead, the mentors and mentees are close in age, experience, educational level, and they may overlap in their personal identities. Therefore, the 4th year mentor can have either 2nd year mentee or 3rd year mentee as shown in Figure 4.0.

Sample Population

The aim of the research was to develop a system that would optimize student peer assisted mentoring of female computer science at undergraduate. The ideal sampling frame for this research would have been all universities registered with the Ministry of Higher Education in 2017 -2019 period, using probability-based sampling, whereby all universities would have had an equal chance of being selected from the sampling frame. Unfortunately, due to time constraints and financial limitations, it was not possible to use this sampling method. Instead, a convenience sampling method was used, where relationships already existed with universities, to maximize the response rate and meet the research deadline.

Interviews

The Interview review highlighted the fact that the Deans and Head of Departments are an important influential factor on students with regard to their career choices. To explore this theme, a semi-structured interview checklist was designed to gather qualitative data trying to find out mentorship program that the universities are running for the female undergraduate and how many female students' advances to second year in Computer Science as a course of study. According to Miller and Crabtree (1992), semi structured interviews are open-ended but focused and guided events that are co-created by the interviewer and the interviewee. These types of interview give the researcher some flexibility to adapt the questions to the situation e.g. omit questions, change the ordering or to adapt to information initiated by the interviewee (Saunders et al., 2009).

Conducted five (5) interview sessions with Dean and Head of Departments of computer science. Participants were invited to attend a face-to-face interview at a time and location that was convenient for them. Two (2) interview sessions took place face-to-face while three (3) were conducted by phone, due to constraints on the part of the interviewee. Interviews took approximately 20 minutes.

IV. FINDINGS AND RESULTS

This chapter reports the findings of the literature reviewed and semi-structured interviews with Deans and Computer Science Heads of Department of selected universities in Zambia. Used mixed methods to collect and analyzed data.

After reviewing literature and conducted interviews the results shows that mentorship program is 99 percent nonexistence in the Zambian universities that meant data collection would be a challenge, since the program is nonexistence in Zambian universities. However, informal type of mentorship was used by 0.1 percent of individual lecturers without being aware of its application, since mentorship has not being clearly defined and structured so many educators are not sure of it.

Based on the literature reviewed found out that mentorship program is lacking in the following areas: differing in structure and methods, focus and theoretical orientation. Because of this gap wish to propose the Multi-level Student Peer Assisted Mentoring (MSPAM) where integration and social academic support are most appropriate for this program that focus on engagement rather than instruction. Below figure 4.0 is the proposed Multilevel Student Peer Assisted Mentoring (MSPAM) framework for a 4 year computer Science Female student program.

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)

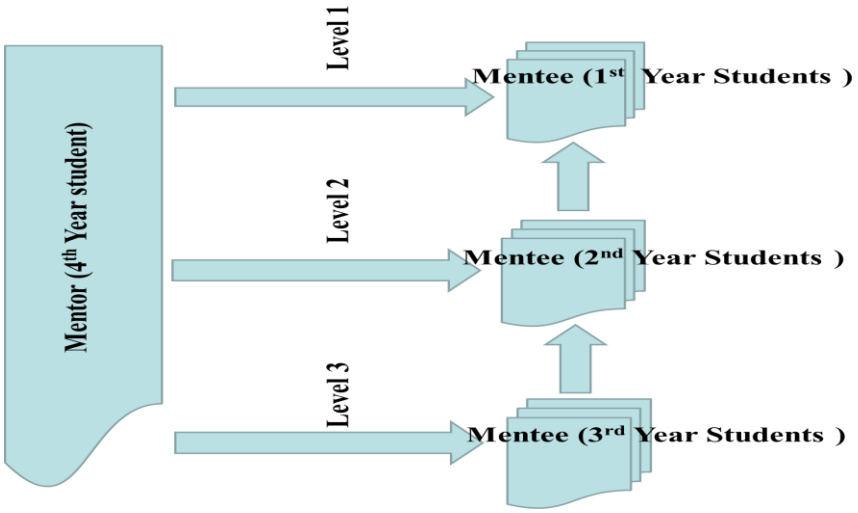


Figure 4.0 Model of proposed integrated multi –level student peer assisted mentoring framework for a 4-year computer science female student program. (MSPAM)

As shown in Figure 4.0 and Figure 4.1 below, the proposed Multi-level Student Peer Assisted Mentoring (MSPAM) activity for a 4-year computer science female student program shows the model and the activities of a 4-year program. In the first year, the major activities for students are advised on the best course to study or if the student has already chosen the course she is advised on staying in computer science course, that's career advising by either their female fellow students who are in second year or fourth year in computer science with experience. Mapping takes place in first year where, the first year female student (mentee) is mapped with the second or third year female student (Mentor), who at this time help the fellow female student with guidance aspect on social and academic.

The major activities in the second year are that, depending on the university course structure, in the second year the female student belong to school of natural science under the department of computer science, the recruitment and training of student leaders for the mentorship program happens at this level, also at this level academic leader (Course tutor/ Lecturer/HOD) makes recommendations for student mentors. The objectives of the mentorship program and variable dates and times for group meetings are set. University female student is busy because of that the Academic leader request from them the convenient timings for the meetings with suggested topics. Peer Mentor Group Leader who happens to be 3rd – 4th year Students and Lecturers / HODs starts the matching and agree on the goals and objectives of mentorship program. Conduct Interviews with the prosperous mentor who are recommended by the group tutor from the department of computer science.

In the third year, the following are the activities proposed to take place; produce meeting guideline and modules, these are set of independent units of study or training that would form part of a course. Plan regular program activity, e.g., monthly gathering, mentor recognition. Fixed pre-scheduled meeting dates and times for mentee group based on student schedules, this is a form of a timetable which should have a serious consideration of the formal class time table and availability of the particular mentee who happens to be 1st or 2nd Year female computer science student.

In the final or fourth year among the many activities proposed be the meeting with a member of the course team on a monthly basis, to report back on how course content is being received at all levels, for instance, how second year students are progressing and what difficulties they are facing. Since it is a proposed multi-level student peer assisted mentoring of computer science female student at undergraduate, the mentorship can be done at any level of study, which mean first year can as well be mentored by either the 3rd year or 4th year student and verse versa. And also the 3rd year female student can be mentored by the 2nd year female student. As shown below Fig 4.1.

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)

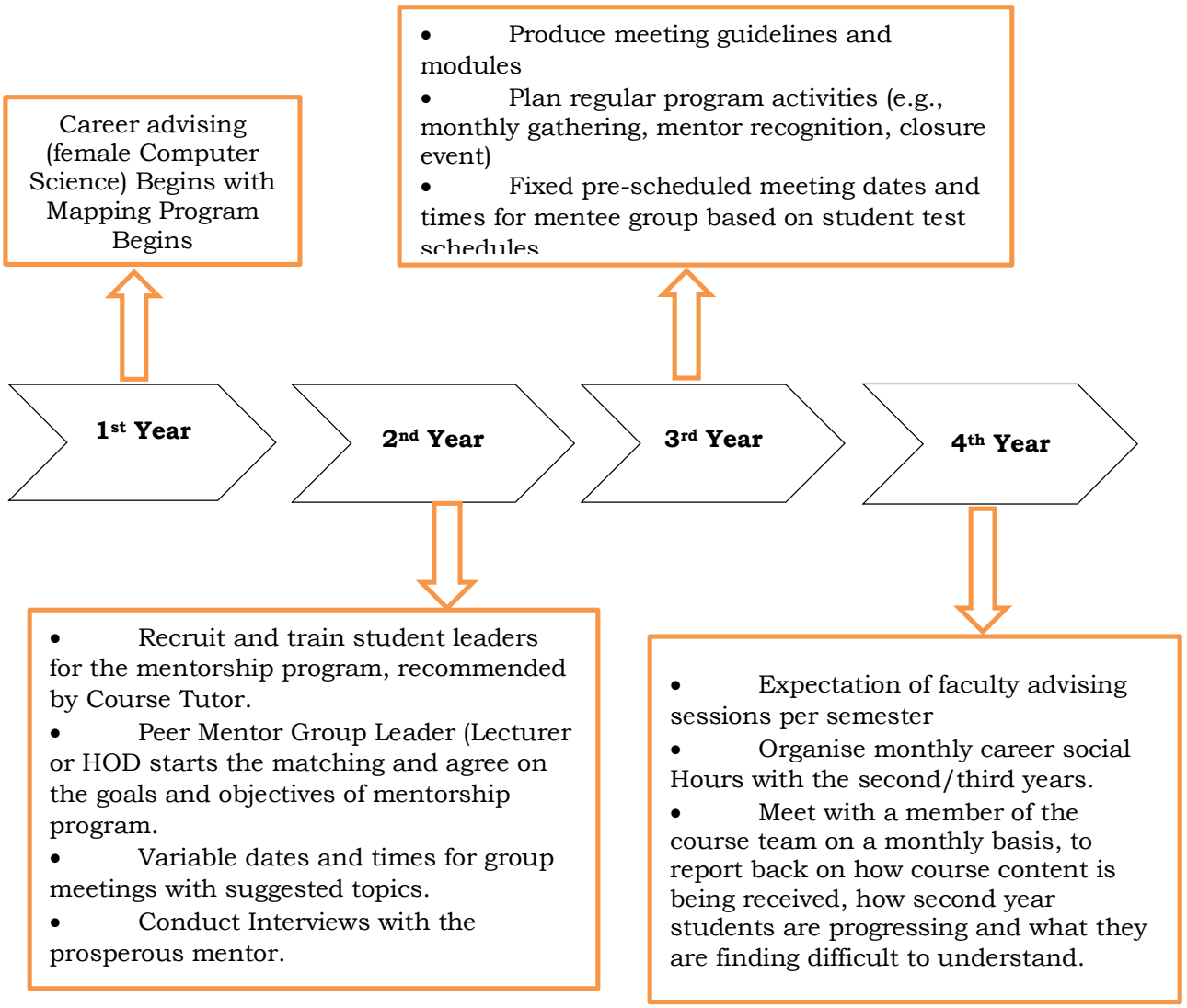


Figure 4.1 Proposed Integrated Multi-level Student Peer Assisted Mentoring (MSPAM) activity for a 4-year female computer science program.

Identified Gaps of the current state of mentorship program

1. Informal type of mentorship was used by 35 percent of individual lecturers without being aware of its application, since mentorship has not being clearly defined and so many educators are not sure of it.
2. Differing in structure and methods, focus and theoretical orientation.
3. Lack of integration and social academic support, it is the most appropriate for this program that focus on engagement rather than instruction.
4. There is no focus on the female student at undergraduate of computer science.

Women Career Inspiration

Participants were asked who inspirations their career choices. 60 percent of the total students (participates) stated that their family were one of their main influencer of career choice. The parents were next with 25 respondents mentioning it as another career choice influencer. Teachers, Internet and friends were the other main influences as shown in Table 4.3.

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)

Table 4.3 – Female Career influences

Inspiration	Number of respondents
Family	55
Parents	25
1st Year to 2nd Year Results determination	15
Subject Teachers	12
Internet (Facebook, LinkedIn, WhatsApp, Google)	9
Friends	7
University Perspective	5
Professional in Computer Science	3
Former Students	1
Neighbors	1
Television (ZNBC)	1
School Career Guidance Teacher	1

Interview Findings

Interviews took place with five (5) participates among them the Dean of Computer Science, Head of Department and Computer science lecturers from a variety of universities to get their views on multi-level student peer assisted mentoring of female computer science at undergraduate.

The Dean of Computer science, Head of Department and Computer science lecturers were asked specific questions about mentoring in their Universities/schools and gender stereotypes with regard to course choice. Information was sought on the guidance offered to female student in their universities and their opinions on Computer Science as a course of study. The interviews followed a semi-structured format so while the basic questions were the same for each interviewee, new questions and topics were raised during the course of the interviews.

The Dean and computer science Lecturers were asked whether the first year female students are aware of career in computer science, the unanimity was that 30 percent of students are aware about the computer science career. Of the two universities conducted research on, the female students seemed to be more cognizant of computer science as a career. In these universities, the Dean/HOD appeared to be very knowledgeable on the subject and very active in promoting it, while the other lecturer actively promotes it as one of the careers where there are a lot of job opportunities because it was a field which is not yet overwhelmed.

Closing the gap of gender disparity in Computer Science

Interviewees were asked on what can be done in order to close the gap of gender disparity and increase the numbers of female in computer science course. Some of the main ideas and suggestions emerged included: introduction of mentorship programs in universities where female students (mentor) mentors their fellow female student (mentee) on how to go about difficult courses in computer science. Inviting speakers from computer science and Information Technology related fields to give talks on importance of mentoring female students in computer science and inviting former students who had made it in Computer Science and gone on to work in the industry back to colleges and universities to talk to the students about how merchantable and golly of the course as a female student.

Among the interviewee suggested that requesting female professional from the ICT related industry to tête-à-tête to the students might work, carefully choosing a speaker who is approachable and somebody students could relate to ask questions that worry them about the course and this is a form of mentorship. This method would introduce female students to a positive role model in the industry and showcase women working in IT related field and how they have built successful careers. This, in a way of mentorship.

V. CONCLUSIONS AND RECOMMENDATIONS

The aim of this research was to develop an activity of multi-level student peer assisted mentoring of female computer science student at undergraduate that can be integrated in the 4-year computer science program at undergraduate.

Multi-level Student Peer Assisted Mentoring (MSPAM) is not only of the knowledge and skills gained but also students can learn from peer mentors and professionals. Mentoring provides professional, socialization and personal support to

facilitate success at undergraduate school and beyond postgraduate.

The shortage of female role models in the Computer Science industry were cited as a reason why there are so few women choosing to study computer science. Female role models can inspire more females to choose Computer Science as a career. The literature reviewed identified the potential reasons for this, however, no studies were identified that focused on female in Computer Science in Zambia and due to the extensive growth of the computer science industry in recent years, the issue of a gender disparity in computer science based jobs is becoming an ever increasing concern.

Three quarters of female students in this study cited that they have no interest in Computer Science or that it is 'Tough' and 'challenging', yet they also state that they have no background and foundation from secondary level. Computer Science is not offered as a compulsory subject at secondary level in Zambia, which has resulted in a lack of awareness and knowledge regarding the subject for students. Ministry of general education have avoided introducing Computer Science or programming as a compulsory subject in the curriculum, because of many factors from lack of computers in schools to shortage of computer science teachers. Ultimately, this is affecting negatively on the numbers of students choosing to study Computer Science at undergraduate.

Recommendation

Recommend that the relevant stakeholders including private and public universities among others adopt the multi-level student peer assisted mentoring (MSPAM) to be implemented at undergraduate as a means to close up gender disparity at undergraduate in computer science and also increase and maintain the female graduate in the field of computer science.

Primary to Secondary School Curriculum

The Zambian secondary school curriculum should be reviewed to make it more relevant to the current needs of the Zambia's ICT economy. With so many real jobs available in the ICT sector and that Zambia is developing in terms of ICT infrastructure, this is where the focus needs to be for second year students choosing computer science. The lack of education in ICT from primary school age has a disadvantageous effect on the numbers choosing it as a career option. This is particularly affecting females who tend to shy away from subject areas they know least about like computer studies.

The introduction of Computer Studies as a compulsory subject at junior and senior secondary level would create an awareness of the subject and would ensure that girls get an opportunity to try it out in a classroom situation. This should also improve confidence levels in female students and start to break-down the stereotype that is associated with people who study Computer Science at undergraduate. Guidance and counselling office can be introduced if it is in existence be strengthen in secondary schools so that through their office mentorship programs can be coordinated.

Mentoring and Partnership Program

Research shows that the negative stereotype of females' suitability for male dominated careers is harmful. To help eliminate the stereotype, girls need to be exposed to Computer Science in real world situations from an early age.

Partnerships should be formed between industry and Universities to showcase that Computer Science is a great career option for females.
A partnership/mentorship program would lead to:

- Increased exposure for female students to female role models in Computer Science careers
- Mentors to hold workshops that brings secondary school students to their campus for a day to experience what studying Computer Science at university level is really like.
- To increase the student's Computer Science work experience with the mentor and mentee to practice in a real technology companies with a lot of exposure.

Promotion of Computer Science

Results from this research show that students are not receiving enough information regarding Computer Science and the resulting career opportunities available. Through the multi-level student peer assisted mentorship program there are able to inform their fellow students (mentee) on the career opportunities in computer science.

Multi-level student peer assisted mentorship program coordinator and Student leaders to hold special career's day on Computer Science for parents of female students to help educate them on the options available for their children when it comes to career choice of computer science. Through the mentorship program or career expo, female representatives from ICT industry, who are zealous about their work, could also come out to universities to give talks/workshop to promote Computer Science program. This would also encourage university students, particularly females, to have a mind shift and adopt a neutral attitude to Computer Science.

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 6, ISSN No. 2455-2143, Pages 8-21
Published Online October 2021 in IJEAST (http://www.ijeast.com)

Future Research Opportunities

Information from students surveyed in this research suggests that lack of exposure to Computer Science is one of the main reasons why particularly second year females are not pursuing it as a career option. Parents, Students and computer science lecturers support the introduction of a Computer Science course into secondary level curriculum and find a way of making it softer or two steams of computer science for weak and strong students.

Non-progression, crossovers and dropout rates from Computer Science courses are one of the highest of all courses offered at undergraduate. In the academic year 2014/15, the non-progression rate for Computer Science was 35 per cent and 25 per cent in the academic year 2016. As this figure is inclusive of both males and females, due to limitation in my research, research could be carried out to investigate if female students who enter to study Computer Science are progressing to graduation and if not, what are the barriers to this?

Summary

The objective of this research was to review the structure of student peer mentoring programs. Secondly, propose an integrated student peer assisted mentoring framework for a 4-year computer science program.

Student peer assisted mentoring in higher education have regarded as an effective intervention to ensure the success and maintenance of students. Many universities and colleges have therefore implemented some form of mentoring program as part of their student support services. (Jenepher Lennox Terrion & Dominique Leonard, 2007). In agreement to the researcher, the Zambian universities can as well use the multi-level student peer assisted mentoring program by integrating it in our 4 year computer science program; the multi-level student peer assisted mentoring can help retain and maintain the number of female computer science at undergraduate.
Peer mentoring programs have been widely adopted by universities outside Zambia and colleges as important components of their strategies to enhance the experience of first year students to assist them in making the transition from secondary school to university. These programs involve senior students mentoring beginning students that is the first year. Using senior students as mentors rather than faculty members takes advantage of their ability to share their own recent experiences as students, and thus the process does not involve the status differences that may exist between faculty and students. Academic achievement is, however, just one indicator of the success of a peer-mentoring program and is not necessarily applicable to all such programs.

This research has further demonstrated that there are a number of barriers that have contributed to the number of female computer science student' stopping choosing to study Computer Science at undergraduate such as poor self-efficacy, curricula, a lack of role models and negative stereotypes.

VI. REFERENCE

1 Brenda FD. (2011). "Researcher reveals how "Computer Geeks" replaced "Computer
2 Girls"". Gender News. Stanford University. Archived from the original on 12 March 2015.
3 Camp T.(2001). "Women in Computer Science: Reversing the Trend". Colorado School of Mines.
4 "Computing Degree and Enrollment Trends", 2010-2011 CRA Taulbee Survey. The Computing Research Association.
5 Clarke H., Caroline (2010). "Computer Science: The Incredible Shrinking Woman". In Misa, Thomas (ed.). Gender Codes: Why Women Are Leaving Computing. Hoboken, NJ: Wiley. p. 32. ISBN 9780470597194.
6 Randall S. (2008). "What Has Driven Women Out of Computer Science?", The New York Times.
7 Kemp Peter E.J., Billy W. and Miles B.G. (2019). "Female Performance and Participation in Computer Science: A National Picture". ACM Transactions on Computing Education (TOCE). doi:10.1145/3366016.
8 Allen T.D., Eby L.T, Poteet M.L, Lentz E., and Lima L. (2004). "Career benefits associated with mentoring for proteges: a meta-analysis". J. Appl. Psychol. 89, 127.
9 Arendale D.R.(2007). "Postsecondary Peer Cooperative Learning Programs: Annotated Bibliography, College of Education and Human Development", University of Minnesota: Minneapolis, MN.
10 Arnold R.M.(2005). "Mentoring the next generation: a critical task for palliative medicine". J Palliat Med. 2005;8(4):696–8. 10.1089/jpm.2005.8.696 [PubMed] [CrossRef] [Google Scholar].
11 Balster N., Pfund C., Rediske R., and Branchaw J., (2010). "Entering research: a course that creates community and structure for beginning undergraduate researchers in the STEM disciplines". CBE-Life Sci. Educ. 9.
12 Campbell T.A. and Campbell D.E. (1997). Faculty/Student Mentor Program: Effects on Academic

Performance and retention. Research in Higher Education, 38(6), pp727-742.

13 Carter J. and Jenkins T. (2001). "Arresting the Decline: how can we encourage female students back into Computer Science? Proceedings of the Higher Education Close Up Conference 2", Lancaster University, 16-18 July. 2001.

14 Clarke-Hayes C. (2010). "Computer Science: The Incredible Shrinking Woman in: T.J Misa, (Ed.), Gender Codes: Why Women Are Leaving Computing". Hoboken, N.J: Wiley & Sons.

15 Cohoon J., McGrath. (2001). "Toward Improving Female Retention in the Computer Science Major." Communications of the ACM. May, 2001.

16 Corbett C., Hill C.(2015). "Solving the Equation: The variables for Women's Success in Engineering and Computing "(AAUW, Washington, DC), 2015.

17 *Crisp G., Cruz I. (2009). "Mentoring college students: A critical review of the literature between 1990 and 2007". Research in Higher Education. 50 (6): 525–545,* 2009.

18 Ferrari J.R. (2004). "Mentors in life and at school: Impact on undergraduate protégé perceptions of university mission and values. Mentoring and Tutoring", 12(3), 295-307.

19 Fricker R.D, and Schonlau M. (2002). "Advantages and Disadvantages of Internet Research Surveys: Evidence from the Literature. Field Methods 14", pp. 347–367.

20 McGrath J. Cohoon, (2002). "Recruiting and Retaining Women in Undergraduate Computing Majors," University of Virginia- Charlottesville, Virginia 22904-4265: USA.

21 Jackson V., Arnold R.M. (2010). "A model of mosaic mentoring". J Palliat Med. 2010;13 (11):1371 10.1089/jpm.2010.9764 [PubMed] [CrossRef] [Google Scholar].

22 Jacobi M. (1991). "Mentoring and undergraduate academic success: A literature review. Review of Educational Research", 61, 505-532.

23 Johnson-Bailey J., and Cervero R.D. (2004), "Mentoring in black and white: the intricacies of cross-cultural mentoring. Mentor." Tutoring Partnersh. Learn. 12, 7–21.

24 Kutoma J. Wakunuma, (2008). "Gender and ICTs in Zambia:" Coventy University, UK.

25 Lane N.J. (1997). "Women in Science engineering and technology: The rising tide report and beyond," in: Maynard, M. (Ed.), Science and the Construction of Women. London: UCL Press.

26 Kirkham R. and Ringelstein D. (2008). "Student Peer Assisted Mentoring (SPAM): A Conceptual Framework, e-Journal of Business Education & Scholarship of Teaching," Vol. 2, Issue 2, 2008, pp: 39–49.

27 Spencer S.J., Steele C.M. and Quinn D.M. (1999). "Stereotype threat and women's math performance". Journal of experimental social psychology, 35(1), pp. 4-28.

28 Strauss A. and J.M Corbin. (1998) "Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory". California: SAGE Publications.

29 Tashakkori A. and Teddlie C., (2010). (Eds.), "Sage Handbook of Mixed Methods in Social & Behavioural Research," London: SAGE.

30 Tenenbaum H.R and Leaper C. (2003). "Parent-child conversations about science: The socialization of gender inequities? Developmental Psychology", 39(1), pp. 34.

IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

ABOUT IJEAST

International Journal of Engineering Applied Science and Technology (IJEAST) is a peer-reviewed, open access journal that publishes high-quality research papers in the field of Engineering, Applied Science and Technology.

IJEAST aims to provide a platform for researchers, academicians, and professionals to share their innovative ideas, research findings, and practical experiences with the global scientific community.

FOCUS AREAS

- Engineering
- Applied Science
- Technology
- Innovation & Development
- Interdisciplinary Studies

PEER REVIEWED
All submissions are rigorously peer reviewed to ensure quality.

OPEN ACCESS
Free and unrestricted access to research for all.

GLOBAL REACH
Connecting researchers and professionals worldwide.

TIMELY PUBLICATION
We ensure a swift and efficient publication process.

For more information, visit our website
www.ijeast.com

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

editor@ijeast.com
www.ijeast.com
India

2455-2143