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**Author(s):** Agbo, Friday Joseph; Olawumi, Olayemi; Oyelere, Solomon Sunday; Kolog, Emmanuel Awuni; Olaleye, Sunday Adewale; Agjei, Richard O.; Ukpabi, Dandison C.; Yunusa, Abdullahi Abubakar; Gbadegeshin, Saheed A.; Awoniyi, Luqman; Erinle, Kehinde O.; Mogaji, Emmanuel; Silas, Aziaka Duabari; Nwachukwu, Chijioke E; Olawuni, Adedayo

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**Social Media Usage for Computing Education: The Effect of Tie Strength  
and Group Communication on Perceived Learning Outcome**

**Friday Joseph Agbo, Olayemi Olawumi, Solomon Sunday Oyelere  
University of Eastern Finland, Finland**

**Emmanuel Awuni Kolog  
University of Ghana Business School, Ghana**

**Sunday Adewale Olaleye  
University of Oulu, Finland**

**Richard O. Agjei  
University of Central Nicaragua Medical Center, Nicaragua**

**Dandison C. Ukpabi  
University of Jyväskylä, Finland**

**Abdullahi Abubakar Yunusa  
Universiti Sains Malaysia, Malaysia**

**Saheed A. Gbadegeshin, Luqman Awoniyi  
University of Turku, Finland**

**Kehinde O. Erinle  
The University of Adelaide, Australia**

**Emmanuel Mogaji  
University of Greenwich Maritime, UK**

**Aziaka Duabari Silas  
Cranfield University, UK**

**Chijioke E Nwachukwu  
Mendel University in Brno, Czech Republic**

**Adedayo Olawuni  
Irish College of General Practitioner / Health Service Executive, Ireland**

**ABSTRACT**

Social media has become an important platform where users share, comment, discuss, communicate, interact, and play games. Aside from using social media for personal, social, and business purposes, the use of social media has gained attention, particularly for collaborative

learning in the educational sector. This paper examines the role of social media in computing education based on the use of WhatsApp social media group. Additionally, the study explores how social media usage by students influences their perceived learning outcomes. Given these aims, the study formulated four research hypotheses and tested using Partial Least Square Structural Equation Modelling. With the participants of three hundred and thirteen ( $n=313$ ) students, the study found a positive relationship between social media usage for computing education and perceived learning outcomes. In addition, the study found a linear relationship between communication in-group and perceived learning outcomes. Finally, the study revealed that social media positively relates to tie strength, and that tie strength influences in-group communication.

**Keywords:** *Social media, Computing Education, WhatsApp, Communication, Learning outcome, Nigeria*

## INTRODUCTION

Social media is an innovative environment that emerged out of Web 2.0. As a product of second-generation internet development, it is characterized by dynamic user-generated contents (Kaplan & Haenlein, 2010). Although there seems to be no unanimity on the definition of social media, scholars have attempted to provide a tentative definition that focuses on its relationship to context, tools, and purpose for use (Qi, 2019). For instance, the Australian Government defines social media as several tools - Blogs, Wikis, Microblogs, and Social networking sites (SNS) (Qi, 2019). Their definition focused on the tools but failed to mention their usage. Other researchers similarly define social media as a group of Internet-based services built to allow for interaction, sharing of resources in various format (text, audio, or video), expression of ideas, thoughts, and feelings (Kaplan & Haenlein, 2010; Qi, 2019; Saini & Abraham, 2019). Since the emergence of social media, its usage has spread widely across regions and disciplines. For example, technological advancement through social media has created the opportunity for teaching and learning at higher education institutions.

In recent times, the proliferation of the Internet and digital devices has transformed the face and structure of teaching and learning across the educational landscape. Learners across academic disciplines can access the Internet and social media applications from different devices such as laptops, desktops, tablets, phablets, and smartphones generally (Badri et al., 2017). In recent times, social media such as Telegram, WhatsApp, and Facebook have been used for collaborative learning and create engagement among a network of students, thus making these integral media part of students' social and academic life. Social media, as a learning platform, can be used to foster students' learning and engagement (Deng & Tavares, 2013; Oyelere, Paliktzoglou & Suhonen, 2016). Kikilias, et al. (2009) elaborated in their research paper how social media and E-learning have contributed to flexibility in learning and carved out open and distance learning, where students are given the possibilities of educating themselves, at their convenience, from anywhere. Some of these researchers have also explored teachers' and learners' adoption of these social media platforms and devices (Kalogiannakis & Papadakis, 2019; Papadakis, 2018; Kalogiannakis & Papadakis, 2007). These studies have used different models and methods to examine how social media platforms and devices have been adopted for study. Similarly, Abdulahi et al. (2014), Oyelere, Paliktzoglou & Suhonen (2016) pointed out that social networking and media tools offer students the opportunity to communicate, get in touch, access information, research, and chat. The extensive use of social media has encouraged teachers to adopt social media as an e-learning platform (Qi, 2019). However, as an evolving phenomenon, research on the different aspects of social media usage, particularly the perception of computing education students' use of WhatsApp as a learning and collaborative medium needs to be explored.

According to Oyelere (2017), computing education is basically the use of different pedagogical approaches, technology (software and hardware) and content for teaching and learning of computer science. A similar designation was made by Passey (2017), that computer science education is concerned with the pedagogy of computer science subjects. Computing education has several features that are suitable for social learning. Provided that learning is through computers, it is routine that many learning activities are completed and delivered through computing technology. Accordingly, computing education can easily integrate social media technology into its pedagogical activities, thereby enhancing the learning experience.

Previous studies have dwelled extensively on the adoption of social networking in education (Al-Mukhaini et al., 2014), the theories, constructs and conceptual frameworks of social media (Ngai, et al., 2015), the potentials and obstacles of social media (Manca & Ranieri, 2016), the purpose of social media use (Bal & Bicen, 2017; Tayo, Adebola & Yahya, 2019), and the implementation of a Facebook-based instructional approach (Saini & Abraham, 2019). In addition, studies on computing education in the context of the developing countries are gaining scholars' interest (Oyelere, et al., 2018; Samuel et al., 2019; Agbo et al., 2019). These studies are insightful but still leave some gaps for future research. There is a need for further investigation of other social networking services such as WhatsApp, whose visibility is not on par with Facebook and other Web 2.0 applications (Cheung & Lee, 2010). Furthermore, the role of *age* as a demographic variable in the study of social media needs more clarity as does the relevance of social media in a scientific discipline such as computing education (Manca & Ranieri, 2016).

This study aims to investigate students' perceptions and opinions regarding the use of social media – *WhatsApp* - for learning computing education in the Nigerian context. This study intends to fill the existing gap in the previous social media studies and discusses the gaps in the reviewed literature. This study examines the following research questions to respond to the unanswered questions in the literature of social media:

- 1) *What is the role of social media in teaching computing education in a tertiary institution?*
- 2) *What is the effect of tie strength in using social media for a group study?*
- 3) *What is the outcome of using social media for computing education?*

## **LITERATURE REVIEW**

This section highlights previous efforts at investigating the impact of social media on academic achievement in different contexts in order to gain a clear focus for the present study. Previous related articles were systematically retrieved following the guidelines of Tranfield et al. (2003).

### **The Use of Social Media in Underserved Regions**

The utilization and application of social media in resource-constrained regions, particularly sub-Saharan Africa, are relatively poor (Wickramanayake & Jika, 2018; Stanciu et al. 2012; Munguatocha et al. 2011). In Nigeria especially, literature on the role of social media in education has focused on students' political participation in decision-making (Boulianne, 2015; Kushin & Yamamoto, 2010), and social media support knowledge management (Zhang et al. 2015a). In the area of education, several authors (Blair & Serafini, 2014; Cao & Hong, 2011; Stanciu, Mihai, & Aleca, 2012; Baro, Idiodi, & Godfrey, 2013; Lim, Agostinho, Harper, & Chicharo, 2014; Abbas, Aman, Nurunnabi, & Bano, 2019; Oyelere, Paliktzoglou & Suhonen, 2016) have explored social media usage across different contexts of education. Diyaolu and Rifkah (2015) highlighted the benefits, negatives, positive features, and limitations of social media platforms.

### **The Influence of Social Media in Education**

The manifestation of social media as an evolving phenomenon in the educational sector is evident in the literature as theories have been formulated to explain its impact (Boulianne, 2015). Zhang et al. (2015b) also noted the acceptance of social media as a networking medium in education. Abbas, Aman, Nurunnabi, and Bano (2019) investigated the relationship between positive and negative characteristics of social media, and the learning attitude of university students for sustainable education. The study was underpinned by the social gratification theory and a sample of 831 university students (aged between 16-35) in Pakistan. The study revealed that the use of social media in Pakistan has a negative influence on students' behavior as compared to positive behavior. However, the authors pointed out that the result cannot be generalized beyond the specific context of the research and recommended further research. Furthermore, the study did not consider the influence of the network's ties on student behaviors in the use of social media.

### **The Impact of Tie Strength in Social Learning Environments**

Regarding the strength of social ties in education, Gilbert and Karahalios (2009) examined the impact of ties in social media engagement and corroborated Granovetter's (1973) classification of tie strength in social media. From a dataset of over 2000 social media ties, the researchers reported differences between strong ties and weak ties. However, there was no linkage between the strength of ties with learning outcomes reported in the research. Over the last two decades, researchers in the social sciences have focused on Tie Strength in social media engagements. For instance, Petróczi, Nepusz, & Bacsó (2007) developed a scale for measuring tie strength in virtual social networks. The virtual tie-strength scale (VTS-scale), as it was commonly known, was tested on two asymmetric samples of sizes 56 and 16, respectively. The reliability indices of Cronbach alpha of 0.92 and 0.86 were established, assuring a strong validity and reliability of the scales. According to Petróczi et al. (2007), the VTS-scale can be modified for off-line social groups from the virtual environment. In a related study, Lim, Agostinho, and Chicharo (2014) investigated undergraduate informatics students' engagement with social media for academic purpose in Malaysia. The study was grounded on the Connectivism and Community of Practice theories, and a mixed-method sequential transformative research strategy. The results revealed a close match of ownership, time spent online, types of social media users, and pattern of usage between informatics and non-informatics students. The study also indicated that students and lecturers had accepted and explored the potency of social media for engagement with the institution, their peers, as well as for teaching and learning purposes.

### **Theoretical Foundation**

**Social constructivism theory:** Social constructivism focuses on social interaction (Vygotsky, 1978), which is beneficial due to the large number of cognitions in groups (Lave and Wenger, 1991; Mishra, 2014; Slavin, 1995). Learning occurs through interactions with each other and with the social-cultural environment (Prawat and Floden, 1994). Conceptually, participation in a social context and values of knowledge as decentralized, accessible, and co-constructed among many users makes social constructivist views of learning an appropriate lens through which to explain social media practices (Dede, 2008). Social constructivism theory has been used to explain the role of social technologies and social media in fostering socially constructed knowledge (for example, Gaytan, 2013), how social media lead to the creation of an online community of practice for learning (Kelm, 2011; Churcher, 2014), how social media facilitate participation, communication, and collaboration (Mcloughlin and Lee, 2010), and how social media technologies support learning in computing education (Oyelere, 2017, pp. 35). From a social constructivist perspective, people make meaning together, and the process adds value or makes them better (Barkley, Cross and Major, 2014); frequent social media usage increases communication while communication in groups enhances perceived group task performance of students (Qi, 2019). Research has shown that collaborative learning enables social groups to draw from various skills,

resources, knowledge, and experiences to achieve common objectives (Li, Ingram-EI Helou and Gillet, 2012; Serce and Yildirim, 2006; Muronaga and Harada, 1999 in Serce and Yildirim, 2006).

Social media supports people working in groups, which enhances task progress. Group members communicate and interact with peers through discussion, chatting, and sharing of ideas. Social media can offer a convenient means of receiving and giving feedback among learners, instructors, and experts. In the context of social constructivist theory, social media can support active collaborative learning, communication, information sharing, and enhance learning outcomes. Moreover, Vygotsky (1978) cited in Benson (2013), acknowledged that human mental activities are shaped by social experience while the others mediate learning outcomes. Social constructivism emphasizes the role of social interaction in knowledge construction, and social media can help create a social environment. In this study, a social constructivism theoretical lens is used to explain the connections between social media usage for computing education, group communication, and perceived learning outcomes.

**Social Identity theory:** Social identity theory suggests that the importance and relevance placed on group membership(s) to which an individual belongs determine one's self-concept (Turner and Oakes, 1986). One's attitude and behavior are shaped by the groups to which they belong. Social identity theory focuses on how individuals make sense of themselves and other people in the social environment (Korte, 2007). The theory acknowledges that social identities influence people's attitudes and behaviors regarding their in-group and out-group (Jenkins, 2004). Emotional tie to the group is strengthened when individuals consider membership in a particular group to be relevant to their self-concept (Leaper, 2011).

The effect of social identity depends on the situation and the relative strengths of internal and external factors at the time (Korte, 2007). Researchers have used social identity theory to explain conformity and socialization in peer groups (Harris, 1995), group-based prejudice (Bigler and Liben, 2007), and the relationship between individuals and groups within which individuals work and learn (Korte, 2007). The trend in learning towards a competency-based system of knowledge and skills (Solomon, 2001) leads to tension caused by conflicting identities among group members (Korte, 2007). Therefore, it is important to acknowledge the influence of a group's identity in the learning of new knowledge, skills, and practices. Arguably, the awareness and management of identity factors that stem from group membership can improve learning outcomes. Indeed, social identity is an essential lens through which people perceive new information and choose to undertake new learning. In the context of social identity theory, tie strength (Leaper, 2011) may enhance the relationship between social media usage in computer education and perceived learning outcomes.

### **Social Media Communication on Learning Outcome**

In recent years, social media (Web 2.0) has been growing at an unprecedented rate. Social media has become an important platform where users share, comment, discuss, communicate, interact, and play games. Aside from using social media for personal, social, and business purposes, the use of social media has gained attention in the field of education (Tess, 2013). It is rapidly changing how people teach and learn. This development has motivated teachers and developers to start experimenting with the use of social media for formal educational purposes (Bennett et al., 2012). As a result, research on the effect of social media on learning outcomes has become essential. According to Armstrong and Franklin (2008), in the face of the increasing popularity of Web 2.0 in education, higher education institutions run the risk of losing their privileges as a primary source of knowledge as knowledge is becoming widely accessible to the student through other online sources. Surprisingly, few studies have been done on the learning outcomes and performance of students with regard to the use of Web 2.0 for college or university courses. This section, however, discusses how social media affects leaning outcome.

Bennett et al. (2012) studied the effect of the implementation of Web 2.0 technologies in higher education. They evaluated six different Web 2.0 technology implementations in Australian higher education. Their result shows that there are potential benefits to using Web 2.0 technology in education. The researchers revealed further that students acquire more skills and knowledge using Web 2.0 technology while studying. Importantly, researchers highlighted the essence of students' previous familiarization with Web 2.0 technology before using it as a teaching tool. Similarly, a mixed research approach was applied to investigate the experiences of 87 computing education students with *Edmodo*, a social media learning tool (Oyelere, Paliktzoglou & Suhonen, 2016). According to Oyelere, Paliktzoglou & Suhonen, (2016), the learners from the study confirmed that *Edmodo* supported their learning outcomes and declared the benefits of social media as a learning tool to include: "... opportunities for social learning, information sharing, collaboration; interaction was created when using Edmodo for learning. Learners could connect and interact with their teachers, peers and obtain learning supports (pp. 55)."

In contrast, some studies have shown that time spent on social media negatively affect student performance. For example, Paul, Baker, and Cochran (2012) examined the relationship between the academic performance of 340 business students at a large state university and their use of social media. They found a negative relationship between time spent by students on social media and their academic performance (Paul et al., 2012). Likewise, Kirschner and Karpinski (2010) studied the effect of Facebook usage on academic performance as a measure of GPA. They evaluated 219 students and found that Facebook users have a lower GPA when compared to non-Facebook users, although the researchers emphasized that the result of their study did not infer a causal relationship between social media usage and academic performance. This therefore suggests that further research is needed to understand the impact of social media on the academic performance of students (Kirschner & Karpinski, 2010). The popularity of social media has affected the way we interact with our neighbors, colleagues, friends, and family (Subramanian, 2017). The previously familiar face-to-face interaction has been reduced to emails, chats, and text. People are more interested in checking their mobile phones than engaging in any meaningful conversation. This new form of social order has strengthened public and mass communication but weakens interpersonal communication (Bala, 2014).

Brady, Holcomb, and Smith (2010) surveyed 50 online students enrolled in three different courses to determine their perception of social media network for distance learning. *Ning*, a social media platform, was the subject of study in the work. The authors show that 70% of the respondents agreed that *Ning* facilitates communication among peers relative to face-to-face class interaction. Additionally, 82% of the respondents indicated that *Ning* facilitated interaction outside of the class, and 74% agreed that *Ning* gave them the chance to think and comment about other people's work.

Communication is defined as a way of interacting with diverse communities and individuals who are different from oneself, and as an indispensable medium for appreciating and understanding divergent views of people (Buzzanell, 2000). In an alignment, Guffey (2008) defines communication as a process in which a sender encodes a message and sends it over a channel. This may be physical or face-to-face, telephone, email or through other transmitting media, wherein the receiver decodes and makes meaning of it (Kayode, 2018). Meanwhile, communication in a social group is defined as group members' evaluation of the level of group discussion effectiveness and development (Qi, 2019). Communication is said to be a critical factor in social media usage in the educational landscape. According to Fox (2017), the most significant advantage of social media is communication, which is evident in social media's ability to facilitate connection with peers and "anyone", "anytime", "anywhere". Social media assists communication through synchronous and asynchronous exchange of information, which may be text, graphics, audio, and video (Qi, 2019). Consequently, it engenders collaborative learning that motivates learners toward the achievement of better results. Social media has found its place in education as

a critical tool of communication among teachers, students, and their peers, offering new possibilities for communication and interaction, as well as creating new learning spaces.

Previous studies have shown that communication bridges the information divide between students and teachers, given that information and communication technologies, and administrative support assist in the actualization of learning outcomes (Sobaih and Moustafa, 2016; Ahmad, et al., 2010). Abbas, Aman, Nurunnabi et al. (2019) reported that results from a Massive Open Online Courses (MOOCs) delivered through social media showed improved performance of the students. Furthermore, it indicated that the involvement of social media and technology in learning programs did help in reducing the number of students who dropped out of the programs.

Salvation and Adzharuddin (2014) highlighted the relationship between social media communication and academic performance. The communicative affordances offered by the social media platform such as exchange of ideas through discussion and chat forums between learners, their peers, and teachers enhance academic performance. Griffith and Liyanage (, 2008) reported that support from instant messaging, wikis, blogs, discussion boards and other Web 2.0 devices complements the traditional mode of instruction.

Moreover, Hershkovitz and Forkosh-Baruch (2013) argued that these tools are generating several questions about the impact of student-teacher communication on the teaching-learning process. Similarly, Dabbagh and Kitsantas (2012) asserted that social media is capable of fostering the creation of a personal learning environment that empowers students to take control of their learning by selecting, creating, and organizing resources that assist in the achievement of set learning goals and task performance. In contrast, Abbas et al. (2019) warned that despite the overwhelming importance of social media in the everyday life of learners and instructors, users must ensure a healthy balance as it has been reported that social media has both positive and negative impacts on students' learning processes (van Zoonen, Verhoeven, & Vliegthart, 2017). As an evolving phenomenon, studies on social media are still growing. However, these research efforts have thrown up mixed outcomes, which has made continuous research an imperative endeavor. Despite the growing interest in research on social media in the teaching-learning process (Qi, 2019; Abbas, Aman, Nurunnabi et al., 2019; Diyaolu & Rifqah, 2015; Wickramanayake & Jika, 2018), there are few studies based on the relationship between social media usage, communication and tie strength, especially in the context of computing education and developing countries.

### **Tie Strength in Social Network Communications**

Researchers define tie strength as the weight or robustness of the bond of the relationship shared in a social network or interaction. Gilbert and Karahalios (2009) affirmed that the strength of ties in social network influences the level and quality of communication in the network. Granovetter (1973) identified four features of tie strength: *intimacy, amount of time, intensity, and complimentary services*. While these features describe tie strength, the researchers further described two types of ties: *strong* and *weak* ties. The strong tie is between people with a strong bond of trust between them with overlapping social circles, while weak ties are based on acquaintance occurring outside the network of friends. The present study seeks to measure the influence of tie strength on the relationship between computing education, students' usage of social network and their learning outcomes or task performance.

In line with Qi (2019), this is an exploration of the relationship between students' social media usage and their constructive learning performance in a senior-level undergraduate business course with a specific focus on the mediating role of communication in group and the moderating role of tie strength. Using quantitative research design, results collated through Facebook usage revealed frequent social media usage by the business students increased communication among



group members. In addition, the researchers found that communication in groups enhanced perceived group task performance of students. While tie strength negatively moderated the relationship between social media usage and communication in the group, the study reported a significant relationship between social media usage and communication, between communication in group and perceived task performance, and between interaction effect and communication in the group. However, no significant relationship was found between social media usage and perceived task performance. The exogenous variables (social media usage and communication) in the model explained 23% of the variance in perceived task performance.

## **HYPOTHESIS DEVELOPMENT**

In this section, the hypotheses for this study are formulated and pictorially represented in Figure 1. The various constructs, in line with the theories, are supported by extant literature.

### **Social Media Usage and Learning Outcome**

The past few years have seen social media used for several purposes, depending on the domain and context of use. In education, for instance, the interactive nature of social media has advanced collaborative learning among students and their teachers (Mushtaq and Benraghda, 2018). Students who use social media regularly create their own communities with shared interests and activities. Popescu and Ghita (2013) found that social media improves learning and have advocated for its adoption in the educational ecosystem. Irrespective of the relevance and impact of social media in education, some researchers maintain that social media has a negative influence on students' learning outcome (Noreen, 2017; Mustafa, 2018). Because of this paradox, we propose and seek to investigate the hypothesis that:

*H1: Social media usage for computing education is positively related to the perceived learning outcome.*

### **Social Media Usage and Group Communication**

Social media platforms are increasingly used in education. Despite the challenges, students are often allowed to use social media to improve teaching and learning. Social media improves collaborative learning and social interaction among students. Al-Rahmi & Zeki (2017) assert that collaborative learning positively influences students' learning outcome (Al-Rahmi & Zeki, 2017). This result and many other related findings have prompted computing education researchers to integrate systems that allow collaborative learning, such as social media and its related platforms. In recent years, some schools have recognized the use of WhatsApp as a medium wherein students are allowed to engage in group discussion (assignments and group tasks) with each other and their teachers. With the use of social media platforms, students can co-create knowledge, share experiences, work, and learn collaboratively (Popescu, 2013). Conversely, research has found that students prefer to use social media for informal social interaction other than academic engagements. The influence of social media usage on group communication, especially in education, has been researched less in developing countries. While this may be so in the educational arena, Kolog et al. (2018) found that students in Ghanaian senior high schools are not allowed to use any electronic device to engage in collaborative learning. Given this gap and the paradox of its impact on education, we hypothesize:

*H2: Social media usage is positively related to communication in groups.*

### **Group Communication and Learning Outcomes**

Group communication in education is considered an essential approach for students and teachers to co-create and share knowledge (Riedel, 2013). While there are educational technology tools designed to motivate group communication, social media is widely considered a readily available platform for group communication and collaborative learning. In effect, collaborative learning

environments, such as WhatsApp and Facebook, motivate group communication. Social media features, such as video and voice, facilitate group communication, and provide flexibilities for teaching and learning. Fox (2017) noted that social media websites have improved students' communication as they can connect with their classmates easily. Students can interact at anytime and anywhere provided there is a stable Internet connection. Despite the benefit of social media on facilitating group communication, some researchers are skeptical about its influence on students' learning outcomes. Sobaih, Moustafa, Ghandforoush, Khan (2016) maintain that some students do not harness the potential of social media to learn but use the platform for their parochial interest, which fails to improve learning outcome.

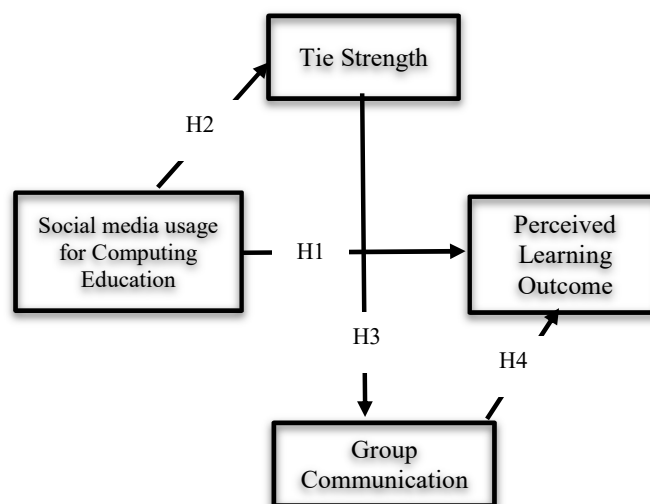
In view of this, we hypothesize in this study that:

*H3: Communication in group is positively related to perceived learning outcomes.*

### **Tie Strength Moderates Social Media Usage and Group Communication in Computing Education**

Social media usage and group communication are related attributes. Social media is thought to improve group communication and facilitates learning. However, social media linkage to group communication is moderated, among other factors, by tie strength. Mark Granovetter first introduced tie strength in his paper "The Strength of Weak Ties" (Granovetter, 1973). The concept defines the degree of relationship that one shares with other people. The term is commonly used in social media because of its tie in nature. In computer science education, tie strength can be used to study students' collaborative tie with others, including their teachers. Tie strength is characterized into two: strong and weak (Marsden, 1981). Several indicators of tie strength have been proposed by researchers to explain the strength of association among people. The most important indicator of tie strength – the strength of weak ties – was proposed by Granovetter (Granovetter, 1973). Granovetter differentiated between strong and weak ties, and hypothesized that "the stronger the tie between any two people, the higher the fraction of friends they have in common." This hypothesis was later taken up and researched by researchers in a diverse context. Naturally, in a social setting, students have very close relationships (strong tie) with few friends and family members, and tend to have a rather weak tie or a somewhat weaker tie with a larger group of individuals with whom they interact less frequently (Mattie, Engø-Monsen, Ling & Onnela, 2018). In this study, we hypothesize:

*H4: Tie strength negatively moderates the effect of social media usage for computing education on communication in groups.*



**Figure 1: Research Model**

## **RESEARCH METHODOLOGY**

This section explains how the study was designed, how the instruments used for data collection were obtained, the participants in the study, and what approach was utilized to analyze the data. This study applies quantitative research method to investigate the hypotheses presented in the earlier section. Quantitative research method provides a scientific foundation for a study. It also gives the possibility for generalization of findings and replicability of the study. Most importantly, the method reduces bias that is common with other research methods. In other words, the method ensures objectivity (Eyisi, 2016; Creswell, 2009).

### **Study Design and Survey Tool**

The data used in this study were collected by sending questionnaires to students who physically presented themselves to voluntarily respond to the list of questions. The questionnaire consisted of personal and hypothetical questions. The list of questions was adapted from standard studies, such as Gilbert and Karahalios (2009), Bal and Bicen (2017), Saini and Abraham (2019) and Qi (2019). In general, these questions are connected by the constructs of the study, which consist of social media usage, communication in the group, tie strength, and perceived learning outcomes. The questions were close ended, giving the participants the opportunity to select from a list of provided options. The options were formulated as a five-point Likert scale (that is, 1 for strongly disagree and 5 for strongly agree).

### **Participants and Ethical Considerations**

The goal of this study is focused on higher education institutions. Specifically, the study intends to investigate the use of WhatsApp among the university students for computing education. Regarding the context, two Nigerian universities from different geopolitical regions were involved in the study. One of the universities is located in the North-West of Nigeria while the other is located in North-Central. The study considered students who major in computer science for their degree. The consent of these universities and their students was sought before administering the survey. No incentive of any kind was given to the respondents, since participating in the study was voluntary. One of the co-authors carried out the distribution of the questionnaires, during which an explanation regarding the aim of the study was given and students were asked to provide their honest responses to the list of questions. In the end, three hundred and thirteen (313) students responded to the questionnaires.

### **Method of Data analysis**

According to Fellows and Liu (2008), statistical analysis extracts essential information on data, and it enables researchers to have new knowledge or mutual understanding of their study. Thus, the conceptual constructs from the hypotheses for this study were tested through Structural Equation Modelling (SEM), beginning with Confirmatory Factor Analysis (CFA). CFA examines constructs in relation to SEM. After CFA, reliability analysis was done to get Cronbach's alpha ( $\alpha$ ), to ensure the reliability of the data. Tests of convergent and discriminant validity were then conducted to prove the validity of SEM. Lastly, partial least square, using bootstrapping, was conducted to test the hypotheses. All these tests were conducted using SmartPLS 3.0 software.

## **RESULTS**

Table 1 shows the demographic summary of the participants. From the table, we note that the number of male ( $n= 260$ ) participants in the study was more than that of female participants

(n=53). This gender difference does not have any influence on the study as the focus is generally geared towards social media impact on computing education.

Tables 2, 3, 4 and 5 show the validity indicators, such as the composite reliability (CR), the average variance extracted (AVE), the latent variance phenomenon, as well as all the observable independent variables. The study estimates the path model and parameters in Smart PLS version 3.0 to assess the measurement model and to evaluate the structural model using the guidelines for PLS-SEM given by Hair Jr et al. (2016). In the model, all the variables were reflective. The reliability and validity of the constructs were assessed using indicator loadings in each variable. There were no items that had factor loading below 0.5 for average variance extracted, therefore none of the variable items were removed.

**Table 1: Participants' Demography**

	<b>Characteristics</b>	<b>Freq.</b>	<b>Percentage</b>
<b>Gender</b>	Male	260	83.07
	Female	53	16.93
<b>Age</b>	17 or younger	10	3.19
	18-25	238	76.04
	26-35	63	20.13
	35-45	2	0.64
	45 and above		
<b>Year of Study</b>	100 Level	8	2.56
	200 Level	120	38.34
	300 Level	173	55.27
	400 Level	12	3.83
	Twitter	22	7.03
<b>Device used for SM</b>	Facebook	110	35.14
	YouTube	7	2.24
	LinkedIn	2	0.64
	WhatsApp	172	54.95
<b>ATS on SM/day</b>	1hr or less	136	43.45
	2-4hrs	116	37.06
	5-7hrs	32	10.22
	8-10hrs	10	3.19
	11hrs or more	19	6.07
<b>Use of SM</b>	Chatting	99	31.63
	Educational purpose	113	36.10
	Calling	13	4.15
	Social credibility	30	9.58
	Enhanced LMS	43	13.74
	building relationship	15	4.79

*NB: SM – Social media and LMS – Learning management system, ATS – Average time spent*

Variance Inflation Factor (VIF) determines the degree of correlation between predictors in a model. It is a diagnostic tool to check the presence of collinearity or multicollinearity. Higher values of VIF indicate difficulty in assessing the contribution of predictors to a model. This study computes as:  $VIF = \frac{1}{1-R^2}$ . However, there is a divided opinion on the Threshold of VIF. Some agree on the maximum level of 5 (Ringle, Wende and Becker, 2015), while (Hair, Anderson, Tatham and Black, 1995) recommend a maximum level of 10. In Tables 2 and 5, our inner and outer VIF were less

than (2). Results show that our predictor's correlation is free from collinearity or multicollinearity issues.

The results from Table 2 indicate that all the items loaded well and the composite reliability (CR) of all the constructs (range from 0.77 to 0.85) was superior to the threshold value of 0.70, the average variance extracted (AVE) of each construct; (communication in the group (CG) = 0.82, Perceived Learning Outcome (PLO) = 0.85, Social Media Usage (SMU) = 0.77 and Tie Strength (TS) = 0.82) exhibit individual reliability coefficients exceeding the minimum threshold of 0.5, indicating that reliable indicators exist. The composite reliability, just like Cronbach alpha, was used to assess the reliability of the responses and the degree of bias in the sample. According to Hair Jr. et al. (2014) in exploratory studies, composite reliability coefficients of (0.60 - 0.70) are considered to be good, and coefficients of (0.70 - 0.90) are considered satisfactory for the other types of research (Hair Jr. et al., 2014). The high external loadings (CG)=0.82, (PLO) =0.85, (SMU) =0.77; (TS) =0.82), within the same construct indicate that the associated or correlated indicators are significantly common with the phenomenon. The latent construct which captures the external loadings of all indicators was statistically significant. This study concludes that reliable indicators exist because composite reliability, just like Cronbach's alpha, is used to assess the reliability of the responses and the degree of bias in the sample.

**Table 2: Items loading and outer variance inflation factor**

	Communication in Group	Perceived Learning Outcome	Social Media Usage	Tie Strength	Outer VIF
QPL1		0.70			1.32
QPL12		0.78			1.77
QPL13		0.79			1.77
QPL14		0.74			1.57
QPL7		0.65			1.27
QST1				0.89	1.41
QST2				0.69	1.29
QST3				0.75	1.38
SMCG2	0.76				1.21
SMCG4	0.78				1.39
SMCG5	0.79				1.39
SMU1			0.79		1.07
SMU3			0.80		1.07

**Table 3: Quality criteria for social media mode**

	Composite Reliability	Average Variance Extracted (AVE)	R Square
Communication in Group	0.82	0.60	0.12
Perceived Learning Outcome	0.85	0.54	0.22
Tie Strength	0.82	0.61	0.01
Social Media Usage	0.77	0.63	

**Table 4: Correlation of social media variables**

	Communication in Group	Perceived Learning	Social Media	Tie Strength
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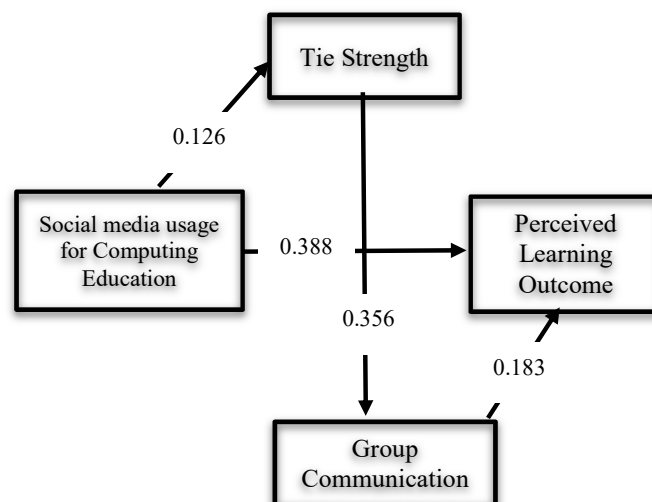
		Outcome	Usage	
Communication in Group	<b>0.78</b>			
Perceived Learning Outcome	0.30	<b>0.73</b>		
Social Media Usage	0.29	0.44	<b>0.79</b>	
Tie Strength	0.36	0.21	0.13	<b>0.78</b>

The coefficient of determination ( $R^2$ ), and the path coefficients ( $\beta$ ) were employed as the major criteria to evaluate the predictive significant purpose of the structural model (Hair et al. 2011). To ascertain the discriminant validity of the constructs the square root of the AVE of the latent variable obtained from SEM in SmartPLS must be higher than 0.7 as indicated in Table 3. Since the square of AVE's of all latent constructs are superior to the correlation coefficients, it can be concluded that discriminant validity exists.

The coefficient of determination ( $R^2$ ) was employed as the major criterion to evaluate the significant predictive purpose of the structural model (Hair et al., 2011). ( $R^2$ ) values range from 0 - 1, with higher levels indicating higher accuracy. However, it depends on the model complexity and the research discipline (Hair Jr et al., 2016).  $R^2$  values 0.18 is considered to be weak, 0.40 indicates moderate and 0.70 is regarded as a substantial variance for a given model (Henseler, Ringle and Sinkovics 2009). The CG and PLO, SMU and TS accounted for 0.12, and 0.22 of the variance explained by the model, indicating a weak predictive validity of the model over the substantial value (0.70= 70%).

### Hypotheses Results

The hypotheses results indicate the path-coefficient of university communication in the group, social media usage, tie strength as predictors of perceived learning outcome, tie strength, and communication in the group. All the predictors and outcome variables of Beta and T Statistics are significant. The results obtained from the bootstrapping of 5000 subsamples indicated that P-values for CG->PLO, SMU->PLO, SMU->TS and TS->CG were (0.01), (0.04) and (0.00) respectively. Therefore, all the path coefficients were significant at a 95% confidence interval, which confirms the predictive validity of the model. The path coefficients ( $\beta$ ) also considered as the sample mean were used to examine the predictive power of the model. Research reveals that ( $\beta$ ) values closely approaching 0.20 and 0.30 or superior exhibit good predictive power of the model (Chin, 2010). The ( $\beta$ ) values for SMU->PLO (0.39, SD=0.06, (t) =6.21), SMU->TS (0.13, SD=0.06, (t) =2.10), and TS->CG (0.37, SD=0.06, t=6.40) were superior to the recommended level of 0.20 except for the path from CG->PLO which is (0.18, SD=0.07, (t) =2.73) as shown in Table 5. The hypothesized model shows that tie strength is the highest predictor of communication in the group, while social media usage is the highest predictor of perceived learning outcome; communication in the group is the lowest predictor of perceived learning outcome. Also, social media usage predicts tie strength significantly.



**Figure 2:** Path coefficients of the Model

**Table 5:** Latent variable relationship and inner variance inflation factor

	Sample Mean	Standard Deviation	T Statistics	P Values	Inner VIF
Communication in Group -> Perceived Learning Outcome	0.18	0.07	2.73	0.01	1.10
Social Media Usage -> Perceived Learning Outcome	0.39	0.06	6.21	0.00	1.10
Social Media Usage -> Tie Strength	0.13	0.06	2.10	0.04	1.00
Tie Strength -> Communication in Group	0.37	0.06	6.40	0.00	1.00

**DISCUSSION AND IMPLICATIONS**

This study examined the role of social media in computing education and investigated the influence of social media usage on perceived learning outcomes of students in Nigeria. To achieve these objectives, this study was grounded in the social constructivism and social identity theories where four unobserved latent variables were deduced. It was based on these theories that, tie strength, social media usage for computing education, group communication and perceived learning outcome were curved. Thus, we tested four different hypotheses with t-statistics in PLS\_SEM with 0.05 significance level. As reported in Tables 1- 5, this study revealed interesting results, which largely suggest a positive influence of all the predictor variables on students' learning outcomes. This study was based on the use of WhatsApp by students in two institutions of higher learning in Nigeria. Given this, we elicited students' perception of their preferred choice of social media platforms for computing education. The study revealed that, among other social media platforms, students dominantly use WhatsApp (55%) for communication and other academic activities. This is followed by Facebook (35%), which is the second favorite social media platform for learning. This finding reinforces the need for undertaking this study that aims at finding the factors that influence WhatsApp usage on students' learning outcomes in computing education.

From Table 5, social media usage for computing education was found to influence the perceived learning outcomes of students in Nigeria. This finding suggests that students value the use of social media, particularly WhatsApp, for their academic work. This finding lends support to the work of Chang, Tu and Hajiyev (2019) who found that the use of social media for task-based and academic-related activities positively impacts students' performance. This finding implies that social media could improve student learning performance in computing education. Students use WhatsApp to interact and collaborate effectively with their peers and teachers. This finding is in line with an earlier study by Oyelere, Paliktzoglou & Suhonen (2016) in which students agreed that the social media learning tool, *Edmodo*, facilitated participation, personal reflection, collaboration, flexible learning, and discussion with peers and the course instructor. In addition, Alwagait, Shahzad and Alim (2015) opined that social media use does not affect students negatively. However, the researchers were quick to add that users of social media can be negatively influenced if they are abused through social media platforms. This paradox has generated an ongoing debate on the impact of social media use on students' academic performance (Lau, 2017). While social media is touted to promote collaborative learning,

especially in institutions of higher learning (Lane, 2016), other schools of thought believe the disadvantages of social media usage outweigh that of the advantages (Abbas, Aman, Nurunnabi and Bano (2019). Abbas, Aman, Nurunnabi and Bano (2019) found that students, instead of harnessing the potentials of social media for studies, rather rely on it for non-academic activities, especially for social interaction only.

The influence of communication in groups on perceived learning outcome was found to be significant. This implies working in groups improves students' academic outcomes. Many social media users, mainly on WhatsApp, belong to groups as a way of satisfying their social, psychological, academic and informational needs (Gazit and Aharony, 2018). Accordingly, these groups use social media to promote collaborative learning, which has become a critical part of their success in essential issues. Lane (2016) provided evidence to suggest that a collaborative learning environment, such as WhatsApp, is satisfying to students and motivates them to continue their learning experience. To complement this is the fact that Nigeria scores very high on Hofstede's collectivism model (Zagorsek, Jaklic and Stough, 2004), so, in-group and communal living is a dominant part of the social system. Kolog et al. (2018) and Oyelere, Paliktzoglou & Suhonen (2016) found the use of electronic devices, in the academic environment, as tools for promoting social and collective learning. However, the researchers cautioned that electronic devices used in academic environments must be used under strict conditions that gear towards learning. From the data in Table 5, we note that a positive relationship was established between social media for computing education and communication in groups. There are various uses of social media but more people, particularly students, find it more productive when they use it to learn in groups (Fauzi, 2019). This finding suggests that social media, particularly WhatsApp, promotes collaborative learning. With WhatsApp, students who shy away from seeking face-to-face academic help from teachers and peers have the opportunity to interact remotely. Conversely, in a social environment, some students prefer to be taught and be passive learners, rather than active learners (Lane, 2016). Finally, our study shows that social media relates positively to tie strength, which tends to influence communication in groups. As pointed out earlier, this finding demonstrates the role of social media in promoting tie strength among students.

This study has contributed to theory and practice. Theoretically, this study adds to existing knowledge by adapting social constructivism and social identity theories to study the factors that influence students' outcome using WhatsApp as a learning tool, where two unobserved latent constructs were introduced: *Tie strength* and *communication in-groups*. From the best of our knowledge, this study is the first of its kind to combine these two theories to study WhatsApp's effect on students' learning outcomes. Additionally, there is increasing adoption of social media for computing education in Africa, but there is a scarcity of knowledge on how its use impacts students' academic performance. The current study fills this gap by not only examining this phenomenon but also by indicating in practical terms how social media is used to influence students' academic performance. Practically, our study provides critical insights for administrators of educational institutions and app developers. For academic institution administrators, particularly from Africa, modern teaching and learning aids are changing how students learn. The findings of this study seek to guide policy formulation on the use of social media for social and collaborative learning in two institutions of higher learning in Nigeria. It technically brings out the determinants of students' learning outcomes when using social media, such as WhatsApp. With these findings, teachers can be guided to effectively incorporate and motivate the use of social media in teaching and learning. We recommend, accordingly, that management should come up with clear guidelines on how teaching can be conducted virtually. WhatsApp and many other social media platforms were developed in the Western world with no consideration for indigenous or local contents. This omission leaves mobile app developers with a challenge to develop apps that do not only have local content but can aid teaching and learning with the local content. A



practical example is to develop apps that have at least the three major Nigerian languages in addition to the English Language. In this way, students can quickly learn in the language of their choice. This study was conducted in Nigeria, in which WhatsApp was used as a social media platform to determine its impact on students' learning outcomes.

Just like WhatsApp in this study, we recommend that other social media platforms such as Facebook be explored to ascertain their impact on students' learning outcome in the developing country context. Thus, a comparative study can be conducted with other countries in the developing country context. Uses and gratification theory can be adapted to explore further the impact of social network use on students' learning outcomes. Studies on social media for computing education have to dwell mostly on task and non-task-based activities and its effect on students' performance (Chang, Tu and Hajiyev, 2019; Alwagait, Shahzad and Alim, 2015). However, this study introduces the dynamics of in-group relationships.

## CONCLUSION

The current influx and easy access to smartphones among students of all classes in developing countries have resulted in them developing and using social media applications for various purposes. The implications of access to these social media apps on students' academic and social performance have been studied. However, little is known about the perceptions and opinions of tertiary students regarding the use of social media apps for learning computing education. Therefore, this paper aimed to investigate the role of a free messenger app, WhatsApp, on the socio-cultural behaviors of tertiary students, vis-à-vis its implications in teaching computing education in a Nigerian context. The results of the study emphasized a positive relationship between WhatsApp usage for computing education and perceived learning outcomes. Students' academic performance was positively improved with the use of WhatsApp for academic-related purposes. The study further emphasized the benefits of joining academic groups, as communication in-group among students was linearly related to perceived learning.

Additionally, communication in-group promoted tie-strength among students who are group members. The use of social media such as WhatsApp, and in particular belonging to academic groups, should not replace the real-life classroom but could serve as a virtual classroom where students support one another with the sole aim of achieving academic success. Here, privilege is given to the weak students to benefit more from the brilliant members of the group. Academic management could, therefore, encourage 'virtual classes' where students share and benefit together, for the purpose of improving their academic and also socio-cultural performances. However, management needs to come up with clear guidelines on how teaching can be conducted virtually, while also establishing regulations to guide the conduct of group members.

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