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# OUSL Journal

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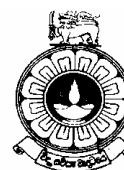
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## Editorial

This is the Volume 16, Number 1 of the OUSL Journal, the Journal of The Open University of Sri Lanka which is published biannually. The articles published in this Volume include research based on Education, Management, Chemistry, and Coastal Ecology.

Mentoring is a process of tutoring a junior person in a workplace by a senior colleague is becoming more challenging especially in the modern university system. Into this backdrop, the study on *Challenges of Mentoring among University Academics in Nigeria* provides an empirical investigation into the notion of mentoring in the Nigerian context focusing on the challenges associated with mentoring for both the mentor and the protégé in the university system. The survey research design was employed using questionnaire administered to academics across different cadres. The population consists of all academic staff in three randomly selected universities in Edo state namely: University of Benin, Ambrose Ali University, and Igbinedion University. Data collected were statistically analyzed using frequency, percentages, mean, standard deviation, exploratory factor analysis, t-test and analysis of variance (ANOVA). Prominent mentoring challenges among Nigerian university academics as revealed in the study include victimization, instant gratification, gender-based bias, work life imbalance and incivility. It was also found that mentoring challenges experienced by academics do not significantly differ based on demographic characteristic attributes. The study recommends that universities and other tertiary institutions should promote an atmosphere of organizational harmony where faculty members will seek the growth of younger academic staff for the advancement of the educational system.

*Instructional leadership* is not a new concept. Adjectives such as collective, shared, transformational, and distributed are used with instructional leadership according to researchers, who also affirm that instructional leaders establish clear goals and provide educators with direction and sense of mission. Furthermore, they motivate educators to enhance their performance. On this basis, the paper titled *Exploring Instructional Leadership Practices in Institutional Schools of Kathmandu: A Narrative Inquiry* tries to explore the practice and perception of two principals on instructional leadership under the research question- "How do school principals' practice and perceive

instructional leadership in their schools”? The paper has McEwan’s (2003) theory of the seven steps to successful instructional leadership as the theoretical lens. In this study a qualitative approach has been employed to explore the personal experiences of the subjects. Principals’ personal experiences are of central focus in this research. Therefore, a narrative inquiry has been used as the research methodology that offers practical and specific insights for the researcher. The interviews were recorded and field notes were used as a method of recollecting information. Coding was made in the diaries for some of the information obtained from the interviews and digital records were also prepared for the interview. An elaborative process of coding, categorizing, and thematizing as per the theory of Creswell (2007) were adopted. It was concluded that both the principals perceived and practiced instructional leadership as modes of setting direction, focusing on curriculum, and monitoring learners’ progress.

Pharmaceutical application of silver was first recognized with the use of silver nitrate ( $\text{AgNO}_3$ ) in the early 1800s for treatment of ulcers. Silver complexes containing ligands such as N-heterocyclic carbenes (NHC), N-heterocycles and phosphines possess several properties ranging from antimicrobial, antibacterial, anti-inflammatory and antiseptic to anti-neoplastic activity. Ag(I) salts are good catalysts for alkyne-based organic reactions such as alkynylation, hydrofunctionalization, cycloaddition, cycloisomerization and cascade reactions. Coordination complexes of Ag(I) centres usually exhibit various geometries: linear, tetrahedral or trigonal planar. Ag(I) centres form mononuclear, binuclear, trinuclear, tetranuclear and polynuclear complexes with pyridines, bipyridines, diphosphines and pyridyl phosphines. The objective of the study on *Synthesis of Ag(I) complexes containing N and P donor ligands* is to explore the chemistry of Ag(I) centres with different chelating ( $\text{N}^{\wedge}\text{N}$ ), ( $\text{N}^{\wedge}\text{N}^{\wedge}\text{N}$ ) and ( $\text{P}^{\wedge}\text{P}$ ) donor ligands such as 3,4,5,6-tetraphenyl-2,2'-bipyridine (tpbpy), 6,6'-dimethyl-2,2'-bipyridine (dmbpy), 4'-(4-methylphenyl)-2,2':6',2''-terpyridine (ttpy), 3,6-di(2-pyridyl)-4,5-diphenyl-pyridazine (dppz), bis(diphenylphosphino)methane (dppm), and 4,5-bis(diphenylphosphino)-9,9'-dimethyl xanthene (xantphos). During this study, synthetic routes to Ag(I) complexes of the type  $[\text{Ag}(\text{N}^{\wedge}\text{N})]^+$ ,  $[\text{Ag}(\text{N}^{\wedge}\text{N})_2]^+$ ,  $[\text{Ag}(\text{NCMe})(\text{xantphos})]^+$  and  $[\text{Ag}(\text{N}^{\wedge}\text{N})(\text{P}^{\wedge}\text{P})]^+$  have been developed. The preparation of a five-coordinate complex

[Ag(xantphos)(tppy)]ClO<sub>4</sub> and a binuclear Ag(I) complex [Ag<sub>2</sub>(μ-dppm)<sub>2</sub>{μ-dppz}][ClO<sub>4</sub>]<sub>2</sub> containing bridging ligands dppz and dppm has also been discussed.

Mangrove forests are an ecotone ecosystem that is widely distributed in the tropical and subtropical coastlines of the world. Although, their coverage spans only 0.5% of the Earth's coastal areas, they contribute numerous ecological functions and services. One such function is sequestering and maintaining of blue carbon stock in the coastal ecosystems. Data on total retaining of carbon stock in whole ecosystems assist the realistic estimates of ecological and economical importance as well as decision making on conservation and management of mangroves. In the paper titled *Assessment of Blue carbon stock of mangroves at Malwathu Oya estuary, Sri Lanka*, authors attempt to quantify the total blue carbon stocks in vegetation and in soils of the mangrove areas in the Malwathu Oya estuary located in the dry/arid climatic zone of Sri Lanka. Total biomass of the mangrove plants in Malwathu Oya estuary was 377 Mg ha<sup>-1</sup> which contained 191 Mg C ha<sup>-1</sup> of total organic carbon (TOC) sequestered by the plants. TOC in the mangrove soils was 346 Mg C ha<sup>-1</sup> which is 1.8 times more than that in the vegetation. Total blue carbon stock of the mangrove ecosystem in Malwathu Oya estuary therefore was 537 Mg C ha<sup>-1</sup>, out of which 64% is sequestered in soils. Despite being located in dry/arid coast, this mangrove area retains more carbon than most other areas in Sri Lanka. This may possibly be due to its pristine nature and vegetation structure, characterized by unique dominance of *Sonneratia alba*, which is recorded as a rare mangrove species in Sri Lanka.

School closures due to the lockdown triggered by the COVID-19 pandemic have become a major disruption to the education sector in Sri Lanka. Accordingly, this situation is causing learning losses among Sri Lankan students. Due to the abruptness of the current pandemic, teachers and other administrations in the education sector were unprepared for this transition and forced to set up immediate remote learning systems. Even though, online education was neglected in the Sri Lankan education prior to COVID-19, the government was forced to promote online learning systems to facilitate continuous learning for Sri Lankan school children. As a developing

country, the move to online learning has generated conflicting responses and aggravated the current socio-economic gaps in the country's education system. Since access to the internet and to computer services is not uniform for all students, current disparities were identified. Hence, the paper titled *How the COVID-19 outbreak shapes the Education of School Children: A Case of Engineering Technology Students in the Mulatiyana Educational Zone, Matara, Sri Lanka*, aims to examine the impact of the COVID-19 pandemic on the education of school children as online learning has become an essential part of the current Sri Lankan education sector. The engagement of the students in online learning, their perceptions, and the barriers that the students face are important factors in this situation in order to implement future online classes more efficiently and effectively. Therefore, the results of the study offer the current Sri Lankan education system concepts for the smooth functioning of teaching and learning process.

The study on *Availability and Utilization of Information and Communication Technology among Instructors in Adult and Non-formal Education Centers in Kwara State, Nigeria*, examined availability and utilization of information and communication technology (ICT) among instructors in adult and non-formal education centers in Kwara State, Nigeria. Three objectives were raised and translated to research questions to guide the study. A descriptive survey research design was adopted for the study and 271 was considered as the target population comprising of male and female instructors. A sample size of 160 respondents was selected across the State. A multi-stage sampling procedure consisting of cluster sampling, purposive sampling and simple random sampling was adopted. Check lists and questionnaire were used as instruments for data collection for the study. The reliability of instruments was conducted using test-retest technique and a co-efficient 0.82 was obtained. The administration of the instruments was done by the researchers and five volunteer field research assistants. The data collected were analyzed using frequency count and percentages. One of the findings revealed that the level of utilization of ICT among instructors was low. It is, therefore, recommended that there is a need create awareness among instructors on the level of utilization of ICT to increase the level of consciousness for effective teaching learning process.



We welcome your suggestions for further improvement of this Journal. We are looking forward to publishing your current research findings in our next issue.

**Professor Shyama R. Weerakoon**

Editor in Chief/OUSL Journal

Email: [ouslj@ou.ac.lk](mailto:ouslj@ou.ac.lk)

 <https://orcid.org/0000-0003-0975-2738>

## Challenges of Mentoring Among University Academics in Nigeria

**Enaruna Ehimwenma IDUBOR, Simon Ayo ADEKUNLE\***

*Department of Business Administration, Faculty of Management Sciences, University of Benin, Nigeria*


### Abstract

Mentoring which is a process of tutoring a junior person in a workplace by a senior colleague is becoming more challenging especially in the university system. The objective of this study therefore is to provide empirical investigation in the Nigerian context on the challenges associated with mentoring for both the mentor and the protégé in the university system. The study employed a survey research design. The population consists of all academic staff in three randomly selected universities in Edo state namely: University of Benin, Ambrose Ali University, and Igbinedion University. The research instrument used was a structured questionnaire administered to academics across different cadres. Data collected were analyzed using frequency, percentages, mean, standard deviation, exploratory factor analysis, t-test and analysis of variance (ANOVA). All statistical analyses were done using Statistical Package

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\* Correspondence should be addressed to **Dr. Simon Ayo ADEKUNLE**, Department of Business Administration, Faculty of Management Sciences, University of Benin, Nigeria

**Email:** adeksim@uniben.edu, adeksim@yahoo.com

 <https://orcid.org/0000-0002-4171-8903>

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for the Social Sciences (SPSS 24). The study found that prominent mentoring challenges among Nigerian university academics include victimization, instant gratification, gender-based bias, work life imbalance and incivility. It was also found that mentoring challenges experienced by academics do not significantly differ based on demographic characteristics such as status, gender, age, qualification and work experience. The study recommends that universities and other tertiary institutions should promote an atmosphere of organizational harmony where faculty members will seek the growth of younger academic staff for the advancement of the educational system.

**Keywords:** Academics, challenges, mentor, mentoring, universities

## **Introduction**

The act of mentoring is an age-long practice that dates back to ancient Greek mythology when Odysseus entrusted the care of his son Telemachus to the charge of an old man named Mentor who guided Telemachus to adulthood and saved his life several times (Cartwright, 2012). Inzer & Crawford (2005) stated that mentoring is a one-to-one relationship that exists between the mentor and the protégé with the aim of the expert (Mentor) voluntarily giving time to teach, support and encourage a younger, less experienced person (Protégé). Sawiuk, Taylor & Groom (2017) found that many organizations have come to recognize the importance of mentoring and coaching programs and have formalized systems of doing both. The world of work is rapidly changing in Nigeria with the influx of younger persons, women and other minorities into the workforce and the exit of older workers either voluntarily or involuntarily (Agbonifoh & Idubor, 2016). It is therefore expedient that the experience and knowledge of the older workforce be passed on seamlessly to the younger generation through the act of mentoring and knowledge management (Maxwell, 1998).

Continuous reform and renewal of the educational system are germane (Walters, Robinson & Walters, 2020). This underscores the importance of mentoring in the educational system to build the requisite capacity to engage in result-oriented reforms. The importance of mentoring and its benefits to the organization, the

mentor and protégé, have been demonstrated especially in the Western countries (Kram, 1985; Noe, 1988; Zachary, 2000; Leidenfrost et al., 2014). The situation may be slightly different in the Nigerian organizations as noted by Okurame (2008) because of the negative connotation of mentors as godfathers. The notion of godfatherism is best described as the idea that an employee is under the protection and influence of a more powerful person with the aim of the junior employees getting benefits, they may not ordinarily be entitled to them, and avoid punishment for infractions. As observed by Akanni (2011), mentoring should focus on helping protégé acquiring the requisite knowledge, experience and guidance to enable him or her to perform exceptionally on the job and in life generally. It is about getting the protégés to learn from the mentors what they may not ordinarily learn or for them to learn it faster and in greater depth.

Agbonifoh & Idubor (2016) allude to the attitude of many young people in the workplace who regard the older generation as “old school” and the reciprocal perception by the older generation that the young ones have nothing to offer. These attitudes may make mentoring quite difficult because mentoring requires involvement and sacrifice on the part of the mentor and protégé.

Several studies have been done on the concept of mentoring in organizations in many parts of the world and there is a consensus on the need for, and the benefits of mentoring (Kram, 1985; Rothwell, 2005; Olowookere, 2012; Ekechukwu & Horsfall, 2015; Tanoli, 2016). An informal mentoring system is in place within many organizations and formal mentoring is also greatly advocated (Inzer & Crawford, 2005; Kolade, 2015; Sola, 2018).

Several studies have also been done in Nigeria concerning mentoring. The general approach of Nigerian studies has been to stress the importance and benefits of mentoring in organizations as a tool for accelerating employee performance, career growth, competencies and even for succession planning and staff retention (Elegbuanya, 2012; Ekechukwu & Horsfall, 2015; Omale et al., 2017). Based on the review of extant literature, there is a paucity of empirical investigation in the Nigerian context on the challenges associated with mentoring for both the mentor and the protégé.

## **Research Objectives**

- i. To identify mentoring challenges confronting academics in universities in Nigeria;
- ii. To determine whether a significant difference exists in the forms of mentoring challenges confronting academics in Nigerian universities; and
- iii. To examine the influence of demographic characteristics on academics' perception of different forms of mentoring challenges in Nigerian universities.

## **Literature Review**

### ***Mentoring and its benefits***

The concept of mentoring is by no means a new one. The term was first used in 1616 and it implies a teacher (Cartwright, 2012). However, judging from the current definitions of the word mentor as a trusted counselor (Kram, 1985), guide (Moon, 2014), tutor (Azman, Muhammad & Sebastian, 2009), coach (Collins, Brown & Newman, 1987), it would seem that the mentoring function has been going on for as long as humans have existed. The Bible records the relationship between Moses and Joshua, Elijah and Elisha, and even Jesus Christ and his disciples; these were all forms of mentoring relationships. Invariably, the result of mentoring is for the mentor to at least reproduce himself in the protégé or to produce a protégé that can surpass him in his field of expertise and to be able to say, as Jesus Christ said to his disciples 'he that believeth on me (follows my footsteps), the works that I do shall he do also; and greater works than these shall he do...' (John 14: 12. The Holy Bible KJV).

Rao (2010) defines mentoring as a relationship in which a senior manager in an organization assumes the responsibility for grooming a junior person. The relationship involves technical, interpersonal and political skills that are taught by the more experienced person to the less experienced person. Popoola, Adesopo & Ajayi (2013) opine that it is the process whereby an experienced and highly empathic person called the mentor, assists and guides another individual called the protégé (whether male or female) in the development of their skills, knowledge and attitudes and their competence in the workplace.

In the academic setting which is the focus of this study, Olasupo (2011) states that an academic mentor is usually a senior faculty member who guides a junior faculty member by way of advice, guidance, support and other relevant means in matters connected to the attainment of academic success; the protégé, on the other hand, is the junior faculty member who is the beneficiary of the mentorship. Generally, it has been agreed that mentoring is one of the easiest and most effective methods of assisting individuals to develop the required skill sets in different organizations (Olasupo, 2011; Olowookere, 2012; Okurame, 2008; Ojokuku & Sajuyigbe, 2015; Sola, 2018).

The benefits of mentoring are not limited to the protégé alone, the mentor and the organization also gain from the process. The importance of mentoring based on the benefits to these three categories – protégé, mentor, and organizations are discussed further: *Benefits of mentoring for Protégés*: Nnaji, Uko & Nwafor (2015) aver that new and younger academic staff are often confronted by a new culture and tradition which is different from what they may have been used to in their previous places of work or institutions of learning. Nnaji et al. (2015) agree by stating that the range of duties that faces a new academic staff in the university can be quite daunting and if appropriate support is not given, it can lead to a host of problems for the staff. Some may be entering the world of work for the first time and hence would need guidance to navigate the new territory successfully.

Mentoring is also a way of enhancing the skill sets of junior academics. Ballet & Kelchetermans (2009) opine that in fluid societies, it is important to stress continuous professional development if teachers are to successfully adapt to changes and cope with the pressure of meeting organizational standards. In Nigeria, the declining standards in the education sector are being continually decried (Ndaguba et al., 2018), the general opinion is that academic excellence which the country enjoyed in time past is fast decaying and it is all blamed on the "younger generation". A potent way of stopping this seeming downward spiral is to get the older generation of the "good old days" of academics to transfer knowledge through mentoring to the younger generation to regain the lost academic glory. Mentoring is another way for new academics to gain a professional identity.

When coming into the academic system, the new employee may know little or nothing about the profession or the values of the profession. Through mentoring, mentors pass on the values and tenets of the profession; regulate the behavior of new employees by ensuring that they understand the professional ethics and requirements of their job (Hobson et al., 2015).

*Benefits of Mentoring for Mentors:* Mentors also benefit a great deal from the mentoring process personally and for the general good of the organization. The self-actualization which Maslow talks about in the need's theory comes into play here (Maslow, 1954). Mentors are usually well-established, experienced and accomplished people in their fields and life generally. After attaining this height, that is, they have actualized themselves, what is left for them is building the next generation that may surpass them. This feeling of being a part of and contributing to something that will outlive their physical presence in the organization gives a sense of purpose and deep satisfaction to these mentors.

Secondly, mentoring offers the mentor an opportunity to see new perspectives on the culture of the university. With the rapid changes in the world of work, organizational culture is also changing, therefore by interacting with the younger and newer generation; the mentor can grasp the changing dynamics of culture thus enabling him or her to stay in touch with the environment. Thirdly, mentoring gives mentors countless opportunities to share their experience and expertise. Some senior academics have been prompted to write books documenting their experience and expertise by their protégés so that many others can benefit from that wealth of information. This also causes the mentor to reflect on current practices to see if they are an improvement or not on former practices, to refine them. Mentoring also enables the mentor to focus on their ideas, behaviour and choices because they realize that junior academic staff are looking up to them in terms of morals and workplace ethics. In this way, standards are maintained, and younger academics have befitting role models on which to model their behaviours, ideas and choices. Mentoring also offers the mentor opportunities to increase his/her circle of friends and be recognized for his/her skills and experience (Aston University, 2020).

Finally mentoring allows the mentors to mold the next generation of leaders by helping them build the requisite leadership skills. When mentoring is properly done and the mentoring relationship is well cultivated, the mentor remains relevant for life even, because from time to time, the protégé, no matter his/her current status will revert to the mentor when faced with thorny issues (Tjan, 2017).

*Benefits of Mentoring for the University:* A proper and well-structured mentoring programme is also of great importance to the university, and not just to the mentor and protégé. Firstly, it will help in the identification and retention of excellent staff. The mentoring process thrusts the mentor and protégé close together under many situations in the workplace. The mentor can observe, test and gauge the capabilities of the protégés and therefore able to identify those who have the skill sets that are valued by the organization. Such people are then carefully groomed, provided with training and learning opportunities and steered into positions of increasing responsibilities. A staff that has been so treated is more likely to develop some degree of loyalty to the organization and therefore less likely to entertain turnover intentions. This also helps the organization to avoid the hassles and costs associated with acquiring and training new staff (University of the People, 2020).

Another benefit for the organization is that when excellent staff are identified and retained in the organization, this will eventually raise the standard of the organization and enable it to compete favorably with other similar organizations.

A good mentoring programme will also increase diversity within the organization. One major challenge with mentoring is that mentors and protégés alike enter mentoring relationships with people alike them. The effect of this is that those people in the minority (females, minority ethnic groups, minority religions, the physically challenged, those with different sexual orientations and so on) are usually left out of mentoring relationships or are not properly mentored. An effective mentoring programme, however, will ensure that these groups are included and therefore well mentored so that their insignificant contributions will be made available to the organization. Their inclusion will bring fresh ideas, new perspectives and deeper



understanding that if properly harnessed may become a competitive advantage for the organization (Lambert, 2016).

Finally, mentoring is an effective means of transmitting corporate culture within the organization and for increasing communication in the organization. Through mentoring, management's views can be passed on to protégés in a non-threatening, non-combative atmosphere where they have the liberty to question what they do not understand or agree with and management through the mentors will take time to explain and educate the protégés on them. Likewise, information about issues affecting the protégés can also be passed on to management through the mentors. In this way, the mentors form and become a link bridging the gap between younger employees and management thereby improving organizational communication.

### ***Need for Mentoring amongst Nigerian Academics***

Many studies have been undertaken to establish the need for mentoring among academic staff in Nigerian universities (Sola, 2018; Omale et al., 2017; Undiyaundeye & Basake, 2017; Kolade, 2015; Nnaji et al., 2015). The consensus based on the works of the above-mentioned scholars is that young academic staff just entering the university system face many challenges and that if not properly guided they may be unable to successfully overcome them at the appropriate time. In a study by Hassan, Baharom & Mutalib (2017) on female academic staff in Nigerian universities, it was observed that the academic environment is fraught with many pitfalls for the unwary new entrant and at the same time, it holds many opportunities for growth and advancement that new academic staff may not be knowledgeable enough to take advantage of quickly. The role of mentoring therefore is to help the protégé avoid the dangers inherent in lecturing and harness the positive potentials to ensure a rewarding academic career (Ekechukwu & Horsfall, 2015).

According to Undiyaundeye & Basake (2017), the pursuit of development by young academic staff in Nigeria is not without challenges, fears and anxieties and therefore mentoring can be an effective way of mitigating the stress of new lecturers, help them resolve challenges and help them achieve their career goals more readily. Mentoring has also been advocated as a means of transferring

the skills which protégés need and can apply in diverse professional circumstances, promote learning and productive use of knowledge, definition of goals and career paths and job satisfaction (Okurame & Balogun, 2005). Ayodeji & Adebayo (2015) also indicate that mentoring can ensure and maintain effective school administration in Nigeria, because teaching is a multifaceted and complex task that demands the guidance and experience of senior academic staff. Undiyaundeye & Basake (2017) also state that mentoring is needed in academics because it increases job satisfaction, self-confidence, enhances staff retention rate, encourages professional growth, develops competence and encourages collaboration while reducing competition. This view is also corroborated by Nnaji et al. (2015) who state that professional competence of newly employed lecturers could be significantly enhanced through mentoring. Sola (2018) also concurs when he states that mentoring has a significant influence on the career development of academic staff. Kolade (2015) advocates mentoring as a means of building a new generation of academics and responsible leadership. Omale et al. (2017) aver that mentoring improves staff retention and knowledge transfer in Nigerian universities.

### ***Challenging Factor to Mentoring Relationship***

*Victimization:* This involves the action of selecting an individual or group of individuals for inhumane or unjust treatment. Victimization in the workplace can be committed by both supervisors and subordinates, mentor and mentee, and among co-workers. This may be in form of minor abuses, denial of promotion, demotion, bearing false witness or false accusation and so on. In the university setting, victimization may include alienation of some colleagues because of their allegiance to certain senior academics, high tendency of a protégé becoming a target by other senior colleagues who are opposed to the mentor, fear of sexual harassment, as well as fear of being branded as the ‘mentor’s boy or girl’ by peers and other faculty members.

*Instant gratification:* This is the desire to experience pleasure or fulfillment without delay or deferment. Instant gratification behaviors can be detrimental by reprogramming individual mindsets and cause distraction from more meaningful and rewarding pursuits. The culture of instant gratification can lead to destructive financial, social,

and health outcomes. Some young academics especially in public universities in Nigeria lack interest in anything that will not immediately yield financial gains for them. As a result of this, Agbonifoh & Idubor (2016) assert that some mentors or senior colleagues are unwilling to introduce protégés to lucrative aspects of the job such as consultancy, book writing, adjunct lecturing among others.

*Gender-based bias:* This is the predisposition to prefer one gender over another. According to Bailey (2019), "gender bias is a form of unconscious bias, or implicit bias, which occurs when one individual unconsciously attributes certain attitudes and stereotypes to another person or group of people". It entails discriminatory practices against individuals in the workplace because of gender differences. Gender bias is a serious challenge in a mentoring relationship as mentees may be afraid of being romantically linked to the mentor in a different gender mentoring relationship. It is also possible that preferred gender may be scarce for proteges to select from. There is also a high tendency for mentoring relationship to become too personal for either the mentor or the mentee.

*Work-life Imbalance:* Work-life balance entails fair allocation of time for both work and other aspects of life which include family and personal-related issues. Talukder, Vickers & Khan (2018) identified the benefits of work-life balance to include an increase in efficiency and productivity; decline in staff absenteeism, illness and stress; motivated workforce and higher retention of workforce. Despite these benefits, work-life imbalance which is the inability to fairly allocate time for work and other activities serve as a challenge in a mentoring relationship as mentors may be too engaged thereby unable to pay adequate attention to the mentoring needs of proteges. Especially in the Nigerian setting, what other people may say about a perceived cordial relationship between mentor and protégé may prevent some mentors from spending quality time with their proteges.

*Incivility:* This can be described as bad behaviour characterized by rudeness, discourteous behaviours, as well as lack of regards or consideration toward others in the organization (Gabriel et al., 2018). Incivility in the workplace leads to low intensity deviant behaviour

with ambiguous intent to harm the target, in violation of workplace norms for mutual respect (Anderson & Pearson, 1999). Examples of incivility include making nasty and demeaning comments to/about someone, cutting people off while they are yet speaking, browbeating, undermining one's credibility in the presence of other people. In a mentoring relationship, incivility may include lack of freedom and opportunities for the protégé to freely speak about his ideas and feelings, a lack of reverence and respect by junior academics for the expertise and person of the mentor, rebuffing or disdaining the attempts of other individuals, and so on.

### ***Theoretical Framework***

This study is built on the apprenticeship model. Barab et al. (2001) define apprenticeship as a process where apprentices work side-by-side with an expert to learn a specific task. Traditionally, apprenticeship was associated with the training of craftsmen and later in vocational training; however, in recent times, it has been extended to other types of training. Nielson & Kvale (1997) indicate that the apprenticeship model has now been introduced outside of the traditional vocational education as a general pedagogical model. Apprenticeship as a term has gone beyond the description of the statutory institutional structures that dominate vocational training to becoming a general metaphor for a relationship where a novice (protégé) learns from an experienced person (mentor). Nielsen & Kvale (1997) discuss four things that characterize the apprenticeship model: participation in a community of practice, professional identity, learning through imitations of the master and that the qualities of work are evaluated through practice.

Wegner – Trayner and Wegner – Trayner (2015) define communities of practice as groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. The communities of practice have three main characteristics that are very important or that must exist before a community can be called a community of practice and they are the domain, the community and the practice. According to Wenger – Trayner & Wenger – Trayner (2015), the domain refers to the commitment that members must have to the community and involves a shared competence that differentiates members from non-members.

The members value their collective competence and learn from each other. The community means that members of the community of practice engage in joint accounts and discussions, assist one another and share information (Cheng, 2011). Relationships are built that allow them to learn from each other, there is active interaction which may not necessarily be daily. Lastly, the practice refers to members of the community of practice being practitioners, they share practice by developing a joint repertoire of resources – experiences, stories, tools, methods of handling recurring challenges. This happens over time and sustained interaction.

In a community of practice, there are several types of mentoring relationships going on. The traditional mentor – protégé, is available where protégés have access to several mentors to aid their development (Menges, 2016). Peer mentorship also goes on the communities of practice because people come together to share ideas and learn from each other (Holland, 2018). The internet has made it possible for the members of a community of practice to be in various locations and still be able to interact closely. The benefits for protégés in belonging to a community of practice are enormous. As observed by Agbonifoh & Idubor (2016), the protégé learns by taking part in a group of competent practitioners of his profession, to become more and more competent until he becomes a very competent member of the professional community.

Professional identity as explained by Hirsch, Lloyd & Kennedy (2019) is acquired by the protégé as he acquires and masters' new skills by learning and completing practical assignments that are increasingly become tougher. The protégé is engaged in a reflective conversation soon after the completion of the assignment to ensure that he understands the processes and that his success was not just a fluke. In learning through imitation of the master (mentor), the protégé not only observes the work of the mentor or other skilled professionals in the community, but he must also imitate it (Cheng, 2012). The mentoring process here is quite clear, the mentor demonstrates how a task should be properly executed, then the protégé begins to practice how to execute the same task, he is corrected and guided by the master until he becomes proficient at the task or acquires the skill.

Finally, the work of the protégé will be evaluated through practice. The mentor has accumulated knowledge about the required skills necessary to execute a task therefore he will judge the quality of the protégé's work based on his knowledge, functionality and feedback from others. Therefore, this model could be instrumental in dealing with mentoring challenges of victimization, instant gratification, gender-based bias, work-life imbalance and incivility by evaluating mentee's background in terms of knowledge and skill, scrutinize mentee's motives and drives for engaging in a mentoring relationship, deal with the inexperience of mentee, address possible misconceptions that mentee may have about mentoring and set challenging but achievable goals for the relationship.

## **Methodology**

### ***Research design***

This study employed a survey research design. The design was adopted because of its high flexibility of data collection, potential to build a rapport and a high degree of diversity of questions to capture various perceptions of respondents (Malhotra, Birks & Wills, 2013).

### ***Population, sample size and sampling technique***

The population consists of all academic staff in three randomly selected universities in Edo State namely: University of Benin (Federal University); Ambrose Ali University, Ekpoma (State University); and Igbinedion University Okada (Private University). These universities were chosen because they are the oldest universities in the State. Only those academic staff who have spent at least twelve months (12) in the university were included in the study. This is because new entrants in the university might not be aware of some of the issues the study seeks to investigate. Based on information from the registries of the various universities, the total academic staff strength of these universities is 3,054 as of July 2018. The breakdown is as follows: University of Benin (1,824), Ambrose Alli University (680) and Igbinedion University (550).

The sample size for this study was 459; however, only 230 questionnaires could be retrieved, of which only 177 copies of the questionnaire were found usable due to non-response or partial

completion of the remaining 53 copies. The details are presented in Table 1

**Table 1.**

*Questionnaire distribution to sampled universities*

S/N	Institution	Population	Questionnaire			%
			Administered	Retrieved	Valid	
1	University of Benin	1824	274	150	134	75.7
2	Ambrose Alli University	680	102	50	31	17.5
3	Igbinedion University	550	83	30	12	6.8
<b>Total</b>		3054	459	230	177	100

Table 1 shows that 459 copies of questionnaire were administered while 230 were retrieved. 177 copies of the questionnaire were found to be valid and useable. The distribution of the valid responses for the universities is: University of Benin (75.7%); Ambrose Alli University (17.5%); and Igbinedion University (6.8%).

Copies of the questionnaire were administered using convenience sampling to the academic staff in the three universities. Though convenience sampling was used, the sample size requirement could not be met. However, the researchers ensured that copies of the questionnaire were administered to the different categories of academic staff in the selected universities to provide a comprehensive assessment of the subject matter.

### ***Instrumentation***

The research instrument for this study is a structured questionnaire. The questionnaire is designed in sections (A and B). Section A consists of personal information about the respondents. Section B consists of questions on the challenges of mentoring. The questions in Section B are designed on a 5-point Likert scale of 5, 4, 3, 2, and 1 for Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree respectively.

### ***Validity and reliability***

The face and content validity of the research instrument were based on the meticulous scrutiny and evaluation of senior faculty members who are experts in Human Resource Management and Sociology. With respect to the reliability of the instrument, a pilot test was conducted to aid in testing the reliability of the research instrument. Fifty (50) copies of the questionnaire were administered to both senior and junior academic staff. The Statistical Package for the Social Sciences (SPSS 24.0) software was used to ascertain the internal consistency as demonstrated by the Cronbach alpha value of 0.888.

### ***Method of data analysis***

Data generated from the use of structured questionnaire were analyzed using descriptive statistics such as frequency distribution, percentages, mean and standard deviation. Factor analysis was used to identify the mentoring challenges confronting academics in Nigerian universities. T-Test was conducted to find out whether significant differences exist between two demographic variables (status and gender) and the different forms of mentoring challenges. Analysis of variance (ANOVA) was used to test whether significant differences exist between the remaining respondents' demographics (age, qualification and work experience) and the different forms of mentoring challenges. All analyses were conducted using Statistical Package for Social Sciences (SPSS 24) at 5% level of significance.

## **Results and Discussions**

This section presents the analysis of the data collected with the questionnaire administered to academics in three selected universities in the Edo state. The results are presented in line with the research objectives.

### ***Respondents' demographics information***

The demographic profile of respondents such as status, gender, age, highest educational qualification, and work experience are presented in Tables 2 below:



**Table 2.***Respondents' demographics*

Variable	Category	Frequency and Percent
Status	Senior Academic Staff	69 (38.9%)
	Junior Academic Staff	108 (61.1%)
	Total	177 (100%)
Gender	Male	114 (67.5%)
	Female	55 (32.5%)
	Total	169 (100%)
Age	18-24years	22 (12.5%)
	25-35years	47 (26.7%)
	36-45years	71 (40.3%)
	46-55years	25 (14.2%)
	56years and above	11 (6.3%)
	Total	176 (100%)
Qualification	PhD	74 (42.5%)
	Masters	68 (39.1%)
	First Degree	32 (18.4%)
	Total	174 (100%)
Work Experience	Less than 3years	55 (32.4%)
	3-6years	47 (27.6%)
	7-12years	41 (24.1%)
	Above 12years	27 (15.9%)
	Total	170 (100%)

**Note:** Senior academic staff include Professors; Associate Professor; and Senior Lecturers while junior academic staff include Lecturer I; Lecturer II; Assistant Lecturers and Graduate Assistants.

Table 1 shows that majority of the respondents are in junior category, which are 108 accounting for 61.1% of the total respondents. The senior academic staff were 69. This represents 38.9% of the total respondents. Table 1 also shows that majority of the respondents are male, who are 114 accounting for 67.5% of the total respondents. The female respondents were 55. This represents 32.5% while 8 respondents did not indicate their gender. The age distribution shows that majority of the respondents (71) are between 36 and 45years old. This category accounts for 40.3% of the total respondents. This is

followed by 25-35 years old (47, 26.6%) and 46-55years (25, 14.2%). Respondents within the age category of 18-24years account for 12.5%. Finally, respondents that are 56years old and above account for 6.3%. Only 1 respondent did not indicate his/her age category. Majority of the respondents (74) had Ph.Ds. This category accounts for 42.5%. 68 (39.1%) of the respondents have Master's Degrees while 32 (18.4%) of the respondents have first degrees. Three (3) of the total respondents did not indicate their highest educational qualification. The results further show that majority of the respondents (55) have less than 3years' working experience as lecturers which accounts for 32.4% of the total respondents. 27.6% of them have worked for three to six years while 24.1% have worked for 7 to 12years. Respondents who have worked for more than 12years accounted for 15.9% of the total respondents. 7 (3.9%) of the total respondents do not indicate their years of experience.

### ***Identification of mentoring challenges among academics in Nigerian universities***

To identify the mentoring challenges confronting academics in Nigeria universities the 18-item instrument was subjected to exploratory factor analyses to identify the factors. The results are shown in Table 3:

**Table 3.**

*Exploratory factor analyses of research items*

S/N	Items	VM	IG	GB	WL	IN
VM1	Association with some senior colleagues may cause the young academic to be alienated by others	0.68				
VM2	The protégé may become a target by other senior colleagues who are opposed to the mentor	0.82				
VM3	Fear of being branded as the mentor's boy by peers and other faculty members	0.71				
VM4	Fear of being approached by the mentor for sexual relationship (sexual harassment)	0.81				

IG1	Young academics lack interest in anything that will not immediately yield financial gains		0.74			
IG2	Mentors' unwillingness to introduce protégés to lucrative aspects of the job e.g. consultancy, book writing, adjunct lecturing		0.69			
GB1	Fear of being romantically linked to the mentor in a different gender mentoring relationship			0.85		
GB2	Mentors of the preferred gender are lacking			0.70		
GB3	Inadequate number of female mentors			0.76		
GB4	I would prefer to mentor a protégé of the same gender as me			0.61		
GB5	The mentoring relationship might become too personal for my liking			0.66		
WL1	Mentors are usually quite busy and are hence unable to pay adequate attention to the mentoring needs of the protégé				0.65	
WL2	Inability to spend quality time with the mentor because of what people will say				0.78	
WL3	Lack of work – life balance makes mentoring difficult				0.55	
IN1	Protégés are usually unable to measure up to the standards of the mentor					0.62
IN2	Lack of freedom and opportunities for the protégé to freely speak about his ideas and feelings					0.78
IN3	Lack of reverence and respect by junior academic for the expertise and person of the mentor					0.81

IN4	There is someone I would have loved to mentor but he rebuffed my attempts at mentoring					0.72
Eigenvalues		6.57	2.56	1.53	1.23	1.04
Percentage of variation		36.5	14.2	8.5	6.9	5.8
Kaiser-Meyer-Olkin (KMO)		0.731				
Bartlett's test of sphericity		1827.345				
Sig.		0.000				
Total variation		71.9%				

**Note:** VM = Victimization, IG = Instant Gratification, GB = Gender-based bias, WL = Work life imbalance and IN = Incivility.

Based on the results of the factor analysis in Table 3, 71.9% of the total variance was explained with an eigenvalue greater than 1.0 by generating five (5) factors or challenges labeled as Victimization (36.5%), Instant Gratification (14.2%), Gender-Based Bias (8.5%), Work Life Imbalance (6.9%) and Incivility (5.8%). The Kaiser-Meyer-Olkin (KMO) value was 0.731 while the Bartlett's test of sphericity of 1827.345 was significant at the 0.000 level. The KMO value of 0.731 is adequate since the value is greater than 0.5.

### ***Determination of statistical differences in the forms of mentoring challenges***

To determine whether significant difference exists in the forms of mentoring challenges among academics in Nigerian universities, analysis of variance (ANOVA) was used. The result is shown in Table 4:

**Table 4.***ANOVA Result of different forms of mentoring challenges*

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.9390	4	3.9847	<b>4.6468</b>	<b>0.001</b>
Within Groups	754.6151	880	0.8575		
Total	770.5541	884			
Post-Hoc-Test using Student-Newman-Keuls					
Forms of mentoring challenges	N	Subset for alpha = 0.05			
		I	II		
Incivility	177	2.737			
Work Life Imbalance	177	2.918			
Gender Based Bias	177		2.982		
Instant Gratification	177		3.062		
Victimization	177		3.127		
Sig.		0.067	0.146		

The result in Table 4 ( $F=4.6468$ ;  $p=0.001$ ) shows that there is a statistically significant difference in the evaluation of the various forms of mentoring challenges (victimization, instant gratification, gender-based bias, work life imbalance and incivility) by respondents (academics) in the Nigerian universities. Due to the significant result of the ANOVA output, post-hoc-test using Student-Newman-Keuls (S-N-K) was conducted to further categorize the forms of mentoring challenges confronting academics. The result shows that items in Category II (Gender Based Bias [2.982], Instant Gratification [3.062] and Victimization [3.127]) were significantly rated higher than items in Category I (Incivility [2.737] and Work Life Imbalance [2.918]).

### ***Demographic characteristics and mentoring challenges among academics***

The influence of demographic characteristics such as status, gender, age, qualification and work experience on the different forms of mentoring challenges namely victimization, instant gratification, gender-based bias, work life imbalance and Incivility are presented in Table 5:

**Table 5.**

*Demographic characteristics and mentoring challenges among academics*

Variable	Category	test statistic	Forms of Mentoring Challenges				
			Victimization	Instant Gratification	Gender based bias	Work Life Imbalance	Incivility
Status	Junior Academics	t-test	0.390 (0.697)	-0.561 (0.559)	0.034 (0.973)	0.195 (0.846)	- 0.325 (0.746)
	Senior Academics						
Gender	Male	t-test	1.581 (0.116)	0.018 (0.922)	0.928 (0.355)	1.637 (0.104)	0.001 (0.999)
	Female						
Age	18-24years	ANOVA	0.239 (0.916)	0.873 (0.481)	0.937 (0.444)	0.799 (0.527)	1.208 (0.070)
	25-35years						
	36-45years						
	46-55years						
	56years and above						
Qualification	Ph.D	ANOVA	1.514 (0.223)	0.864 (0.423)	0.737 (0.480)	1.188 (0.307)	0.327 (0.722)
	Master's						
	First Degree						
Work Experience	Less than 3years	ANOVA	<b>3.307</b> <b>(0.022)</b>	1.081 (0.359)	1.041 (0.376)	0.267 (0.849)	0.590 (0.623)
	3-6years						

Variable	Category	test statistic	Forms of Mentoring Challenges				
			Victimization	Instant Gratification	Gender based bias	Work Life Imbalance	Incivility
	7-12years						
	Above 12years						

T-Test was conducted to find out whether significant differences exist between two demographic variables (status and gender) and the different forms of mentoring challenges. The use of t-test was because the variables (status and gender) involve only two categories each. The results in Table 5 showed that victimization { $t=0.390$ ;  $p=0.697$ }, instant gratification { $t=-0.561$ ;  $p=0.559$ }, gender-based bias { $t=0.034$ ;  $p=0.973$ }, work life imbalance { $t=0.195$ ;  $p=0.846$ } and Incivility { $t=-0.325$ ;  $p=0.746$ } do not significantly differ by academics' status. Similarly, the results showed that victimization { $t=1.581$ ;  $p=0.116$ }, instant gratification { $t=0.018$ ;  $p=0.922$ }, gender-based bias { $t=0.928$ ;  $p=0.355$ }, work life imbalance { $t=1.637$ ;  $p=0.104$ } and Incivility { $t=0.001$ ;  $p=0.999$ } do not significantly differ by academics' gender.

Analysis of variance (ANOVA) was used to test whether significant differences exist between the remaining respondents' demographics (age, qualification and work experience) and the different forms of mentoring challenges. The result in Table 5 shows that the forms of mentoring challenges (victimization, instant gratification, gender-based bias, work life imbalance and Incivility) do not significantly differ based on respondents' demographics such as age, qualification and work experience except for victimization and work experience { $t=3.307$ ;  $p=0.022$ } that is significant at 5% level of significance.

## Discussion

This study identified victimization, instant gratification, gender-based bias, work-life imbalance and incivility as some of the mentoring challenges confronting university academics in Nigeria. Victimization

in a mentoring relationship in the university system may include alienation of some colleagues because of their allegiance to certain senior academics, high tendency of a protégé becoming a target by other senior colleagues who are opposed to the mentor, fear of sexual harassment, as well as fear of being branded as the mentor's 'boy or girl' by peers and other faculty members. According to Rodriguez & Sjostrom (2000), the mentors see themselves as older, wiser, having reached the pinnacle of their careers and holding all the power in the mentoring relationship. Some mentors may overawe the new academic, treat him as a mere 'errand boy/girl' and fail to impart any knowledge to him/her. This act of superiority may make the protégé feel resentful and begin to avoid the mentor since he/she cannot perceive any benefit from the relationship. A mentoring style that is purely hierarchical and does not include a collaborative or communal style is bound to breed these types of problems. Inappropriate choice of mentor/protégé, unrealistic expectations from the relationship by the parties, feelings of superiority/inferiority can create serious problems with the mentoring relationship. According to Dabiri & Olorunleke (2006), the mentoring programme is built on trust and respect, where this is lacking, the relationship is doomed to fail.

Instant gratification impedes effective mentoring as discussed in this study. This is further reiterated by Undiyaundeye & Basake's (2017) finding that the challenges to effective mentoring in the academia include the inability and unwillingness of young academics to follow instructions from mentors, due to the "get rich quick" mentality, the inability of the institution to manage personnel and ensure good community partnerships, inability and unwillingness of the mentors to support subordinate professional growth and finally, the inability of the school management to sanction untoward behaviour by young academics due to godfatherism. To deal with the challenges confronting the mentoring programme, participants in the mentoring exercise should be committed to their roles and responsibilities (Al Makhamreh & Stockley, 2020).

Incivility is another challenge in mentoring relationship as preferred mentors sometimes decline protégés' requests for mentorships. Some senior academics who ought to act as mentors to new and younger lecturers are hardly available and accessible. Many professors are



either on sabbatical in other universities, leave of absence, or are busy as adjunct lecturers, external examiners and consultants elsewhere. This creates a situation where the younger lecturers are left without mentors to who they can relate with. The senior academics hurriedly attend to proteges when they are available; they are saddled with other responsibilities such as Deanships, Headships and other positions within the university that make it difficult for them to have a meaningful mentoring relationship with their protégés if they have any. According to Hoy & Spero (2005), the most frequently anticipated characteristic of effective mentors is the willingness and ability to nurture another person. Nnaji et al. (2015) add that the mentor should be people-oriented, open-minded, flexible, empathetic, collaborative, willing to make time and space for productive discussions, establish an equitable relationship and so on. These are obvious activities that require time and commitment. In a similar vein, gender bias is identified as a serious challenge in mentoring relationship as mentees may be afraid of being romantically linked to the mentor. It is also possible that preferred gender may be scarce for proteges to select from. Work-life imbalance serves as a challenge in a mentoring relationship as mentors may be too engaged thereby unable to pay adequate attention to the mentoring needs of proteges. For instance, what other people may say about a perceived cordial relationship between mentor and protégé in Nigerian universities may prevent some mentors from spending quality time with their proteges.

It was also found that mentoring challenges such as victimization, instant gratification, gender-based bias, work-life imbalance and Incivility do not significantly differ based on demographic characteristics such as status, gender, age, qualification and work experience. This implies that respondents' evaluation of mentoring challenges does not substantially differ based on their status which was broadly categorized into senior academic staff (Professors; Associate Professor; and Senior Lecturers) and junior academic staff (Lecturer I; Lecturer II; Assistant Lecturers and Graduate Assistants), gender, age, qualification and work experience.

## **Conclusion and Research Implications**

Considering the importance that many organizations attach to mentoring programs and the benefits that have been demonstrated to accrue from it, the concept must also be studied in relation to academics in Nigerian Universities. This study provides information on the challenges associated with the mentoring relationship among academics. The information generated by this study will help Universities to embark on or improve their mentoring programs as a way of improving service delivery. Moreover, it will be useful for educational policymakers to enable them to make policies that will harness the vast potentials that mentoring offers. The study found that the major challenges encountered by academics in mentoring relationships include victimization, instant gratification, gender-based bias, work-life imbalance and incivility.

Firstly, universities and other tertiary institutions should promote an atmosphere of organizational harmony where faculty members will seek the growth of younger academic staff for the advancement of the educational system.

Secondly, the compensation packages of lecturers should be appreciably enhanced to curb the worrisome culture of instant gratification that promotes corruption and other questionable acts among lecturers. Also, a reorientation of the values that are important to the university system should be taught and enforced across the university system.

Finally, more females should be encouraged to not only seek higher-level academic positions within the university, they should also be urged to take up mentoring of younger faculty members by making themselves more available to address the problem of gender-based bias in mentorship.

## **Limitations and Suggestions for Further Studies**

One of the limitations of this study is the sample size used. The sample size was originally determined to be 459. Due to non-response or partial completion of some of the questionnaires, only 177 copies

were used for data analyses out of the 230 copies retrieved. Secondly, the use of factor analysis requires at least ten participants per item for accurate loading and analysis. This could not be achieved in this study as only 177 responses were obtained instead of 180 responses required. However, the difference of 3 responses may not pose any significant alteration to the research outcomes. Finally, the instrument used for this study was the self-report questionnaire; future studies should include interviews and focus studies to get more accurate information and explore other areas that may not be adequately captured with the use of a questionnaire.

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## Exploring Instructional Leadership Practices in Institutional Schools of Kathmandu: A Narrative Inquiry

**Subash Shrestha\***

*Department of Educational Leadership, Kathmandu University School of Education, Nepal*


### Abstract

Principals of schools are more focused on managerial work rather than supporting teaching and learning in the school. As a result, they spend most of their time behind the desk and in work pertaining to documentation. Principals are guided by the principles of achieving good grades in examinations. They tend to be more focused on rote learning rather than knowledge and skills-based learning that add value to the lives of students. However, the instructional leadership advocates that the principal should be able to create school cultures that encourage students' progress by ensuring teachers' accountability. Thus, the main aim of the paper is to explore perception and practices of principals on their instructional leadership in addressing the skills required for the 21<sup>st</sup> century. This research makes use of applied narrative approach to explore the perceptions and practices. For this purpose, this study undertook in-depth interviews with two principals from different schools of the Kathmandu valley. The findings of the study revealed that setting

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\*Correspondence should be addressed to **Mr. Subash Shrestha**, Department of Educational Leadership, Kathmandu University School of Education, Nepal.

**Email:** [subash@kusoed.edu.np](mailto:subash@kusoed.edu.np)

 <https://orcid.org/0000-0002-4229-1323>

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direction, focusing in curriculum and monitoring the learners' progress are the perception and practices of instructional leadership.

**Keywords:** Instructional leadership, Institutional schools, Leadership and management practices

## **Introduction**

In 1984 this researcher's father, a non-academician, established a school based on requests from a group of close associates who were teachers. The school performed well and became popular in its area in terms of students' enrollment and their achievements. After five years, the teachers demanded their share in the institution which the founder of the school refused. As a consequence, the teachers resigned from their posts and established another school. During the initial stage, their departure did not affect the original school visibly though with time their absence was felt as the school's management standards and academic achievements began to decline. However, despite these concerns, the school continued to operate. To assist the school in whatever the way possible, this researcher would spend some time there daily after college class. The researcher was deeply inspired by his college's extra-curricular activities and tried to incorporate them in the school. In addition, this researcher worked as a part-time teacher of English in the school. With the advent of the new millennium, the leadership of the school was entrusted to this researcher, reminding Bush's (2006) statement that school principals in the developing countries were appointed based on a successful record as teachers with the assumption that this provided a sufficient starting point for school leadership. For a fresh undergraduate with only practical, yet unsystematic knowledge of teaching and learning, this was a daunting challenge.

Initially, the school was managed as per the norm that had established itself under its founder, which was a time-tested traditional mode of management with the focus on obtaining better Secondary Education Exam (SEE) results. Coming from a school that maintained its position in the top ten ranking in producing the best SEE results, the school was run by this researcher with strict focus on gaining top marks. In

this respect, Huber (2004) argued that a school cannot any longer be regarded as simply imparting traditional knowledge within a fixed frame. Rather it is becoming an organization which needs to renew itself continuously in order to take present and future needs into account.

For three decades, this researcher managed the school on those lines and produced 23 SEE batches with top marks. This period had this researcher desk bound and dealing with reams of document focusing on financial matters. Over a period of time, this researcher witnessed the inadequacy of this method on his personal and professional growth. In the meantime, academic exposure to M.Ed. Leadership and Management Program of the Kathmandu University offered this researcher fresh perspectives on inadequate school leadership (Leithood et al, 2006). Harris (2009) said that effective school leadership determines school improvement. According to Bush (2007), there has been a great interest in educational leadership during the early part of the 21<sup>st</sup> century because of the widespread belief that the quality of leadership makes a significant difference to school and student outcomes. In many parts of the world, there is recognition that schools require effective leaders and managers if they are to provide the best possible education for their students (Bush, 2007). Much of the available literature on effective school leadership indicates that school leaders play an important role by exerting their influence over several factors, including, most importantly, teachers (Hallinger & Heck, 1998; Leithwood et al., 2004). Effective school leadership directly affects teacher capacity, motivation, and commitment and working conditions, all of which directly affect teaching practices linked to student learning and achievement (Leithwood et al., 2008). According to Louis et al. (2010), school leaders influence student learning mainly through establishing appropriate school conditions by setting goals, influencing culture, setting parameters for classroom conditions through designing and managing curricular planning and resource allocations, and also by directly influencing teachers. The review of literature conducted by Hallinger & Heck (1998) on instructional leadership literature published between 1980 and 1995 suggests that school principals who employ an instructional leadership had an indirect effect on

students' reading achievement and direct effects on schools' climate changing in elementary schools. Additionally, Spiro (2013) affirms that instructional leaders establish clear goals, provide educators with direction and sense of mission. Furthermore, they motivate educators to enhance their performance. Teacher motivation is also highlighted as having a drive that leads to improved educational outcomes. This knowledge and awareness on leadership practices finally has given this researcher the background to issues like how school principals practice and perceive instructional leadership in their schools. Thus, this research attempts to throw light upon the instructional leadership practices in institutional schools of Kathmandu.

Instructional leadership is not a new concept. Salo, Nylund & Stjernstrom (2014) said that the origin of instructional leadership was an Anglo-American concept developed intensely in the early 1980s for effective school management. However, critics argued that instructional leadership as an outdated and authoritative position of the principal (Sebastian & Allenswoth, 2012). In the same lines, Hallinger (2003) had a view that principals could not have the capabilities of being curriculum experts in all the learning areas so they might be ineffective in managing the school. However, instructional leadership has been reawakened as a form of leadership for learning that aimed to achieve goals set by the school. Adjectives such as collective, shared, transformational and distributed are used with instructional leadership (Louis & Wahlstrom, 2012). This issue needs to be explored in institutional schools where the principals are also teacher, administrator and leader (Bush, 2006).

Since this study focuses on leadership practices of institutional school, this study will be taking McEwan's (2003) model "7 steps to effective instructional leadership" as the theoretical lens. The first step in instructional leadership practices highlights the need for leaders to be aware of academic standards and establish them in the long run. To achieve this, the leader should thoroughly study a school's curriculum and sit with the teachers to prepare the instructional plan which is consistent with national curriculum standards; they should ensure that this plan is detailed and easy to understand and has continuous assessment plans that are

explainable to staff and students in terms of their relevance and importance.

The second step in instructional leadership practices talks about leaders being an instructional source who constantly help to solve difficult instructional problems. To master this step, the leaders should be eager learners and discuss instruction and learning by utilizing the four Cs— collaboration, collegiality, cooperation, and creative problem solving. They need to read a variety of publications, attend all kinds of workshops, go to national conferences, present staff development programs to their teachers, and should be constantly on the lookout for potential resources for their buildings.

The third step focuses on leaders creating a school culture and climate conducive to learning. To achieve this goal, the leaders need to communicate with all the stake holders the expectations set for all of them to achieve maximum student learning outcome. The leaders also need to establish inclusive classrooms, good work-place environment, plan for extended learning opportunities for low achievers, etc., that help create conducive learning environments.

The fourth step suggest that instructional leaders should communicate the vision and mission of the school with its stakeholders and provide systematic two-way communication with staff regarding the achievement standards and the improvement goals of the school. They should establish, support, and implement activities like career awareness, academic clubs, student quality circle, etc. that communicate the value and meaning of learning to students.

According to step 5 instructional practices of leaders prioritize the setting of high expectations for the staff and leaders themselves. To achieve this, the leaders need to assist teachers in setting and reaching personal as well as professional goals. The leaders must also engage in planning of classroom observation and make regular classroom observation including both formal and informal. Lastly, the leaders need to conduct post observation conferences that provide

thorough evaluations and make recommendations for personal and professional growth of the teacher.

The sixth step emphasizes on the need to develop teacher leaders. To achieve this, instructional leaders should schedule, plan, or facilitate regular meetings of all types (planning, problem solving, decision making, or in-service and training) with and among teachers to address instructional issues. They should be able to provide opportunities for, and training in, collaboration, shared decision making, coaching, mentoring, curriculum development, and presentations. Moreover, they should provide motivation and resources for faculty members to engage in professional growth activities.

The seventh step stresses on the notion that instructional leaders should communicate with students about their school life and serve as an advocate for them. To achieve this, the leaders should interact and familiarize themselves with students and should be engaged in at least 6 behaviours like calling students by their names, playing with them, celebrating students' success, attending student conferences, showing consideration for students' problems and participating in the resolution of such problems wherever appropriate.

## **Research Methodology**

Since the study tries to explore the practice and perception of instructional leadership in institutional schools, this research has employed the narrative inquiry method as its research methodology offers practical and specific insights for this researcher looking for personal experiences (Creswell & Poth, 2012). Clandinin & Connelly, (2004) also viewed that experience happens narratively, and therefore, educational experience should be studied narratively. Principals' personal experience is of a central focus in this research. Therefore, two principals were chosen from different institutional schools. Principal-1 is a male participant who has been in the educational field for the past 20 years. Similarly, principal-2 is a female participant who has also been in the field for the last 15 years. They were purposely selected with a belief that their leadership experiences

contribute to the inquiry of the research. As stated by Punch (2005), purposive sampling involves the existence of some purpose in mind.

Since the intent of research was to explore and articulate the practice of the principals on instructional leadership, this researcher was concerned about the quality of the relationships that would develop between the participants as this researcher was acquainted with them. Though initially this researcher had reservations about interviewing subjects whom he knew personally, he later found out that they were keen to share their experiences which were individual and unique. Thus, this researcher not only developed an insider's perspective, but also worked towards the sort of research relationship described by Connelly and Clandinin (2000) as where participants "feel cared for and have a voice with which to tell their stories".

This researcher interrogated both of them inside the school in their cabin during and even after the regular classes. The questions used were open ended and flexible so that this researcher could explore the perceptions of the respondents. While interviewing, this researcher kept very neutral and friendly to keep the participants in a comfort zone. In the beginning, this researcher started with introducing the research topic followed by further in-depth inquiry. Interviews were recorded and field notes were used as a method of recollecting information. Coding was made in the diaries for some of the information obtained from interviews and digital recordings were made of all the interviews. An elaborative process was adopted for coding, categorizing, and thematizing (Creswell, 2007). Then the experiences shared by the participants were analysed through a theoretical lens.

## **Findings and Discussion**

Findings suggest that both the participants have different understanding on instructional leadership. This researcher found that both principal-1 and principal-2 followed step 4, 5 and 7 according to McEwan's 7 steps to instructional leadership which are elaborated in three different themes setting direction, focussing on curriculum and monitoring learners' progress.

### **Setting Direction**

When asked about instructional goals, principal-1 stated the vision of the school as *“creating an appropriate environment where all the stakeholders can excel in the skills to face the everyday world”*. He said that teachers integrate the element of child friendly activities based on the vision statement. He gave an example of teaching about the solar system in grade 2. He said that a teacher would bring the students out from the classroom, draw the solar system on the ground and name each one of them according to the name of the existing planets and let them revolve around the sun. This is related to Robinson’s (2011) comment on instructional leaders to direct the work of teachers to develop clear and common goals. The Wallace Foundation (2013) also found that effective principals shape a vision of academic success for all students.

When it comes to the vision of the school, principal-2 said, *“I haven’t developed one yet. I think our vision is reflected in our bulky report card since our school is marks-oriented and we emphasize on exam achievements”*. She expressed her pride in being associated with a marks-oriented culture of teaching and learning. She strongly asserted that parents admit their children to her school because they want them to score good marks. Parents, she said, wanted a greater number of exams because they thought that such tasks kept the children occupied at home and improved exam marks at the same time. She considered achievement of marks as a traditional mode of thinking, though parents demanded such attitudes. Leithwood et al. (2004) identified setting directions as one of the three critical components of school leaders. Setting directions in this case includes incorporating daily lesson plan and activities with the vision statement of the schools.

In the school of principal-1, teachers are encouraged to include child friendly activities to enhance learning whereas in the case of principal-2, teachers are encouraged to achieve marks. Principal-2 claimed that it is because of such instructions that they have been able to achieve successful grades in SEE for more than a decade and awarded the best school by the Ministry of Education of Nepal. The organization for economic cooperation and development OECD research (2009)



supports the view that successful instructional leaders are actively involved in ensuring that schools' goals are achieved.

## **Focusing on Curriculum**

When questioned about the curriculum, principal-1 said that although they followed the national curriculum, they had a provision of sequential planning and the teachers stayed after school for lesson plan. So did their supervisors and department heads to support maintaining the quality. He said that they had sharing sessions and focused on team work. The supervisors would go to the classes with the teachers. They would see how it was operated and provided regular coaching and mentoring sessions. Based on the feedback the teachers would improve their sessions. These data suggests that principal 1 was more focused on modifying the curriculum according to the relevance and practicality of the contents being taught indicating flexible curriculum of the school. Sim (2011) had a similar view that the principals motivated and inspired the educators to plan and engage in classroom teaching in a way that was aligned with the school vision. Mulford & Silins (2011) also said that successful principals involve others in the leadership process to increase and build capacity.

Principal-2 viewed that they too followed the national curriculum. However, the teachers did not prepare lesson objectives as they solely followed the books and they measured the success of students through examination marks. When asked why teachers were only limited to prescribed books? She said:

*"We have teachers who have been working for 20 years and above. It is very difficult to change them as we have three types of teachers: teachers at the same level, growth level and elderly level. The same level means such types of teachers who has been working at the same level for many years. For example, the teachers of the primary section or pre-primary who do not want to initiate change. The elderly level teachers have very few years in their service and are very stubborn to accept change to improve teaching-learning; there are few growth level teachers who have helped sustain the quality of the school".*

Despite the professional development practices in her school, the data suggested obtained from principal-2 suggest that the teachers are reluctant to adopt new teaching and learning processes which also indicated that the text books were being followed without taking into consideration the relevance and practicality of the contents being taught. She referred the attitude of teachers using the famous quote, “*a dog tail will not be straightening no matter how hard you try*” suggesting that it is impossible for teachers to adopt any new change in the curriculum.

### ***Monitoring Learners’ Progress***

Regarding the ways the school monitors the learners’ progress and outcomes, assessments, principal-1 asserted that they follow formative assessment system whereby the students are assessed not just in terms of what they know but also in terms of their skills and understanding. To assess the learners’ skills, teachers set criteria or indicators that help the teacher to know the level of the students and guide them accordingly. He shared an example to prove his point, -

*Instead of explaining how seeds grow, the teachers ask students to bring seeds from home and ask them to monitor the growth. They inform them of the requirements for optimum plant growth but the students have the upper hand in taking care of the plant to ensure that it grows. The teachers observe the students and assess them not just in terms of whether the plant sprouted and grew into a bigger unit, but also in terms of other indicators set during the process like students’ attitude and enthusiasm towards the experiment, their presentation on explaining their experiment, their new understanding and reflection.*

The above suggests that the school focused on improving motor skills and 21<sup>st</sup> century skills.

Principal-2, on the other hand, said:

*There are a lot of examinations and the teachers are always correcting copies and filling in their report cards. There is no time for teachers to go for training to develop their professional skills.*

Moreover, when asked as to why she had kept such a busy schedule for the teachers, she replied that the school was known for achieving good scores in SEE examination and parents admitted their children because they appreciated the values created by the school. That was the reason for having six (06) exams annually which satisfied the parents. The above data suggests that principal-2's school followed summative assessment system. Whether it is formative or summative the data indicated that both the schools have organized practice of assessment to help parents understand about how their children are performing.

Thus, the above findings revealed that both the principals did not seem to have in-depth knowledge of instructional leadership as the study revealed that they were unaware of McEwan's step 1, 2, 3, and 6 of instructional leadership practices. However, they attempted to achieve effective learning and teaching by setting direction, setting expectations in the way the curriculum was taught and monitoring learners' progress thus suggesting that they follow McEwan's step 4, 5 and 7.

The theme "setting direction" is aligned with step-4 of McEwan's 7 steps to effective instructional leadership. In step-4, according to McEwan (2003), instructional leaders should be able to communicate the vision and mission of the school to their teachers. He or she must have a clear vision of what the school should be and should become at some time in the future. In the case of principal-1, he has a well-defined vision and seems to encourage teachers to align lesson plans based on the vision of the school. It is aligned with what Harris et al. (2008) claimed that goal setting is considered as one of the key dimensions of success for a successful school leader. This shows that he is following step-4 of McEwan. In case of principal-2 although she claimed she was unaware of the vision of the school; the goal of the school was to ensure students' excellence in SEE results and to satisfy those parents who admitted their children to obtain good grades in the examination. This suggests that although she was unknown about the vision, McEwan step 4 theme setting direction was indirectly observed by this researcher since the school strove to achieve excellent SEE results.

Similarly, the theme “focusing on curriculum” align with step-5 emphasizes that the instructional leader should able to set high expectations for the staff and oneself. According to McEwan (2003) a principal should engage in planning classroom observations, post observation conferences that focus on the improvement of instructions. In the case of principal-1, he supported and mentored teachers in designing daily lesson plans and providing constructive feedback to make sure that each lesson plan incorporated the activities that helped achieve the vision of the school. This shows principal-1 exercised collaborative and collegial environment to enhance the effective teaching of the curriculum. On the other hand, principal-2 expressed her negative experiences with the existing teachers. The teachers’ negative attitude towards her efforts to check students’ answer scripts and conflicting meetings among teachers showed that there was resistance to her mode of operation of the school. Since there was no visionary thinking in the school of principal-2, their whole effort was to secure good scores in the examinations.

The theme “monitoring the learners’ progress” aligns with step-7 that strongly advocates that the instructional leader should show their concern for students and prioritize their development. Effective instructional leaders do not engage in mindless chatter about how much they care about students. They demonstrate such thoughts through their actions. On a daily basis, they work to change practices in the areas of discipline and their achievements. With this reference, in the case of principal-1, he practiced formative assessment. Teachers were given full responsibility and the progress of the students were being measured in terms of acquiring knowledge and skills. Whereas in the case of principal-2, she was found to be practicing summative assessment and students’ progress were measured in terms of obtaining scores in the examinations.

## **Conclusions**

From the above data and discussion, it is concluded that both the principals perceived and practiced instructional leadership as setting

direction, focusing on curriculum and monitoring learners' progress. On one hand, principal-1 had a vision to engage students, so he seemed to be focusing on every activity and progress of the students to achieve the set goals. On the other hand, principal-2, was marks-oriented and thus, focused mainly in achieving good scores in the examination. Moreover, principal-1's school gave priority to developing teacher leaders, building strong relationship among stakeholders and to create a culture conducive to learning whereas principal-2's school seemed to be uninformed on the knowledge and skills in developing a teacher leader, teacher as an instructional source, a school culture and most importantly, positive relations with students and parents.

This study had several limitations including the limited time and resources. As only two principals were selected as participants, the conclusion of this study can hardly be generalized. Another limitation is that this study was carried out only on two secondary school principals of the Kathmandu district. Similar studies need to be carried out covering a wide area and a larger number of such schools so that the results could be generalized. Another limitation is that this study was carried out only to explore the perception and practice of instructional leadership of principals but not of other teachers, non-teaching staff, students, parents and school management committee members. If their perceptions were added the findings could vary. Finally, multimethod to collect the data from informants to triangulate the data for reliability and validity of the data would have been the better methods for this study. In this connection, use of other methods such as observation, focus group discussion, collection of artifacts, etc. would be further relevant. Multiple interviews as well as multi-method data collection procedures would have been ideal for the saturation of the research themes. However, the researcher realized that the data provided by both the principals and their analysis provided a strong foundation for more in-depth examination of the existing practices of instructional leadership.

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## Synthesis of Silver(I) Complexes Containing N and P Donor Ligands

**Sarath D. Perera**\*#

*Department of Chemistry, The Open University of Sri Lanka, Sri Lanka*

### Abstract


Treatment of one equivalent of 3,4,5,6-tetraphenyl-2,2'-bipyridine (tpbpy) with  $\text{AgClO}_4$  afforded  $[\text{Ag}(\text{tpbpy})]\text{ClO}_4$  (**1a**). Similarly,  $[\text{Ag}(\text{tpbpy})]\text{BF}_4$  (**1b**) was prepared using  $\text{AgBF}_4$ . Reaction of two equivalents of tpbpy with  $\text{AgClO}_4$  yielded the homoleptic  $\text{Ag}(\text{I})$  complex  $[\text{Ag}(\text{tpbpy})_2]\text{ClO}_4$  (**2**). The four-coordinate heteroleptic  $\text{Ag}(\text{I})$  complex  $[\text{Ag}(\text{tpbpy})(\text{xantphos})]\text{ClO}_4$  (**3**) containing both N and P donor ligands was prepared by treating  $\text{AgClO}_4$  with a (1:1) mixture of tpbpy and 4,5-bis(diphenylphosphino)-9,9'-dimethylxanthene (xantphos).  $[\text{Ag}(\text{dmbpy})(\text{xantphos})]\text{ClO}_4$  (**4**) (dmbpy = 6,6'-dimethyl-2,2'-bipyridine) was prepared in a similar manner. Reaction of one equivalent of xantphos with  $\text{AgClO}_4$  in acetonitrile produced the labile three-coordinate  $\text{Ag}(\text{I})$  complex  $[\text{Ag}(\text{xantphos})(\text{MeCN})]\text{ClO}_4$  (**5**). Treatment of (**5**) with one equivalent of tpbpy or dmbpy afforded the heteroleptic complexes (**3**) and (**4**), respectively. Reaction of (**5**) with one equivalent of 4'-(4-methylphenyl)-2,2':6',2''-terpyridine

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\*Correspondence should be addressed to **Prof. K. S. D. Perera**, Department of Chemistry, Faculty of Natural Sciences, The Open University of Sri Lanka.

#Dedicated to the memory of Professor Bernard Leslie Shaw FRS of University of Leeds who died on 8<sup>th</sup> November 2020 at the age of 90 years

**Email:** ksper@ou.ac.lk

 <https://orcid.org/0000-0001-5917-7327>

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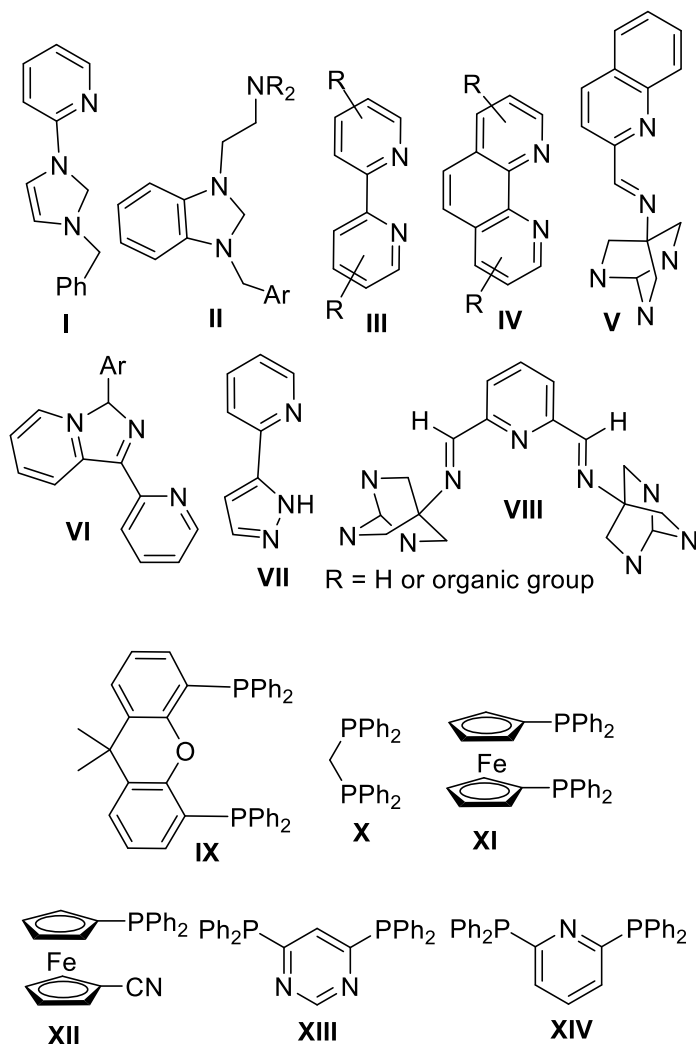
(ttpy) afforded the five-coordinate Ag(I) complex  $[\text{Ag}(\text{xantphos})(\text{ttpy})]\text{ClO}_4$  (**6**). Treatment of  $\text{AgClO}_4$  with one equivalent of bis(diphenylphosphino)methane (dppm) in a (1:1) solvent mixture of chloroform and methanol resulted in the formation of  $[\text{Ag}_2(\mu\text{-dppm})_2][\text{ClO}_4]_2$  (**7**). Reaction of (**7**) with one equivalent of 3,6-di(2-pyridyl)-4,5-diphenyl-pyridazine (dppz) gave the binuclear complex  $[\text{Ag}_2(\mu\text{-dppm})_2\{\mu\text{-dppz}\}][\text{ClO}_4]_2$  (**8**). Above complexes were characterized by a combination of elemental analysis, IR, Mass and NMR spectroscopy.

**Keywords:** homoleptic, heteroleptic Ag(I) complexes, xantphos, dppm, pyridyl ligands

## Introduction

Pharmaceutical application of silver was first recognized with the use of silver nitrate ( $\text{AgNO}_3$ ) in the early 1800s for the treatment of ulcers. Silver complexes containing ligands such as N-heterocyclic carbenes (NHC), N-heterocycles and phosphines possess several properties: - ranging from antimicrobial, antibacterial, anti-inflammatory and antiseptic to anti-neoplastic activity (Medici et al., 2016; Kızrak et al., 2019; Jimenez et al., 2017). Water-soluble homoleptic Ag(I) complexes of the type  $[\text{Ag}(\text{N}^{\wedge}\text{N})_2](\text{CF}_3\text{SO}_3)$  based on adamantylamines showed antibacterial properties (Jimenez et al., 2017). Many applications of silver nanoparticles are known in addition to their antimicrobial property (Handoko & Gulo, 2019; Abbas et al., 2018). Silver(I) salts are good catalysts for alkyne-based organic reactions such as alkynylation, hydrofunctionalization, cycloaddition, cycloisomerization and cascade reactions (Fang & Bi, 2015). Coordination complexes of Ag(I) centre usually exhibit linear, tetrahedral or trigonal planar geometry with ligands containing donor atoms such as C<sup>^</sup>N (NHC) (**I**, **II**) (Medici et al., 2016; Kokunov et al., 2016; Hasson et al., 2019; Athi & Gülle, 2019), N<sup>^</sup>N (**III-VII**) (Durini et al., 2017; Carbonell-Vilar et al., 2019; Xing et al., 2020; Fresta et al., 2019), N<sup>^</sup>N<sup>^</sup>N (**VIII**) (Jimenez et al., 2017; Artem'ev et al., 2019), P<sup>^</sup>P (**IX-XI**) (Kaltzoglou et al., 2007; Bruce et al., 2016; Hutton et al., 1983; Gimeno et al., 1995), P<sup>^</sup>N (**XII, XIII**) (Hung-Low & Klausmeyer,

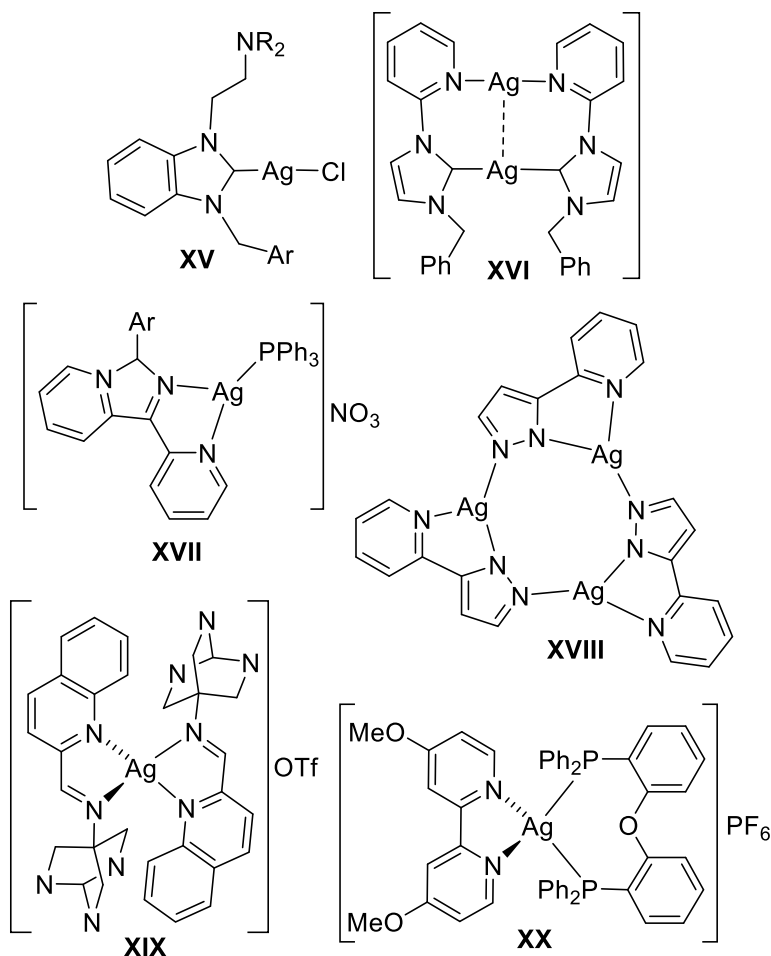
2008; Škoch et al., 2017; Artem'ev, 2020), P<sup>N</sup>P (**XIV**) (Nayeri et al., 2020) (Figure 1).



**Figure 1.** Molecular structures of ligands **I** - **XIV**.

Ag(I) centres form mononuclear (Medici et al., 2016), binuclear (Medici et al., 2016; Hung-Low & Klausmeyer, 2008; Artem'ev, *et al.*, 2020), trinuclear (Artem'ev et al., 2019; Nayeri et al., 2020), tetranuclear (Medici et al., 2016; Nayeri et al., 2020) and polynuclear (Medici et al., 2016; Škoch et al., 2017; Artem'ev et al., 2020) complexes with pyridines, bipyridines, diphosphines and

pyridyl phosphines; some of these complexes show weak Ag-Ag interaction. A few basic mononuclear, binuclear and trinuclear Ag(I) complexes with linear, trigonal planar and tetrahedral geometries are shown in Figure 2.



**Figure 2.** Molecular structures of complexes **XV- XX**.

First examples of emissive square-planar Ag(I) complexes  $[\text{Ag}(\text{N},\text{N}'\text{-Py}_3\text{PO})_2]\text{X}$  ( $\text{X} = \text{OTf}, \text{ClO}_4$ ) were reported recently by reacting tris(2-pyridyl)phosphine oxide ( $\text{Py}_3\text{PO}$ ) with Ag(I) salts (Artem'ev et al., 2019). Five- and six-coordinated Ag(I) complexes are less common (Medici et al., 2016; Jimenez et al., 2017; Nayeri et al., 2020, Artem'ev et al., 2019). Two examples of octahedral Ag(I) complexes

include  $[\text{Ag}(\text{N},\text{N}',\text{N}''\text{-Py}_3\text{PO})_2]\text{BF}_4$  (Artem'ev et al., 2019) and  $[\text{Ag}(\text{N},\text{N}',\text{N}''\text{-VIII})_2]\text{OTf}$  (Jimenez et al., 2017).

Silver is a less expensive metal with promising catalytic, structural and photophysical properties which can be tuned with other co-ligands (Artem'ev et al., 2020), thus, it is of interest to explore the chemistry of Ag(I) centres with different chelating ( $\text{N}^{\wedge}\text{N}$ ), ( $\text{N}^{\wedge}\text{N}^{\wedge}\text{N}$ ) and ( $\text{P}^{\wedge}\text{P}$ ) donor ligands. Here we report studies carried out to synthesise Ag(I) complexes using 3,4,5,6-tetraphenyl-2,2'-bipyridine (tpbpy), 6,6'-dimethyl-2,2'-bipyridine (dmbpy), 4'-(4-methylphenyl)-2,2':6',2''-terpyridine (ttpy), 3,6-di(2-pyridyl)-4,5-diphenyl-pyridazine (dppz), 4,5-bis(diphenylphosphino)-9,9'-dimethylxanthene (xantphos), and bis(diphenylphosphino)methane (dppm). The bidentate dmbpy ligand and terdentate ttpy ligand are planar symmetrical molecules whilst tpbpy is a bulky unsymmetrical bidentate ligand. The symmetrical dppz ligand has four nitrogen donors which can bridge two metal centres or produce polynuclear complexes.

## Methodology

All the experiments were carried out in an inert atmosphere of dinitrogen or argon. IR spectra were recorded on a Perkin-Elmer Spectrum One spectrometer fitted with a diffuse reflectance accessory. Electrospray mass spectra were obtained on a Micromass LCT electrospray mass spectrometer. MALDI-TOF mass spectra were recorded on a Waters MALDI-QTOF Premier spectrometer using  $\alpha$ -cyano-4-hydroxy cinnamic acid matrix. Accurate mass spectra were referenced against Leucine Enkephalin. Elemental analyses were carried out on a Carlo Erba 1006 automatic analyser. NMR spectra were recorded on a DPX 400 spectrometer operating at 400.13 MHz for  $^1\text{H}$  and 100.62 MHz for  $^{13}\text{C}$ ; the  $^1\text{H}$  and  $^{13}\text{C}$  chemical shifts ( $\delta$ ) are in ppm with respect to TMS while coupling constants (J) are in Hz.  $^{31}\text{P}$  NMR spectra were recorded at 161.02 MHz and are standardized with respect to phosphoric acid.  $\text{AgBF}_4$ ,  $\text{AgClO}_4$ , 6,6'-dimethyl-2,2'-bipyridine (dmbpy), 4,5-bis(diphenylphosphino)-9,9'-dimethylxanthene (xantphos) and bis(diphenylphosphino)methane (dppm) were purchased from Aldrich. 3,4,5,6-tetraphenyl-2,2'-bipyridine

(tpbpy), 4'-(4-methylphenyl)-2,2':6',2''-terpyridine or tolylterpyridine (ttpy) and 3,6-di(2-pyridyl)-4,5-diphenyl-pyridazine (dppz) were prepared according to literature procedures (Ollangnier, *et al.*, 2008; Schubert, *et al.*, 2006; Gil, *et al.*, 2011).

### **[Ag(tpbpy)]ClO<sub>4</sub> (**1a**)**

A solution of AgClO<sub>4</sub> (9 mg, 0.0434 mmol) in methanol (1 mL) was added to a solution of 3,4,5,6-tetraphenyl-2,2'-bipyridine (tpbpy) (20 mg, 0.0434 mmol) in dichloromethane (1 mL) to yield a colourless solution and the reaction mixture was heated to 50 °C for 1 h. The solution was concentrated to a low volume under reduced pressure to yield (**1a**) as a white solid, (20 mg, 71%). Found: 61.63; H, 4.02; N 4.03, calcd. (%) for C<sub>34</sub>H<sub>24</sub>ClN<sub>2</sub>O<sub>4</sub>Ag: C, 61.14; H, 3.62; N 4.19. IR (neat, cm<sup>-1</sup>): 1579, 1477, 1404, 1269, 1094, 833, 792, 750 and 703. Maldi (DCM, m/z): found: 567.0973; calcd. 567.0990 for C<sub>34</sub>H<sub>24</sub>N<sub>2</sub>Ag, [M-ClO<sub>4</sub>]<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 8.57 (d, br, 1H, <sup>3</sup>J(HH) = 4.0 Hz, H<sup>Py</sup>), 7.50-7.39 (m, 2H, H<sup>Py</sup>) 7.32-7.24 (m, 2H, H<sup>Ph</sup> overlaps with chloroform signal), 7.22-7.12 (m, 3H, H<sup>Ph</sup>), 7.10-6.94 (m, 9H, H<sup>Ph</sup>), 6.88 (d, 2H, <sup>3</sup>J(HH) = 7.0 Hz, H<sup>Ph</sup>), 6.85-6.77 (m, 3H, H<sup>Py</sup> & H<sup>Ph</sup>) and 6.73 (d, 2H, <sup>3</sup>J(HH) = 6.5 Hz, H<sup>Ph</sup>).

### **[Ag(tpbpy)]BF<sub>4</sub> (**1b**)**

A solution of AgBF<sub>4</sub> (8.4 mg, 0.0431 mmol) in methanol (1 mL) was added to a solution of 3,4,5,6-tetraphenyl-2,2'-bipyridine (20 mg, 0.0434 mmol) in dichloromethane (1 mL) to give a colourless solution. After 3 h, the solvent was removed under reduced pressure and the residue triturated with methanol to yield (**1b**) as a white solid, (18 mg, 64%). Found: 61.95; H, 4.00; N 4.05, calcd. (%) for C<sub>34</sub>H<sub>24</sub>BN<sub>2</sub>F<sub>4</sub>Ag: C, 62.32; H, 3.69; N 4.28. IR (neat, cm<sup>-1</sup>): 3057, 1592, 1536, 1470, 1443, 1397, 1058, 1029, 832, 763 and 699. Maldi (DCM, m/z): Found: 567.0963, calcd. 567.0990, for C<sub>34</sub>H<sub>24</sub>N<sub>2</sub>Ag, [M-BF<sub>4</sub>]<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 8.57 (d, br, 1H, <sup>3</sup>J(HH) = 4.5 Hz, H<sup>Py</sup>), 7.52-7.39 (m, 2H, H<sup>Py</sup>) 7.26 (d, 2H, <sup>3</sup>J(HH) = 7.5 Hz, H<sup>Ph</sup>), 7.21-7.11 (m, 3H, H<sup>Ph</sup>), 7.10-6.95 (m, 9H, H<sup>Ph</sup>), 6.88 (d, 2H, <sup>3</sup>J(HH) = 7.0 Hz, H<sup>Ph</sup>), 6.84-6.76 (m, 3H, <sup>3</sup>J(HH) = 7.5 Hz, H<sup>Py</sup> & H<sup>Ph</sup>) and 6.73 (d, 2H, <sup>3</sup>J(HH) = 7.0 Hz, H<sup>Ph</sup>).

**[Ag(tpbpy)<sub>2</sub>]ClO<sub>4</sub> (2)**

3,4,5,6-Tetraphenyl-2,2'-bipyridine (22 mg, 0.048 mmol) and AgClO<sub>4</sub> (4.8 mg, 0.023 mmol) in acetonitrile (1.5 mL) were heated under reflux for 3 h. The resulting colourless solution was concentrated to obtain a low volume and diethyl ether was added to yield **(2)** as a white solid (23 mg, 88%). Found: C, 70.63; H, 4.17; N 4.72, calcd. (%) for C<sub>68</sub>H<sub>48</sub>ClN<sub>4</sub>O<sub>4</sub>Ag·0.5CH<sub>2</sub>Cl<sub>2</sub>: C, 70.26; H, 4.22; N 4.79. IR (neat) cm<sup>-1</sup>: 3057, 1592, 1535, 1473, 1443, 1395, 1088, 998, 765 and 658. Mass (acetone, m/z): found: 1027.2948, calcd. 1027.2930 for C<sub>68</sub>H<sub>48</sub>N<sub>4</sub>Ag, [M-ClO<sub>4</sub>]<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 8.57 (d, 2H, <sup>3</sup>J(HH) = 4.5 Hz, H<sup>Py</sup>), 7.51-7.24 (m, 2H, H<sup>Py</sup>), 7.33-7.24 (m, 4H, overlaps with the solvent peak), 7.22-7.11 (m, 6H, H<sup>Ph</sup>), 7.10-6.94 (m, 18H, H<sup>Ph</sup>), 6.88 (d, 4H, <sup>3</sup>J(HH) = 7.5 Hz, H<sup>Ph</sup>), 6.85-6.77 (m, 6H, H<sup>Py</sup> & H<sup>Ph</sup>) and 6.73 (d, 2H, <sup>3</sup>J(HH) = 7.5 Hz, H<sup>Ph</sup>).

**[Ag(xantphos)(tpbpy)]ClO<sub>4</sub> (3)**

A suspension containing 4,5-bis(diphenylphosphino)-9,9-dimethyl xanthene (xantphos) (41 mg, 0.071 mmol), 3,4,5,6-tetraphenyl-2,2'-bipyridine (tpbpy) (33 mg, 0.071 mmol) and AgClO<sub>4</sub> (14 mg, 0.067 mmol) in acetonitrile (3 mL) was heated under reflux for 2 h. The resulting colourless solution was concentrated to a low volume and diethyl ether was added to yield **(3)** as a white solid (77 mg, 91%). Found: C, 69.85; H, 4.47; N 2.22, calcd. (%) for C<sub>73</sub>H<sub>56</sub>ClN<sub>2</sub>O<sub>5</sub>P<sub>2</sub>Ag: C, 70.34; H, 4.53; N 2.25. Mass (acetone, m/z): found: 1145.2926, calcd. 1145.2919 for C<sub>73</sub>H<sub>56</sub>N<sub>2</sub>OP<sub>2</sub>Ag, [M-ClO<sub>4</sub>]<sup>+</sup>. IR (neat, cm<sup>-1</sup>): 3054, 1596, 1548, 1436, 1399, 1220, 1083, 746 and 695. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 7.67 (d, 2H, H<sup>Py</sup>), 7.49-7.32 (m, 5H, H<sup>Ph</sup>/Ar/Py), 7.27-7.00 (m, 19H, H<sup>Ph</sup>/Ar/Py), 6.99-6.76 (m, 18H, H<sup>Ph</sup>/Ar/Py), 6.72-6.60 (m, 4H, H<sup>Ph</sup>/Ar/Py), 6.55-6.26 (br, 2H, H<sup>Ph</sup>/Ar/Py) and 1.69 (br, 6H, Me). <sup>31</sup>P NMR (161 MHz, CDCl<sub>3</sub>): -5.4 (dd), <sup>1</sup>J(<sup>107</sup>AgP) = 384 Hz and <sup>1</sup>J(<sup>109</sup>AgP) = 444 Hz.

**[Ag(xantphos)(tpbpy)]ClO<sub>4</sub> (3) from [Ag(xantphos)(MeCN)]ClO<sub>4</sub>**

[Ag(xantphos)(MeCN)]ClO<sub>4</sub> **(5)** (15 mg, 0.018 mmol) and 3,4,5,6-tetraphenyl-2,2'-bipyridine (9 mg, 0.0195 mmol) were dissolved in dichloromethane (1.5 mL) to yield a colourless solution. After 2 h, it was concentrated, and hexane was added to deposit **(3)** as a white solid (19 mg, 84%). Characterizing data are as same as given above for **(3)**.

**[Ag(xantphos)(dmbpy)]ClO<sub>4</sub> (4)**

A suspension containing 4,5-bis(diphenylphosphino)-9,9'-dimethylxanthene (xantphos) (82 mg, 0.14 mmol), 6,6'-dimethyl-2,2'-bipyridine (dmbpy) (25 mg, 0.135 mmol) and AgClO<sub>4</sub> (29 mg, 0.14 mmol) in acetonitrile (5 mL) was heated under reflux for 1 h. The resulting colourless solution was concentrated to yield **(4)** as a white solid (111 mg, 82%). Found: C, 63.55; H, 4.40; N 2.60, calcd. (%) for C<sub>51</sub>H<sub>44</sub>ClN<sub>2</sub>O<sub>5</sub>P<sub>2</sub>Ag: C, 63.14; H, 4.57; N 2.89. Maldi (MeCN, m/z): Found: 685.1021, calcd. 685.0979 for C<sub>39</sub>H<sub>32</sub>OP<sub>2</sub>Ag, [Ag(xantphos)]<sup>+</sup>. IR (neat, cm<sup>-1</sup>): 3049, 2961, 1594, 1574, 1435, 1402, 1222, 1085, 785, 736 and 692. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 8.23 (d, 2H, <sup>3</sup>J(HH) 8.0 Hz, H<sup>Py</sup>), 8.00 (t, 2H, <sup>3</sup>J(HH) 7.5 Hz, H<sup>Py</sup>), 7.66 (d, 2H, <sup>3</sup>J(HH) 7.5 Hz, H<sup>Ar</sup>), 7.33 (t, 4H, <sup>3</sup>J(HH) 7.5 Hz, H<sup>Ph/Ar</sup>), 7.30-7.23 (m, 2H, H<sup>Ph/Ar</sup> overlap with the solvent peak), 7.22-7.12 (m, 8H, H<sup>Ph/Ar/Py</sup>), 7.09-6.98 (m, 8H, H<sup>Ph/Ar</sup>), 6.66-6.58 (m, 2H, H<sup>Ph/Ar</sup>), 2.17 (s, 6H, Me), and 1.74 (s, 6H, Me). <sup>31</sup>P NMR (161 MHz, CDCl<sub>3</sub>): -6.2 (dd) <sup>1</sup>J(<sup>107</sup>AgP) = 357 Hz and <sup>1</sup>J(<sup>109</sup>AgP) = 412 Hz.

**[Ag(xantphos)(dmbpy)]ClO<sub>4</sub> (4) from [Ag(xantphos)(MeCN)]ClO<sub>4</sub>**

[Ag(xantphos)(MeCN)]ClO<sub>4</sub> **(5)** (20 mg, 0.024 mmol) and 6,6'-dimethyl-2,2'-bipyridine (6 mg, 0.035 mmol) were dissolved in dichloromethane (1.5 mL) to yield **(4)** as a colourless solution. After 3 h, it was concentrated, and hexane was added to yield a white solid (22 mg, 95%). Characterizing data are same as given above for **(4)**.

**[Ag(xantphos)(MeCN)]ClO<sub>4</sub> (5)**

4,5-Bis(diphenylphosphino)-9,9'-dimethylxanthene (xantphos) (164 mg, 0.28 mmol) and AgClO<sub>4</sub> (58 mg, 0.28 mmol) were heated under reflux in acetonitrile (10 mL) for 2 h. The resulting colourless solution was concentrated to yield **(5)** as a white solid (191 mg, 83%). Found: C, 59.27; H, 4.06, N, 1.75 calcd. (%) for C<sub>41</sub>H<sub>35</sub>ClNO<sub>5</sub>P<sub>2</sub>Ag: C, 59.55; H, 4.27, N, 1.69. Maldi (MeCN, m/z): found: 685.0958, calcd. 685.0979 for C<sub>39</sub>H<sub>32</sub>OP<sub>2</sub>Ag, [M-ClO<sub>4</sub>]<sup>+</sup>. IR (neat, cm<sup>-1</sup>): 2978, 2937, 2270, 1586, 1480, 1445, 1403, 1236, 1109, 1059, 789, 746 and 694. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 7.62 (d, 2H, <sup>3</sup>J(HH) 7.5 Hz, H<sup>Ar</sup>), 7.41-7.27 (m, 20H, H<sup>Ph</sup>), 7.16 (t, 2H, <sup>3</sup>J(HH) 7.5 Hz, H<sup>Ar</sup>), 6.71 (m, 2H, H<sup>Ar</sup>), 2.04 (s, 3H, MeCN), and 1.69 (s, 6H,



Me).  $^{31}\text{P}$  NMR (161 MHz,  $\text{CDCl}_3$ ): -5.3 (dd),  $^1\text{J}(^{107}\text{AgP}) = 461$  Hz and  $^1\text{J}(^{109}\text{AgP}) = 532$  Hz.

**[Ag(xantphos)(ttpy)]  $\text{ClO}_4$  (6)**

[Ag(xantphos)(MeCN)] $\text{ClO}_4$  (**5**) (15 mg, 0.018 mmol) and tolylterpyridine (ttpy) (7 mg, 0.021 mmol) were dissolved in dichloromethane (1.5 mL) to yield a colourless solution. After 3 h, it was concentrated, and hexane added to yield (**6**) as a white solid (18 mg, 90%). Found: C, 65.26; H, 4.31; N 3.72. calcd.(%) for  $\text{C}_{61}\text{H}_{49}\text{N}_3\text{AgClO}_5\text{P}_2 \cdot 0.25\text{CH}_2\text{Cl}_2$ , C, 65.07; H, 4.41; N 3.72. Mass (acetone, m/z): found: 1008.2442, calcd. 1008.2402 for  $\text{C}_{61}\text{H}_{48}\text{O}_5\text{N}_3\text{P}_2\text{Ag}$ , [Ag(tpy)(xantphos)] $^+$ . IR (neat,  $\text{cm}^{-1}$ ): 3054, 2960, 1600, 1584, 1567, 1477, 1434, 1402, 1220, 1089, 789, 746 and 694.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ): 8.44 (s, 2H,  $\text{H}^{3'}$ ), 8.27 (d, 2H,  $^3\text{J}(\text{HH})$  7.7 Hz,  $\text{H}^3$ ), 8.21 (s, 2H,  $\text{H}^6$ ), 7.85 (d, 2H,  $^3\text{J}(\text{HH})$  8.0 Hz,  $\text{H}^{\text{Ar}}$ ), 7.65 (d, 2H,  $^3\text{J}(\text{HH})$  7.5 Hz,  $\text{H}^{\text{xan}}$ ), 7.58 (vt, 2H,  $^3\text{J}(\text{HH})$  7.5 Hz,  $\text{H}^4$ ), 7.42 (d, 2H,  $^3\text{J}(\text{HH})$  8.0 Hz,  $\text{H}^{\text{Ar}}$ ), 7.34-7.24 (m, 8H,  $\text{H}^{\text{Ph}}$ ), 7.22-6.96 (m, 16H,  $\text{H}^{\text{Ph}}$   $\text{H}^{\text{xan}}$  &  $\text{H}^5$ ), 6.63 (m, 2H,  $\text{H}^{\text{xan}}$ ), 2.49 (s, 3H, Me) and 1.72 (s, 6H, Me-xan).  $^{31}\text{P}$  NMR (161 MHz,  $\text{CDCl}_3$ ): -6.2 (br, d),  $^1\text{J}(^{107/109}\text{AgP})_{\text{av}} = 402$  Hz.  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ,  $\delta$  in ppm): 155.99, 154.90, 153.63, 151.50, 149.46 ( $\text{C}^6$ ), 137.93 ( $\text{C}^4$ ), 133.14 ( $\text{C}^{\text{Ph}}$ ), 132.56, 131.34 ( $\text{C}^{\text{xan}}$ ), 130.23 ( $\text{C}^{\text{Ar}}$ ), 129.02 ( $\text{C}^{\text{Ph}}$ ), 128.88 ( $\text{C}^{\text{Ph}}$ ), 127.31 ( $\text{C}^{\text{Ar}}$ ), 127.25 ( $\text{C}^{\text{xan}}$ ), 124.56, 122.63 ( $\text{C}^3$ ), 120.67 ( $\text{C}^{3'}$ ), 29.20 ( $\text{Me}^{\text{xan}}$ ) and 21.39  $\text{Me}^{\text{tol}}$ .

**[Ag $_2$ ( $\mu$ -dppm) $_2$ ]( $\text{ClO}_4$ ) $_2$  (7)**

A solution containing bis(diphenylphosphino)methane (dppm) (54 mg, 0.14 mmol) and  $\text{AgClO}_4$  (29 mg, 0.14 mmol) in a degassed mixture of chloroform and methanol (1:1) (4 mL) was heated under reflux for 1.5 h. The solution was concentrated to a low volume to yield white crystals, which were filtered off and washed with cold methanol (71 mg, 85%). Found: C, 50.45; H, 3.40, calcd. (%) for  $\text{C}_{50}\text{H}_{44}\text{Cl}_2\text{O}_8\text{P}_4\text{Ag}_2$ : C, 50.75; H, 3.75. IR (neat)  $\text{cm}^{-1}$ : 3057, 1590, 1480, 1438, 1085, 990, 700 and 680. Maldi (MeCN, m/z): found: 1080.9888, calcd. 1080.9980 for  $\text{C}_{50}\text{H}_{44}\text{ClO}_4\text{P}_4\text{Ag}_2$ , [M- $\text{ClO}_4$ ] $^+$ . Found: 491.0232, calcd. 491.0248 for  $\text{C}_{25}\text{H}_{22}\text{P}_2\text{Ag}$ , [Ag(dppm)] $^+$ . Found: 875.1442, calcd. 875.1444 for  $\text{C}_{50}\text{H}_{44}\text{P}_4\text{Ag}$ , [Ag(dppm) $_2$ ] $^+$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ): 7.64-7.55 (br, m, 16H,  $\text{H}^{\text{Ph}}$ ), 7.41-7.31 (m, 24H,  $\text{H}^{\text{Ph}}$ ) and 3.95 (m, 4H, J(PH) ca. 5 Hz,  $\text{CH}_2$ ).  $^1\text{H}$  NMR (400

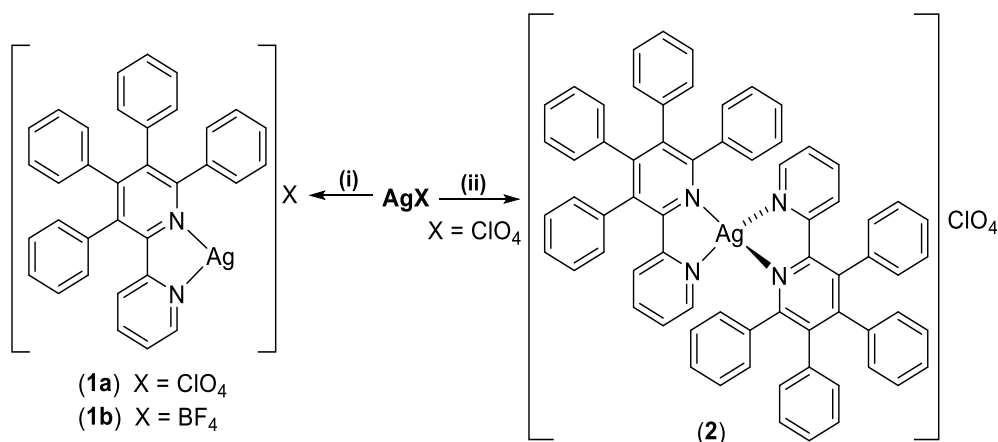
MHz, CD<sub>3</sub>CN,  $\delta$ ): 7.54-7.50 (br, m, 16H, H<sup>Ph</sup>), 7.44 (t, 8H, J 7.5 Hz, H<sup>Ph</sup>), 7.33 (t, 16H, J 7.7 Hz, H<sup>Ph</sup>) and 3.74 (m, 4H, J(PH) 4.8 Hz, CH<sub>2</sub>). <sup>31</sup>P NMR (161 MHz, CDCl<sub>3</sub>): 10.4 (m, 2nd order), Tentative <sup>1</sup>J(<sup>107</sup>AgP) = 499 & <sup>1</sup>J(<sup>109</sup>AgP) = 576 Hz. <sup>31</sup>P NMR (161 MHz, CD<sub>3</sub>CN): 7.0 (br, dt, 2nd order), N = 36.2 Hz, <sup>1</sup>J(AgP)<sub>av</sub> = 507 Hz. <sup>13</sup>C NMR (101 MHz, CD<sub>3</sub>CN,  $\delta$ ): 134.02 (t, J(PC) 3.4 Hz), 132.30 (s), 131.13 (m, J(PC) *ca.* 10 Hz), 130.02 (s), and 25.53 (m, J(PC) *ca.* 7 Hz).

**[Ag<sub>2</sub>( $\mu$ -dppm)<sub>2</sub>( $\mu$ -dppz)](ClO<sub>4</sub>)<sub>2</sub> (**8**)**

3,6-Di(2-pyridyl)-4,5-diphenyl-pyridazine (dppz) (6 mg, 0.0155 mmol) was added to a solution of [Ag<sub>2</sub>( $\mu$ -dppm)<sub>2</sub>](ClO<sub>4</sub>)<sub>2</sub> (**7**) (18 mg, 0.0152 mmol) in dichloromethane (1.5 mL) to give a colourless solution. This solution was allowed to concentrate at room temperature for 5 h. Addition of diethyl ether precipitated (**8**) as a light off-white solid (21 mg, 88%). Found: C, 56.24; H, 3.92; N 3.29, calcd. (%) for C<sub>76</sub>H<sub>62</sub>Cl<sub>2</sub>N<sub>4</sub>O<sub>8</sub>P<sub>4</sub>Ag<sub>2</sub>·1.0CH<sub>2</sub>Cl<sub>2</sub>: C, 55.89; H, 3.90; N 3.39. IR (neat) cm<sup>-1</sup>: 3656, 3057, 1590, 1483, 1435, 1377, 1083, 998, 739 and 689. Maldi (MeCN, m/z): Found: 1080.9933, calcd. 1080.9980 for C<sub>50</sub>H<sub>44</sub>ClO<sub>4</sub>P<sub>4</sub>Ag<sub>2</sub>, [Ag<sub>2</sub>(dppm)<sub>2</sub>ClO<sub>4</sub>]<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 8.00 (br, d, 2H, J(HH) 4.0 Hz, H<sub>Py</sub>), 7.53 (br, m, 4H), 7.40 (br, t, 2H, J(HH) 8.0 Hz), 7.36-7.25 (br, m, 28H), 7.24-7.16 (br, m, 8H), 7.15-7.03 (br, m, 16H), 6.86 (br, m, 2H, J(HH) 8.0 Hz) and 3.76 (br, m, 4H, CH<sub>2</sub>). <sup>31</sup>P NMR (161 MHz, CDCl<sub>3</sub>): -5.7 (br, dt), <sup>1</sup>J(<sup>107/109</sup>AgP)<sub>av</sub> = 449 Hz.

## Results and Discussion

First, the coordination chemistry of the Ag(I) centre with the bulky bidentate nitrogen-donor ligand 3,4,5,6-tetraphenyl-2,2'-bipyridine (tpbpy) was studied. The two-coordinate Ag(I) complex of the type [Ag(tpbpy)]<sup>+</sup> (**1**) was prepared by treating AgClO<sub>4</sub> or AgBF<sub>4</sub> with one equivalent of the ligand (Scheme 1).

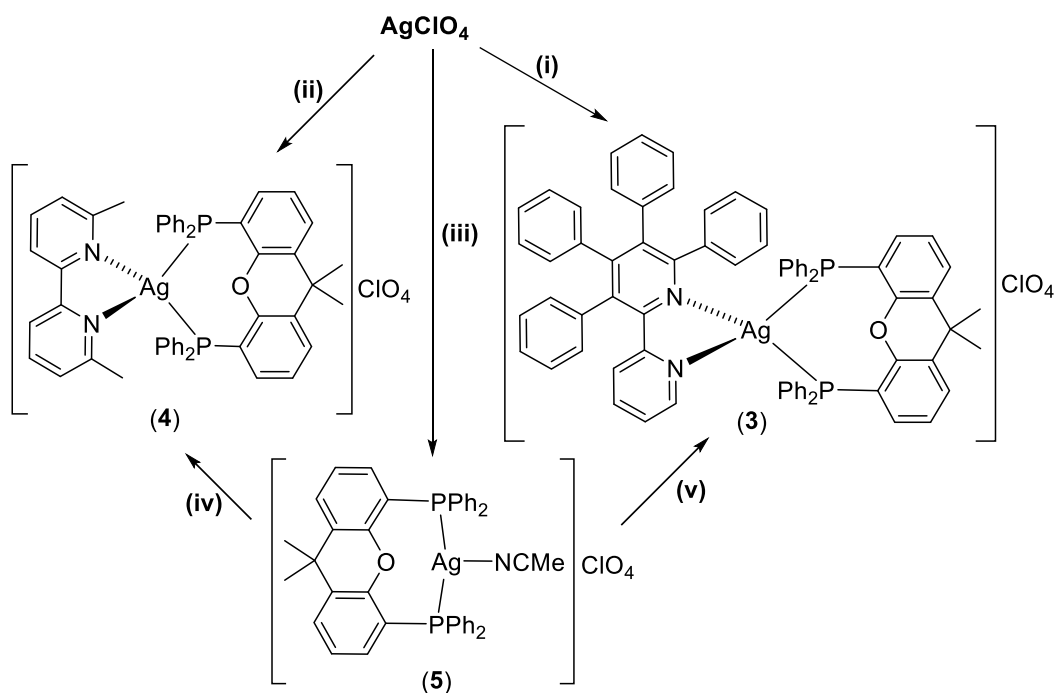


**Scheme 1.** Synthetic routes to **(1)-(2)**. (i) 1 equiv. tpbpy; (ii) 2 equiv. tpbpy

This complex and other Ag(I) complexes were characterized by a combination of elemental analysis, IR, Mass and NMR spectroscopy. Mass spectrum of **(1a)** indicated an accurate mass value of ( $m/z$  567.0973) for the  $[M-ClO_4]^+$  ion and elemental analyses confirmed the proposed structure with the composition  $C_{34}H_{24}ClN_2O_4Ag$ . The four-coordinate Ag(I) complex  $[Ag(tpbpy)_2]ClO_4$  (**2**) was isolated in 88% yield as a white solid by reacting  $AgClO_4$  with two equivalents of tpbpy in acetonitrile. The elemental analysis and mass spectral analyses ( $m/z$  1027.2948 for  $[M-ClO_4]^+$ ) confirmed the proposed structure with the composition  $C_{68}H_{48}ClN_4O_4Ag$ .

Four-coordinate heteroleptic Ag(I) complexes containing both P and N donor ligands can be achieved by reacting silver(I) salt with a (1:1) mixture of bidentate ( $P^{\wedge}P$ ) and ( $N^{\wedge}N$ ) ligands. The four-coordinate Ag(I) complex  $[Ag(xantphos)(tpbpy)]ClO_4$  (**3**) was obtained as a white solid in 91% yield by treating  $AgClO_4$  with a (1:1) molar ratio of tpbpy and xantphos in acetonitrile. The  $^{31}P$ - $\{^1H\}$  spectrum of (**3**) showed a doublet of doublets (or two doublets coupled to two isotopes of silver) at -5.4 ppm with  $^1J(^{107}AgP) = 384$  Hz and  $^1J(^{109}AgP) = 444$  Hz.  $^1J(AgP)$  values agree with the published data (M. C. Gimeno, *et al.*, 1995). Similarly, the complex  $[Ag(xantphos)(dmbpy)]ClO_4$  (**4**) (dmbpy = 6,6'-dimethyl-2,2'-bipyridine) was isolated as a white solid with 82% yield. The  $^{31}P$ -

$\{^1\text{H}\}$  spectrum of **(4)** showed a doublet of doublets at -6.2 ppm with  $^1J(^{107}\text{AgP}) = 357 \text{ Hz}$  and  $^1J(^{109}\text{AgP}) = 412 \text{ Hz}$ .

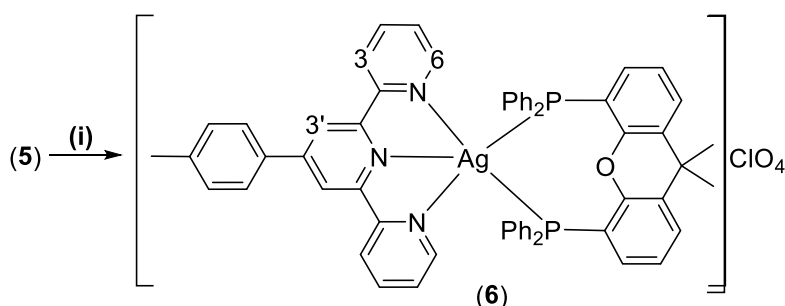


**Scheme 2.** Synthetic routes to **(3)**–**(5)**. (i) tpbpy and xantphos (1:1); (ii) dmbpy and xantphos (1:1); (iii) 1 equiv. xantphos.; (iv) 1 equiv. tmbpy ; (v) 1 equiv. tpbpy

The possibility of stepwise preparation of heteroleptic complexes of the type  $[\text{Ag}(\text{N}^{\wedge}\text{N})(\text{P}^{\wedge}\text{P})]^+$  *via* the complex  $[\text{Ag}(\text{P}^{\wedge}\text{P})(\text{labile ligand})]^+$  was explored by replacing the labile ligand with a bidentate ligand  $\text{N}^{\wedge}\text{N}$  as shown in scheme 2. Treatment of  $\text{AgClO}_4$  with one equivalent xantphos in acetonitrile gave a white solid with 83% yield. Characterizing data including elemental analysis suggests it to be a three-coordinate  $\text{Ag}(\text{I})$  complex  $[\text{Ag}(\text{NCMe})(\text{xantphos})]\text{ClO}_4$  **(5)**. It showed a phosphorus-31 resonance at -5.3 ppm (dd) with  $^1J(^{107}\text{AgP}) = 461 \text{ Hz}$  and  $^1J(^{109}\text{AgP}) = 532 \text{ Hz}$ . The proton resonance of the coordinated MeCN appeared as a singlet at 2.04 ppm. Treatment of this  $\text{Ag}(\text{I})$  complex **(5)**, containing a labile acetonitrile ligand, with one equivalent of tpbpy gave the heteroleptic complex

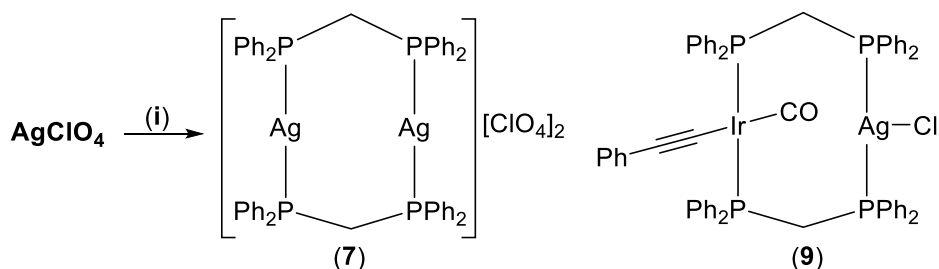
$[\text{Ag}(\text{tpbpy})(\text{xantphos})]\text{ClO}_4$  (**3**) in 84% yield. Similarly,  $[\text{Ag}(\text{dmbpy})(\text{xantphos})]\text{ClO}_4$  (**4**) was prepared in 95% yield.

The five-coordinate heteroleptic complex  $[\text{Ag}(\text{xantphos})(\text{ttpy})]\text{ClO}_4$  (**6**) was prepared in 90% yield by treating (**5**) with one equivalent of ttpy in dichloromethane (Scheme 3). Elemental analysis and mass spectral data of (**6**) agreed well with the composition  $\text{C}_{61}\text{H}_{49}\text{N}_3\text{ClO}_5\text{P}_2\text{Ag}$ . The proton NMR and phosphorus-31 NMR data suggest (**6**) to be a symmetrical molecule; only one set of signals was observed for H3, H3' and H6 protons. The  $^{31}\text{P}\{-^1\text{H}\}$  NMR spectrum showed a broad doublet centred at -6.2 ppm with average  $^1J(^{107/109}\text{AgP})$  of 402 Hz.



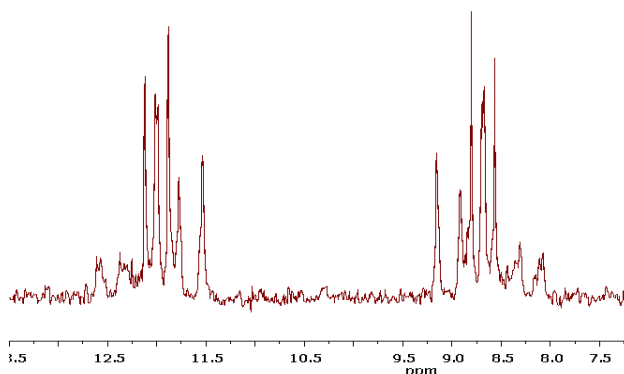
**Scheme 3.** Synthetic routes to (**6**) (i) 1 equiv. ttpy.

The chemistry of  $\text{AgClO}_4$  with the diphosphine, bis(diphenylphosphino)methane (dppm) was then studied. The diphosphine dppm is known to bridge two metal centres than forming 4-membered chelate rings. “A-frame”  $\text{Ag}(\text{I})$  complexes  $[\text{Ag}_2(\text{dppm})_2(\text{FBF}_4)_2]$ ,  $[\text{Ag}_2(\text{dppm})_2(\text{PO}_2\text{F}_2)]\text{PF}_6$  and  $[\text{Ag}_2(\text{dppm})_2(\text{MeCN})_2(\text{PO}_2\text{F}_2)]\text{PF}_6$  have been structurally characterised (Bruce, *et. al.*, 2016). In order to prepare a binuclear complex of the type  $[\text{Ag}_2(\mu\text{-dppm})_2]^{2+}$ , the reaction was carried out in chloroform and methanol in the absence of MeCN. Treatment of  $\text{AgClO}_4$  with one equivalent of dppm in a (1:1) mixture of chloroform and methanol resulted in the formation of  $[\text{Ag}_2(\mu\text{-dppm})_2][\text{ClO}_4]_2$  (**7**) as a white solid in 85% yield (Scheme 4).



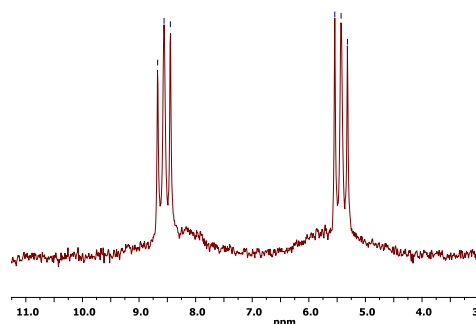
**Scheme 4.** Synthetic routes to **(7)** (i) 1 equiv. dppm and the molecular structure of **(9)**

Elemental analysis confirmed the proposed structure with the composition  $\text{C}_{50}\text{H}_{44}\text{Cl}_2\text{P}_4\text{O}_8\text{Ag}_2$ . The proton resonance at 3.95 ppm (4H, broad multiplet) was assigned to the  $\text{CH}_2$  groups. The  $^{31}\text{P}\{-^1\text{H}\}$  NMR spectrum was recorded in  $\text{CDCl}_3$  (Figure 3); it showed a complex second order spin system centred at 10.4 ppm with probable  $^1\text{J}(^{107}\text{AgP}) = 499$  and  $^1\text{J}(^{109}\text{AgP}) = 576$  Hz; very similar spectrum was reported for the  $\text{P}_2\text{AgCl}$  moiety of the binuclear complex  $[(\text{PhC}_2(\text{OC})\text{Ir}(\mu\text{-dppm})_2\text{AgCl})]$  **(9)** (Hutton et al., 1983).



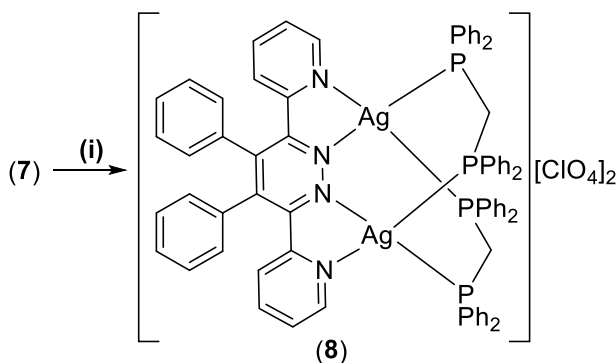
**Figure 3.** The  $^{31}\text{P}\{-^1\text{H}\}$  NMR spectrum of **(7)** in  $\text{CDCl}_3$ .

In  $\text{CD}_3\text{CN}$  for **(7)**, simplified  $^{31}\text{P}\{-^1\text{H}\}$  NMR spectrum was observed: 7.0 (br, dt, 2nd order),  $N = 36.2$  Hz,  $^1\text{J}(\text{AgP})_{\text{av}} = 507$  Hz (Figure 4), probably due to coordination and exchange of  $\text{CD}_3\text{CN}$  molecules to  $\text{Ag(I)}$  centres.



**Figure 4.** The  $^{31}\text{P}\{-^1\text{H}\}$  NMR spectrum of **(7)** in  $\text{CD}_3\text{CN}$

Treatment of complex **(7)** with one equivalent of dppz in dichloromethane afforded an off-white solid of  $[\text{Ag}_2(\mu\text{-dppm})_2\{\mu\text{-dppz}\}][\text{ClO}_4]_2$  (**8**) in 88% yield (Scheme 5). The elemental and mass spectral analyses ( $m/z$  1080.9933 for  $[\text{M}\text{-ClO}_4]^+$  confirmed the proposed structure with the composition  $\text{C}_{76}\text{H}_{62}\text{Cl}_2\text{N}_4\text{O}_8\text{P}_4\text{Ag}_2$ . In the  $^1\text{H}$  NMR spectrum, the proton attached to carbon adjacent to nitrogen of the pyridyl group appeared at 8.00 ppm as a broad doublet ( $^3J(\text{HH}) = 4.0$  Hz) whilst  $\text{CH}_2$  protons appeared as a multiplet at 3.76 ppm.



**Scheme 5.** Synthetic routes to **(8)** (i) 1 equiv. dppz.

The  $^{31}\text{P}\{-^1\text{H}\}$  NMR spectrum showed a second order spin system centred at -5.7 ppm (br, dt) with average  $^1J(^{107/109}\text{AgP}) = 449$  Hz.  $[\text{Cu}_2(\mu\text{-dppm})_2\{\mu\text{-3,6-di(2-pyridyl) tetrazine}\}][\text{PF}_6]_2$  was prepared in a similar manner (Perera, 2020) and the crystal structure of the

analogous heteroleptic Cu(I) complex  $[\text{Cu}_2(\mu\text{-dppm})_2\{\mu\text{-dppz}\}][\text{NO}_3]_2$  has been reported (Gil et al., 2011).

## Conclusions

We have developed synthetic routes to homoleptic Ag(I) complexes of the type  $[\text{Ag}(\text{N}^{\wedge}\text{N})]^+$  and  $[\text{Ag}(\text{N}^{\wedge}\text{N})_2]^+$ . Four-coordinate heteroleptic complexes of the type  $[\text{Ag}(\text{N}^{\wedge}\text{N})(\text{P}^{\wedge}\text{P})]^+$  can be prepared by mixing both  $\text{P}^{\wedge}\text{P}$  and  $\text{N}^{\wedge}\text{N}$  to a solution of  $\text{AgClO}_4$  in acetonitrile or by adding one equivalent of a bidentate  $\text{N}^{\wedge}\text{N}$  ligand to a solution of  $[\text{Ag}(\text{NCMe})(\text{P}^{\wedge}\text{P})]^+$ . Five-coordinate heteroleptic complex  $[\text{Ag}(\text{xantphos})(\text{ttpy})]\text{ClO}_4$  was synthesised. A route to binuclear heteroleptic Ag(I) complex containing bridging ligands 3,6-di(2-pyridyl)-4,5-diphenyl-pyridazine and dppm was developed.

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## Assessment of Blue Carbon Stock of Mangroves at Malwathu Oya estuary, Sri Lanka

**K. A. R. S Perera<sup>1\*</sup>, M. D. Amarasinghe<sup>2</sup>**

<sup>1</sup>Department of Botany, The Open University of Sri Lanka, Sri Lanka

<sup>2</sup>Department of Plant and Molecular Biology, University of Kelaniya, Sri Lanka


### Abstract

Mangroves occupy tropical and subtropical inter-tidal areas and provide numerous ecological functions and services. One such function is sequestration of atmospheric carbon, especially in their anoxic soils. This study is an attempt to quantify the total blue carbon stocks in vegetation and in soils of mangrove areas in Malwathu Oya estuary located in the dry/arid climatic zone in Sri Lanka. Plant biomass and the total organic carbon (TOC) content were estimated using allometric relationships available between biomass/TOC and stem diameter of constituent mangrove species. Published data on soil TOC of the same locality was used to estimate the total blue carbon stock associated with this mangrove area. Total biomass of the mangrove plants in Malwathu Oya estuary was 377 Mg ha<sup>-1</sup> which contained 191 Mg C ha<sup>-1</sup> of organic carbon sequestered by the plants. Above ground plant components contained 5 times more biomass and 5.5 times more carbon than those below ground. TOC in the mangrove

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\*Correspondence should be addressed to **Dr. K. A. R. S. Perera**, Department of Botany, Faculty of Natural Sciences, The Open University of Sri Lanka.

**Email:** [kaper@ou.ac.lk](mailto:kaper@ou.ac.lk)

 <https://orcid.org/0000-0003-3387-8146>

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soils was 346 Mg C ha<sup>-1</sup> which was 1.8 times more than that in the vegetation. Total blue carbon stock of the mangrove ecosystem in Malwathu Oya estuary therefore was 537 Mg C ha<sup>-1</sup>, out of which 64% was sequestered in soils. Despite being in low rainfall coast this mangrove area retains more carbon than most other areas which may be possibly due to its pristineness and vegetation structure characterized by unique dominance of *Sonneratia alba*, which is considered a rare species among Sri Lankan mangroves.

**Keywords:** carbon retention capacity; plant biomass; soil carbon; Sri Lankan mangroves

## Introduction

Mangrove forests are characterized as unique and complex coastal ecosystems in the tropical and sub-tropical regions of Sri Lanka. They line the coasts of the oceans between approximately 30° N and 30° S latitude (Spalding et al., 2010; Giri et al., 2011) and are the source of several ecosystem services. High primary productivity compared to other terrestrial plant communities (Donato et al., 2011) renders mangroves a great potential in contributing to carbon sequestration function (Kathiresan, 2007; Suratman, 2008; Khan et al., 2009; Alongi, 2011). It has been proven that mangroves represent a potentially important repository of blue carbon, thus they have been ranked among the most carbon-dense forests in the tropics, due to its deep organic carbon-rich soils and dense vegetation (Donato et al., 2011; Kauffman et al., 2011). Mangroves are not only a carbon-rich ecosystem but also are proven to be of high potential in capturing and sinking significant amounts of atmospheric carbon, thus compensating for negative impacts of anthropogenic greenhouse gas (GHG) emissions (McLeod et al., 2011; Siikamaki et al., 2012; Murdiyarso et al. 2020, Howard et al., 2017; Perera & Amarasinghe, 2016). As such, mangroves and other coastal wetlands (with “blue carbon” deposits) can potentially play a crucial role in climate change mitigation (Price & Warren, 2016).

More recent estimates of global mangrove distribution range from 12 to 20 million ha with spreading over 113 countries (FAO, 2003) with 55 species of true mangrove plants (Tomlinson, 2016). The current

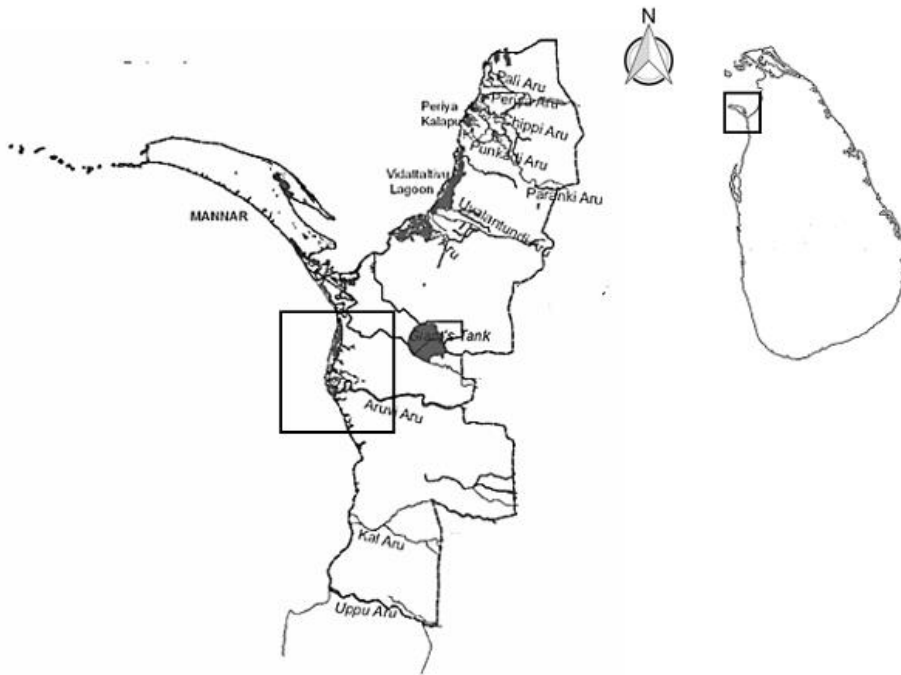
extent of mangroves in Sri Lanka is 19,000 ha (unpublished records of the Department of Forest Conservation) and these areas support 23 true mangrove species and 34 mangrove associated plant species (Amarasinghe & Perera, 2017). Despite the relatively low extent, distribution of species among mangrove ecosystems in Sri Lanka is ecologically intrigued. Mangroves in Malwathu Oya estuary are visually dominated by *Sonneratia alba*, a species considered to be rare and endangered in Sri Lanka. This is the only locality where *S. alba* occurs as a dominant species in the water-front zone of a mangrove stand with individual plants reaching up to 75cm in diameter. Besides, this estuarine mangrove area is in a very remote part of Sri Lanka, where human interference is negligible, for which the size of plants/trees provide testimony. Objective of the present study, therefore, was to determine the blue carbon stocks of this relatively pristine mangrove area dominated by a mangrove species that is uncommon in other coastal areas of Sri Lanka.

## Materials and Methodology

### Study area

Malwathu Oya estuary is located between 8° 47' – 8° 49' N and 79° 55' – 79° 56' E, on the north western coast of Sri Lanka and belongs to the North-Western province and Mannar District. Malwathu Oya estuary lies in the arid climatic zone of Sri Lanka (Fig. 1).

The estuary created the discharge of the Malwathu Oya, which has the second largest catchment in Sri Lanka, *i.e.*, approximately 3264 km<sup>2</sup>, and discharges 196 million cubic meters of water to the sea annually (Survey Department of Sri Lanka, 2007). The soils of the area are alluvial (IUCN, 2011). An arid climate prevails in the area where the annual rainfall is 700-1000 mm, of which 60 – 70% occurs during the north east monsoon from October to April. The mean atmospheric temperature ranges from 25°C -29°C with higher temperatures normally recorded between May and August.



**Figure1:** Location of the study area

Being a dry climatic area, the mangroves are associated with salt marshes and species of other terrestrial vegetation such as woody scrub jungles, sand dunes and strand vegetation are found as associated species. Although, current extent of mangroves around associated with Malwathu Oya estuary is unavailable, the total mangrove extent of the Mannar District was reported to be 1351 ha (Edirisinghe et al., 2012).

### **Field Sampling**

Four (4) sampling sites were selected within the mangrove areas of the Malwathu Oya estuary to collect data on vegetation structure and total organic carbon (TOC) content in soil. In each sampling site, 10 m wide belt transects were laid perpendicular to the shoreline at randomly selected locations. Length of the transect was determined on the width of the mangrove vegetation. Each transect was divided into 10m x 10m (100 m<sup>2</sup>) sampling plots and a total of thirteen (13) sampling plots were laid in all four sampling sites.



### **Species composition and vegetation structure**

Data on mangrove vegetation structure *i.e.*, species diversity, plant density, tree diameter at breast height (dbh) and tree height were measured using standard methods (Cintron & Novelli, 1984; Kathiresan & Khan, 2010) with plants in each sampling plot (100 m<sup>2</sup>). Trees which are equal to or greater than 2.5 cm in dbh were measured for the purpose.

Structural complexity (CI) of the vegetation (Kathiresan & Khan, 2010) was calculated using data on the number of species, stand density, basal area and height, to represent the overall vegetation structure.

Structural complexity (CI) = Number of species x stand density x stand basal area x stand height x 10<sup>-5</sup>

Importance value index (IVI) was calculated for each constituent species to represent the relative contribution of constituent species to complexity of total vegetation structure using the following relationship

IVI of a species = Relative density + Relative dominance (basal area) + Relative frequency

### **Biomass and total organic carbon (TOC) content in above and below ground components of mangrove vegetation**

Above ground biomass (AGB) and below ground biomass (BGB) of mangrove species present in sampling plots were estimated by using the allometric relationships,  $\log_e(\text{AGB}) = 6.247 + 2.64 \log_e(\text{dbh})$  and  $\log_e(\text{AGB}) = 5.551 + 2.153 \log_e(\text{dbh})$  to determine above ground biomass of *Rhizophora mucronata* and *Avicennia marina* respectively (Amarasinghe & Balasubramaniam, 1992). Common equations, *i.e.*,  $\text{AGB} = 0.251 \rho \text{ dbh}^{2.46}$  and  $\text{BGB} = 0.199 \rho 0.899 \text{ dbh}^{2.46}$  ( $\rho$  – density of wood) (Komiyama et al., 2005), were used to calculate the above and below ground biomass of all the other species encountered in the sample plots.

Biomass values (above and below ground biomass) mangrove species were then converted to the total organic carbon (TOC) content with the percentage TOC content in biomass of each mangrove plant component (Perera & Amarasinghe, 2016).

### **Total organic carbon (TOC) storage in mangrove soil**

Published data on total organic carbon (TOC) content retained in each depth, 0 – 15cm, 16 – 30cm and 31 – 45cm of its soils (Perera & Amarasinghe, 2019) were used to calculate the magnitude of total blue carbon stock of Malwathu Oya estuarine mangrove ecosystem.

## **Results**

### **Structure of mangrove vegetation**

Stand density values recorded in the study sites ranged between 2550 – 4833 trees/ha. Higher relative frequency values recorded for *Rhizophora mucronata*, *Avicenna marina*, *Sonneratia alba* and *Excoecaria agallocha* revealed those were the most abundant mangrove species in the area (Table 1).

**Table 1.**

*Vegetation structural variables recorded at Malwathu Oya estuary*

Species relative frequency	Stand density (per ha)	dbh  Mean (cm)	Basal area (m <sup>2</sup> ha <sup>-1</sup> )	Mean height (m)	Complexity index (CI)
AM(27.5%);	3808	9.25	32.22	4.86	23.94
EA(13.3%);	±1766	(6.21-	(18.13-	(4.0-	(5.42-
PA(2.5%);	(2552-	14.51)	43.38)	6.02)	42.46)
RM(43.2%);	4833)				
SA(14.4%)					

(AM–*Avicennia marina*; EA–*Excoecaria agallocha*; RM–*Rhizophora mucronata*; SA–*Sonneratia alba*)

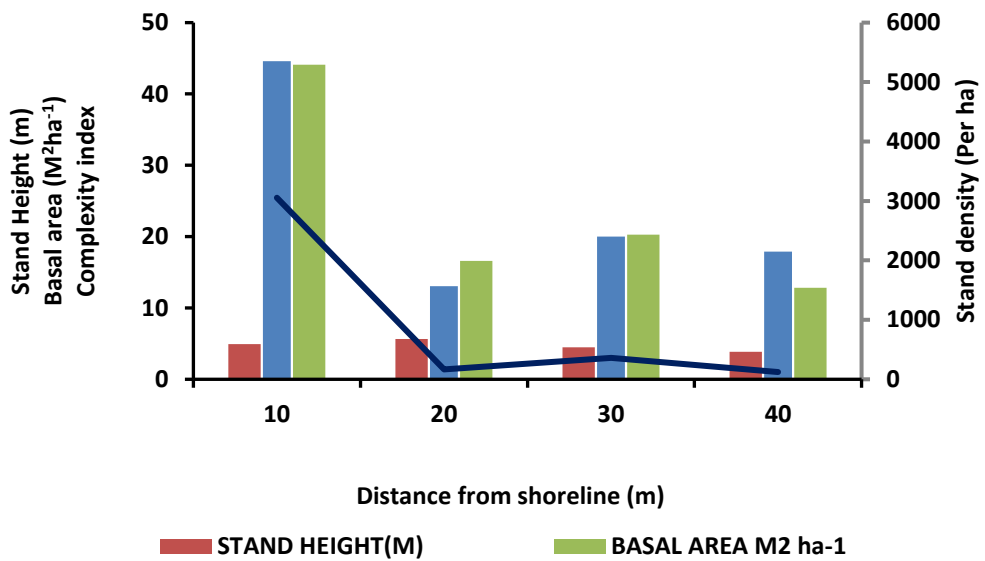
*Sonneratia alba* trees were larger in diameter and taller than other species. The average size of *Rhizophora mucronata* plants was smaller than *S. alba*, nevertheless, occurred in high density (1382 trees per ha), making it the species that contributes most to the overall structure of the vegetation (with an IVI of 82.25), even in the presence of larger trees of *S. alba* in the vegetation (Table 2).

**Table 2.**

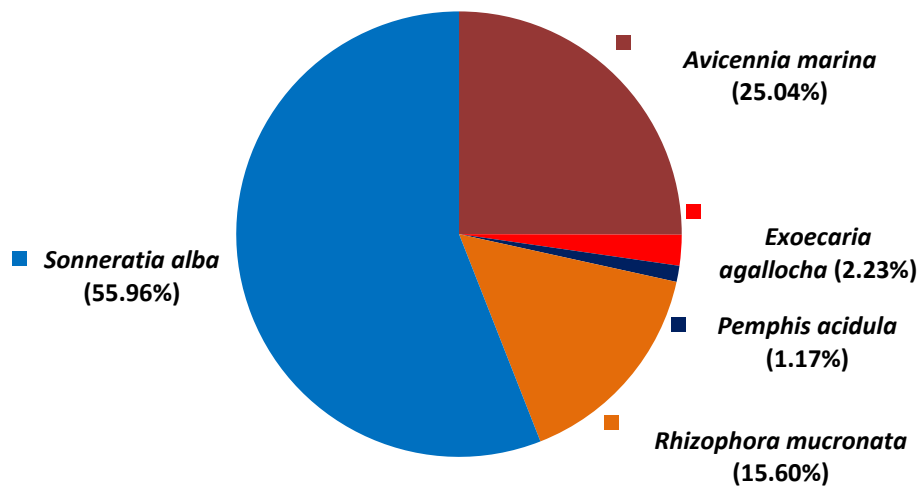
*Structural data of constituent species of Malwathu Oya estuarine mangroves*

Mangrove species	Density (No. Trees per ha)	Mean basal area(m <sup>2</sup> /ha)	Mean height (m)	Total biomass (Mg/ha)	IVI
<i>Avicennia marina</i>	882 ±221	7.31 ±0.05	4.51 ±0.04	79.59 ±0.89	93.95
<i>Excoecaria agallocha</i>	427 ±102	1.67 ±0.01	4.21 ±0.03	7.81 ±0.82	30.77
<i>Pemphis acidula</i>	82 ±20	0.29 ±0.00	6.31 ±0.46	3.47 ±0.04	14.79
<i>Rhizophora mucronata</i>	1382 ±340	4.47 ±0.03	4.48 ±0.29	46.22 ±0.52	82.25
<i>Sonneratia alba</i>	427 ±98	12.81 ±0.10	6.36 ±0.05	187.73 ±2.12	78.21

Structural variables of mangroves at Malwathu Oya estuary, were analyzed across the gradient from estuarine shoreline towards the land. The highest stand density and the relevant basal area were observed as being near the water-front zone of this mangrove area (Fig. 2). The highest relative contribution to the total organic carbon pool in the vegetation is by *S. alba* (Fig. 3)

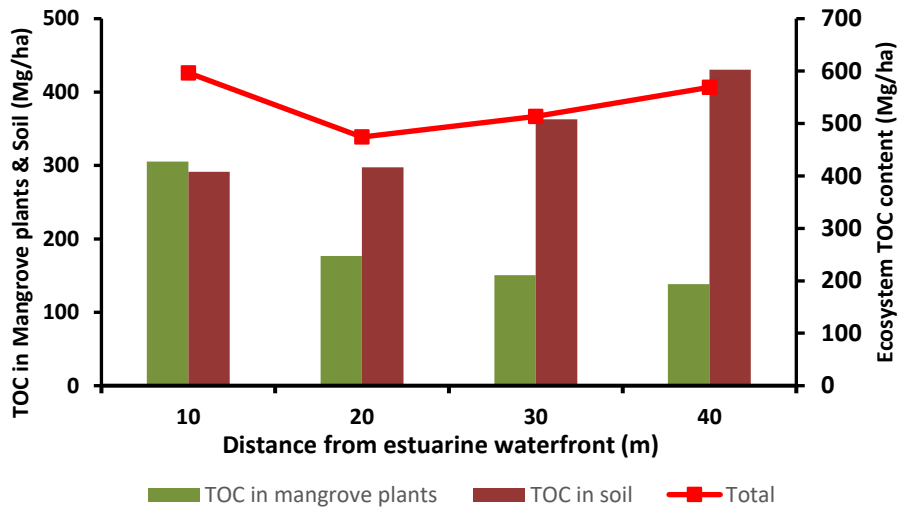


**Figure 2:** Vegetation structural variables vary with the distance from the estuarine shoreline



**Figure 3:** Percentage contribution of mangrove species to the carbon retention capacity of the mangrove areas at the Malwathu Oya estuary

The amount of carbon retained (blue carbon content) in plant biomass declines while that in the soil increases along the water-land gradient in Malwathu Oya estuarine mangrove areas. The overall magnitude of blue carbon stocks along the same gradient manifests an increasing tendency (Fig. 4)



**Figure 4.** Variation in blue carbon content along the water-land gradient in Malwathu Oya estuary

The stock of blue carbon retained by the mangrove ecosystem was 536.95 Mg C ha<sup>-1</sup>. Mangrove soil contained 64% (345.54 Mg C ha<sup>-1</sup>) of the TOC stock while 30% (162.17 Mg C ha<sup>-1</sup>) was in above ground and 5% (29.97 Mg C ha<sup>-1</sup>) in the below ground components of mangrove plants (Table 4).

**Table 4.**

*Estimated total blue carbon content in the mangrove ecosystem at Malwathu Oya estuary*

TOC in Mangrove plants (Mg C ha <sup>-1</sup> )	Above ground components	162.17 ±9.20 (30.20%)
	Below ground components (roots)	29.27 ±1.57 (5.45%)
	Total	191.41 ±10.77 (35.64%)
TOC in Mangrove soil (Mg C ha <sup>-1</sup> ) (Source: Perera and Amerasinghe, 2019)		345.54 ±18.06 (64.46%)
Total (Mg C ha <sup>-1</sup> )		536.95 ±29.02

## Discussion

Mangrove species richness in the Malwathu Oya estuarine mangrove ecosystem is relatively low compared to mangrove areas in the wet zone of Sri Lanka (de Sliva & de Silva, 1989; Jayatissa et al., 2002; Amarasinghe & Perera, 2017). High soil salinities characteristic to arid coastal areas consequential of low rainfall and high evapotranspiration rates restrict the presence of mangrove species that are well adapted to hypersaline soils. *Sonneratia alba* is the most dominant species, having the highest contribution to blue carbon stock of Malwathu oya estuarine mangrove ecosystem. It generally inhabits low intertidal zones of downstream estuarine systems and it is one of the superior salt tolerant mangrove species. It reaches an optimal growth in 5 to 50% seawater, indicating its capacity to tolerate high salinity and hypoxia (Ball & Pidsley, 1995).

Heterogeneity in vegetation structure and distribution of biomass per unit area, along the water-land gradient in Malwathu Oya mangroves was observed to be a pattern, *i.e.*, the highest structural diversity and biomass at the water-front zone that gradually diminishes towards land, similar to that exists in the mangrove areas of Negombo estuary (Perera & Amarasinghe 2016), Uppar lagoon and the Batticaloa lagoon (Perera & Amarasinghe 2014) in Sri Lanka. Availability of river-borne nutrients, favorable salinity regimes and optimal seed rain in the

water-front zone may potentially contribute to this pattern. The micro-tidal conditions prevailing in coastal waters around Sri Lanka (Pattiaratchi & Wijeratne, 2009) that is not conducive to have frequent inundations of the landward zones of mangrove areas may contribute to this situation.

The above ground biomass ( $317.43 \text{ Mg ha}^{-1}$ ) and the TOC content ( $162.17 \text{ Mg C ha}^{-1}$ ) of mangrove plants estimated in the present study were found to be higher than the average biomass values available for South East Asia (Hutchison et al., 2014; IPCC, 2013). Plant biomass represents the potential amount of total organic carbon (TOC) content retained by them. Nearly 70% of the total mangrove biomass reported to occur in mangrove vegetation are retained by those located within  $00$  to  $10^{\circ}$  (N/S) latitudes. The average above ground biomass of mangroves ranges from  $283.6 \text{ Mg ha}^{-1}$  near the equator (tropical), to  $104.2 \text{ t ha}^{-1}$ , in areas within  $30^{\circ}$  to  $40^{\circ}$  (N/S) (sub-tropical) zones (Twilley, 1992). Sri Lanka being located within the tropical belt which receives the highest quantum of solar energy throughout the year and rainfall provides conducive environment for primary production that results in greater amounts of biomass where atmospheric carbon is sequestered.

Mangrove soils of Malwathu Oya estuary retains nearly 64% of the total blue carbon stock of  $536 \text{ Mg C ha}^{-1}$ , highlighting the significance of its contribution to total carbon sequestration capacity of this mangrove ecosystem. This is a higher amount than that is reported ( $511 \text{ Mg C ha}^{-1}$ ) by the Intergovernmental Panel on Climate Change (IPCC) for mangroves in 2013 and the average soil carbon pools of upland forests that ranges from  $83 \text{ Mg C ha}^{-1}$  in dry forests to  $210 \text{ Mg C ha}^{-1}$  in tropical rain forests (Kauffman et al., 2011). Our results also revealed that the increasing magnitude of total blue carbon stocks along the water-land gradient, is primarily contributed by the increasing soil carbon content across the gradient, rather than the organic carbon in biomass of the vegetation. Organic carbon in mangrove soils may derive from both the primary production and litterfall of mangroves (autochthonous) and the river-borne organic matter produced by terrestrial ecosystems (allochthonous). Owing to the high primary productivity characteristic to mangroves and the relatively low rainfall of the Malwathu Oya catchment, coupled with

micro-tidal coastal waters, the autochthonous fraction of the soil carbon pool may dominate in this estuarine mangrove area.

The near-pristine mangrove areas in the Malwathu Oya estuary, therefore, retain a significant stock of blue carbon, especially in the soil. Remoteness of this locality and poor accessibility to this area during the recent past due to civil unrest which prevailed in these areas may have kept human interference at bay. Despite the low extent, mangrove areas in the Malwathu Oya estuary deserve conservation as a refugium for *S. alba*, which is reckoned as a rare mangrove species in Sri Lanka, and their noteworthy capacity to sequester atmospheric carbon as well as for the production (particulate and dissolved organic matter) and nursery functions that mangrove areas are proven to contribute (Lee et al, 2014).

Quantification of sequestered carbon stocks within ecosystems has become a requirement under the current context where market-based mechanisms to address climate change issues have gained popularity. Carbon trading strategies initiated by the United Nation's REDD+ (Reducing Carbon Emissions from Deforestation and Forest Degradation) demands quantification of sequestered carbon stocks to value them and other ecosystem services that these forests/ ecosystems generate, to provide financial incentives to reduce deforestation (when forests are converted to other uses, such as agriculture), reduce degradation (when forests lose their ability to provide ecosystems services) and to promote their sustainable management that ensures social, ecological and economic benefits for future generations.

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## How the COVID-19 outbreak shapes the Education of School Children: A case of Engineering Technology students in the Mulatiyana Educational Zone, Matara, Sri Lanka

**D. M. M. Sandeepani\*, S. U. Wagachchi, P. V. S. Harshana, G. C. Samaraweera**

*Department of Agricultural Economics, Faculty of Agriculture, University of Ruhuna, Sri Lanka*


### Abstract

In Sri Lanka, the conventional learning in schools has been disrupted with the COVID-19 lockdowns. Even though the government has introduced an online learning system with the hope of making a concerted effort to maintain the continuous learning of school children, the grass-root level's feedback has not been adequately explored yet. Therefore, the present study was designed to examine the effects of the COVID-19 pandemic on Sri Lankan school education system and locate the obstacles of the online education system with special reference to the Advanced level Engineering Technology students in the Mulatiyana Educational Zone, Matara, Sri Lanka.

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\*Correspondence should be addressed to **Ms. D. M. M. Sandeepani**, Department of Agricultural Economics, Faculty of Agriculture, University of Ruhuna, Sri Lanka

**Email:** madusha0906@gmail.com

 <https://orcid.org/0000-0003-3523-1258>

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Primary data were collected through a questionnaire survey directed to the purposively selected 84 Engineering Technology students in the selected educational zone. Data analyzed using SPSS showed that 88% of the students have continued their academic process via online learning. Among these students, 39% had the capability to learn 02 hours per day.

Student exhibited their highest consent (48%) to use mobile apps for online learning while illustrating a significant gender difference ( $M_{\text{male}}=4.38$ ,  $M_{\text{female}}=3.50$ ;  $t=2.553$ ,  $p=0.015$ ). Interestingly, the majority of the students (59%) were satisfied with online education though with a significant gender difference ( $M_{\text{male}}=2.84$ ,  $M_{\text{female}}=3.75$ ;  $t=3.716$ ,  $p=0.000$ ). The study revealed that lack of access to devices is the major drawback for the majority (40%) of students for online learning. Accordingly, the study adds Asians' voice to the existing literature to implement future online classes in a more efficient and effective manner. Present study suggests the need for future research in this direction while addressing representative samples from whole country, if possible, to generalize the current findings.

**Keywords:** Advanced level students, COVID-19, Online learning

## **Introduction**

The outbreak of COVID-19, also known as the coronavirus disease, in the world was declared on 30th January 2020, by the Director-General of the World Health Organization (WHO) (Upoalkpajor & Upoalkpajor, 2020). It has changed lives of the people in the world by forcing them to self-isolation at homes that limited their social interaction. With the lockdowns, social gatherings were suspended and people from most parts of the world were asked to work and learn from home (Agung & Surtikanti, 2020). First and most critically, the COVID-19 epidemic is a critical health problem where children and elders seem more susceptible. 1.2 billion children have been affected by the virus in 186 nations globally (Upoalkpajor & Upoalkpajor, 2020). Protection of children has become the main aim of all nations in particular. Many nations around the world have agreed to shut schools, other academic institutions and universities. The shutting down of schools (objectives: reducing interaction and protecting lives)

and leaving them open (so as to permit teachers to work and protect the economy), the crisis offered dilemmas for policymakers. The closing of schools worldwide was one of the main attempts taken to thwart the spread of COVID-19. On 12<sup>th</sup> March 2020, the abrupt closing of schools to counter the spread of COVID-19 showed how the education sector responded rapidly to the crisis. Consequently, they undertook a radical transition from face-to-face mode of teaching to online and other distance education methods.

## **Review of Literature**

### ***Education amidst COVID-19: Global Responses***

It is critical for the whole world to respond immediately in order to mitigate the impact of COVID-19 pandemic because most nations were not initially prepared for this epidemic condition. Onyema, Sen & Alsayed (2020) revealed that various schools were shut and the examinations were cancelled in the United State which affected 60 million school children in the country. In Spain, school closure affected 11 million students and as well as those employed in jobs related to educational institutes. Lots of self-governing schools were closed in New South Wales in order to alleviate the spread of the COVID-19 pandemic. The beginning of schools during the outbreak period was monitored and facilitated by the Australian government. All educational institutions were shut down in India due to the curfew imposed by the Indian government. In France, all the schools were closed in response to the critical health situation in the country. Even though the death rate was low in Germany, they closed all schools while moving to online classes. The federal government in Nigeria ordered a total closure of all schools along with a lockdown of the country to control the spread of Coronavirus. Agung & Surtikanti (2020) showed that Indonesia's education system has moved from the physical classroom to the internet-based classroom with the temporary closure of the school and other educational institutes according to the Circular Note issued by the Indonesian Minister of Education and Culture.

### ***School Education and the effects of School Closures***

From primary to tertiary levels, free public education system was introduced to Sri Lanka in 1943. It paved the path for students from

economically deprived families to access greater educational opportunities and ensure their right to education. The conventional classroom is the core of this structure where students from various economic and cultural backgrounds share a common physical space. Moreover, it has helped to mitigate and balance many institutional and regional differences among students over time. It is recommended that for learning skills the best public policy means available is learning at a school. Even a comparatively short amount of school time achieves this; even a relatively short amount of missing education would have consequences for the advancement of skills. It is not easy to guess how much learning will be compromised by the COVID-19 interruption.

The lively classroom dynamics can never be replaced by any online forum. Not only is the classroom a learning area, but it is also a place where students connect with each other through the social and cultural barriers that divide them and develop lifelong relationships, connections and unity (Chandasiri, 2020). This shared physical environment that has nourished thoughts and interactions of students over the decades can in no way be harmed by the steps taken today to overcome the problems created by the pandemic.

Over 100 countries initiated nationwide closures of schools according to the United Nations Educational, Scientific and Cultural Organization (UNESCO). This move affected over half of the world's student population, parents, teachers and the society at large. It led to a loss of students' interest in learning and thus reducing their academic performance (Onyema et al., 2020). School closings have an impact on society as well as the economy of countries. Transition to online education during school closings may increase the pressure on the students and teachers due to their lack of digital skills and unequal access to technology. It is an extra burden to parents as they have to engage in supervision tasks to ensure that their children participate in their studies at home. Unscheduled school closure also disrupts students' academic goals. It could delay students from graduating and starting their chosen careers. Closure of schools also leads to social isolation of children thus reducing opportunities for growth, development and learning within a micro society. Some lessons can only be taught in the conventional classroom through



face-to-face learning. Therefore, online learning is a barrier to improve the practical skills of school children by providing instructions and guidance through digital devices (Upoalkpajor & Upoalkpajor, 2020).

Upoalkpajor & Upoalkpajor (2020) argued that education and the social lives of children have been greatly affected by the home education method. Moreover, it has negatively affected the efficiency of parents. Both parties have to undergo uncertainties and different trials and errors to cater the online student evaluations. Most exams were cancelled. Importantly, not only these interruptions have become problems in the short-term, but they may also have long-term consequences for the populations affected and are likely to exacerbate inequalities.

According to studies by Chandasiri (2020), the mentality of students is highly affected during the pandemic period expressing symptoms of stress, depression and anxiety. This is due to the problems caused by delays in their academic work due to the closure of education institutes. Research studies that are associated with schools are also negatively affected due to lockdown since the researchers are unable to conduct their field work within the school premises.

### ***Concept of Online Education***

Online education is a universal concept for learning and teaching with the assistance of technology tools and platforms (Onyema et al., 2020). According to Ramasamy & Sundarraj (2020), online learning was first recognized in South-Saharan Africa in 1976 by the National Teachers' Institute, Kaduna. This was an initiative supported by the Federal Government of Nigeria. This method became popular among many countries thereafter, and particularly during the COVID-19 pandemic period. It facilitates a flexible learning approach that motivates students to participate and learn at home. It features: continuing teaching and learning experiences, sharing lectures, providing assignments and obtaining feedback while maintaining constant student-teacher collaboration and relationship. Online learning is a practical approach for school children during an outbreak. They can continuously engage in their educational activities through visual presentations without any physical

boundaries (Ramasamy & Sundarraj, 2020).

About 80–85 percent practice distance learning in high-income countries, while these declines to less than 50 percent in low-income countries (Onyema et al., 2020). This shortfall may be largely due to the inadequate technology facilities, cost of accessing online education and poor digital literacy among students, parents, and teachers in the developing countries. Students who do not have the financial resources to afford the requisite equipment to engage with their classmates and instructors are unable to benefit from online education.

After Access Nationally Representative Survey conducted in 2020 revealed that only 34% of Sri Lankan households with children (aged 18 and under) have any kind of internet computer connectivity by the start of 2019 (this includes connections via fiber connections, dongles, mobile phones etc.) to access online learning. The services studied range from the basic tutorials sent over WhatsApp to synchronous classroom experiences on approaches like Google Classroom. Poorer rural households are methodically worse off, in fact, the number declines to 21% in the lowest socioeconomic group households. Clearly, this means that the vast majority of students after the COVID-19 school closures were unable to use e-learning (Amarasinghe, 2020).

According to the After Access Nationally Representative Survey (2020), though online learning is a necessity but there are no sufficient devices to connect to this mode of learning as the data affordability remains a barricade for many again, especially the poor. This is in spite of the fact that Sri Lanka has always remained high up in data usability metrics among the top five nations. Similarly, to access the web experience pupils, parents and teachers alike need to be technologically literate; where children are involved, this requires not only being able to locate details, set up and log into teaching sites, but also to manage their internet environment in a safe and stable manner.

Therefore, the move to online learning has earned conflicting reactions, magnifying the current socio-economic gaps inherent in

the educational system of the state. Because access to the internet and computing services for all students is not universal current disparities have been identified (Kitnasamy & Vincent, 2020). Even though online education has reformed the way of learning, it also comes with certain demerits (Ramasamy & Sundarraj, 2020). Lack of research studies at grassroots level creates a knowledge gap in this area which denies accessible education for school children who are metaphorically considered as the backbone of any nation. Hence, further studies are required to examine the impact of current online education system on Sri Lankan student in order to design future online classes in an effective and efficient way while facilitating equal access to all students and addressing all the barriers and the negative consequences of online learning.

Therefore, this research study focused on assessing the effect of COVID-19 pandemic on the education of school children in Sri Lanka with the objectives of exploring the students' engagement with online learning, identifying their preference towards various modes of online learning and examining the barriers faced by students while adapting online learning during COVID-19. Accordingly, the study aims to provide suggestions to the academic and policymaking authorities to enhance online learning system in Sri Lanka.

## **Methodology**

A pre-tested questionnaire survey was designed for the present study and it mainly focused on the Mulatiyana Educational Zone in the Matara district, Sri Lanka as it is an area of limited resources for online learning. By selecting a sample of Advanced Level Engineering Technology students, the study mainly focused to examine the impact of online learning on a particular category of students (Engineering Technology) whose subjects depended on practical components. Therefore, the sample does not represent a larger segment of the population and thus limits the researcher's ability for generalization.

Data were primarily collected through the questionnaire survey directed for the purposively selected 84 Engineering Technology students in the Mulatiyana Educational Zone, Sri Lanka. The questionnaire was designed to assess the demographic features of the

school children and their preferences and perceptions towards online learning during the outbreak. Accordingly, the respondents' preference for different modes of the online education system was assessed using a 5-point Likert scale. Furthermore, the problems faced by the students when engaged in online education during the pandemic period were also evaluated. Cronbach's alpha was used to measure the reliability of the questionnaire and each questionnaire item has more than 0.7 Cronbach's alpha value confirming high reliability (Taber, 2018).

Secondary data were collected using research paper articles, journals, newspaper articles and other websites etc. IBM SPSS version 25 was used as the main analytical software in the present study. The study used descriptive analytical tools such as sample mean, standard deviation etc. and inferential analytical tools such as independent sample t-test to analyze data.

## Findings and Discussion

### *Demographics of the sample*

When considering the gender of the sample, 55% of the respondents were females and 45% males. This denotes that majority of the respondents were females. Majority of them were 18 years old occupying 60% of the sample while there were 30% of 17 years old students and 11% of 19 years old students. Majority of the respondents were from Narandeniya National School that comprised 48% of the sample. Out of these respondents, the majority were from Kmburupitiya comprising 38% whereas 21% of respondents were from Hakmana and 17% from Deyyandara (Table 1).

**Table 1.**  
*Demographic Factors of the sample*

		Frequency	Percent (%)
Gender	Male	38	45.2
	Female	46	54.8
Age	17	25	29.8
	18	50	59.5

	19	9	10.7
School	Thihagoda National School	6	7.1
	Narandeniya National School	40	47.6
	Deyyandara National School	18	21.4
	Hakmana Methodist School	20	23.8
Place of residence	Kamburupitiya	32	38.1
	Makandura	6	7.1
	Mawarala	4	4.8
	Akuressa	1	1.2
	Hakmana	18	21.4
	Narandeniya	1	1.2
	Deyyandara	14	16.7
	Kirinda	3	3.6
	Thihagoda	1	1.2
	Mulatiyana	4	4.8

### ***Students' engagement with online learning during the COVID-19 outbreak***

According to the respondents, 88% of the students stated that they have engaged with different online learning methods while 12% stated that they have not engaged in any online learning methods during the pandemic period.

Five-point Likert scale was used to assess the perspective of students towards different education methods that they have used during the pandemic period. According to the results, the majority of the students, accounting 77% of the sample, have used e-learning as their learning method during the outbreak ( $w=4.495$ ,  $p=0.000$ ). Out of them only 37% of the students strongly liked to use e-learning such as Learning Management System (LMS), e-thakshalawa etc. 72% of the respondents have used mobile apps such as WhatsApp/Viber to obtain their continuous learning ( $w=5.279$ ,  $p=0.000$ ). Out of these respondents, 48% of the students notified that they strongly liked to use them. 69% of the student have accomplished their education with

the help of public media such as television, radio etc. ( $w=5.188$ ,  $p=0.000$ ) and out of them 42% stated that they strongly liked to use them for their learning. Furthermore, 63% of the students utilized software like zoom, Google Classroom etc. ( $w=4.722$ ,  $p=0.000$ ). Out of them, 43% strongly liked to use these modes of learning. According to the results, most of the learners (48%) showed higher consent to use mobile apps. It may be due to the convenience, flexibility and cost-effectiveness of using mobile apps for online education.

Students' capacity for online learning was assessed in terms of the maximum hours they have spent per day for online learning activities. Out of the students who engaged in online learning during the pandemic period, 39% of school children have engaged 2 hours per day on their learning. 24% of students have the capacity to engage in their online learning for more than 2 hours per day. 30% of respondents have selected 1 hour as their most preferred duration for online classes while 0.5 hours were selected by 7% of respondents ( $\mu=2.81$ ,  $SD=0.886$ ). There was a significant gender difference for the maximum hours that the students spent on their education during COVID-19 pandemic period ( $t=2.234$ ,  $p=0.029$ ) (Table 2). The results revealed that male students preferred ( $M=3.06$ ) to spend more on their online learning activities than female students ( $M=2.61$ ).

### ***Students' preference towards various modes of online learning***

Independent samples t-test was done to examine the students' preference to study through various modes of online learning during COVID-19 pandemic period. Additionally, the homogeneity of variances was tested via Levene's Test (Table 2). There was a significant difference between the perception of male and female students for the usage of WhatsApp/Viber ( $t=2.553$ ,  $p=0.015$ ). The male student ( $M=4.38$ ) showed their highest preference to study through mobile apps than their female ( $M=3.50$ ) counterparts (Table 2). Further, independent sample t-test revealed that there was not a significant difference between the perception of male and female students for the usage of e-learning ( $t=0.587$ ,  $p=0.560$ ), public media ( $t=-1.289$ ,  $p=0.205$ ) and different software ( $t=1.990$ ,  $p=0.053$ ) for their online learning (Table 2).

Moreover, the results showed that majority of the students (59%) were

satisfied with online learning while 41% of the respondents were not satisfied ( $\mu=3.33$ ,  $SD=1.204$ ) which could pose a threat to the expected outcomes of online teaching. The independent sample t-test showed the significant gender difference towards the satisfaction of online learning ( $t=-3.716$ ,  $p=0.000$ ) at the 0.05 level of significance (Table 2). Female students ( $M= 3.75$ ) were more satisfied with online learning than male students ( $M=2.84$ ). Moreover, results suggested that the COVID-19 has affected students' education with a significant gender difference ( $t= 2.667$ ,  $p=0.010$ ) (Table 2). Comparatively, female students were affected more ( $M= 4.41$ ) than male students ( $M=3.78$ ).

**Table 2.**

Independent sample t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Preference for e-learning	Equal variances assumed	0.008	0.929	0.587	0.560	0.222	0.379
	Equal variances not assumed			0.587	0.560	0.222	0.379
Preference for public media	Equal variances assumed	0.710	0.404	-1.289	0.205	-0.455	0.353
	Equal variances not assumed			-1.352	0.186	-0.455	0.336
Preference for software	Equal variances assumed	3.243	0.079	1.990	0.053	0.762	0.383

e	Equal variances not assumed			1.912	0.066	0.762	0.399
Preference for WhatsApp/Viber	Equal variances assumed	4.527	0.039	2.602	0.013	0.875	0.336
	Equal variances not assumed			2.553	0.015	0.875	0.343
Maximum duration on online learning	Equal variances assumed	1.472	2.229	2.234	0.029	0.451	0.202
	Equal variances not assumed			2.197	0.032	0.451	0.205
Satisfaction level on online learning	Equal variances assumed	4.121	0.046	-3.648	0.000	-0.91216	0.25005
	Equal variances not assumed			-3.716	0.000	-0.91216	0.24547
Effect of COVID-19 on education	Equal variances assumed	8.968	0.004	-2.759	0.007	-0.631	0.229
	Equal variances not assumed			-2.667	0.010	-0.631	0.237

### ***Barriers faced by students during online learning***

Different attributes were assessed to locate the problems faced by students in adapting online learning during COVID-19 pandemic period. According to the responses, majority of the students, 40%, stated that lack of devices ( $\mu=1.60$ ,  $SD=0.494$ ) was the major barrier for engaging in online learning because they did not own mobile phones or personal computers. When considering the usage of digital devices of the respondents, 50% of the students owned mobile phones



( $\mu=1.56$ ,  $SD=0.499$ ) and 44% of students had access to personal computers ( $\mu=1.50$ ,  $SD=0.503$ ). It shows that majority of the school children in Sri Lanka do not have digital devices for their online education. Network issues ( $\mu=1.75$ ,  $SD=0.434$ ) have been a barrier for 25% of the respondents while lack of digital skills ( $\mu=1.75$ ,  $SD=0.438$ ) has been a barrier for 25% of the students. The lowest number of students (10%) stated that undesirable weather conditions ( $\mu=1.90$ ,  $SD=0.307$ ) as the main problem in online learning as it leads to electricity problems and lack of connectivity.

## **Conclusions**

Majority of the students (88%) followed their education through online learning during the COVID-19 pandemic period. Respondents showed their highest consent to use mobile apps as the learning mode and male students showed the highest preference than females. However, the majority stated that lack of devices is the major barrier to engage in online learning. Moreover, 59% of students were satisfied with online learning, but with a significant gender difference. Accordingly, female students were more satisfied with online learning than male students. Even though online education is a good approach to learning, the preferred requirements are not equally distributed among all the students in Sri Lanka. Therefore, identified problems must be taken into consideration by policymakers in designing future online educational pathways effectively, while giving equal access to all students with minimum disparities.

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# Availability and Utilization of Information and Communication Technology among Instructors in Adult and Non-Formal Education Centers in Kwara State, Nigeria

**Ambali Taiwo Toyin, Abdullahi Abdulazeez Kolapo\*, Sholagberu Abdulsalam Oladimeji, Kayode Sadiq Toyin**

*Department of Adult & Primary Education, Faculty of Education, University of Ilorin, Nigeria*

## Abstract

This study examined the availability and utilization of information and communication technology (ICT) among instructors in adult and non-formal education centers in Kwara State, Nigeria. Three objectives were raised and translated to research questions to guide the study. A descriptive survey research design was adopted for the study and 271 was considered as the target populations comprising male and female instructors. A sample size of one hundred and sixty (160) respondents was selected across the State. A multi-stage sampling procedure consisting of cluster sampling, purposive sampling and simple random sampling was adopted. Check list and questionnaire were used as an instrument for data collection for the study. The reliability of instruments was achieved using test-retest technique and a co-efficient 0.82 was obtained. The administration of the instruments was carried

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\*Correspondence should be addressed to **Mr. A. Abdulazeez Kolapo**, Department of Adult & Primary Education, Faculty of Education, University of Ilorin, Nigeria.

**Email:** [azeezkola75@gmail.com](mailto:azeezkola75@gmail.com)



<https://orcid.org/0000-0003-0373-1442>

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out by the researchers and five volunteer field research assistants. The data collected was analyzed using frequency count and percentages. One of the findings revealed that the level of utilization of ICT among instructors was low. It is therefore, recommended that there is a need to create awareness among instructors on the level of utilization of ICT to increase the level of consciousness for effective teaching learning process.

**Keywords:** Availability, Adult and Non-Formal Education Centers, Instructors, Utilization ICT,

## **Introduction**

Information and communication technology is as ancient as human civilization going by its metamorphosis from analogue age to the digital era. Advancement in sciences and technology brings about numerous innovations in e-learning, e-commerce, e-banking among others. Therefore, increased access to knowledge and enables greater exchange of ideas in all the areas of human endeavor. The applications of Information and Communication Technology (ICT) and its uses in adult education has gained global recognition. Nigeria, in particular, when literacy by Radio organized by UNESCO and the federal government of Nigeria in 2000 with the aims to mobilize and sensitize nomadic pastoralists to appreciate the value of modern education and encourage them nomads to contribute meaningfully towards the education of their children (National Commission for Nomadic Education, 2000).

Akuegwu et al. (2011) were of the view that ICTs provide teachers with opportunities for experimenting with emerging technologies, thereby aiding in the provision of interesting and creative presentation of content. It engenders a multi-media presence in the classroom. ICTs provide teachers with increased opportunities to collaborate and network with colleagues, thereby increasing communication and exchange of linkages among themselves. In recent years, research has shown that the potential and benefits derived from Information and Communication Technology (ICT) has improved the quality of education. ICT is viewed as a major tool for building knowledge societies (UNESCO, 2003). Rai (2006) reported that ICT is changing the world and the modalities of learning among its citizens. He further buttressed that ICT changes teaching and learning through its

potential as a source of knowledge, a medium of transmitting content and a means of interaction and dialogue.

Ghavifekr & Rosdy (2015) view ICT as a shorthand for computers, software, networks, satellite links and related systems that allow people to access and share information and knowledge in a variety of forms. Hughes (2013) defines integration of technology in teaching and learning as a mean by which the use by teachers supports the constructivist teaching and learning process. According to Aduwa-Ogiegbaen & Imogie (2005), materials and resources including audio and video tape recorders, slide opaque and over-head projectors, still pictures, programmed instructions, filmstrips, maps, and charts among others. These offer a variety of learning experiences individually or in combination to offer different teaching and learning experiences. Adult literacy instructor required a high level of professionalism and experiences to handle modern communication technology gadgets to facilitate learning. Akudolu, & Olibie (2007) reported that instructors/teacher's job in this ICT era was to provide clear explanation and help learners learn better. He further stressed that, instructors maximize ICT gain in their career through computer literacy skills acquisition. Oni (2011) noted that, many untrained instructors/teachers were teaching at different levels and categories of institutions of learning, an assertion that holds forth in adult literacy classes. This possibly explains the demise of many adult literacy programs (Fajonyomi & Adeyemi, 2000). In addition, the effectiveness and poor performance of adult literacy programs could also be because of unconducive learning environment and inappropriate instructional resources.

## **Theoretical Framework**

This research made used of two theories, namely:

- Technological Pedagogical Content Knowledge (TPACK) framework by Mishra & Koehler (2006)
- Experiential Learning Theory by David Kolb (1970)

### ***Technological Pedagogical Content Knowledge (TPACK) framework by Mishra & Koehler (2006)***

This study is guided by Technological Pedagogical Content Knowledge (TPACK) framework developed by Mishra & Koehler (2006). This framework promotes the view that a teacher depends on three domains of knowledge for effective integration of ICT into teaching and learning, which are: content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK). The position is further enhanced by the following statements:

- *Instructor must know and understand the subject that he/ she teaches, including knowledge of central facts, concepts, theories, and procedures if the teacher is to integrate technology in teaching.*
- *Instructor with deep pedagogical knowledge is likely to integrate technology in his or her teaching considering how students can best learn in a given classroom context and nature of learners.*
- *Instructor with TK has good knowledge of operating system and computer hardware, the ability to use standard sets of software tools (e.g., word processors, spreadsheets, browsers, e-mail).*

The above assertions led to the development of Technological Pedagogical Content Knowledge (TPACK) framework by Mishra & Koehler (2006). Interaction of these three knowledge domains, CK, PK and TK, will enable instructors to integrate ICT into effective teaching. Understanding TPACK is not about going above and beyond understanding technology, content, or pedagogy in isolation, but on understanding how these forms of knowledge interact with each other.

### ***Experiential Learning Theory by David Kolb (1970)***

This study is also guided by David Kolb's experiential learning theory of 1970. The theory remains valid today and significant in the process of training to bridge the gap in learning styles. The theory stated that people can learn from experience emerging from their daily activities. Kenny (2008) defines experiential learning as the process of creating and transforming experience into knowledge, skills, attitudes, values, emotions, beliefs, and senses. In the same manner, Fajonyomi (2015) noted that experiential learning has been associated with educational practices in informal and non-formal settings. Its application in formal setting includes colleges and university and involves liberal, civic, and

professional subjects. He affirms that, experiential learning philosophy involves many methodologies in which educators or instructors purposively engage with learners' indirect experience and focused on their reflection to increase knowledge, development skills, clarify values and develop people's capacity to contribute to communities. The theory is related to the present study because instructors/facilitators play a major role in the learning process through uses and application of Information and Communication Technologies (ICT's) and by putting into practice what they learnt during teaching and learning process.

Both Technological Pedagogical Content Knowledge (TPACK) framework and experiential learning theory are important to this study because they place emphasis on instructors' knowledge in application of ICT's in the teaching and learning process. To this end, instructors' experience and knowledge can help to sustain learners' interest in adopting ICT as a way of teaching.

## **Statement of the Problem**

The uses and applications of ICT have so far not grown beyond the entertainment industry. Over the years, efforts have been made by the researchers to reposition and direct its scope towards the field of adult education and other areas of discipline across the globe. However, it has not been effectively and efficiently utilized among instructors in adult and non-formal education centers in sub-Saharan African countries. Despite its benefit in facilitating teaching learning process as it seen in developed countries. Adebisi (2013) observed that without being put into use ICT offers no contributory factors towards effective teaching and learning. Therefore, this study focuses on availability and utilization of ICT among instructors in adult and non-formal education centers in Kwara State, Nigeria by focusing on the identification of types of ICT's, level of utilization and the challenges faced in utilization of ICT among instructors especially where gaps exist, and the ways to fill these gaps.

## **Objectives of the study**

The following objectives are formulated to guide the study.

- i. to identify types of ICT available in adult and non-formal education centres' in Kwara state.
- ii. to determine the level of utilization of ICT among instructors in adult and non-formal education centres in Kwara state.
- iii. to examine the challenges faced in utilization of ICT among instructors in adult and non-formal education in Kwara state.

## **Research questions**

The following research questions have been formulated for the study.

- i. What types of ICT facilities are available in adult and non-formal education centres in the Kwara state?
- ii. What is the level of utilization of ICT among instructors in adult and non-formal education centres in the Kwara state?
- iii. What are the challenges faced in utilization of ICT among instructors in adult and non-formal education centres in the Kwara state?

## **Methodology**

The descriptive survey was used for the study. Check & Schutt (2010) define descriptive survey research design is an efficient method for systematically collecting data from a broad spectrum of individuals and educational setting. The justification for this design is to seek the opinions and views of the respondents on the availability and utilization of information and communication technology among instructors in adult and non-formal education centers in the Kwara state, Nigeria.

The population for the study comprises of male and female instructors in adult and non-formal education centers across the state. 271 instructors employed in 209 government approved ICT centers were considered as the target population. The relevant information was



obtained from the Kwara Ministry of Education. A sample size of 160 was done by using Raosoft online sample calculator (2019) which was recommended for a population of that magnitude, to have a fair representation of the target population. Multi-stage sampling procedure was adopted. At the first stage, a purposive sampling technique was used to sample government approved ICT centers/institutions awarding Degree and Diploma certificates within Kwara State. They include National Open University of Nigeria (NOUN) and adult literacy centers and private ICT centers. Also, at the second stage, purposive sampling was adopted to sample instructors/facilitators. At the final stage, simple random sampling was employed to sample 77 respondents willing to participate in the study.

Two research instruments were used for data collection for the study. These include check list and a self-developed questionnaire tagged "Availability and Utilization of Information and Communication Technology among Instructors Questionnaire (AUICTIQ)". The questionnaire consisted of four sections. Section A contained demographic information of the respondents, that is, gender, age, years of working experience and educational qualifications. Section B contained 10 items on the types of ICT facilities are available in adult and non-formal education centers. Section C focused on level of utilization of ICT among instructors in adult and non-formal education. Section D focused on the challenges faced in utilization of ICT among instructors in adult and non-formal education centers.

The options to these items were taken on four (4) point Likert scale type rating Very Often (VO), Often (O), Less Often (LO) and Not All (NA) and Strongly Agree (SA); Agree (A); Disagree (D); and Strongly Disagree (SD). In the same manner, check list was designed to obtain information from respondents (instructors) on the types of ICT available in adult and non-formal education centers. The checklist contained items 1-10 with two different columns of "available" and "not available". The items in the instruments were validated by experts in the fields of adult education, test, and measurement through a cross-examination by peer review in relation to the research questions raised for the study. The reliability co-efficient of the questionnaire was carried out using test re-test technique and 0.82 was obtained which revealed that the questionnaire was reliable for the study.

The administration of the instrument was carried out by the researchers and five volunteer research assistants who have preliminary knowledge on the content of the questionnaire, administration procedure, privacy, and confidentiality of the respondents. All the questionnaires and checklist were successfully filled and returned. The data collected were analyzed using frequency counts and percentages.

## Results

This section presents the results and interpretation from the data collected:

**Research Question 1:** What types of ICT facilities are available in adult and non-formal education centers in the Kwara state?

This research question was also analyzed using frequency count and percentages. The result is shown in Table 1.

**Table 1.**

*Types of ICT facilities are available in adult and non-formal education centers in Kwara state.*

S/N	Statements/Items	Available		Not Available	
		F	(%)		(%)
1.	Computer set	160	(100%)	0	(0%)
2.	Interactive white board	36	(22.5%)	124	(77.5%)
3.	Tablet devices	114	(71.25%)	46	(28.75%)
4.	Projector	67	(41.88%)	93	(58.12%)
5.	Radio recorders/players	41	(25.62%)	119	(74.38%)
6.	Presentation clicker	51	(31.88%)	109	(68.12%)
7.	Digital camera	62	(38.75%)	98	(61.25%)
8.	Mobile internet	128	(80%)	32	(20%)
9.	E-library.	14	(8.75%)	146	(91.25%)
10.	Mobile phone	160	(100%)	0	(0%)

Table 1 shows the results of the respondents on the types of ICT facilities available in adult and non-formal education centers using frequency counts and percentages from the data collected. The result

indicated that items 1, 3, 8 and 10 were available as they have higher percentages. While, items 2, 4, 5, 6, 7 and 9 were not adequately available. This indicated that there is low level of ICT availability in adult and non-formal education centers in the Kwara state.

**Research Question 2:** What is the level of utilization of ICT among instructors in adult and non-formal education centers in the Kwara state?

This research question was also analyzed using frequency count and percentages. The result is shown in Table 2.

**Table 2.**

*Level of utilization of ICT among instructors in adult and non-formal education centers in the Kwara state.*

S/N	Statements/Items	Frequency, Percentage (%)			
		VO	O	LO	NA
1.	Use ICT to design and develop primers/materials relevant to the needs of the learners.	84 (52.5%)	57 (35.63%)	19 (11.87%)	0 (0%)
2.	Use interactive white board for teaching learners.	4 (2.5%)	24 (15%)	63 (39.37%)	69 (43.13%)
3.	Use tablet devices in teaching learners.	79 (49.38%)	60 (37.5%)	21 (13.12%)	0 (0%)
4.	Used projector to presented picture, chart and diagram for appropriate illustrations.	15 (9.37%)	22 (13.75%)	58 (36.25%)	65 (40.63%)
5.	Use recorder/player for teaching learning process	12 (7.5%)	27 (16.88%)	87 (54.37%)	34 (21.25%)
6.	Use presentation clicker to make teaching learning process to learners clear.	14 (8.75%)	11 (6.88%)	62 (38.75%)	73 (45.62%)
7.	Use digital camera to present real objects to learners.	13 (8.12%)	24 (15%)	69 (43.13%)	54 (33.75%)
8.	Use mobile internet to facilitate teaching learning process to learners.	84 (52.5%)	68 (42.5%)	8 (5%)	0 (0%)
9.	Use e-library to facilitate teaching learning process.	0 (0%)	6 (3.75%)	11 (6.87%)	143 (89.38%)
10.	Used mobile phone application to pass information to learners.	83 (51.88%)	46 (28.75%)	18 (11.25%)	13 (8.12%)

able 2 shows the results of the respondents on the level of utilization of ICT among instructors in adult and non-formal education centers in

the Kwara state using frequency counts and percentages from the data collected. The result indicated that items 2, 4, 5, 6, 7 and 9 were utilized often or not utilized at all among instructors in adult and non-formal education centers as indicated by the higher percentages. While, items 1, 3, 8 and 10 were utilized very often or often utilized among instructors.

**Research Question 3:** What are the challenges faced in utilization of ICT among instructors in adult and non-formal education centers in the Kwara state?

This research question was also analyzed using frequency count and percentages. The result is shown in table 3.

**Table 3.**

*Challenges faced in utilization of ICT among instructors in adult and non-formal education centers in the Kwara state.*

S/N	Statements/Items	Frequency, Percentage (%)			
		SA	A	D	SD
1.	Low-capacity building affects using ICT to develop primers and instructional materials.	58 (36.25%)	65 (40.63%)	13 (8.12%)	24 (15%)
2.	Lukewarm attitude towards ICT affects it usage for effective teaching.	63 (39.37%)	69 (43.13%)	4 (2.5%)	24 (15%)
3.	Low confidence affects usage of ICT for presenting lesson appropriately.	79 (49.38%)	60 (37.5%)	21 (13.12%)	0 (0%)
4.	Infrastructural support makes it difficult for using ICT to facilitate teaching learning process.	72 (45%)	51 (31.88%)	22 (13.75%)	15 (9.37%)
5.	High cost of maintenance discourages using ICT for teach learners.	62 (38.75%)	73 (45.62%)	14 (8.75%)	11 (6.88%)
6.	Inadequate distribution of ICT facilities affects teaching learning process.	84 (52.5%)	61 (38.13%)	15 (9.37%)	0 (0%)

Table 3 above shows the result of the respondents on the challenges faced in utilization of ICT among instructors in adult and non-formal education centers in the Kwara state using frequency counts and

percentages from the data collected. The result indicated that items 1, 2, 3, 4, 5 and 6 had higher percentages which indicated that low-capacity building, lukewarm attitude, fair of failure, infrastructural support, high cost of maintenance and inadequate distribution were among the challenges faced in utilization of ICT.

## **Summary of Findings**

From the analysis of data in the preceding tables, the following findings were deduced:

- i. Common types of ICT facilities are available in adult and non-formal education centers in the Kwara state includes computer set, mobile phone, tablet devices and mobile internet.
- ii. The level of utilization of ICT among instructors in adult and non-formal education centres in the Kwara state was low-high as evidently shown in the area of the usage of projectors, radio recorder/player for the teaching-learning process, e-library to facilitate the teaching-learning process, and interactive white board for teaching learners.
- iii. The challenges faced in utilization of ICT among instructors in adult and non-formal education in the Kwara State was high as shown in area of low-capacity building affects using ICT to develop primers and instructional materials, lukewarm attitude towards ICT, low confidence, infrastructural support and high cost of maintenance.

## **Discussion of Findings**

One of the findings of this study revealed that common types of ICT facilities are available in adult and non-formal education centers includes computer set, mobile phone, tablet devices and mobile internet. This finding agrees with the work of Adebisi (2013) who found that the uses of ICTs in schools depends on the availability of ICT equipment. There is always a discrepancy between availability of ICT equipment and their usage. He affirmed that the use of ICTs in teaching and learning has become imperative at all levels of education.

Availability of ICTs without being put into use has no positive contributory factor for enhancing teaching and learning.

Another finding from the study revealed that the level of utilization of ICT among instructors in adult and non-formal education centers in the Kwara state was low. This finding is in accordance with Carlson & Gardio (2002) who found that multimedia cannot be effectively utilized in literacy instruction without the instructor. Facilitators determine whether technologies are used appropriately or not. In the same manner, these present findings also support the finding of Yusuf (2005) who found that effective utilization of multimedia into learning depends on facilitators' conviction of the relevance of multimedia as a means of providing better access to richer range of resources for themselves and their learners.

In addition to the above, finding of Aktaruzzaman, Shamim & Clement (2011) revealed that when used appropriately, different ICTs help in expanding access to education to the increasingly digital workplace through information distribution, learning management systems and managing of educational services and make them affordable and available anytime and anywhere. For example, they argued that opportunities are now open to individuals and groups who were previously constrained from attending traditional universities to access higher education and other forms of adult learning through online modes of learning such as e-learning, blended learning among others.

The third finding of the study revealed that the challenges faced in utilization of ICT among instructors in adult and non-formal education in Kwara State was high and affects using ICT to develop primers and instructional materials, lukewarm attitude towards ICT, low confidence, infrastructural support and high cost of maintenance as evidently showed. This finding is in accordance with the work of Charles, Michael & Polycarp (2017) who reported that training of facilitators enhances the utilization of multimedia to a very high extent; this is true because training makes the facilitators comfortable and motivated to utilize multimedia in instruction, exposes them to the multimedia technologies they will meet in class and equips them with knowledge and skills for multimedia utilization. Similarly, the finding agrees with the work of Ezeonyirimba (2013) who observed that inadequate fund is also a challenge faced by facilitators in utilization of

multimedia in adult literacy centers. There are lots of multimedia technologies which makes learning much easier and faster, but lack of fund has effect on its availability and use in the literacy centers.

## **Conclusion**

ICT is an integral part of facilitating teaching learning process if available and adequately utilized by instructors or facilitators. Application of ICT in adult and non-formal education can help to bridge learning between instructors and learners to increase access to knowledge and enabled greater exchange of ideas. Research findings have shown that there is low level of utilization of ICT among instructors in adult and non-formal education centers. For this reason, concerted efforts should be made to sustain and improve on utilization of ICT for sustainable development.

## **Recommendations**

Based on the findings of the study, the following recommendations are made.

- i. There should be adequate availability and supply of ICT appliances by the management of adult and non-formal education centres.
- ii. There is need to create awareness among instructors in adult and non-formal education centres on the level of utilization of ICT to increase level of consciousness for effective teaching learning process.
- iii. Advanced studies should be encouraged among instructors to complement their existing knowledge on uses of ICT and adequate infrastructural support and maintenance should be provided to address the challenges faced in utilization of ICT among instructors in adult and non-formal education.

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