Inornatus: Biology Education Journal
Volume 5, Issue 1 (2025): 1 – 15
DOI: 10.30862/inornatus.v5i1.731

Relative effectiveness of Google classroom and WhatsApp in enhancing biology interest among Nigerian university students

Josephine Nwanneka Okoli[1], Geoffrey Ukala[2,*]

[1]Department of Science Education, Nnamdi Azikwe University, Awka, Nigeria
[2]Department of Science Education, University of Nigeria, Nsukka, Nigeria

*Corresponding author, email: geoffrey.ukala@unn.edu.ng

Submitted: 09-10-2024

Accepted: 04-12-2024

Published: 01-01-2025

Abstract: This study compares the effectiveness of Google Classroom and WhatsApp in enhancing biology interest among university students in southeast Nigeria. A quasi-experimental, specific, non-randomized pre-test and post-test compare group design was used. The population comprised 252-year undergraduate biology education students from the five Federal Universities in South-East Nigeria, out of which 118 (70 male and 182 female) students were purposively sampled from two universities. The instrument used for data collection was the Biology Interest Inventory (BII). Mean and standard deviation were used to address the research questions, whereas ANCOVA was utilized to evaluate the hypothesis. Results showed that students instructed using Google Classroom instruction had higher mean interest scores than their counterparts taught using WhatsApp instruction. Although female students were found to have slightly higher interest than males on the test of significance, gender was found not to have a significant influence on students' mean interest scores. Implying that both instructions enhance students' interest irrespective of gender. Similarly, no interaction effect of instructional strategies and gender on students' interest in basic biology was found. It was recommended that training programs should be implemented to ensure both students and instructors are proficient in using these platforms to their full potential.

Keywords: Academic interest, instructions and biology, Google classroom, WhatsApp

Abstrak: Studi ini membandingkan efektivitas *Google Classroom* dan *WhatsApp* dalam meningkatkan minat biologi di kalangan mahasiswa di Nigeria Tenggara. Kuasi eksperimen dengan *non-randomize pre-test post-test compare group design* digunakan. Populasi terdiri dari 252 mahasiswa pendidikan biologi sarjana tahun dari lima Universitas Federal di Nigeria Tenggara, yang mana 118 (70 laki-laki dan 182 perempuan) mahasiswa diambil secara *purposive* dari dua universitas. Instrumen yang dipakai untuk pengumpulan data adalah Inventaris Minat Biologi (BII). Nilai rata-rata dan standar deviasi digunakan untuk menjawab pertanyaan penelitian, sedangkan ANCOVA digunakan untuk mengevaluasi hipotesis. Temuan penelitian mengungkap bahwa siswa yang diajar menggunakan instruksi *Google Classroom* memiliki skor minat rata-rata yang lebih tinggi daripada rekan-*rekan* mereka yang diajar menggunakan instruksi *WhatsApp*. Meskipun siswa perempuan ditemukan memiliki minat yang sedikit lebih tinggi daripada laki-laki pada uji signifikansi, jenis kelamin ditemukan tidak berpengaruh signifikan terhadap skor minat rata-rata siswa. Hal ini menyiratkan bahwa kedua instruksi tersebut meningkatkan minat mahasiswa tanpa memandang jenis kelamin. Demikian pula, tidak ditemukan efek interaksi yang signifikan antara strategi pengajaran dan jenis kelamin terhadap minat mahasiswa terhadap biologi dasar. Disarankan agar program pelatihan dilaksanakan untuk memastikan bahwa siswa dan instruktur mahir menggunakan platform ini secara maksimal.

Kata kunci: Minat akademis, instruksi dan biologi, Google Classroom, WhatsApp

INTRODUCTION

Globally, the development of digital technology has transformed the education sector, and Nigeria, is not left out. The irruption of different digital learning platforms, initially designed for leisure, are now reshaping the way people learn and teach in classrooms (Tondeur et al., 2016). The act of teaching involves the transfer of knowledge through a variety of instructional strategies to establish a lasting impact on learning (Kasim et al., 2024; Pambudi et al. 20223; Nasir et al., 2020). The reinforcing of teaching and learning outcomes through innovative instructional strategies has been a major concern in the business of education globally. The goal is to prepare learners that will be productive academically both during and after their learning period. Teachers can facilitate the discovery of new information, the development of knowledge, the testing of new ideas, the development of skills, and the improvement of students' academic performance by incorporating a diverse array of learning opportunities into their instruction, as per (Baransano et al., 2017; Damopolii et al., 2019; Olugbenga, 2016; Saputra et al. 2024).

In the 21st century, learning and instruction in schools necessitates the use of computers by instructors as a meaningful instructional strategy (Ala et al., 2023). Both instructors and learners can effectively use Google Classroom and WhatsApp Instructions, which are microcosms of computer-assisted instruction, to enhance learning. It is imperative to implement technology-based platforms to enhance the instruction and learning of biology to enhance student performance (Okoli et al., 2022). According to Upula et al. (2019), countries worldwide are adopting technologies to remain current and pertinent in industries such as medicine, transportation, manufacturing, entertainment, and education. Similarly, Bates (2017) noted that teacher's ability to incorporate digital platforms like Google classroom and WhatsApp in instruction delivery varies, even though, effective instructions delivery require teacher to uses diverse pedagogical approaches and tactics to support students in the learning environment (Ala et al., 2023).

Visual, auditory, and motion-enabled qualities are among the intriguing features of Google Classroom and WhatsApp instructions, which render their integration into the educational process increasingly important (Baglama et al., 2018). Google classroom is a complimentary online learning management system (LMS) established by Google in 2014, and are only accessible to users with Google Applications for Education (GAFE). GAFE is a robust cloud-computing system that operates independently of students' location, time, and device type (Lalap Jr, 2021). GAFE accounts users have access to free collaborative sets of web tools such as Google classroom,Google docs, drive, Gmail, and more (Locketz, 2019). It streamlines the process of creating, distributing, and grading assignments in an educational environment (Lalap Jr, 2021), supports a structured approach to learning (Albashtawi & Bataineh, 2020).

Conversely, WhatsApp is an application of instant messaging that enables users to transmit text, video and voice messages, emoticons, and both animated and static photos

(Durgungoz & Durgungoz, 2022). WhatsApp's global popularity in education stems from its perceived simplicity, enjoyment, and utility by both educators and learners (Gasaymeh, 2017), as it integrates instructional components with engaging features, including auditory, visual, and interactive components (Magde et al., 2019). Like Google classroom, WhatsApp is free and very easy to use (Hidayawati, 2020), enables multimedia sharing among group members (Anjarwati & Sa'adah, 2022), enables online collaboration and support between students-student and teacher -students, connect easily with people around the world (Rachmawaty 2021).

With the multisensory nature of WhatsApp and Google classroom instructions, if applied in biology classroom, it would stimulate students' senses and allow interaction between students and teachers (Hussaini et al, 2020). They provide educators with tools to organize class materials, deliver assignments, facilitate discussions, provides a good user interface and deliver prompt feedback (Jordan & Duckett, 2018; Locketz, 2019). With feature like real-time feedback, Google Classroom and WhatsApp will helps to engage students cognitively by encouraging deeper interaction and foster a more organized academic experience, making it a popular choice among educators, particularly in higher institutions (Martín-Roda & Sassan-Luiz, 2016). Studies show that both Google Classroom and WhatsApp instructions facilitates collaborative learning, positively influence students' performance, and increases students' perception and interest positively (Albashtawi & Bataineh 2020).

Despite the numerous advantages of Google Classroom and WhatsApp instructions studies shows that lecturers still prerfer the conventional face-to-face instruction and learning sciences especially biology (Yelamali & Beelagi, 2021). Gupta and Pathania (2021) adduced that the adoption of Google Classroom among lecturers as pedagogy is still very low. Similarly, to the best of the researcher's knowledge, no work has been done using both GC and WhatsApp instructions within the content and area scope of the study to determine its relative effectiveness in enhance undergraduate students' interest in universities. Interest is a psychological force that propels an individual or student into executing an action. Nasir et al. (2023) characterized interest as a compelling impetus that prompts an individual to focus on a person, thing, or action. It is the resultant feelings of enjoyable, profitable and complete satisfaction (Serdyukov, 2017).

Studies revealed that students' interest in a course, is correlated with academic achievement and engagement (Bond bet al., 2020; Mappadang et al, 2022; Mustofa et al., 2024). Similarly, Onu et al. (2020) found that students' poor academic achievement in biology is linked to a lack of interest. A separate study revealed that students with more academic interest often attain better levels of success (Amerstorfer, 2020; Mappadang et al, 2022). However, in contrast to the above finding, Meyer et al. (2019) discovered that students' academic interest does not correspond with academic success and interest. With the contradictory findings, one cannot fully state the real state of interest with respect to its

influence on students' academic performance. Many problems contribute to students' diminished interest in biology, including a lack of understanding of the subject and the absence of well-equipped scientific laboratories (Glory & Sopuruchi, 2017; Ukala & Ugwu, 2019).

Additional factors include insufficient funding for the acquisition and upkeep of the little equipment available, as well as ineffective pedagogical tactics used by the instructors (Hayuana et al., 2024; Obanya, 2021), lack of workshop centres for in-service training of teachers, lack of textbooks, journals and materials needed for professional growth (Mappadang et al, 2022) as well as teacher inability to deploy gender friendly methods/strategies (Nasir et al., 2023). Gender is a socio-cultural construct developed by society to ascribe characters, and mental and emotional roles to sex. Ukala (2018) defined gender as the attributes or characteristics associated with being a man or woman, male or female, boy or girl. In Nigeria, due to a strong culture and religion affiliations, issues of gender have remained topical in academic discussion. Researchers such as Ugwu and Nwagbo (2019), and Ukala (2018) agreed that gender discrimination stifles the growth and actualization of students' potential especially among women. Kang and Keinonen (2018) reported that when male and female are subjected to the same teaching condition, they have equal academic engagement and achievement.

The problem, therefore, is the absence of empirical evidence comparing the relative effectiveness of Google Classroom and WhatsApp in enhancing academic interest among biology education students in this region. In the absence of this knowledge, educators and university administrators may struggle to make informed decisions on which platform to prioritize, potentially hindering student learning outcomes and interest. The deployment of internet and technology into classrooms, especially through digital platforms like WhatsApp application and Google classroom are now performing magic in the realm of education (Umroh et al., 2024). As technology is being used as a medium for learning, the connection between education and technology is becoming inextricable. Digital platforms used in education according to Agustian and Salsabila (2021), include but not limited to Schoology, Google Meetings, Zoom, talentLMP, Google Classroom, Module, and WhatsApp.

WhatsApp is the most popular and successful learning medium among these due to its simplicity of use and accessibility. It can be utilized as a practical educational platform in digital learning (Rukmana & Inayah, 2023). Additionally, Google Classroom is a service or feature of Google that facilitates instructors and learners to participate in digital educational activities (Hussaini et al., 2020). Google Classroom facilitates the process of teaching and delivering knowledge to students in a precise and appropriate manner, which is advantageous for educators (Sudarsana et al., 2019). In the same vein, research conducted by Azhar and Iqbal (2018), Harjanto and Sumarni (2019), Scholl (2019), and Subandoro and Sulindra (2019) demonstrated a substantial disparity in students' interest between learning through Google Classroom and WhatsApp. In light of the existing gap in literature regarding which platform

reign supreme, this study aims to dive deep into the comparison and uncovers the insights that will help guide users in making informed decisions that would ultimately promote students' academic interest in universities in South East Nigeria. This study compares the effectiveness of Google Classroom and WhatsApp in enhancing biology interest among university students based on gender differences.

METHOD

This study used a quasi-experimental design with pre-test and post-test in two comparison groups. The design was considered appropriate for the study because quasi-experimental design does not permit random assignment of participants into experimental groups (Nworgu, 2015). That implies that intact classes were used to avoid the disruption of normal class periods. The study was carried out in South-East Nigeria, specifically, Federal Universities in South-East Nigeria. The justification for the area was; due to huge commerce and several money-making opportunities, students lack interest in learning and prefer activities that bring fast money instead of academic. Another justification is the consistently report of poor academic achievement among undergraduate students in the area.

The research population consisted of 252 (70 male and 182 female) first year undergraduate biology education students for 2023/2024 academic session in Federal Universities in South-East Nigeria offering basic biology for science education students (SED III). Purposive sampling techniques were used to sample 118 (36 male and 82 female) first year undergraduate biology education students from two out of the five Federal Universities in Southeast Nigeria. The choice of these universities is because they offer this course (basic biology for science education students), and they have the facilities that enable the use of Google Classroom and WhatsApp instructions as well as other ICT facilities the students need for the study such as strong and free internet connection.

Biology Interest Inventory (BII) was the data collection instrument. BII was developed by the researchers and consist of two section). First section contains respondents' bio-data while second section contain thirty (30). It is structured on a four-point scale of Strongly Agree to Strongly Disagree with scores of 1 to 4. Three experts, one specializing in educational psychology, one in biology education, and one in measurement and evaluation, all from the Faculty of Education at the University of Nigeria, Nsukka, validated the instrument. The trial testing was given to 50 students outside of the study are, thereafter it was subjected to factor analysis to estimate its construct validity and only 22 items survived construct validity. Reliability was then established using Cronbach alpha technique yielding a coefficient of 0.81.

Before the commencement of the experiment, four lecturers (two from each institution) were trained (Research assistants) for two weeks on how to teach basic biology concepts using Google Classroom and WhatsApp instructions. The two trained lecturers for each group, one taught while the other was there as back up in case of unforeseen circumstance. This is to ensure that there is no break during the treatment period for both

groups. Measures were adopted to ensure extraneous variables such as Hawthorne's effect (students were taught in their normal lecture hall by their lecturers using their regular lecture timetable), teacher variable (the lesson plan used for the study was prepared by the researchers for the two groups), non-equivalence of the intact classes (ANCOVA statistics were employed), subject interactions (we ensure both groups were not selected from the same school) were properly controlled. The data from this study were analyzed using mean and standard deviation (SD) to address research issues, while hypotheses were assessed using ANCOVA at a significance level of 0.05.

RESULTS AND DISCUSSION

Interest scores of year one undergraduate students

Table 1 revealed that students instructed basic biology using Google Classroom lessons had a pre-test interest mean score of 41.16 (SD = 11.91) and a post-test interest mean score of 72.55 (SD = 7.670). In contrast, their counterparts taught using WhatsApp lessons had a pre-test interest mean score of 40.75 (SD = 14.44) and a post-test interest mean score of 67.08 (SD = 9.51). The mean gain scores for the two groups (Google Classroom instruction and WhatsApp instruction) were 31.39 and 26.33, respectively. This indicates that students instructed instructed Google Classroom had higher interest mean scores than their counterparts taught with WhatsApp instruction. The post-test (SD = 7.67 and 8.65) for the two groups indicate that students instructed via WhatsApp had more variability in their interest levels compared to those taught using Google Classroom.

Table 1. Students' interest scores mean and SD

Intervention	N	Pre-interest		Post-interest		Gain
		Mean	SD	Mean	SD	
Google Classroom Instruction	76	41.16	11.91	72.55	7.67	31.39
WhatsApp Instruction	36	40.75	14.44	67.08	9.51	26.33

Table 2 indicates that the probability value related to the computed F value (10.57) about the impact of Google Classroom and WhatsApp instructions on students' mean interest scores is (0.00). Given that the sig. (0.00) is below the significance threshold of (0.05). Thus, implying a significant difference exist between the mean interest scores of year one undergraduate students instructed basic Biology using Google Classroom instruction and those taught using WhatsApp instruction in favour of those taught with Google Classroom instruction. The supreme of Google Classroom instruction over WhatsApp instruction could be due to its innovative nature, user friendly interface and novelty as an instruction strategy in education system in Nigeria.

Table 2. Calculation of ANCOVA for differences in mean interest score of students

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	871.041[a]	2	435.521	6.386	0.002
Intercept	42225.251	1	42225.251	619.186	0.000
Pretest_Intrs	140.304	1	140.304	2.057	0.154
Treatment_Group	720.964	1	720.964	10.572	0.002
Error	7433.235	109	68.195		
Total	569635.000	112			
Corrected Total	8304.277	111			

a. R Squared = 0.105 (Adjusted R Squared = 0.088)

Influence of gender on mean interest scores of year one undergraduate students

Table 3 showed male students pretest interest mean score of 40.91 (SD = 11.98), and a post-test interest mean score of 86.86 (SD = 11.37), while their female counterpart had pretest interest mean score of 41.08 (SD = 13.11), and a post-test interest mean score of 71.68 (SD = 6.99). The mean gain scores for male and female were 27.95 and 30.6 respectively. Female students had a higher average interest score than their male counterparts. Similarly, the post-test SD score for male and female were 11.37 and 6.99 suggesting that male students had more scores in their individual interest levels, while female students' scores were more tightly grouped around the mean.

Table 3. SD and Mean of interest score based on gender differences

Gender	N	Pre-interest		Post-interest		Mean gain
		Mean	SD	Mean	SD	
Male	35	40.91	11.98	68.86	11.37	27.95
Female	77	41.08	13.11	71.68	6.99	30.6

Table 4. Results of ANCOVA for mean interest scores based on gender differences

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	339.167[a]	2	169.584	2.321	.103
Intercept	42532.374	1	42532.374	582.042	.000
Pretest_Intrs	148.059	1	148.059	2.026	.157
Gender	189.090	1	189.090	2.588	.111
Error	7965.110	109	73.074		
Total	569635.000	112			
Corrected Total	8304.277	111			

a. R Squared = .041 (Adjusted R Squared = .023)

Table 4 indicates that the probability value corresponding to the computed F value (2.59) about the impact of gender on the mean interest scores of first-year undergraduate students is (0.11). As the sig. (0.11) exceeds the significance threshold (0.05). Consequently, gender does not affect undergraduate students' mean interest scores in basic biology.

Interaction effect of instructional strategy and gender on interest of students

Table 5 further shows that the sig. value associated with the computed value of F (1.75) for the interaction effect of teaching strategies and gender on year one undergraduate students' mean interest scores is (0.19). Since the p-value (0.19) is greater than (0.05) level of significance. Thus, therefore is no interaction effect of teaching strategies and gender on year one undergraduate students' mean interest scores in basic biology for education students.

Table 5. Calculation of ANCOVA for the interaction effect

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1128.905[a]	4	282.226	4.209	.003
Intercept	40104.347	1	40104.347	598.041	.000
Pretest_Intrs	168.234	1	168.234	2.509	.116
Treatment_Group	786.719	1	786.719	11.732	.001
Gender	213.317	1	213.317	3.181	.077
Treatment_Group * Gender	117.538	1	117.538	1.753	.188
Error	7175.372	107	67.060		
Total	569635.000	112			
Corrected Total	8304.277	111			

a. R Squared = .136 (Adjusted R Squared = .104)

The findings of this study underscore the strengths and limitations of both platforms (Google Classroom and WhatsApp instruction) in promoting students' interest academically. The study result in Table 1 illustrates that year one undergraduate biology education students taught basic biology using Google Classroom instruction had higher mean interest score than their counterpart taught using WhatsApp instruction. Also, it revealed further in Table 2 that the difference in the students' mean interest scores instructed using Google Classroom and instructed instructed using WhatsApp instruction was statistically significant, in favour of Google Classroom instruction. Thus, leading to the rejection of null hypothesis. Therefore, the superiority of Google Classroom instruction over WhatsApp instruction could be due to its innovative nature, user friendly interface and novelty as an instruction strategy in education system.

The findings aligned with Scholl (2019), Subandoro and Sulindra (2019), and Suparman, et al. (2022) demonstrated a substantial difference in student interest between studying via WhatsApp Group and Google Classroom. who reported that Google Classroom

has positive influence on students learning interest while WhatsApp instruction does not have positive effect on students learning interest. Similarly, Azhar and Iqbal (2018), and Harjanto and Sumarni (2019) also found that students taught using Google Classroom gained higher interest. Umroh et al. (2024) found a significant difference in students' interest in biology learning between WhatsApp teaching and Google Classroom.

On the influence of gender, the finding of this study in Table 3 revealed that female students instructed basic biology using Google Classroom and WhatsApp instructions had higher interest mean score than their male counterpart. The reason for the difference in mean interest score between male and female students could be attributed to sampling error. It could also be that both teaching strategies might appeal more to female students than male. However, Njoku (2019) stated earlier that biology is a gender-neutral subject which student interest may not be link to their gender. Furthermore, the finding revealed in Table 4 that the difference was insignificant.

The finding is in agreement with Nwuba, et al. (2023) who reported that gender had no influence on students' interest in biology. The finding also agrees with Ibenegbu et al. (2021) who reported in their study that student's gender does not influence their interest in biology. On the contrary, Ugwu and Nwagbo (2019) found that male students had slightly higher mean interest score than their female counterparts in biology and was statistically significant.

In table 5, the result of this study shows that the interaction effect of gender (male and female) and instruction strategies (Google Classroom and WhatsApp instructions) on students' mean interest scores was not statistically significant, leading to the non-rejection of the null hypothesis. This finding could be linked to the fact that both strategies are innovative mode of instruction, their friendly user interface, novel and been able to hold students' (male and female) attention and active participation in the teaching and learning process, resulting improved interest among students.

The discovery aligns with the findings of Nwuba et al. (2023) and Umroh et al. (2024), which indicated an absence of interaction effects between teaching approaches and gender on students' interest in biology. Onu et al. (2020) identified a significant interaction impact between gender and method of instruction on students' interest in biology. In agreement, Ibenegbu et al. (2021) opined that increase in students mean interest score is not gender dependent.

CONCLUSION

The findings of this study highlight the relative effectiveness of Google Classroom and WhatsApp in enhancing the academic interest of biology education students in South East Nigerian universities. While Google Classroom was found to be significantly more effective in building structured learning interest, WhatsApp contributes to peer collaboration. A blended approach utilizing the strengths of both platforms could offer an optimal solution for fostering comprehensive academic achievement among students.

Universities should consider adopting a blended learning model that combines the structured, formal environment of Google Classroom with the collaborative, peer-driven interactions of WhatsApp instruction for optimal result. Further studies should explore the impact of other emerging digital platforms on academic interest, with a focus on scalability in resource-limited educational settings. Training programs should be implemented to ensure both students and instructors are proficient in utilizing these platforms to their full potential

REFERENCES

Agustian, N., & Salsabila, U. H. (2021). Peran teknologi pendidikan dalam pembelajaran. *Islamika, 3*(1), 123-133. https://doi.org/10.36088/islamika.v3i1.1047

Ala, A. N., Onojah, A. O., Isyaku, A. M., & Adamu, hu'Aibu B. (2023). Effects of Computer-Animation among NCE Students' of Different Ability Levels in Biology Concepts in Bauchi State, Nigeria. *International Journal of Education, Teaching, and Social Sciences*, *3*(2), 160 - 172. https://doi.org/10.47747/ijets.v3i2.892

Albashtawi, A. H., and Al Bataineh, K. B, The Effectiveness of Google Classroom Among EFL Students in Jordan: An Innovative Teaching and Learning Online Platform, *International Journal of Emerging Technologies in Learning (IJET), 15*(11), 78-85. https://www.learntechlib.org/p/217100/

Amerstorfer, C. M. (2020). Problem-based learning for preservice teachers of English as a foreign language. *Colloquium: New Philologies. 5*(1), 75–90. https://doi.org/10.23963/cnp.2020.5.1.4

Anjarwati, R., and Sa'adah, L. (2022). The effect of combining google classroom and whatsapp on student engagement in english class. *E-Link Journal, 9*(2). 152-165. https://doi.org/10.30736/ej.v9i2.666

Azhar, K., & Iqbal, N. (2018). Effectiveness of Google classroom: Teachers' perceptions. *Prizren Social Science Journal, 2*(2), 52-66. http://prizrenjournal.com/index.php/PSSJ/article/view/39

Baglama, B., Yucesoy, Y. & Yikmis, A. (2018). Using animation as a means of enhancing learning of individuals with special needs. *TEM Journal. 7*(3), 670-677. https://dx.doi.org/10.18421/TEM73-26

Baransano, A. Y., Yohanita, A. M., & Damopolii, I. (2017). Penerapan model pembelajaran picture and picture untuk meningkatkan hasil belajar biologi siswa kelas XI IPA SMA YABT Manokwari. *In Prosiding Seminar Nasional MIPA II Universitas Papua Tahun* (pp. 273-280).

Bates, L. (2017). *5 Real Benefits of Using Animation in Classroom. Fractus Learning*. Fractus Learning. https://www.fractuslearning.com/animation-in-the-classroom/

Bond, M., Buntins, K., Bedenlier, S., *et al.,* (2020). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education, 17*(1), 1–30. https://doi.org/10.1186/s41239-019-0176-8

Damopolii, I., Botutihe, V. T., & Nunaki, J. H. (2019). The contribution of science process skill towards students cognitive achievement through guided inquiry-based learning. *Journal of Physics: Conference Series*, *1317*(1), 012184. https://doi.org/10.1088/1742-6596/1317/1/012184

Durgungoz, A., & Durgungoz, F. C. (2022). "We are much closer here": exploring the use of WhatsApp as a learning environment in a secondary school mathematics class. *Learning Environments Research*, *25*(2), 423-444. https://doi.org/10.1007/s10984-021-09371-0

Gasaymeh, A. M. (2017). University students use of WhatsApp and their perceptions regarding its possible integration into their education. *Glob. J. Comp. Sci. Technol. 17*, 1–10. https://computerresearch.org/index.php/computer/article/view/1641/1-University-Students-use-of-Whatsapp_JATS_NLM_xml

Glory, G.-E., & Sopuruchi, I. (2017). Influence of Gender on Interest and Academic Achievement of Students in Integrated Science in Obio Akpor Local Government Area of Rivers State. *European Scientific Journal, ESJ*, *13*(10), 272. https://doi.org/10.19044/esj.2017.v13n10p272

Gupta, A., and Pathania, P. (2021). To study the impact of Google Classroom as a platform of learning and collaboration at the teacher education level. *Education and Information Technologies, 26*(1), 843-857. https://doi.org/10.1007/s10639-020-10294-1

Harjanto, A. S., & Sumarni, S. (April). Teachers'experiences On The Use Of Google Classroom. In *English Language and Literature International Conference (ELLiC) Proceedings* (Vol. 3, pp. 172-178). https://jurnal.unimus.ac.id/index.php/ELLIC/article/view/4704

Hayuana, W., Chotimah, H., Ibrohim, I., Susilo, H., Damopolii, I., Susanti, E., Sasea, L. I., & Syahriridani, M. (2024). OKE STAR: Supporting the success of lesson study in high school. *Journal of Research in Instructional*, *4*(2), 526–536. https://doi.org/10.30862/jri.v4i2.411

Hidayawati, M. S. (2020). *Analysis of Online Learning Through Whatsapp Group (Wag) in Business Economics Subject at SMK Negeri 1 Talaga* [Undergraduate Thesis, Universitas Pasundan]. UNPAS Campus Respository. http://repository.unpas.ac.id/49504/

Hussaini, I., Ibrahim, S., Wali, B., Libata, I., & Musa, U. (2020). Effectiveness of Google classroom as a digital tool in teaching and learning: Students' perceptions. *International Journal of Research and Innovation in Social Science (IJRISS), 4*(4), 51-54. https://rsisinternational.org/journals/ijriss/Digital-Library/volume-4-issue-4/51-54.pdf

Ibenegbu, Q.O., Nzewi, U.M., and Aniaku, O. L. (2021). Stimulating students' interest in biology using blended teaching approach. *Journal of the Nigerian Academy of Education*, *14*(2), 228-238.

https://www.journals.ezenwaohaetorc.org/index.php/JONAED/article/viewFile/1271/1291

Jordan, M. M., & Duckett, N. D. (2018). Universities confront 'tech disruption': Perceptions of student engagement online using two learning management systems. *The journal of public and professional sociology*, *10*(1), 4. https://digitalcommons.kennesaw.edu/jpps/vol10/iss1/4/

Kang, J., & Keinonen, T. (2018). The effect of student-centered approaches on students' interest and achievement in science: Relevant topic-based, open and guided inquiry-based, and discussion-based approaches. *Research in science education*, *48*, 865-885. https://doi.org/10.1007/s11165-016-9590-2

Kasim, M., Latjompoh, M., & Aydalina, R. V. (2024). Reading questioning answering (RQA) method in learning the interaction of living things with their environment: The application to improve students' cognitive learning outcomes. *Journal of Research in Instructional*, *4*(1), 263–272. https://doi.org/10.30862/jri.v4i1.329

Lalap Jr, V. G. (2021). Students' academic performance and their perception on the use of Google applications in social studies. *EPRA International Journal of Research & Development (IJRD)*, *6*(7). https://eprajournals.com/IJSR/article/5533

Locketz, J. M. (2019). *Exploring motivations and informal learning of school administrators adopting Google Apps for Education* (Publication Number 1047) [Doctoral Dissertation, Pepperdine University]. Theses and Dissertations. https://digitalcommons.pepperdine.edu/etd/1047/

Madge, C., Breines, M. R., Dalu, M. T. B., Gunter, A., Mittelmeier, J., Prinsloo, P., & Raghuram, P. (2019). WhatsApp use among African international distance education (IDE) students: transferring, translating and transforming educational experiences. *Learning, Media and Technology*, *44*(3), 267-282.. https://doi.org/10.1080/17439884.2019.1628048

Mappadang, A., Khusaini, K., Sinaga, M., & Elizabeth, E. (2022). Academic interest determines the academic performance of undergraduate accounting students: Multinomial logit evidence. *Cogent Business & Management*, *9*(1), 2101326. https://doi.org/10.1080/23311975.2022.2101326

Martín-Roda, E., and Sassan-Luiz, S. (2016). Posibilidades de google drive para la docencia a distancia y en el aula. *Didáct. Geogr. 16*, 203–220. https://didacticageografica.age-geografia.es/index.php/didacticageografica/article/view/302

Mustofa, A., Hayuana, W., Damopolii, I., Ibrohim, I., & Susilo, H. (2024). The discovery learning and Google sites: Its application in learning the process of urine formation for high school students. *Inornatus: Biology Education Journal*, *4*(2), 132–150. https://doi.org/10.30862/inornatus.v4i2.711

Meyer, J., Fleckenstein, J., & Köller, O. (2019). Expectancy value interactions and academic achievement: Differential relationships with achievement measures. *Contemporary Educational Psychology, 58*: 58–74. https://doi.org/10.1016/j.cedpsych. 2019.01.006

Nasir, N. I. R. F., Arifin, S., & Damopolii, I. (2023). The analysis of primary school student's motivation toward science learning. *Journal of Research in Instructional*, *3*(2), 258–270. https://doi.org/10.30862/jri.v3i2.281

Nasir, N. I. R. F., Damopolii, I., & Nunaki, J. H. (2020). Pengaruh pembelajaran inkuiri terhadap level berpikir siswa SMA. *Bioilmi: Jurnal Pendidikan*, *6*(2), 112–119. https://doi.org/10.19109/bioilmi.v6i2.6948

Njoku, M. I. A. (2019). *Effect of peer tutoring and peer team learning on secondary school students' attitude toward achievement in biology in Rivers State* [Unpublished Doctotal Dissertation]. University of Nigeria Nsukka

Nworgu, B. G. (2015). *Educational research. basic issues and methodology (third and enlarged edition).* University Trust Publishers.

Nwuba, I., Egwu, S. O., Awosika, O. F., & Osuafor, A. M. (2023). Fostering Secondary School Students' Interest in Biology using Numbered Heads Together Cooperative Instructional Strategy. *The Universal Academic Research Journal*, *5*(2), 48-56. https://doi.org/10.55236/tuara.1136342

Obanya, P. (2021). Quality teaching for quality learning at the University level. *In Higher Education Pedagogy Workshop, Association of African Universities,* April 3-16.

Okoli, S. O., Anazodo. O. S., & Okoye, M. N. (2022). Effects of Computer Graphics and Animation Instructional Modes on Secondary School Students' Achievement and Retention in Genetics. *International Journal of Science and Research (IJSR), 11*(5), 72-78. https://www.ijsr.net/archive/v11i5/SR22410103621.pdf

Olugbenga, A. E. (2016). Comparative effectiveness of animated drawings and selected instructional strategies on students' performance in creative arts in Nigeria. Malaysian *Online Journal of Educational Technology (MOJET), 4*(3), 1-13. https://mojet.net/index.php/mojet/article/view/82

Onu, W. O., Anyaegbunam, N J., and Uzoigwe, A. U. (2020). Improving Biology Students' Interest and Achievement through Collaborative Instructional Strategy. *Journal of Education, Society and Behavioural Science (JESBS), 33*(2), 9-20. https://doi.org/10.9734/jesbs/2020/v33i230198

Pambudi, G. D., Winangsih, F., Nunaki, J. H., Nusantari, E., & Damopolii, I. (2022). Encouraging students' metacognitive skills through inquiry learning. *Inornatus: Biology Education Journal*, *2*(1), 43–52. https://doi.org/10.30862/inornatus.v2i1.272

Rachmawaty, A. (2021). Social Media Optimization in Increasing Sales During Large-Scale Social Restrictions. *TEMATIK-Jurnal Teknologi Informasi Dan Komunikasi, 8*(1). 29–44. https://jurnal.plb.ac.id/index.php/tematik/article/view/535

Rukmana, A. H., & Inayah, R. (2023). The Analyzing Of Whatsapp Application As One Of The Learning And Information Medias In Educational Context. *PROJECT (Professional Journal of English Education), 6*(6), 1095-1099. https://journal.ikipsiliwangi.ac.id/index.php/project/article/view/8493

Saputra, M. D. A., Ulfa, S., & Degeng, M. D. K. (2024). Project-based learning in basic photography learning: The effect on student learning outcome. *Journal of Research in Instructional*, *4*(2), 324–332. https://doi.org/10.30862/jri.v4i2.421

Scholl, H. (2019). *My Google Classroom Training Guide. Kindle Edition*.

Serdyukov, P. (2017). Innovation in education: what works, what doesn't, and what to do about it? *Journal of Research in Innovative Teaching and Learning, 10*(1), 4-33. https://doi.org/10.1108/JRIT-10-2016-0007

Subandoro, P. S., & Sulindra, E. (2019). Optimizing collaborative learning: Using google classroom in business English correspondence class. *Vocatio: Jurnal Ilmiah Ilmu Administrasi dan Sekretari*, *2*(1), 547269. http://jurnal.wima.ac.id/index.php/VOCATIO/article/view/1932

Sudarsana, I. K., Putra, I. B. M. A., Astawa, I. N. T., & Wayan Lali Yogantara, I. (2019). The use of Google classroom in the learning process. *Journal of Physics: Conference Series*, *1175*, 012165. https://doi.org/10.1088/1742-6596/1175/1/012165

Suparman, A., Danim, S., Nirwana, Kristiawan, M., and Susanto, E. (2022). The Effect of Using Google Classroom and Whatsapp Applications on Learning interest. *Education Quarterly Reviews, 5*(1), 237-244. https://doi.org/0.31014/aior.1993.05.01.434

Tondeur, J., Forkosh-Baruch, A., Prestridge, S., Albion, P., & Edirisinghe, S. (2016). Responding to challenges in teacher professional development for ICT integration in education. *Educational Technology and Society*, *19*(3), 110-120. https://www.jstor.org/stable/jeductechsoci.19.3.110

Ugwu, T. U. and Nwagbo, C. R. (2019). Enhancing students' interest in basic science using guided inquiry instructional method. *Journal of Science Teacher Association of Nigeria. 54* (1), 121-128.

Ukala, G. (2018). Utilization of innovative teaching in Biology in Delta state. *African Journal of Science, Technology and Mathematics Education (AJSTME). 4*(1), 30-37. http://www.ajstme.com.ng/admin/img/paper/30-37%20Ukala.pdf

Ukala, G. and Ugwu, T. U. (2019). Teachers' Challenges in Integrating Information and Communication Technology (ICT) in Teaching and Learning of Biology in Secondary Schools. *Journal of CUDIMAC (J-CUDIMAC),* 7(*1*), 25-31. https://cudimac.unn.edu.ng/wp-content/uploads/sites/52/2019/12/ukala_and_theresa.pdf

Umroh, S., Rismiyanto, & Ismaya, E. A. (2024). The Effect of Using WhatsApp Group and Google Classroom Platforms for Interests and Learning Outcomes of Fourth-Grade Students. *ICCCM Journal of Social Sciences and Humanities, 3*(1), 30–36. https://doi.org/10.53797/icccmjssh.v3i1.5.2024

Upula, B. E., Idongesit, A. A., Ogar, M. N. (2019). Computer animation instructional package and biology students' academic performance in Akpabuyo Local Government Area, of Cross River State. *Shared seasoned intl journal of library and information science, 3*(2), 82-92. https://globalacademicstar.com/download/article/computer-animation-instructional-package-and-biology-students-academic-performance-in-akpabuyo-local-government-area-of-cross-river-state-65843.pdf

Yelamali, V., and Beelagi, S. (2021). The Results of Classification of Lab Assignment in Object Oriented Programming and Database Management System Lab: A Case Study. *Journal of Engineering Education Transformations, 34*: 277-280. https://dx.doi.org/10.16920/jeet/2021/v34i0/157155