



Ashesi University

The Perception of Class Size on Teaching Quality and the Performance of STEM Students in
Private Undergraduate Universities in Ghana: A Comparison Between Ashesi University and
Central University

By

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in Business Administration.

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DECLARATION

I hereby declare that this paper is my original study and that none of its parts have been presented for another degree in this university or elsewhere.

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I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by Ashesi University.

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ABSTRACT

International Higher Education in the twenty-first century is facing significant uncertainties not only because of the ongoing COVID-19 pandemic but also because of other challenges like limited access and funding. In Africa, higher education is under threat from the growing population that puts pressure on existing resources. This challenge is no different in Ghana, a West African country located along the Gulf of Guinea. This is attributable to the fact that access to higher education is determined to a large extent by the available facilities in the heavily subsidized public universities in Ghana. Private universities exist but they are either more expensive or cheaper but much less reputable than state universities and are often much smaller than public universities although a few are large.

Given the challenges of access and quality in higher education, the study sought to determine the relationship between class size and student performance in STEM courses, in two private undergraduate universities in Ghana. The mixed method approach was used with semi-structured interviews and questionnaires as data collection methods. The sample size was 258 STEM students, and sampling techniques were the simple random sampling and purposive sampling. The findings showed that there was no significant relationship between class size and student performance at the conventional level of significance. However, students indicated that effective time management, learning environment and critical thinking skills impacted them significantly. Therefore, if measures are put in place, where despite the class size, individual needs of students are met, that is most important.

Key words: higher education, class size, student performance/outcomes, teaching quality, stakeholders.

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DEFINITION OF KEY TERMS

Higher Education (Higher Ed): Any education and training that is beyond the second cycle education, with core functions as teaching, researching, and providing service to mankind (Amenyah, 2009).

Chartered Higher Educational Institutions: Institutions that have been given state authority to award degrees and certificates, owing to the issuance of a presidential charter (National Accreditation Board, 2015)

CHAPTER 1: INTRODUCTION

1.1. Overview and Background

Higher Education (Higher Ed) in the twenty-first century is facing significant uncertainty not only because of the ongoing Corona Virus Disease 2019 (COVID 19) Pandemic which often rules out on-campus studies but because of other factors as well. Sow (2018) reported that “by 2050 Africa’s young population (thus the ages between 0 and 24 years) will increase by nearly 50 percent.” This connotes that in the next 50years, Africa’s school-going population would increase with a proportional increase in the demand for higher education.

However, the overall progress of Africa’s higher education has been sluggish and uneven, with challenges like “funding, access, quality concerns, institutional capacities, weak research base and governance.” (Jowi, Obamba, Sehoole, Barifaijo, Oanda & Alabi, 2013; Armah, 2020).

Keer (2001) depicts the state of the history of Higher Ed as being blown by winds from many directions. These “blowing winds” include “shifts in public resources for colleges and universities, as well as changes in the demographics of those who attend higher education institutions” (Zusman, 2005, p. 115, as cited in Chapman and Ludlow, 2010).

In Africa, the very way in which universities operate seems to be under threat as demand for Higher Ed from a growing population may increase class sizes and put pressure on existing resources. The uncertainty plaguing Higher Ed is no different in Ghana, a West African country with one of the fastest-growing Higher Ed sectors in the World (Armah, 2019).

For non-Ghanaian readers, Ghana is a West African country, located along the Gulf of Guinea, with a population of twenty-eight (28) million (World Bank, 2017). Ghana is popularly known for her stellar record of political stability and her natural resource endowments like gold, bauxite, oil, and diamond (Armah, 2016). Although Ghana was ranked as the fastest growing

economy with 8.3% growth rate in 2018 (McDonnell, 2018), illiteracy and income inequality remain a challenge to Ghana (Appiah, 2018).

According to Koto (2015) as cited in Atarebono (2019), Ghana's economy is characterized by a huge informal sector super-imposed on a small formal sector. As a result, the increased rate of unemployment in Ghana usually affects university graduates who are unable to secure office jobs (Ameyaw & Obeng-Odoom, 2014).

However, it is noted that the difficulty in securing job opportunities have been attributed to many factors such as poor quality of graduate labor force (British Council, 2014, p.5), lack of basic employable skills in graduates to complete simple tasks (Baah-Boateng, 2016, p.5) and the lack of transferrable skills like professionalism, reliability, and effective communication (Singh, 2005, p.824; Andrews & Higson, 2008, p.413).

The above evidence iterates the fact that the kind of education that is acquired at the various tertiary institutions in Ghana is one cause of the increasing unemployment rate in Ghana and not the lack of job opportunities. This, therefore, prompts stakeholders that there are defects in the operations of higher education in Ghana, that must be addressed for Ghana's economy to experience a substantial turnaround.

Samuel Okudzeto Ablakwa, former Deputy Minister of Education in Ghana, wrote that African universities must adopt new ways of lecturing with technology to meet global competition in the future (University World News, 2020). He further proposed that dynamic e-learning programs and distance learning would be best methods to address the needs of students who may not gain admission to public tertiary universities in the future (Marguerite, 2020; University World News, 2020).

In Ghana, higher education is relevant to socio-economic development, as it produces skilled labor for the other sectors in the economy. Higher education, as per Boahin (2018) plays a vital role in boosting employable skills (p.21), and the fact that students acquire knowledge and skills to critically analyze and find solutions to the varying socio-economic challenges confronting Ghana makes tertiary education an integral part of Ghana's economic development (GhanaWeb, 2018; Osei-Mensah, 2018).

Economic development as per Todaro and Smith (2015), encompasses vast ideas than just growth because it tackles poverty, unemployment, educational attainment, access to health service and inequality. An Afrobarometer survey conducted on a significant number of youths in Ghana revealed that education and unemployment are the main issues that the government needs to address (MyJoyOnline, 2020). Due to this, getting university education has become one of the primary aims of many pre-tertiary students in Ghana. This desire of the youth has put much pressure on higher education as the number of student placement into tertiary institutions increases every year.

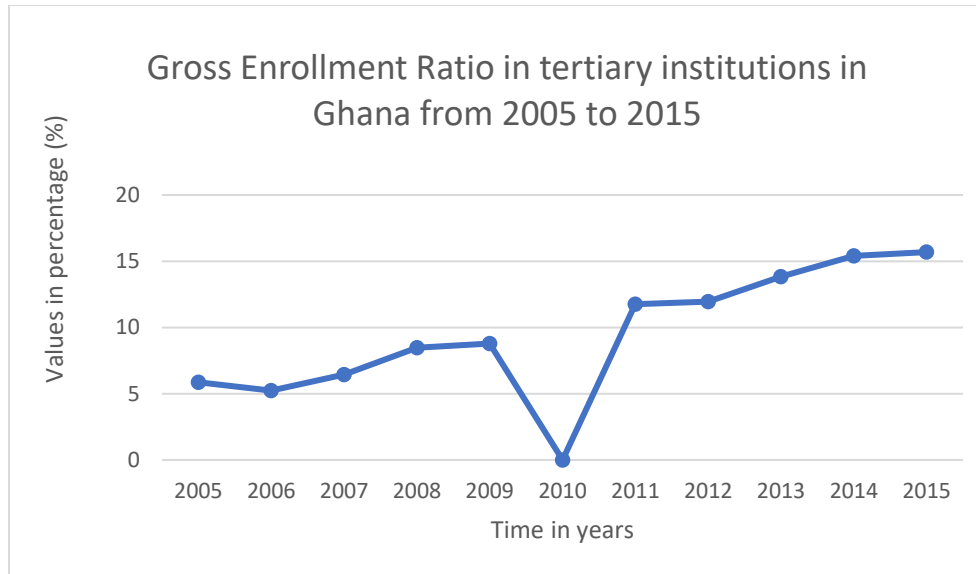
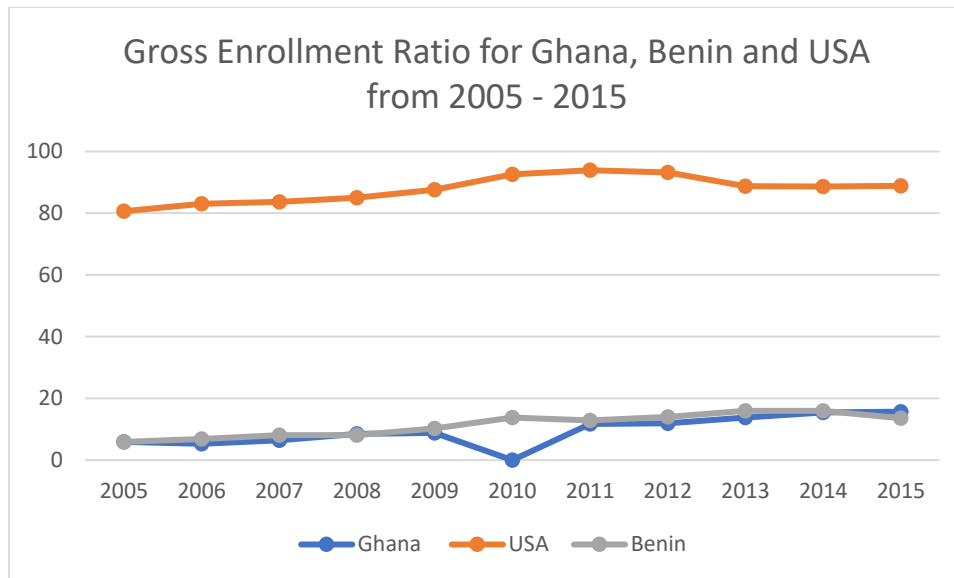


Figure 1: Graph showing the Gross Enrollment Ratio in Tertiary institutions in Ghana from 2005 to 2015.

From historical records, enrollment into tertiary institutions in Ghana has increased steadily from 0.7% in 1972 to 16.2% in 2015. This estimates an average annual growth rate of 28.4%.

Despite this robust demand for university education and a booming private university system, the percentage of the college-going population that goes to college or the Gross Enrollment Ratio (GER) in Ghana remains low and has been historically low as compared to a developing country like Benin and a developed country like the United States of America.

This is attributable to the fact that the pace of extension in housing accommodations and academic facilities are unequal, therefore, access to higher education is ascertained by the available facilities of universities in Ghana (Atuahene & Owusu-Ansah, 2013). Below is a graphical representation of Ghana's enrollment ratio in tertiary education against those of Benin and the United States of America between 2006 and 2016.



Source: The World Bank, UNESCO Institute for Statistics.

Figure 2: Graph showing the Gross Enrollment Ratio for Ghana, Benin, and USA between 2006 and 2016.

1.2. History and Current Structure of Ghana's University System

Wiseman and Wolhuter (2013) assert that colleges in Ghana upgraded to being universities by an act of Parliament in 1961. According to Atuahene and Owusu-Ansah (2013), the University of Gold Coast was the first higher education institution established in Ghana in 1948 and it was renamed the University of Ghana after independence in 1957. Interestingly, the number of public universities in Ghana had increased to three (3) by the close of the 1980s. These universities were the University of Ghana; Kwame Nkrumah University of Science and Technology; and the University of Cape Coast (Atuahene & Owusu-Ansah, 2013).

Osman, Yussif, and Yussof (2013) claim that between 1990 and 2009, the total number of tertiary institutions had increased, with eight (8) public universities. Following the Structural Adjustment Programs (SAPs) in the 1990s, Ghana's university system was liberalized, giving rise to private universities. In 2019, the National Accreditation Board (NAB) recorded a total

number of two hundred and twelve (212) accredited tertiary institutions with ten public universities, thirty-nine public colleges of education, thirty-eight private and public nursing training colleges, and five registered foreign tertiary institutions (National Accreditation Board, 2019).

According to Sawyer (2004), 40,673 students were admitted into public universities and 2500 in private universities in 2001. However, Boateng (2014) says that in 2008, the University of Ghana could not admit the required number of students that they received. Instead, it granted admission to only 38% of the total applicants (thus, 8,774 students out of 22,865 students). Similarly, Atuahene and Owusu-Ansah (2013) confirmed that admittance to the public universities in Ghana is influenced by the availability of classroom and housing facilities, as well as Government subventions to these institutions.

This report suggests that there has been a steady growth in demand for higher education within the last twenty years (The Economist Intelligence Unit, 2014). Nonetheless, public universities have not been able to meet this demand for a lack of educational facilities. Therefore, to support this challenge, there was a need to fuse private institutions into the Ghana educational system.

Currently, there are a total of eighty-one (81) private higher educational institutions in Ghana offering degree and diploma programs (National Accreditation Board [NAB], 2018). Meanwhile, out of eighty-one institutions, only seven have their charters at the time of writing; Ashesi University, Central University, Valley View University, Akrofi-Christaller Institute of Technology, Pentecost University, All Nations University, and Trinity Theological Seminary (NAB, 2020).

It has been observed that student enrollment into the private tertiary institutions has increased steadily over the years (Ponnan, Malek, Marzura & Balaguru, 2016). This obvious increase in the number of private institutions in Ghana, according to Armah (2016), depicts the dire need of Ghanaians to attain higher education. Armah (2016) further argued that “population growth in Africa, the quest for higher degrees to meet job requirements, globalization, and the knowledge economy” are some factors that accounted for the growth in private higher institutions (Armah, 2016, as cited in Atarebono, 2019).

Ostensibly, the increase in private institutions meant that the fewer educational facilities available to students in the public universities were crammed, as there was much pressure on these resources. Armah (2016) observed that the increased pressure on existing public universities to enhance access to higher education, led to the proliferation of private tertiary institutions in Ghana (as cited in Atarebono, 2019). Thus, the advent of private universities into the tertiary education sector “broke the monopoly of public universities in Ghana (Varghese, 2004).

Although there has been the emergence of private institutions, public universities still admit a relatively larger number of students than the private institutions, and this gives a higher chance to compromise quality (Boateng, 2014). Thus, as the number of students increase in public universities without a proportional increase in infrastructure and the number of instructors, the student-lecturer ratio would rise, which may result in poor quality education.

The Ministry of Education, Ghana, reported that although government spending on the education sector grew in nominal and real terms and even exceeded state revenue, there were still funding gaps of 45% in 2016 (Ministry of Education, 2018). Funding gap as per Brady (2020) is the difference between the amount of money needed to commence or continue an ongoing project and the money currently available (Wisegeek, 2020). Therefore, considering the

Government's policy on the implementation of the free Senior High School (S.H.S.), matters could be worse if the needed provisions are not made to facilitate the teaching and learning process. Kale-Dery (2018), reported that The Ministry of Education has estimated a total of 145,000 Senior High School graduates who would be entering into the tertiary sector in the year 2020.

This estimate gives a growth of 37.93% (55,000 students) above the total current tertiary students' admission of 90,000, in 2018 (para 1-3). However, if measures are not put in place to expand lecture halls to accommodate these numbers, then not only will there be unequal access, but teaching quality would also be poor.

According to Atuahene & Owusu-Ansah (2013), "the fact that many students are faced with the challenge of accessing universities and programs of their choice due to limited academic facilities means that Ghana is potentially underutilizing a greater percentage of its human resource capacity."

1.3. Class Size as an Important Determinant of Student Performance

Research has proven that most students consider class size when there is a comparison between courses and experiences. According to Altbach (2005), though universities are labeled as "durable institutions" able to adapt and continuously serve society's needs regardless of their expansive change, it is still critical to examine how these changes affect teaching and student learning in university classrooms (Awbrey, 2005, p.1).

Although there are other factors that account for educational successes, the issue of class size in higher education has been of much importance to stakeholders than just researchers (Chapman & Ludlow, 2010). Bandiera, Larcinese & Rasul (2009) postulate that while higher

education could involve more self-learning than basic education, class size remains sturdily at the topmost of the policy agenda and concerns of both faculty and students.

However, college and university administrators channel their focus on balancing the increasing education costs through larger classes against their desire to optimize academic reputation through small student-to-faculty ratios (Achilles, 2005). Similarly, Gleason (2012) affirms that the reduction in state subsidy in public universities in the United States causes an increase in class size and adversely impact student retention and graduation.

Now, most public universities are crammed beyond normal capacity, and the lack of enough academic and housing facilities have caused universities to adopt stringent admission processes (Atuahene & Owusu-Ansah, 2013). This is not to say that class size is the only determinant factor for student performance. It is rather the simplest variable that policymakers can manipulate. (Ehrenberg, Brewer, Gamoran, & Willms, 2001). Some other factors that can be attributable to student performance are the broader community's influences, the student's background, and student motivation (Alcott, 2017; Reeves, 2015; Saeed, 2012).

Ehrenberg et al. (2001) argue that student learning may be altered when exposed to a particular environment over the period of exposure. Interestingly, most of these research have indicated that smaller class sizes are economically beneficial and more productive to students, overlooking the associated costs. Public universities mostly resort to having a larger student-to-faculty ratio in a lecture hall to minimize cost, since investment in higher education drains the state coffers.

Chapman and Ludlow (2010) cited in their article that the most pressing challenge for change comes through an institution's financial stability level. Meaning, as one of the flexible items in most states' budget, higher education is costly and hence drains the national economy”

(Zusman, 2005). Due to the cost-effectiveness of higher education, budget constraints have instigated a phenomenon whereby larger classes have become the convenient cost-cutting strategy.” (Cuseo, 2007, p. 5).

Nonetheless, Dr. Patrick Awuah, the founder, and President of Ashesi University, at a public lecture themed, "Unleashing Youth Potentials," advised that the education authorities in Ghana cut down the larger class sizes to a significant level to aid the effective and efficient transfer of ideas to the younger generation (GNA, 2014). According to Arthur and Arthur (2016), the large class sizes in tertiary institutions in Ghana affects the quality of education that students receive, as a higher student-teacher ratio hinders the lecturer from addressing students' peculiar learning challenges.

The Graduate School of Business, Stanford in an article about Ashesi university stated that Ashesi admitted 24 percent of applicants in 2007, with an equivalent figure of 40 percent at Legon and KNUST. It further detailed the outstanding nature of Ashesi's education as owing to its small class size and the level of individualization associated with it. Ashesi's class sizes ranged from 10 to 40 students per professor while the university of Ghana had as many as hundreds of students in a lecture hall (Graduate School of Business [GSB], Stanford, 2016). The relatively smaller classes at Ashesi resulted in an effective student-lecturer relation and person-person interaction as lecturers were able to attend to the peculiar needs of students (GSB, 2016).

Most researchers have argued the numerous benefits that could be derived from having smaller classes for student courses. Ballen et al., (2019) assert that in higher education, STEM classrooms “transition from lecturing to active learning, while student interactions increase.” Thus, to measure student participation in STEM courses, the classroom environment can be regulated to facilitate active student learning.

Gakure, Mukuria & Kithae (2013) argue that the number of students in a class can affect what is learned in various ways. For example, person-to-person interaction among students could be affected. Thus, the level of student engagement with one another increases as the class size increases. It is in larger classes that the topic of diversity is emphasized because socialization is common. This informs the activities that a lecturer would implement, given for instance, the emphasis on group work.

To some extent, a larger class size fosters interactive activities and diverse ideas that sharpen students' social skills. Larger classes are less costly, as fewer classroom facilities could be made to contain most students at once. However, given the disruptive nature of larger classes, it affects how much time lecturers can focus on individual students and their peculiar needs rather than on the group (Ehrenberg et al., 2001).

As this research sets out to weigh the differences between larger class size and smaller class size, outlining either capacity's pros and cons give a clear picture of the ideal class size and how it can serve the common good. In theory, Borland, Howson, & Trawick (2005) asserted that the smaller the class size, the greater the individual student's attention from faculty. Class size affects teaching content, faculty allocation of time, and methods of teaching and assessment.

It has been recorded that faculty's teaching method in smaller classes differs from those used in larger classes. For example, lecturers have a higher tendency to provide constructive feedback on students' work and use open-ended assessments for all activities that could be implemented in a small class (Ehrenberg et al., 2001).

Nonetheless, there remains some doubt about the real importance of class size as a determinant factor on student performance especially in the development economics context despite the suggestions of Maimonides rule for optimal class size (Angrist & Lavy, 1999).

1.4.Problem Statement

For most tertiary institutions to satisfy the role of an effective higher education market, there needs to be accurate information that would psyche the minds of students and teachers on how best assessments could be done.

The classroom is a learning environment where students and teachers have access to physical interaction and an in-depth understanding of materials and unknown questions, that enhance students' critical thinking skills.

The objective of this study is to determine whether the variation in student performance is due to fixed student characteristics or classroom capacity and if there are other factors that significantly account for students' performance aside class size.

The impact of class size on student outcomes in post-secondary education has been opened to more than one interpretation. While most researchers found a negative correlation between the student-faculty ratio and student achievement, others proved class size to have had no impact on student performance.

However, given the increase in enrollments in higher education leading to a proportional increase in class size, exploring the concept of class size and its impact on college courses, learning objectives, and workload expectations are best for "effective and efficient transfer of knowledge to the youth."

Although there are additional costs to having smaller classes in higher education, the effectiveness of teaching methods does not depend solely on the objectives being emphasized, but it as well considers the number of students that are enrolled in the course.

It is high time policymakers and institutional heads examined the impact of class size on “students learning and teacher behavior, motivation, and work habits, as they plan to offer fewer sections with larger enrollments” (Clotfelter, Ladd, & Vigdor, 2006).

1.5. Research question

- Do students perform better in smaller classes at Ashesi, or is performance perception of students not associated with class size as in the case of Central University?

1.6. Research objective

- To determine whether students’ performance perception is associated with smaller classes or performance is independent of class size.

1.7. Research Relevance

Most scholars have thoroughly discussed the issue of student-teacher ratio, indicating intervention approaches that must be structured to optimize student outcomes. However, most of these researchers focused their thoughts and facts on elementary and primary schools, with little to no attention to teacher capabilities and tolerances when exposed to different class sizes. Most of these research were primarily student-based, emphasizing the negative impact larger classes have had on students' academic performance.

However, this study contributes to the literature on class size and student academic outcomes, and faculty behavior in Ghana's STEM education. This research will help school administrators to implement policies that would enhance the learning experience in the classroom and make it more conducive for both teachers and students to operate especially in STEM fields.

The findings of this research will as well inform some decisions of school administrators and policymakers on how best they can improve capacity planning in higher education, considering the economic benefits associated with quality control and productivity analysis. In essence, it will

help them to take a strategic view of school administration and the necessities for differentiating their services to gain a competitive edge.

1.8. Scope of study

The scope of this research was limited to two private universities in Ghana, Ashesi university and Central university. These universities will be compared to determine whether class size affect their students' performances or class size is independent of student performance.

These universities were chosen because although they are similar with regards to both being private and non-profit institutions, they differ from each other in terms of enrollment, size and courses offered. Central university is larger as compared to Ashesi university, and, since the study is comparative, it needed to use these different experiences.

Central university is the largest private university in Ghana, offering both graduate and post-graduate courses. It was established in 1988 as a Pastoral Training Institute by Dr. Mensa Otabil. In 1991, it was known as the Central Bible College and later changed to Central Christian College in 1993. In 1988, it was named the Central University College, and received a presidential charter in 2016.

Currently, Central university can be located at four different campus sites - Kumasi, Mitso, Dawhenya (main campus), Mataheko and Christ temple campus. The university's undergraduate school has five (5) schools and two (2) faculties, under which several courses are offered. These are Faculty of Law; Faculty of Arts and Social Sciences; Central Business School; School of Pharmacy; School of Architecture and Design; School of Engineering and Technology; and School of Medicine and Health Sciences. On their main campus at Miotso, the student population is 8400 with 211 academic staff (Central University, 2020; Buzzghana, 2017).

On the other hand, Ashesi university is a private, non-profit liberal arts university in Ghana, that seeks to educate ethical entrepreneurial leaders in Africa. It was founded by Dr. Patrick Awuah in 2002, and it is located at Berekuso, a farming community in the Eastern Region of Ghana. Although Ashesi had been applying to receive a charter through the NAB at the beginning of its operations, it became a fully-fledged university in 2018 under the leadership of the current President, Nana Addo Dankwah Akuffo-Addo.

Ashesi has relatively smaller classes that fosters lecturer-student relationship. Its insistence on quality and leadership education and the core curriculum of the liberal arts which demands critical thinking requires that instructors have a manageable number of students to access, teach and manage. Ashesi also has practical majors like Engineering, Computer Science, Management Information Systems and Business Administration which typically do not command large class sizes.

Currently, Ashesi's has a student population of 1173 and 85 academic staff (ie.37 full-time faculty; 34 faculty interns and 14 adjunct faculty). In 2020, "Ashesi ranked first in Ghana, ninth in Africa and among the world's top 400 in the Global Times Higher Education (THE) University Impact Rankings." For the 18 years (from 2002 till date) that it has operated, Ashesi has distinguished itself in Africa with its educational models and academic programs designed (Ashesi university, 2020).

1.9. Organization of the study

There are five chapters in this study. Chapter one provides a general overview of the study with a focus on the background of the research, research questions and objectives, and the research relevance, and the scope of the study. Chapter two reviews and critiques scholarly

articles to identify the gaps in the existing literature. Chapter three details the methodology, which includes sampling techniques, data sources, and collection methods. Chapter four provides the findings and analysis of this study, while a conclusion and recommendations are given in chapter five.

CHAPTER 2: LITERATURE REVIEW

2.1. Overview of chapter

This chapter elaborates on the concept of class size, the ideal class size and the relationship between class size and student outcomes as proposed by most studies. It also focuses on class size in Africa's higher education as well as class size in Ghana's higher education.

2.2. The Concept of Class Size

The issue of class size has become popular to all the stakeholders of higher education, including parents, students, districts, school administrators, teachers, and educationists (Jepson, 2015). Adeyemi (2008) defined class size as the average number of students per class in a school.

Ayeni and Olowe (2016) also defined class size as the number of students in each course. The discussion of the issue of class size and its importance to quality education has been ongoing for years now. During the final US presidential debate in 2012, the issue of class size was viewed within the subject of global competitiveness. (Benton & Pallett, 2013). While some still argue that there is no significant relationship between class size and student outcomes, a significant amount of research proves that there is a correlation between class size and student achievement (Benton & Pallett, 2013).

According to Kieschnick (2018), class size matters because it makes room for teachers to have an interpersonal relationship with students and it also enhances small-group instructions. This amplifies the assertion that the basis of teaching quality is all about relationships (Veneziale, 2019). Hence, good performance appraisal of students and faculty members based on student outcomes and classroom experience boost faculty retention rates and student learning and impacts the educational system in the long run (Bethel University Online, 2020).

2.2.1. Large class size and why it matters

Higher education in Africa has witnessed an increase in enrollment owing to population growth and increased educational institutions. However, these enrollments, when measured, are less than what is being experienced in the developed countries. This is because as population increases, there is a proportionate increase in the desire of pre-tertiary students seeking to acquire the university education.

Nonetheless, the public universities are unable to accommodate all qualified applicants on admission due to lack of educational facilities and reduced spending on higher education. Alber (2015) asserts that reduced government spending in higher education is what has given rise to larger classes. According to Zusman (2005), education is the most expensive item in most states' budget. As such, investing in education drains state coffers (Ehrenberg *et al.*, 2001).

This financial constraint has caused the government and school authorities to resort to having larger classes as a means for cost containment (Cuseo, 2007, p. 5). Large classes are less expensive and affordable, since it can be manipulated to contain a greater number of students all at once. Looking at the increase in Gross enrollment ratio (GER) at the tertiary level in Ghana, class sizes would increase proportionally.

For most students, classroom experience together with person-to-person interaction means a lot to them. As most research identifies smaller class sizes to as a means to foster interpersonal relationships, larger classes also have a greater opportunity to increase socialization among students. This is done through interactive activities like group works, where students get to share ideas and appreciate one another. The opportunity cost of implementing larger classes is the disruption in the classroom as students would be moving up and down and many voices would be heard at the same time. However, Alber (2012) postulates that although larger classes

tend to be loud, it does not mean students are not learning, as most people often ascribe silence to high-level learning and deep thoughts.

Although there are immense benefits to having large classes over small classes, research shows that student-teacher relation is not much emphasized in large classes because it is time-consuming. Thus, the time needed for teachers to provide feedback to a larger number of students would be lengthy as compared to a smaller class. Suzette Montera-Smith, a Denver kindergarten teacher, lamented that meeting students' needs in larger classes has been difficult for her (Colorado Education Association [CEA], 2020).

Spears (1984) discussed eight disadvantages of having larger classes and how they impact student outcomes and lecturer appraisal. These are “**1.** over-reliance on lecture; **2.** passive student engagement; **3.** reduced student-lecturer interaction; **4.** reduced depth of student thinking; **5.** reduced depth of course objectives and learning strategies outside the classroom; **6.** lower level of academic performance; **7.** dissatisfaction of learning experience and **8.** lower student rating of course instructions” ((Ponnan, Malek, Marzura & Balaguru, 2016). Similarly, Pedder (2006), as cited in Kornfield (2010), confirmed that:

“...in larger classes, more time is needed for non-academic activities that limits teachers from achieving the necessary pace, depth, and breadth of curriculum coverage” (p. 224).

2.2.2. Small class size and why it matters

One of the few educational reforms that enhances student learning, yielding a host of cognitive and non-cognitive benefits, is the reduction in class size (Haimson, 2013). Investing in smaller classes has immense economic benefits (Zyngier, 2014). The Institute of Education Sciences, US, concluded that, “class size reduction is one of only four, evidence-based reforms that increases student achievement through rigorous, randomized experiments.”

Project STAR, as cited by Kornfield (2010), defined small class size as a classroom setting with number of students between 13 and 17. Mostly, students that perform better in smaller classes are those that are from underprivileged homes, whose experiences are double the gains of an average student (Krueger, 2003; Schanzenbach, 2014; Haimson & Donnelly, 2016). It has been estimated that when class size is reduced in the early grades, the achievement gap reduces by 38.3%. For example, it was observed that “the graduation rate for free-lunch students more than doubled, and their likelihood of graduating closed the gap with non-poor students” (Haimson & Donnelly, 2016).

Furthermore, smaller classes develop students' non-cognitive skills that cannot be measured as in the case of tests, overall grades, and attendance levels. However, these non-cognitive skills are part of student success factors both at school and in the working world. These skills were highlighted to be persistence, motivation, and self-esteem (Dee & West, 2011).

According to Krueger (2003):

“For every dollar invested in reducing class size, there is a yield of about \$2 in benefits.”

“This excludes savings from special education referrals and lower rates of grade retention, both of which fall when class sizes are reduced.”

Generally, the importance of class size reduction at the elementary level lasts all through students' educational careers (Schanzenbach, 2014). This was seen in the Tennessee project STAR, where students in the smaller classes were “significantly ahead of their regular-class peers in all subjects in later grades” (Wilson, 2002; Krueger, 2003). These performing students were reported to have received better grades on their college entrance exams. However, it was reported that black students exhibited greater gains after being assigned to smaller classes. This indicated that reducing class size might be an effective strategy to curb the “black-white achievement gap” (Schanzenbach, 2014).

Similarly, in his analysis of class size effect on student outcomes, Krueger (1999) found that the standard deviation of students' performance in smaller classes was 0.2 to 0.3 better than those in the larger classes over the first four years of schooling. The analysis was done using multiple regression analysis, composite mathematics and reading scores from the Stanford Achievement Test (Monks, 2010).

A national survey conducted on educators believed that class size reduction is an effective strategy to optimize teaching quality. For instance, in a survey conducted on teachers in 2008, 76% of the respondents indicated that the quality of teaching is dependent on class size. Thus, the smaller the class size, the more effective the teaching style and vice versa. 21% of the respondents also voiced that class size reduction would be an effective strategy, that, when implemented fully, would outweigh every other reform cited.

Furthermore, a study conducted by McLaughlin *et al.* (2000) aimed at measuring student performance by analyzing student achievement levels on the national NAEP exams, a sample of 50 schools in each state in the US were cited. In this sample included students from “large and small, urban and rural, affluent and poor areas”

After the examination, it was proven that “the only objective factor that correlated with higher test scores was class size, and the gains in the upper grades associated with smaller classes surpassed the gains from smaller classes in the lower grades” (Haimson, 2013; Haimson & Donnelly, 2016). Confirming this, another study conducted by some educators in Colorado identified that a class size that allows for an interpersonal relationship with one another and instructors was the most crucial need of their students (Finn *et al.*, 2003; CEA, 2020).

Diane Whitmore Schanzenbach, a Northwestern University Associate Professor in her research wrote that “smaller classes work because such classes incorporate higher levels of student engagement, increased time on task, and the opportunity it provides for high-quality teachers to better tailor their instruction to the students in the class.” (Strauss, 2014). Ponnann *et al.* (2016) put it as “attention-grabbing and much devoted time for feedback sessions are possible with fewer students.” It is also possible that shy students who hardly contribute in class would build their self-confidence and discover more about their strengths and weaknesses when assigned to smaller classes.

Finn *et al* (2003) after they had analyzed 11 different class size studies, proved that there was a negative correlation between smaller class size and students’ learning behavior. In their findings, students were more “responsive to classroom interactions, observant of all classroom regulations (Babcock & Betts, 2009), and with less disruptive acts” (Bascia, 2010). In North Carolina, disciplinary referrals decreased drastically in two years after the school authorities had implemented small class sizes. The decrease was 26% in the first year and 50% in the second year.

Although the foregoing reviews establish a significant relationship between class size and performance, some empirical studies reveal a counter outcome. Kieschnick (2018) argues that

the greater positive impact of reduced class size is seen at the elementary level, specifically between “grades K-3” (Krueger, 2003). This is because of the foundational literacy and mathematical skills that are required to equip those students. He further urged school principals to investigate capacity planning at these levels before implementing it at the higher level, as it would be too late to build “grownups” from scratch.

Kieschnick believes that in smaller classes, it is the student's behavior that would be altered and not the teaching style. And he attributed this to the fact that fewer student-to-teacher ratio reduces distraction and enhances students' attentiveness.

Also, the cost involved in implementing smaller classes in higher education is one alarming disadvantage of having fewer student-to-teacher ratio. According to Jepson (2015), reducing class size is an expensive educational reform that “exceeds its benefits and the other government policies like tutoring, improving teacher-quality, and childhood programs.”

Class size reduction means the provision for more learning materials and equipment, expansion in educational facilities, and hiring more qualified teachers to cater for students' needs. However, college and school administrators have channeled their focus on balancing the increasing education costs through larger classes against their desire to optimize academic reputation through small student-to-faculty ratios (Achilles, 2005).

Similarly, Gleason (2012) affirms that the reduction in state subsidy in public universities in the United States causes an increase in class size and adversely impact student retention and graduation. Now, universities are crammed beyond normal capacity, and the lack of enough academic and housing facilities has caused universities to adopt stringent admission processes (Atuahene & Owusu-Ansah, 2013).

2.3. The Ideal Class Size

According to Kieschnick (2018), the ideal class size that is widely accepted by most researchers is 18 students. In a Magazine of Elementary Teachers Federation of Ontario, Veneziale (2019) also stated that it is not impossible to teach 32 students. However, the quality of education that his students receive changes in “small but noticeable ways.”

According to Veneziale (2019), her classes have ranged from 18 to 32 students, but she is confident that she is a different teacher with 14 fewer students. Mathematically, 14 fewer students from 32 is equal to 18 (i.e., $32 - 14 = 18$). Ponnann *et al.* (2016) also indicated that for student-lecturer relations to work, there needs to be a good number of 15 to 20 students per tutorial class. Glass and Smith (1978) in their meta-analysis of class size, discovered that a class of 20 or fewer students was associated with great academic outcomes.

Nonetheless, the great twelfth-century Rabbinic scholar Maimonides, interprets the Talmud’s discussion of class size as follows: “twenty-five children may be put in charge of one teacher...if the number in the class exceeds twenty-five but is not more than forty, he should have assistant to help with the instruction.” (Angrist & Lavy, 1999).

This shows that generally, the acceptable maximum number of students that may be put in a class to enhance student learning and performance is 40, as proposed by Maimonides. Mathematically we can represent this as: $25 \leq x \leq 40$, where x is the number of students per class.

2.4. Class Size in Higher Education

According to Dynarski *et al.* (2013), “smaller classes increase the probability of students attending college and earning a diploma or degree in a STEM field.”. Even at levels 300 and 400, when the class size gets smaller as students choose areas of specialization, it increases their participation (Amuah-Sekyi, 2010, p. 144).

In a study at one university in Ghana, students voiced their concerns about how their science practicals are done with inadequate logistics for students to experiment with. According to the respondents, there were not enough microscopes to work with and so they struggled to get the practical aspect of materials taught in class. In agreement with Awuah-Sekyi (2009), Ayeni and Olowe (2016) wrote that “large class size makes teaching and learning of Business Education difficult as it breeds unseriousness among students in the tertiary institutions.”

2.5. The relationship between class size and student outcomes

The relationship between class size and student outcomes has been determined by most techniques other than random experiments, known as the ‘quasi-experimental’ (Jepson, 2015). The most popular among the non-experimental is known as the Maimonides’ rule proposed by 12th-century rabbinic scholar, Maimonides.

An article in *Seattle Times* reported that the debate on the effects of class size on student outcomes has not been finalized because it is ‘hard to isolate and measure’ (Bethel University Online, 2020).

Although it is difficult to measure class size and teaching quality, the Tennessee Student Teacher Achievement Ratio (STAR) project in the 1980s concluded that there is a positive impact of class size on student achievement at the elementary level. The project was done by assigning students randomly to smaller classes ranging between 13-17 students per teacher and bigger classes ranging between 22-25 students per teacher.

The findings proved that in the kindergarten years, there was an advantage to having smaller classes, as student outcomes increased and the likelihood that students would graduate from high school was about 80% (Finn *et al.*, 2005). The students’ academic achievements were

such that they could be measured with their test scores, overall grades, and attendance (Krueger, 2003).

However, Monk (2010) asserts that the Tennessee STAR program has faced “a lot of criticisms for failure to pre-test the student participants to assure that the assignment was truly random across the class size.” Ponnann et al. (2016) recommend that typical organizations that have larger classes but subsequently break them down into smaller classes have a bearing on lecturers’ teaching quality and student learning.

As the emphasis on class size is becoming more assertive in most institutions, Benton, and Palette (2013) have indicated that medium class sizes have “little to no impact on undergraduate student learning and outcomes in mathematics.”

2.6. Class Size and Higher Education in Africa

Higher education has become part of globalization that it is no longer viewed from a national context (Jowi, 2009). Just like other parts of the world, Africa’s history, culture, and context are reflected in how they approach internalization, “consistent with its current needs, priorities and circumstances” (Jowi, 2009).

Mainly from the perspective of Africa's conventionally low postsecondary attendance levels (Teferra & Altbach, 2004), “not only is the dire need for access overwhelming, but higher education is a key player in modernization and growth. According to Eshiwani (1999), although higher education trains the most manpower capacity for most African countries, “the current growth exceeds the capacity of African economies to meet the high demand for university education” (p. 33).

2.7. Class Size and Higher Education in Ghana

Ogbondah (2010) asserts that although “money cannot correct all the difficulties confronting public universities, reduced state funding leads to “fewer educational facilities, less competent teachers, poor learning conditions and lack of instructional materials” (p. 321). Lack of funding, as per a study by Amuah-Sekyi (2010), was perceived to have “implications beyond the classroom to the workplace and eventually to the state of the economy” (p. 144).

Noted by Effah (2011), the colleges of Education in Ghana also face the issue of inadequate human resource and lack of infrastructure, which does not match up to their status of being a tertiary institution. Most countries also have weak educational systems because their youths are not provided with the “quality of education that they need to adapt to their changing environments” (Effah, 2011).

Atuahene and Owusu-Ansah (2013) confirmed that although the enrollment in the public universities increased over the years, there were no equivalent extensions in educational infrastructure to guarantee “equity and inclusion of all social groups.”

2.8. Literature Gap

Most of the literature reviewed indicated that little research has been done on class size and student performance in Ghana. The literature that was available also focused on elementary schools which were mainly public institutions.

Again, most of the research that were conducted were skewed towards the quantitative approach. Thus, either the analysis was done from historical records or econometric models were used.

Therefore, more research needs to be done on the impact of class size on higher education in Ghana. And these research must cover both public and private higher educational institutions.

This would help inform some decisions of school authorities and administrators on capacity planning and student learning conditions that boost their academic performance.

2.9. Conclusion and Recommendations

It is imperative to note that higher education in Africa, specifically in Ghana faces significant challenges that cannot be overlooked. With the emergence of the COVID-19 pandemic that has brought about school closures, school authorities and the relevant stakeholders must draw a contingency plan to make up for unforeseen risks and happenings in the coming years.

Currently, Ashesi operates online with specific provisions to facilitate effective teaching and learning methods. Some of these provisions include provision of data to students for internet connectivity, learning materials and student-lecturer relations via various interactive online platforms. Although lecturing is done online, professors are still able to identify students and meet their peculiar needs because of a smaller class size. Ashesi has distinguished itself by focusing on quality education, critical thinking skills and bridging the educational disparity between rural and urban communities. This is done by providing scholarships to underprivileged students from all areas and encouraging them to give back to society. Ashesi's typical majors like Business Administration, Engineering and Computer Science which usually commands smaller classes have set its students apart on the job market.

Although class size is not the only determinant factor for its students' performance, it has somewhat contributed to students' academic success at Ashesi University. However, Ashesi is gradually deviating from its goal of lecturing students in smaller classes as they keep increasing the number of students for admission each year. Although the class size remains fixed, the number of students increases every year. So, if more facilities are not built to accommodate the

numbers, Ashesi would likely fall victim to having larger classes, which might compromise the quality of teaching and learning.

Therefore, it is important that all universities learn to implement strategies, where despite the class size, students are better equipped to be employable and relevant to the Ghanaian economy.

CHAPTER 3: METHODOLOGY

3.1. Introduction

This study seeks to determine the relationship between class size and the performance of STEM students in Ashesi University and Central University. This chapter highlights the research approach, research design, sampling strategies, data collection methods, and the data analysis techniques. To establish this relationship, we need to first define student performance as it pertains to this study.

According to Narad and Abdullah (2016), student performance is teachers' assessment of students' knowledge by marks and the educational goals set by both teachers and students to be achieved within a given period. For the purposes of this study, student performance will take a critical look at students' grade point average (GPA), as it gives an accurate measure of students' academic standing (Gibson, Rankin & York, 2015). According to these authors, Gibson *et al.* (2015), "the top measurement of academic success accounting for 54.8% of the overall usage is GPA while the degree of critical thinking and completion rate come second with 19.4%."

Having defined our variables, the study will employ the mixed method research approach, to help "triangulate and counterbalance the problems of validity and reliability, giving us the true results" (Abowitz & Toole, 2009). Thus, the mixed method approach analyzes data from multiple lenses to detect inherent weaknesses and recurrent patterns associated with the variables. Triangulation, therefore, is one of the valuable research tools for testing the same hypothesis (Abowitz & Toole, 2009).

According to Abowitz and Toole (2009), triangulation is the simultaneous use of multiple measures to test the same finding. Campbell and Fiske (1959) also define triangulation as a

“convergent validation from multiple operationalism, where multiple tests of the hypothesis are conducted using different operationalizations of the constructs in each test.”

It is generally the use of multiple measures to test “competing hypotheses” ((Brewer & Hunter, 1989; Denzin 1989). The triangulation of measures allows the researcher to get more insights into the phenomenon in question, while using open-ended and closed-ended questions to generate a key construct of people’s behavior, attitudes, and beliefs (Abowitz & Toole, 2009).

Having mentioned open-ended and closed-ended questions, the mixed method approach will help analyze and interpret both quantitative and qualitative data to generate the desired results for the research objectives. Quantitative research is the analysis of statistics and numerical data to test the hypothesis of a study (Hughes & Murray, 2008). It lays emphasis on objectivity, to project its philosophical root into a positivistic philosophy (Newman & Ridnour, 1998).

According to Douglas (1976) and Geertz (1973), although there are theoretical differences in qualitative studies, “multiple realities exist, and multiple interpretations are available from different individuals that are all equally valid.” Qualitative research emphasizes subjectivity by capturing all individual experiences - behavior, traits, beliefs, feelings, as it has a philosophical root in a naturalistic philosophy (Newman & Ridnour, 1998). Newman and Ridnour (1998) believe that “reality is a social construct, with unique individual experiences that must have equal representation.”

Drawing from both concepts, the mixed method approach is arguably neutral as it takes cues from both approaches for analysis. It fuses the positivism and social construction aspects of both approaches to get more facets of the phenomenon in question. Hence, the mixed method approach will help gather data that will be representative of the population, as it determines the

reality (qualitative) and measures it (quantitative). With the mixed method approach, no matter how consistent the data will be, it is still reliable because then “you are likely circling around something “valid” in the data.” It increases the researcher’s confidence level, as the results generated from these multiple measures converge (Abowitz & Toole, 2009).

3.2. Research Design

This study employed the sequential research design since the approach was mixed. This helped the researcher to gather information in stages, building one on the other and integrated the results at the data analysis stage. The researcher first administered questionnaires to participants to gain their views on the issue of class size and how it has impacted them, whether positively or negatively. Here, responses were geared towards quantitative analysis, as participants gave similar responses that could be measured.

The follow up technique was an interview with selected participants to get their wide range of experiences with regards to the impact of class size. Since interviews are classified as a qualitative technique to gaining more insights on human beliefs, experiences, and feelings, it helped to capture aspects of their responses that were not stated in the questionnaire.

Again, since interviews are subjective, it helped the researcher to have an equal representation of quantitative and qualitative data. This further iterates the fact that not all experiences and phenomena are measurable, hence, time must be given to understanding the human-factor in all circumstances. According to Newman and Ridnour (1998) that “reality is a social construct, with unique individual experiences that must have equal representation.”

3.3. Sampling strategy

3.3.1. Sampling method

A simple random sampling and purposive sampling were used to select the sampling frame. For simple random sampling, each person had an equal chance of being selected. Here, although there are categories of students taking STEM courses in both schools, the research was not concerned about the different strata in the population. The main purpose of the research was to test, on average, how students fared when assigned to different classes that differed in size in their course subjects. So, the sampling strategy for this research was independent of student's academic level (i.e., Levels 100 to 400).

Again, these techniques were employed because of the research approach to this study – mixed method. So, to get an accurate measure for the phenomenon, it was advisable to get a technique under probability sampling (quantitative) and non-probability sampling (qualitative), to achieve our research objectives.

3.3.2. Sampling size

Since the focus of the research was on STEM students, the sample population for this study was all current Engineering and Computer Science students at Ashesi University and students at the Physician Assistantship (P.A) department, a sub-department under the School of Medicine and Health Sciences at Central University. Although beyond class size, these are two different students in terms of subjects they study, the campus environment, student-teacher relationships, examination, and so on, these students were more accessible during the time of the study.

The total number of Engineering and Computer Science students at Ashesi was 489, at the time of writing. Hence the sample size for Ashesi university was 115, using a 95% confidence level and an 8% margin of error. The sample size for Central University, however,

differed due to the constraint that only second and third years could be used for the data collection exercise. First years had just reported to campus and so had little to no experience about what the research sought to discover. Final years had also been assigned to hospitals as part of their final practicals and field work. So, with a total of 143 students (72 students in second year and 71 students in third year), the sample size for P.A department, Central University was still 143 students.

Notably, all students in this department (Physician Assistantship department at Central University) are made to attend lectures all at once regardless of their number. It was made known to the researcher that students had no cohorts and so all 72 students were put one lecture hall during lectures while the third years also attended class together regardless of their number (71 students) as well.

3.4. Data collection

The data collection tool was semi-structured questionnaires that were administered online. Looking at the current trends in technology and the emergence of the coronavirus, online questionnaires was best to use because it saved time and resources, and also helped the researcher and all participants to observe the safety protocols that were put in place to curb the pandemic.

3.5. Data preparation, collation, and processing

Three pilot tests were conducted using the questionnaires and the interview questions to prevent instrumentation problems at the final stage. The first pilot test was conducted with the questionnaires to determine if participants understood the concepts and the responses that are expected from them.

The second test was also conducted using the questionnaires to determine whether the questions are sensitive, leading, or double-barreled. Finally, the last pilot test was conducted with a set of semi-structured interview questions that allowed participants to express their views without limitations. The interview sessions were timed, so that the interviewer could have a good sense of the time estimate that needed to be allotted to each interviewee.

3.6. Data analysis

The interview responses were analyzed in excel to make deductions about the phenomenon at hand. The questionnaires were further analyzed in themes, to get a sense of what students believed are some other success factors that enhanced their academic performance. The chi-square test was used to analyze the level of relevance of class size on students' outcomes, to enable the researcher to compare both frequencies objectively, and to make them statistically significant.

3.7. Validity and reliability

Although Noble and Smith (2015) argue that there are uncertainties about the validity and reliability of qualitative research because of its subjectiveness, Ghauri and Gronhaug (2005) explain validity as how well the data collected covers the actual area of investigation. Field (2005), in the same train of thought, defines validity as the ability “to measure what is intended to be measured.”

Similarly, reliability “concerns the extent to which a measurement of a phenomenon provides stable and consistent result” (Carmines and Zeller, 1979). In essence, reliability is concerned with repeatability (Taherdoost, 2016).

Following the definitions above, the validity of this research was assured by administering identical set of questions to all respondents. This gave an accurate measure of the responses as there were little to no variation in the results, doing away with biases.

3.8. Ethical considerations

To gain a permit to conduct the research and protect the participants' identities, all the questionnaires and interview questions were sent to the Human Subject Review Committee at Ashesi University for review and approval. After the approval, the researcher took necessary steps to ensure that the study was not mandatory for participants by letting them sign a consent form, with options that they may opt out at any time. All data and recordings gathered were safeguarded using a password, so it could be far from unauthorized access.

CHAPTER 4: DISCUSSION OF RESULTS

4.1. Introduction

This chapter presents the findings from the research and analyses them in relation to the research objective. Now, although the study sought to determine the effect of class size on students' performance, there was no accurate measure of students' performance like students' academic assessment records and/or GPA. However, this research was mainly about students' perception about how class size has impacted their performance in the course of their study.

The data was gathered with the help of questionnaires and semi-structured interviews to answer the following research question:

- Do students perform better in smaller classes at Ashesi, or is performance perception not associated with class size as in the case of Central University?

4.2. Sample Description

The total sample size for both schools was 258 students. Out of the 258 students, 115 were students from the computer science and engineering department at Ashesi University, and 143 were students in the Physician Assistantship Department, a sub-division under the School of Medicine and Health Sciences at Central University. These students were selected not because they offer the same courses, but because they are all STEM students in both universities. Since Ashesi university is a liberal arts institution, it does not offer a wide range of STEM courses other than computer science and Engineering courses. This study, however, did not make use of STEM students studying the same courses in both schools because at the time of study, these students were more accessible to the researcher

4.2.1. Questionnaire & Interview

The questionnaires were administered online to save time and cost, aid a faster response rate, and to help observe the needed protocols put in place to combat the COVID-19 pandemic. After the questionnaires had been administered, 10 students were interviewed to get a deeper understanding of how class size has impacted their studies over their course of study. There were no requirements for students who were selected for the interview. However, each interviewee was expected to have filled the questionnaire to know exactly what was required of them. Although the interview was semi-structured (having both open-ended and closed-ended questions), interviewees gave broader perspectives on the topic of class size which helped shape the current research better.

4.3. Demographics

Since the study sought to compare Ashesi University and Central University, the demographics will be presented according to the response rate in each school.

Students at Ashesi University

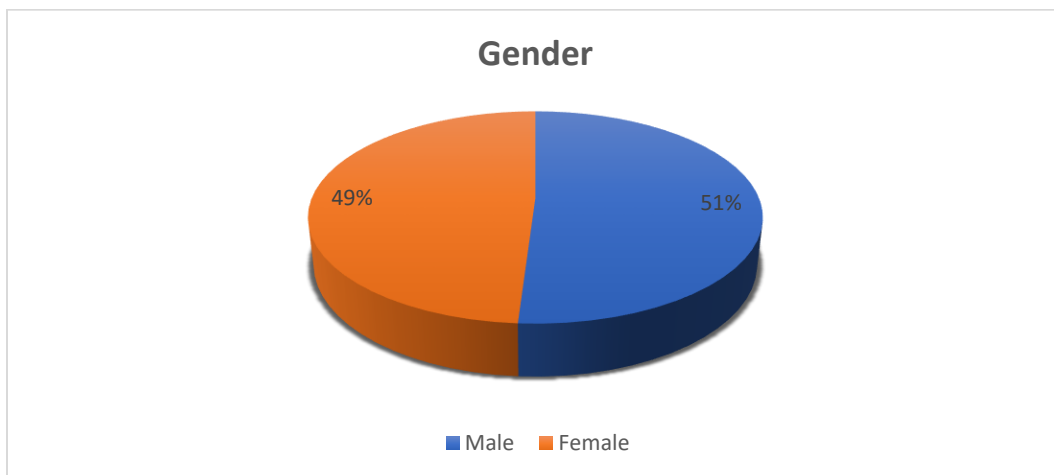


Figure 3: Distribution of respondents by gender.

The chart presents the statistics of student respondents by gender. 51% of the respondents were males and 49% were females.

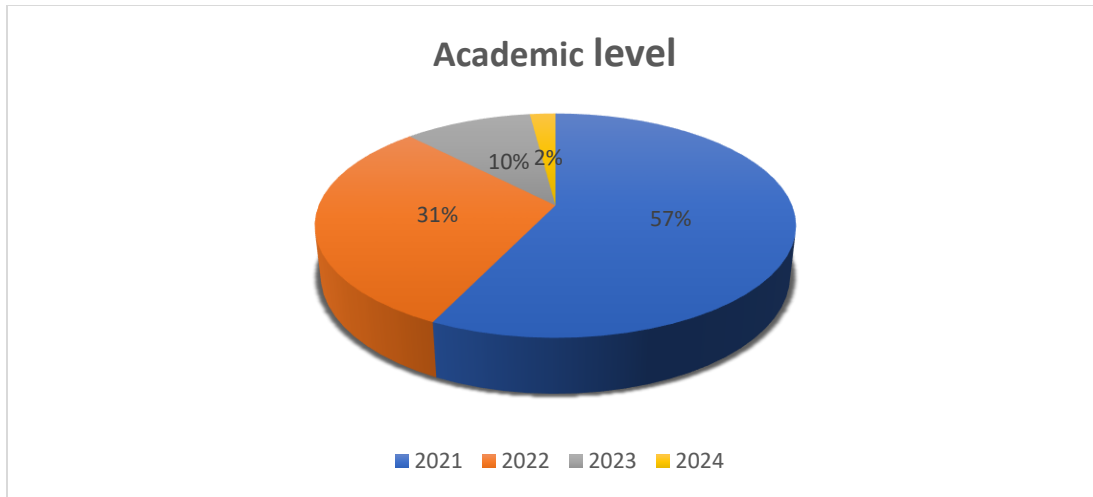


Figure 4: Distribution of respondents by academic level

For Ashesi students, 57.1% were in 2021 (final years), 30.6% were in 2022 (third years), 10.2% in 2023 (second years) and 2% in 2024 (first years).

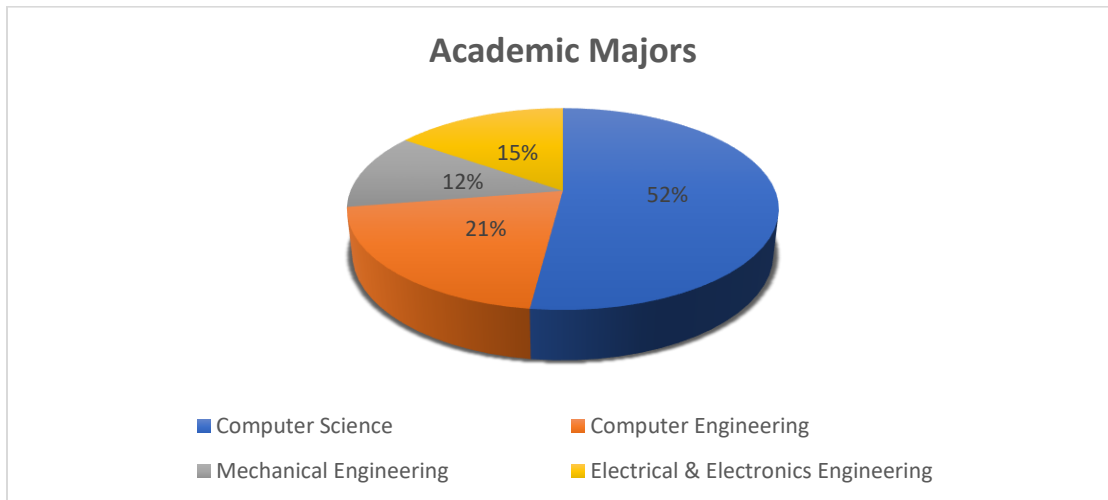


Figure 5: Distribution of respondents by academic majors

From the figure above, 52% of the respondents were computer science students, 20.4% were Computer Engineering students, 12.2% were Mechanical Engineering students and 15.3% were Electrical and Electronics Engineering students.

Students at Central University: Physician Assistantship department

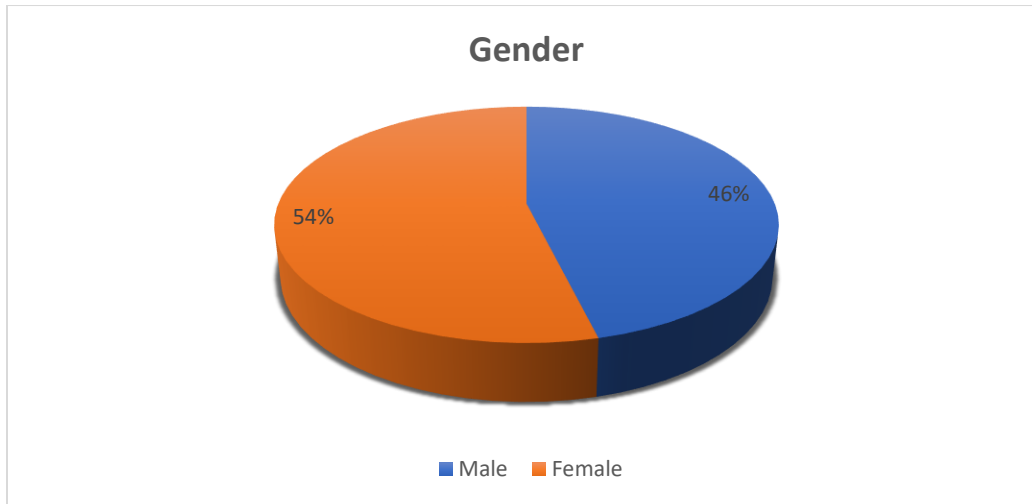


Figure 6: Distribution of respondents by gender

This figure presents the statistics of respondents by gender in Central University. The response rate for females was 53.8% and that of the males was 46.2%.

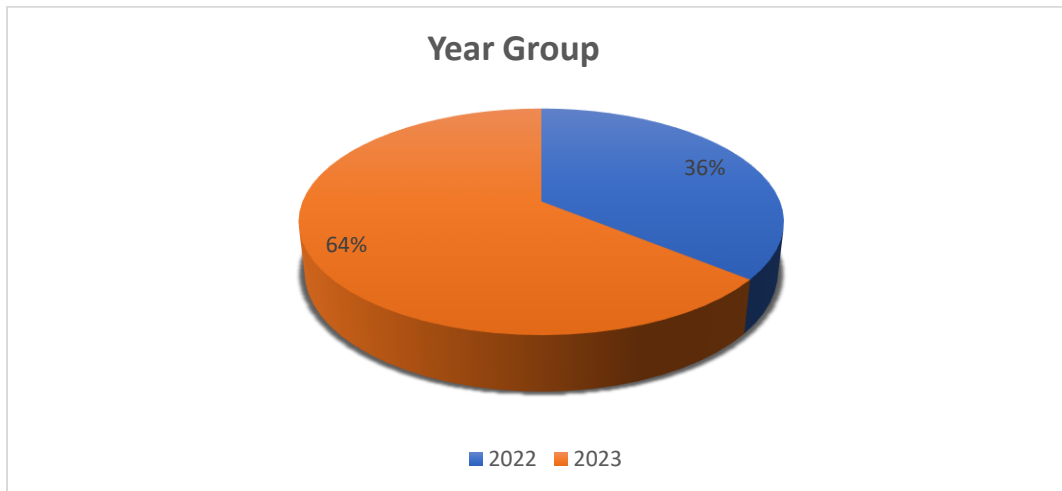


Figure 7: Distribution of respondents by academic level

From the chart above, 64.1% of respondents were in 2023 (second years) while the remaining 35.9% of respondents were in 2022 (third years). This figure has got slight changes in students' academic level at Central University, specifically in the Physician Assistantship department due to some constraints. Students in first years were not included because they had

just reported to school and hence had little to no knowledge about what the current research sought to compare.

Again, final years in this same department were not included because at the time of study, they had just started their medical practicals, and had been assigned to hospitals for field work. Although this was a major setback for this research, the qualitative technique, thus the interviews were used to make up for the low response rate by Central University.

4. 4. Data Analysis Research objective

- To determine whether student performance perception in STEM courses is associated with smaller classes or it is independent of class size

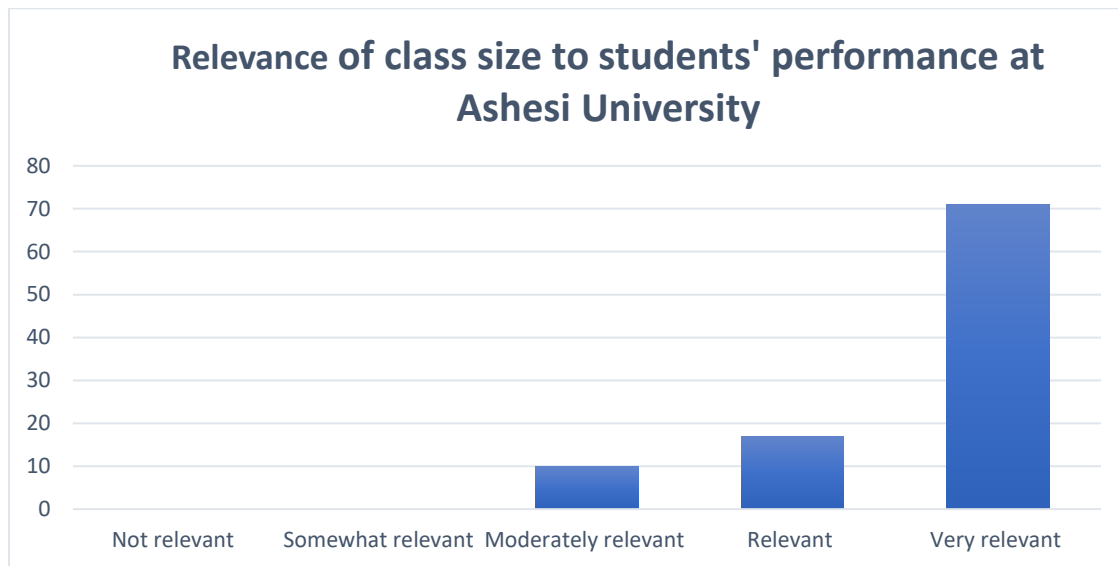


Figure 8: Distribution of Ashesi university students on relevance of their current class size to their performance

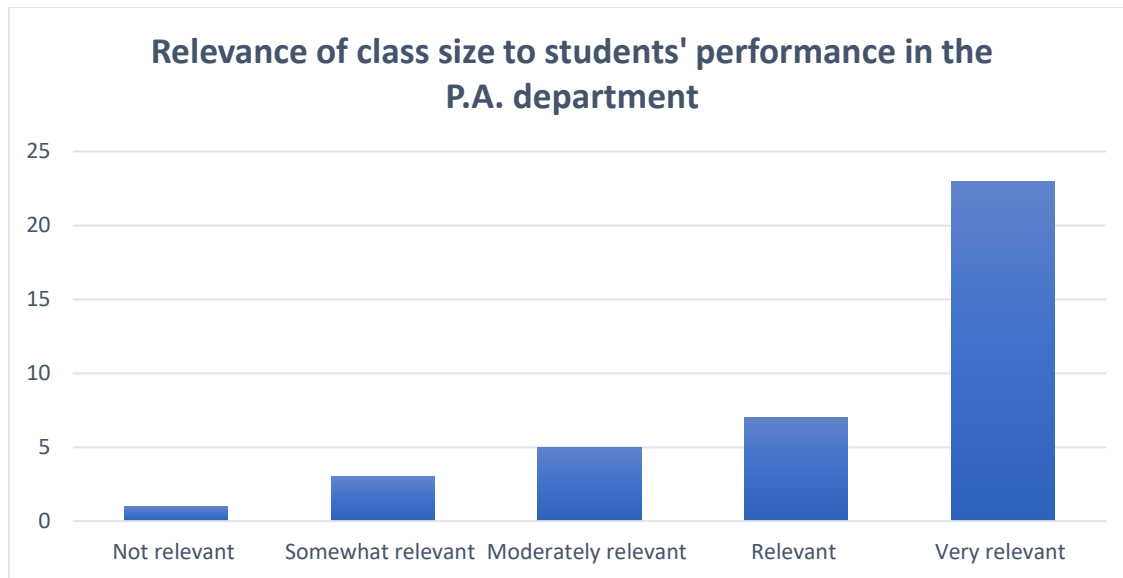


Figure 9: Distribution of P.A. (Central University) students on the relevance of their current class size to their performance

On a scale of 1 to 5, STEM students at Ashesi university and in the Physician Assistantship department in Central University were asked to rate how relevant their current class size is to their performance. In essence, students were required to rate the level of impact of their current class size on their academic performance. With 1 = not relevant, 2 = somewhat relevant, 3 = moderately relevant, 4 = relevant, and 5 = very relevant, 71 students, making 72.4% of Ashesi STEM students rated their current class size to have high relevance to their performance. On the other hand, 23 students, making 59% of P.A. students rated their current class size to have more impact on their academic performance.

Qualitatively, students were asked to further explain their answer as it pertained to this study. Some students gave positive responses concerning their class sizes while others also saw their current class size as not helping. Below are a few responses that were gathered from some of the respondents.

“I follow better when we are few people in a class because I feel free to ask questions. I also observed that when we are many in a class, the lecturer mostly assumes that we all get the concept when only one or five students got it (Respondent 1, Ashesi University).

“I find myself easily distracted. There is difficulty hearing a lecturer speak because you may find yourself way behind. It discourages student-lecturer relationship too. Class size should be smaller as possible to allow easy check” (Respondent 14, Central University).

“The fewer the class size the more interactive the lecture is. This makes it easier for the lecturer to offer a helping hand to struggling (weaker) students” (Respondent 11, Ashesi University).

“Being in a large class increase the understanding of each course much better since there are diverse views from persons with different backgrounds” (Respondent 19, Central University).

“Learning during class is not as personalized due to the number of students the lecturer is trying to communicate with. It makes it a bit difficult to follow along with the teachings because sometimes there are multiple questions from various students that increase confusion, and the rest of the class is left behind” (Respondent 32, Central University).

From the above responses, the impact levels differed from person to person, as some students saw a positive impact while others were negatively affected. For the purposes of this study, we also employed the chi-square test to determine the association between the two categorical variables of interest, class size and degree of relevance (impact). Student responses may not be enough to draw conclusions because they provided qualitative and non-measurable information. Hence, a more objective tool was needed to make deductions. Hence, the use of the chi-square test.

The Chi-Square Test of Independence

Since Ashesi has a smaller class size and Central university (specifically the P.A. department) has a relatively larger class size of 72 students, this study sought to determine whether these two different class sizes had any impact on students’ performance or each student’s academic success was independent of the class in which they found themselves. Clearly there are other differences between the Ashesi students and the Central university students in term of the different lecturers teaching the students and the fact that Ashesi and Central may have different resources and different culture. However, for the sake of this test we ignore these sources of variation and zero in on differences in the class size.

Hypothesis testing:

H_0 = Student performance perception is associated with class size

H_1 = Student performance perception is not associated with class size

Table 1

Test for valid expected counts for chi-square test

Class Size	Degree of relevance (5point scale)					Total
	1	2	3	4	5	
Large (Central University)	1	3	5	7	23	39
Small (Ashesi University)	0	0	10	17	71	98
Total	1	3	15	24	94	137
Expected Count/Frequency	0.284671533	0.854014599	4.270072993	6.832116788	26.75912409	
	0.715328467	2.145985401	10.72992701	17.16788321	67.24087591	
	LowRelevance	HighRelevance	Total			
Large (Central University)	9	30	39			
Small (Ashesi University)	10	88	98			
Total	19	118	137			
Expected Count/Frequency	5.408759124	33.59124088				
	13.59124088	84.40875912				

Now, with the chi-square test, the two categorical variables were class size (small and large) and degree of relevance (HighRelevance and LowRelevance). The degree of relevance

came as a result of the responses in figures 8 and 9. But, to have used the chi-square test safely, we needed no more than 20% of the expected counts/frequency to be less than 5.

However, from table 1 above, we see that the expected count resulting from the observed outcome (which was measured by the degree of relevance) had 50% of its values less than 5. These values have been highlighted in red under scales 1, 2 & 3 to show the invalidity of the expected outcome, as it could not meet the chi-square test requirement stated above.

So, in order to satisfy this condition, we needed to add all the least values in one table and the highest values in another table. The rationale behind the groupings was to get a higher total value for all the least numbers that were added, so that the expected frequencies can be valid. From table 1 above, the least values were found under scales 1 to 3 while the highest values were found in scales 4 & 5. Hence, we had to merge scales 1, 2 & 3 and replace them with LowRelevance while scales 4 & 5 were merged and replaced with HighRelevance.

After these replacements, all the expected frequencies were valid, with values greater than 5. These values have been highlighted in green above to show that it was now possible to conduct the chi-square test using R.

Table 2

Results from Pearson's Chi-squared test

Pearson's Chi-squared test with Yates' continuity correction

data: Relevance_Analysis\$Degree_of_relevance and Relevance_Analysis\$Class_Size
X-squared = 2.8675, df = 1, p-value = 0.09039

From table 2, the statistical result shows a p-value of 0.09039 while the test of significance (significance level), α was 0.05. Since the p-value > 0.05, we fail to reject the null

hypothesis, H_0 . Therefore, we cannot conclude that a significant relationship exists between class size and students' academic performance, since a p-value of 0.09 makes the relationship statistically insignificant at the 5% significance level although the relationship is clearly significant at the 10% significance level. Hence, there is no relationship between class size and performance at conventional level of significance and any relationship is weak at best.

Although one can argue that the test results could be due to the low response rate and the relatively small sample size obtained from both schools, this finding moves in line with Bandiera, Larcinese and Rasul's (2010) assertion that "there is no class size effect across a wide range of intermediate class sizes." They further argued that reducing the size of a class that has above 100 students could be cost-effective but an effective way to improve students' academic performance. However, for classes between 30-100, "reducing class size could be an ineffective strategy" (Bandiera, Larcinese & Rasul, 2010).

Again, it could be argued that since the researcher did not limit herself to identical courses taught in both schools, the difference in performance could be because of the different teachers or because of the different materials that are taught by the two different schools. However, the results also move in line with Angrist and Lavy's assertion that there remains some doubt about the real importance of class size as a determinant factor on student performance, especially in the development economics context despite the suggestions of Maimonides rule for optimal class size (Angrist & Lavy, 1999).

However, not being fixated on class size as the only determinant factor for students’ academic success, it was made known by participants of this study that other reasons account for students’ performance significantly. Therefore, not withholding the other factors that affect student performance, students’ responses in both schools indicated that critical thinking skills, time management, personal ownership of a laptop and the learning environment (considering the serenity and availability of internet connection) are considerably part of the top factors that impact students’ performance.

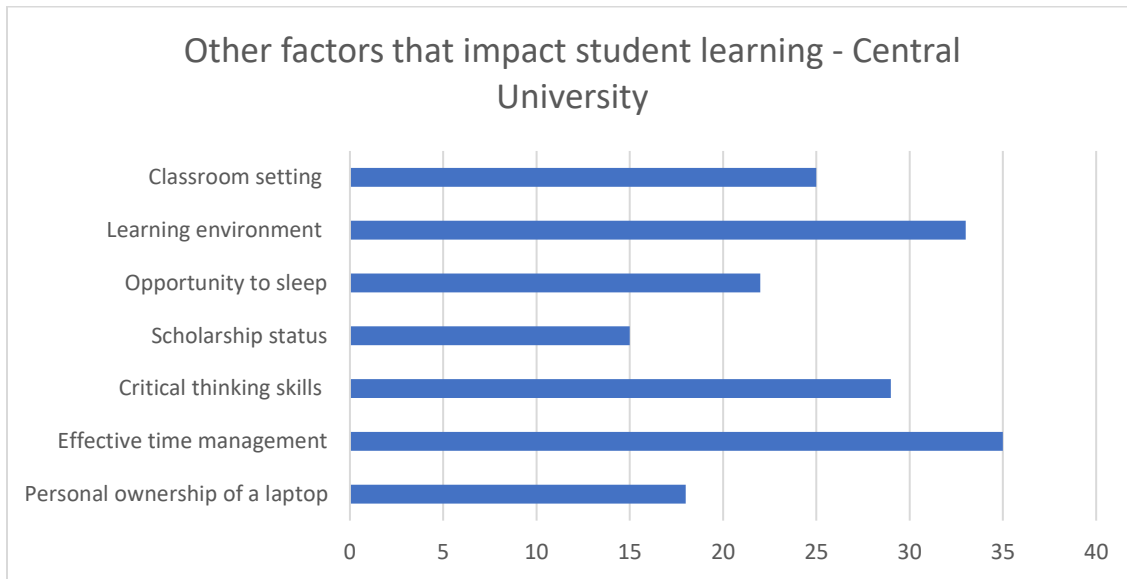


Figure 10: Distribution of respondents in the Physician Assistantship department on other factors that significantly impact student learning

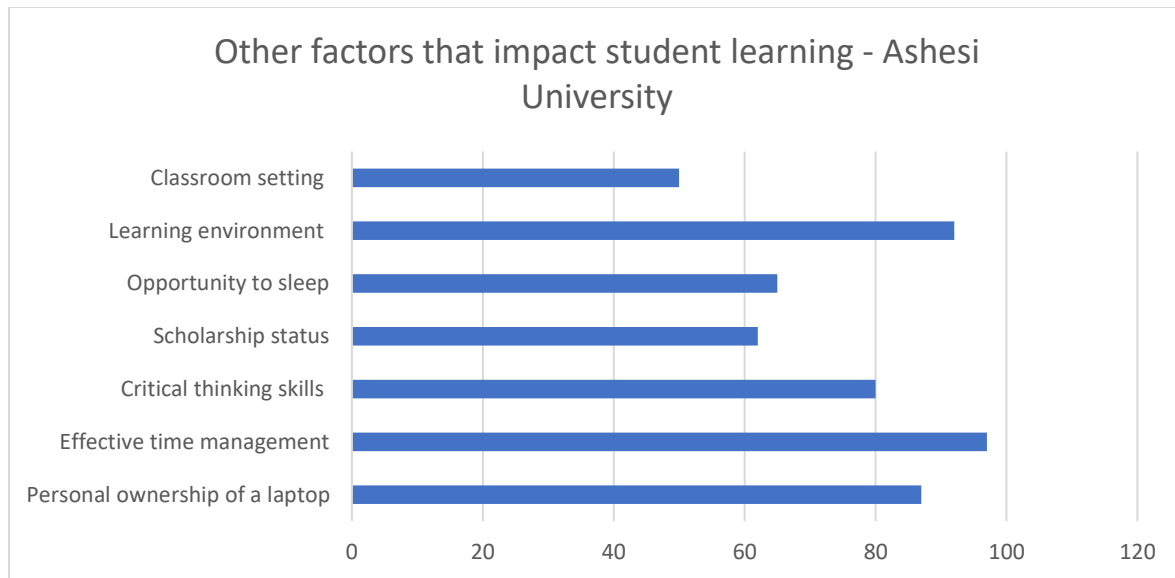


Figure 11: Distribution of respondents in Ashesi university on other factors that significantly impact students' learning.

Effective Time management

Respondents who opted for time management as one factor that impacts student performance revealed that individual efforts and some fixed human characteristics helped them to fully concentrate on becoming better versions of themselves through learning outcomes.

Moreover, respondents explained that having had the pleasure of being good students in high school, they were not ready to trade that reputation they had built for anything less than academic work. In essence, they were driven by their past achievements to make time for studies in the university. When respondents were asked to further explain how time management affects student performance, respondents 8 (Ashesi University) stated that,

“Engineering courses are demanding. Hence, if you do not plan your time well, you will end up lagging behind and give up eventually. Initially I thought because I was a good student in high school, I could maneuver my way through to the top with the same learning strategies I had previously. However, I learnt that time management mechanisms like having a “to-do list” and

setting your priorities right are best ways of becoming not only an excellent student but an excellent leader. Besides, I have always been a good student, so I was not ready to trade that for anything less, due to improper time planning”

This is not to say that extra-curricular activities are not important. However, a well-defined schedule drawn by the students themselves to spend a substantial amount of time on academic related activities inside and outside of class, makes them better performers than those who do little to no planning for such activities.

According to Kaushar (2013), time management is key to improving students’ academic performance. He argues that although students are encouraged to have time management abilities, it is only possible through self-motivation. He believes that although “there is no one right way to time management,” getting to know oneself would help him/her make better decisions about how to use their time. Adopting his model, effective time management results in performance, where;

$$\text{Performance} = \text{motivation} * \text{ability}.$$

Critical Thinking Skills

According to Stedman and Adams (2012), the ability to develop critical thinking skills beyond the classroom is one of the primary goals of colleges and universities. In a survey conducted in 433 higher educational institutions, The Association of American Colleges and Universities [AAC & U], (2011) identified students’ critical thinking skills as one of the most important skills that 81% of employers urged universities to lay a stronger emphasis on (as cited in Nold, 2017).

This reiterates the fact that critical thinking abilities are not only important for academic success but also for survival in the working world. With the “emergence of a knowledge-based economy over a once domineering industrial market,” people’s ability to think critically and find solutions to problems around them has become a necessary intellectual human resource (Abrami et al., 2008; Ahuna, Tinnesz & Keiner, 2014; Meepian & Wannapiroon, 2013, as cited in Nold, 2017). Undoubtedly, schools have become the operational units in reinforcing students’ thinking and conceptual competencies that equips them to create new methods for realizing their goals (Taghva, 2014). Respondents 3, 7, and 9 [Ashesi University] stated that,

“Although there are some external factors that account for low student performance and all, your ability to reflect, analyze and practicalize what you have been taught is what is important. When it comes to thinking or one’s thought process, no one does it for you. The lecturers try their best to encourage us to do more. However, with programming and engineering courses, lack of personal initiatives and analytical thinking skills make the strong students weak and weak students weaker”

This shows that inasmuch as class size is important, students’ ability to think critically is one important factor that accounts for student success.

Personal ownership of a laptop

In this 21st century, students are fond of interacting with technology and the internet because it allows them to learn and grow intellectually (Righi, 2012). As part of the top factors that influence students’ performance, figure 11 shows that 88.8% of Ashesi students opted for personal ownership of a laptop while 46.2% of students in the Physician Assistantship department in Central University opted for personal ownership of a laptop in figure 10.

Looking at the differences in the percentages, it is clear that Ashesi is achieving its goals of making students technologically competent. Ashesi's scholarship package comes with a free laptop for each scholar, to facilitate effective learning. Although one may argue that being technologically competent has nothing to do with owning a personal laptop, STEM courses such as programming and engineering demand that students have the freedom to explore and pursue their dreams at their own pace and in their own time. It is imperative to note that outside the classroom, "opportunities for students are limitless, borderless and instantaneous." (Office of Educational Technology, U.S. Department of Education, 2010, as cited in Righi, 2012). As such, students are expected to have time for personal and practical studies to help them make effective use of the computer for various academic purposes. According to respondent 9 (Ashesi University),

"The advent of the COVID-19 pandemic proved that technology could rule the world. As schools were not allowed to operate physically, school administrators resorted to having studies and other operational activities online. Ashesi being the first to move online, it made it easy for some of us to adapt since we are trained to be tech savvy. Personally, it worked for me because I had my own laptop and didn't have to worry about anything else aside internet connectivity."

Unlike Ashesi students, students in the Physician Assistantship department did not see any significant impact of having a personal laptop and achieving academic success because of the nature of their courses. Although they may conduct research and other things with the personal computer, majority of their class content depend heavily on the laboratory practicals using laboratory tools and techniques. However, it is not surprising that ownership of a personal laptop is considered as having a relationship with student success because it moves in line with Holcomb's assertion that "one-to-one laptop computer initiatives significantly impact education,

as school districts that implement such programs report improvements in day-to-day operations” (Holcomb, 2009, as cited in Righi, 2012).

Learning Environment (Serenity and availability of internet connection)

Okafor, et.al, (2016) define a school as an “environment where knowledge is acquired at various levels.” However, students in both Ashesi university and Central University believe that the learning environment is as important as the knowledge itself that they seek to acquire. From figures 10 and 11, we see that 93.9% of Ashesi students opted for learning environment while 84.6% of students at the Physician Assistantship department also opted for learning environment as one top factor that affects student performance. For the purposes of this study, learning environment was defined as the serenity, availability of internet connection, stability of power supply, good illumination systems in classrooms and all other facilities needed to make the environment conducive enough for students’ learning (Opare, 2021).

Shamaki (2015) asserts that intelligence is not the only determinant for students’ performance. Lizzio, Wilson & Simons (2002) noted that students’ academic success is related with several components of the learning environment. According to Bosque and Dore (1998), the teaching and learning environment must perform the functions of informing, communicating, collaborating, producing, scaffolding, and managing. They added that the learning environment has to do with the “entire range of components and activities within which learning happens.” Hence, the learning environment considers a number of variables that have direct and indirect impact on students’ learning outcomes (Bosque & Dore, 1998).

4.5. Conclusion

The results from the chi-squared test showed that class size has no significant impact on students' performance at the conventional level of significance (thus at 5%). However, at a 10% significance level, class size does have an impact on students' performance, with a p-value of 0.09. Meanwhile, with the options of critical thinking skills, the personal ownership of a laptop, the learning environment and students' ability to manage time effectively, the effects of class size as argued by most authors could be minimized for students to perform well on a large scale.

Therefore, it is imperative to note that if an institution has put measures in place where despite the class size, individual needs of students are being met, that is most important.

4.6. Limitations

The low response rate from students in the Physician Assistantship Department in Central University was a major setback for this current study. Students withheld information for reasons best known to them while others also provided wrong information. This made bias elimination difficult as some vital data and/or information that could add to the validity of results were not available.

Secondly, the unavailability of first and final years for the data collection exercise made it difficult to get the actual sample size for Central University. It also made it difficult running the data through R to get the needed results for this study.

Lastly, the lack of quantitative data such as students' GPA to do the analysis was another limitation for the data collection exercise. This is because department heads and the students themselves were not willing to disclose such confidential details to the researcher. Although there was an informed consent and an assurance of confidentiality, students' academic records could not be shared.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1. Research Summary

This chapter presents a succinct account of the research problem, research objectives, key findings, recommendations for future studies, conclusion, and the limitations of the study.

The objective of this study was to determine whether the variation in student performance perception is due to fixed student characteristics or classroom capacity (class size). Thus, given the increase in enrollments in higher education leading to a proportional increase in class size, it was imperative to explore the concept of class size and its impact on college courses, learning objectives, and workload expectations.

5.2. Key findings

This study sought to determine whether students' performance in STEM courses is associated with smaller class sizes or performance was independent of class size. The results showed that there was no significant relationship between class size and students' performance in STEM courses., although some students revealed that their current class size (large) has a negative effect on their learning.

However, students in both universities gave more priority to time management, critical thinking, personal ownership of a laptop and the learning environment as the top success factors for students' academic performance. Evidently, schools have become the operational units in reinforcing students' thinking and conceptual competencies that equips them to create new methods for realizing their goals.

It was also clear that individual efforts and some fixed human characteristics play significant roles in students' academic outcomes. Some attributed their strong academic standing to the kind of intrinsic motivation that they have, which drives them to fully concentrate on

becoming better versions of themselves. This goes to say that the discipline to manage your time as a student plays a vital role in your academic journey.

It was also revealed that schedules drawn by the students themselves to spend a substantial amount of time on academic related activities inside and outside of class, makes them better performers than those who do little to no planning for such activities.

5.3. Recommendations

5.3.1 Recommendations to improve student performance

1. Students' academic success is related with several components of the learning environment, ranging from the availability of learning facilities to the provision of a stable internet connection. Hence, school administrators must put measures in place where despite the class size, individual needs of students are still met.
2. Although it was not captured in the write-up, students in Central University indicated that bursary opportunities be made available to everyone. Students believe that when their financial burdens are taken care of, it gives them the peace of mind to study which in turn boosts their academic performance.

5.3.2. Recommendations for future research

1. For future studies on class size and student outcomes, I recommend that there be a clearly defined measuring tool for student performance. This research was more subjective as responses were based on students' perceptions and experiences in different class sizes. However, quantitative

data such as students' GPA is one standard and objective measure for student outcomes.

2. Future studies can focus on class size and students' outcomes in more populated schools like some government universities. For comparative studies, researchers should limit themselves to students studying identical courses, to minimize some of the errors.

5.4. Limitations of the study

The lack of cooperation from students in Central University was discouraging and a major setback for this current study. Students withheld information and were reluctant to fill the online questionnaire for reasons best known to them. However, this can partly be attributed to the emergence of COVID-19, which made it difficult for the researcher to meet with students physically to explain the research and content of what is expected of them. The researcher's inability to meet with them was a way of ensuring the safety protocols put in place to combat the pandemic.

Secondly, the unavailability of first and final years in the P.A. department made it difficult to get the actual sample size for Central University. This created a lot of errors in the data for the chi-square test.

Lastly, the research findings could have been strengthened if there was enough quantitative data such as students' GPA to measure their performance. This would have been a standard measure to account for the varying academic performance among students.

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