

University Academics' Perceptions Regarding the Use of Information Technology Tools for Effective Formative Assessment: Implications for Quality Assessment through Professional Development

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Abstract

The study sought the perceptions of university academics on the use of IT tools for the formative assessment (FA) of students' learning outcomes. This study adopted a quantitative research approach and descriptive survey research design using a sample of 180 university academics. Academics' perception questionnaire was used for data collection. The instrument with two clusters was properly validated, and its internal consistency reliability indices found to be 0.79 and 0.85 for clusters A and B using the Cronbach alpha method. The obtained data were analysed using mean and t-test of independent samples. The results revealed that university academics perceived the use of information technology tools as veritable tools for effective implementation of FA. Further analysis revealed that the perceptions of the academics differed significantly by gender and qualification. IT tools are indispensable in the effective implementation of formative assessment practices in institutions of higher learning. This finding implies that quality assessment can be achieved using IT tools, but there is a need for professional development of the lecturers. It was therefore recommended that efforts should be made by the Nigerian Education stakeholders in making adequate provisions for the effective implementation of quality assessment using IT tools.

Keywords: improving classroom teaching, media in education, mobile learning, perceptions, post-secondary education, quality assessment, university academics

1. Introduction

The place of formative assessment practices in the assessment of students' learning outcomes cannot be overemphasized. Through formative assessment, teachers understand what needs to be changed during classroom instruction to enhance learning by the students (Nyberg & Olander, 2015). Black and Wiliam (2018) opined that formative assessment usage results in the understanding of the learning outcomes to enhance the transfer of learning to a similar situation. In Nigeria, proper assessment of students' learning outcomes has become the concern of stakeholders in education owing to the reported cases of the poor performance of students. A possible solution to this ugly situation is the integration of IT tools into formative assessment practices. According to Black and William (2009), formative assessment (FA) helps the teacher to understand the progress in the students' achievement to make adequate arrangements for further learning. Effective use of formative assessment has resulted in enhanced student achievement in various educational contexts (Shirley & Irving, 2015). Researchers have advocated for concurrent use of both FA and summative assessment (SA) (Bernholt et al., 2013).

According to Wiliam (2000), summative assessment is targeted at finding out what an individual has learned while formative assessment is prospective. The main distinction between formative and summative assessments lies in how assessment information are utilised. Thus, an assessment is said to be formative when a student or learner understands and acts on particular assessment information (Wiliam, 2000). From the foregoing, FA practice enables teachers to use learners' previous experiences to the teaching needs of each learner. Different research studies have highlighted fundamental elements of effective FA practices: (1) For FA to be an integral part of teaching, it must be properly planned and systematically practiced (Looney, 2010; Swan, 2005), being in line with basic knowledge and skills (Herman et al. 2005); (2) There should be adequate clarification of learning objectives and criteria for success (Black & William, 2009) and students' process of learning and progress toward set objectives should be a top priority (Looney, 2010); (3) Achieving effective classroom interactions should be the major target of the teachers (Black & William, 2009), encouraging classroom culture that brings about enhanced interaction and active participation of the learners (Looney, 2010); (4) encouraging self and peer-assessment (Black & William, 2009). (5) Providing adequate and timely feedback to monitor learners' progress (Herman et al. 2005), enabling the learners to understand their areas of strength and weakness through feedback mechanism (Looney, 2010; Swan, 2005; Black & William, 2009)

Effective formative assessment is achieved through the provision of adequate feedback at the course of teaching and learning (Rushton, 2005; Nicol & Macfarlane-Dick, 2006). Buttressing this point, Irons (2008) opined that formative assessment provides feedforward to students and enables the learners to understand their learning achievements. Formative assessment allows the teacher to understand where the learners are at the course of teaching and learning and where they will be in the next level of the teaching (Heritage, 2007). Provision of feedback in FA usually possesses a lot of challenges to the teachers due to time constraints. According to EDU SUMMIT (2015), conducting FA in large classrooms is always faced with a lot of challenges due to the diverse need of the learners. As a result of these inherent challenges in the implementation of FA, it becomes imperative to deploy IT tools for its implementation.

The use of information and communication technology in classrooms becomes a necessity for effective formative assessment of learning in the 21st century (Elmahdi, Al-Hattami & Fawzi, 2018). Several researchers have investigated the roles of IT tools in education especially in the area of teaching and learning. (Danielson, 2011; Ali & Elmahdi, 2001; Fawzi, 2010; Irving, 2015; Damick, 2015; Caldwell, 2007; Baylor & Ritchie, 2002). Technology tools contribute to effective teaching, learning, as well as assessment (Ejimonye et al., 2020a, 2020b; Onah et al., 2020; Ugwuanyi et al., 2019a, b, c; Ugwuanyi et al., 2020a, 2020b, 2020c, 2020d; Ugwuanyi & Okeke, 2020; Ugwuanyi et al., 2020). Modern online classroom response systems if managed very well enhance students' learning through formative assessment. According to Shirley and Irving (2015), ICTs are veritable tools that have been demonstrated in assisting to overcome barriers to effective FA.

Formative assessment is facilitated by classroom technologies facilitate (Shirley & Irving, 2015). Irving (2015) opined that the deployment of IT tools in the formative assessment process creates supporting classroom environments that allow for proper assessment and provision of immediate feedback to the students. Gaylard (2015) found that effective online formative assessment can nurture an assessment-centered focus through effective formative feedback and enhanced students' commitment to learning. There are about 75 IT tools that can be used for effective formative assessment of students' learning outcomes (<https://www.nwea.org/blog/2019/75-digital-tools-apps-teachers-use-to-support-classroom-formative-assessment/>).

Among the tools are Google forms, Padlet, Poll Everywhere, Kahoot, Plickers, Quizlet, Vocaroo, and Survey monkey.

Google Forms are used in creating documents that students can play around with via smartphones, tablets, and laptops. Padlet is used in creating and designing collaborative projects for the students. Poll Everywhere is used in creating feedback poll to the students or asking questions in various ways. Kahoot is an environment where teachers can create quizzes for the students. Plickers are used by the instructor of the teacher in collecting real-time formative assessment data. Vocaroo is used by the teachers to create audio recordings for the students through the integration of the recording into slide presentations, or websites. It is normally great for collaborative group work and presentations. Adequate feedback and enrich student commitment with valued learning experiences can be achieved through effective utilisation of online formative assessment (Gaylard, 2015). Learners' performance of complex skills was greatly enhanced after exposure to Viewbrics online assessment tools (Ackermans et al., 2021). Technology facilities can enable a teacher to collect assessment data about student understanding of given task during teaching and learning context (Panero & Aldon, 2016). The use of Technology tool will effectively support formative assessment and informative feedback to 21st-century learners due to the shift in remote learning to a blended learning approach (Spector et al., 2016). Elmahdi, Ismail; Al-Hattami, Abdulghani and Fawzi (2018) found that the use of Plickers for formative assessment enhanced the learning process by making the students participate actively in the learning process and saves the learning time.

This paper was necessitated for the fact that most teachers and lecturers/ academics may not know the relevance of the IT tools in teaching and learning, especially for effective formative assessment purposes. The paper, therefore, surveyed the academics' perceptions on the use of IT tools for effective formative assessment. Specifically, the paper sought answers to the following questions:

1. What are academics' perceptions on the use of information technology (IT) tools for effective implementation of FA?
2. What is the influence of gender on academics' perceptions on the use of IT tools for effective implementation of FA?
3. What is the influence of qualification on academics' perceptions on the use of IT tools for effective implementation of FA?
4. What are the challenges to the use of IT tools for the effective implementation of FA practices?

The researchers hypothesized at 5% probability levels that:

Ho₁: Gender does not significantly influence the academics' perceptions on the use of IT tools for effective implementation of FA.

Ho₂: Qualification does not significantly influence the academics' perceptions on the use of IT tools for effective implementation of FA.

2. Method

2.1 Ethical Considerations

The approval for the conduct of this research was granted by the Research Ethics Committee of the University of Nigeria. Informed consent forms were distributed to the Lecturers before the commencement of the study for them to fill and sign accordingly.

2.2 Research Approach and Design

The quantitative research approach guided the conduct of this research. Specifically, a descriptive survey research design was employed. In recent times, this design has been used by Okeke et al. (2020a, b), Eze et al. (2020), Ugwuanyi et al. (2020), Okenyi et al. (2021), Ezema et al. (2021), Ezeaku et al. (2021).

2.3 Participants

A sample of 180 lecturers from a population of 540 academics in the Faculty of Education, University of Nigeria. This sample participated in the Faculty of Education workshop on "Transformative Pedagogy for Twenty-first-century classroom instructional delivery" on the 11th May 2019. One of the workshop topics was carrying out an effective formative assessment using IT tools. The participants were drilled on how to use IT tools like Google forms, Poll Everywhere, Padlet, and Kahoot in carrying out an effective formative assessment of students' learning outcomes.

Table 1. Demographic Characteristics of the Participants

Demographics	Frequency	%	X^2	P
Gender				
Male	59	32.8	34.21	.000
Female	121	67.2		
Age				
25-30 years	36	20.0		
31-40 years	105	58.3	20.65	.004
41-50 years	21	11.7		
51 years and above	18	10.0		
Marital Status				
Married	138	77.2		
Single	31	17.0	56.10	.000
Divorced	5	2.8		
Separated	6	3.0		
Qualification				
Bachelor's degree	21	11.7		
Master's degree	89	49.4	18.43	.010
Ph.D	70	38.9		
Department				
Adult Education	20	11.1		
Arts Education	34	18.9		
Educational Foundations	37	20.6		
Human Kinetics and Health Ed	28	15.5	3.54	.078
Library and Info. Science	31	17.2		
Science Education	18	10.0		
Social Science Education	12	6.7		

Table 1 shows the demographic characteristics of the participants for the study. It shows that there are significant differences in the gender, age, marital status and educational qualification of the participants, $X^2(1) = 34.21, p = .000$; $X^2(3) = 20.65, p = .001$; $X^2(3) = 56.1, p = .000$; and $X^2(2) = 18.43, p = .010$. However, there is no significant difference in the Departments of the participants, $X^2(6) = 3.54, p = .078$.

2.4 Instrument for Data Collection

The lecturers' perceptions questionnaire was used to collect relevant data. The instrument comprised two sections, A and B. Section A sought information on the personal data of the participants like their gender and qualification. Section B had two clusters, A and B. Cluster A sought information on Lecturers' perceptions on the use of IT tools for effective FA while Cluster B sought information on the problems inherent in the use of IT tools for FA. Both clusters A and B had 10 items each which were structured on a 4-point rating scale of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). The instrument was face validated by Measurement specialists in Science Education Department, UNN, while the internal consistency reliability indices 0.79 and 0.85 were estimated for clusters A and B using the Cronbach Alpha method.

2.5 Procedure for Data Collection

Data were collected through the online data collection system. All the participants who participated in the Faculty of Education workshop on "Transformative Pedagogy for Twenty-first-century classroom instructional delivery" on the 11th May 2019 were requested to fill out the questionnaire items sent to their emails through google forms. The

participants replied to the request by the researchers by responding to the questionnaire items. After that, the researchers downloaded their responses and cleaned the data for data analysis.

2.6 Data Analysis

Data collected from the fieldwork were analysed using mean to answer the research questions and independent samples t-test and analysis of variance to test the null hypotheses at 5 percent probability level. Scheffe post hoc pairwise comparison test was carried out to ascertain the direction of the significant influence of academics' qualification on their perception.

3. Results

Research Question One: What are academics' perceptions on the use of information technology (IT) tools for effective implementation of FA.

Table 2. Mean analysis of the ratings of academics' perceptions on the use of information technology (IT) tools for effective implementation of FA

$n = 180$

Item Statement	Mean	SD
1. Enhances the active participation of learners in the learning process	3.20	.89
2. Helps in recording marks using a spreadsheet	2.89	1.06
3. Helps in periodic assessment of students' learning outcome	3.43	.76
4. Helps in finding information about students' improvement in the learning process	3.39	.78
5. Helps in the provision of immediate feedback	3.22	.79
6. Helps in the easy publication of students' result	3.18	1.13
7. Makes teaching and learning lively and interesting	2.97	.99
8. Serves as motivation to the students	2.77	.92
9. Makes the students creative	2.75	.92
10. Saves both the lecturers' and students' time	2.81	1.05
Overall Mean	30.66	4.22

Table 2 shows that the academics agreed to the statements of items 1 to 10 ($\bar{x} > 2.50$). This indicates that the academics perceived the use of IT tools as veritable instruments for the effective implementation of FA.

Research Question Two: What is the influence of gender on academics' perceptions on the use of IT tools for effective implementation of FA.

Table 3. t-test analysis of the influence of gender on the academics' perceptions on the use of IT tools for effective implementation of FA

Gender	n	Mean	Std. Deviation	df	t	p
Male	59	38.20	3.97	178	5.669	.000
Female	121	30.47	4.14			

Table 3 shows that male academics had higher mean perception rating ($M = 38.20$, $SD = 33.97$) than the female academics ($M = 30.47$, $SD = 4.14$). Besides, the standard deviations of 3.97 and 4.14 for the male and female academics respectively indicate that the variation in the individual ratings of the female lectures is higher than that of the male academics.

H₀₁: Gender does not significantly influence the academics' perceptions on the use of IT tools for effective implementation of FA.

Table 3 revealed that there is a significant difference in the mean ratings of academics on their perceptions on the use of IT tools for effective implementation of FA in favour of the ratings of the male academics, $t(178) = 5.669$, $p = .000$.

Research Question Three: What is the influence of qualification on academics' perceptions on the use of IT tools for effective implementation of FA?

Table 4. Mean analysis for the influence of qualification on academics' perceptions on the use of IT tools for effective implementation of FA

Qualification	n	Mean	Std. Deviation
Bachelor's Degree	21	37.76	12.46
Master's Degree	89	30.66	4.28
Ph.D	70	34.80	18.90
Total	180	33.10	13.06

Table 4 reveals that academics with Bachelor's degree had the highest mean perception ($\bar{x} = 37.76$, $SD = 12.46$) followed by the lectures with Ph.D ($\bar{x} = 34.80$, $SD = 18.90$) while those lectures with master's degree had the least mean rating ($\bar{x} = 30.66$, $SD = 4.28$).

Ho₂: Qualification does not significantly influence the academics' perceptions on the use of IT tools for effective implementation of FA.

Table 5. Analysis of variance of the influence of qualification on academics' perceptions on the use of IT tools for effective implementation of FA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1187.303	2	593.651	3.577	.030
Within Groups	29376.897	177	165.971		
Total	30564.200	179			

Table 5 shows that there is a significant influence of qualification on academics' perceptions on the use of IT tools for effective implementation of FA, $F(2,177) = 3.5787$, $p = .030$.

Table 6. Pairwise comparison test for the significant influence of Qualification

(I) Qualification	(J) Qualification	Mean Difference (I-J)	Std. Error	Sig.
Bachelor's Degree	Master's Degree	7.09	3.12	.019*
	Ph.D	2.96	3.20	.653
Master's Degree	Bachelor's Degree	-7.09	3.12	.079
	Ph.D	-4.13	2.05	.136
Ph.D	Bachelor's Degree	-2.96	3.20	.653
	Master's Degree	4.13	2.05	.136

Table 6 shows that the academics who had a Bachelor's degree and master's degree had the highest positive mean difference ($\bar{x}_{dir} = 7.09$), $p = .019$. This shows that the mean difference between academics who had a Bachelor's degree and master's degree contributed most to the significant influence of qualification on their perceptions.

Research Question Four: What are the challenges to the use of IT tools for effective implementation of FA practices?

Table 7. Mean analysis of the ratings of academics on the challenges to the use of IT tools for effective implementation FA practices

n = 180

	Item Statement	Mean	SD	Decision
1.	Inadequacy of ICT facilities	3.35	.85	Agree
2.	Epileptic power supply	3.43	.64	Agree
3.	Lack of IT technical supports	3.14	.79	Agree
4.	Exposing students to unwanted online materials	3.04	.67	Agree
5.	Inadequacy of lecture time	2.68	.84	Agree
6.	The attitude of school towards the use of IT tools	2.77	.89	Agree
7.	Lack of appropriate ICT skills	2.81	.75	Agree
8.	Societal views about ICT	2.64	1.05	Agree
9.	Little access to ICT	3.29	.89	Agree
10.	Saves both the lecturers' and students' time	3.18	.78	Agree
	Overall Mean	30.37	3.71	Agree

Table 7 shows that the lecturers agreed to the statements of items 1 to 10 as the challenges to the use of IT tools for effective implementation of FA practices ($\bar{x} > 2.50$).

Thus, the inadequacy of ICT facilities, epileptic power supply, lack of IT technical supports, lack of appropriate ICT skills among others are the challenges to the use of IT tools for effective implementation of FA practices.

4. Discussion of the Findings

The results of the study revealed that academics perceived IT tools as veritable instruments for the effective implementation of formative assessment in schools. This finding is not surprising to the researchers owing to the vantage position of ICT in teaching and learning in this twenty-first-century world. In this century, everything is moving in the direction of information technology. Most developed countries in today's world have fully adopted or integrated ICT in every aspect of teaching and learning. In line with these findings, Shirley and Irving (2015) revealed that classroom technologies facilitate formative assessment. Gaylard (2015) found that effective online formative assessment can nurture an assessment-centered focus through effective formative feedback and enhanced students' commitment to learning. Similarly, studies have provided evidence of the significant contribution technology makes in improving teaching, and assessment practices in education (Ejimonye et al., 2020a, 2020b; Onah et al., 2020; Ugwuanyi et al., 2019a, b, c; Ugwuanyi et al., 2020a, 2020b, 2020c, 2020d; Ugwuanyi & Okeke, 2020; Ugwuanyi et al. 2020). Effective teaching in the 21st century necessitated the integration of technology in classrooms (Elmahdi et al., 2018). Besides, Irving (2015) opined that IT tools facilitate the formative assessment process through the provision of classroom environments that allow immediate feedback to the students. Adequate feedback and enrich student commitment with valued learning experiences can be achieved through effective utilisation of online formative assessment (Gaylard, 2015). Learners' performance of complex skills was greatly enhanced after exposure to Viewbrics online assessment tools (Ackermans et al., 2021). Technology facilities can enable a teacher to collect assessment data about student understanding of given task during teaching and learning context (Panero & Aldon, 2016). The use of Technology tool will effectively support formative assessment and informative feedback to 21st-century learners due to the shift in remote learning to a blended learning approach (Spector et al., 2016). Elmahdi et al. (2018) found that the use of Plickers for formative assessment enhanced the learning process by making the students participate actively in the learning process and saves the learning time.

It was further revealed that the gender and qualification of academics moderated their perceptions on the use of IT tools for effective implementation of FA of students' learning outcomes. Thus, male academics had higher mean perceptions than their female counterparts. This could have been that the male lecturers are more interested in the use of IT tools than the female lecturers. Similarly, academics who had a Bachelor's degree had higher mean perception than those with Ph.D. A possible explanation for this could be that most of the lecturers with bachelor's degrees are younger and are more computer compliant than those with Ph.D. This finding implies that quality assessment can be achieved through the use of IT tools but there is a need for professional development of the lecturers. Thus, retraining of academics in the use of IT tools for the proper implementation of formative assessment is very imperative.

5. Conclusions and Recommendations

Based on the findings of the study, the researchers concluded that IT tools are indispensable for the effective implementation of formative assessment practices in institutions of higher learning. However, the gender and qualification of the academics influence the perceptions of lecturers on the use of IT tools for the implementation of FA in schools. Thus, the researchers recommend that:

1. Academics in Nigerian Universities should be properly trained on the use of IT tools for FA.
2. Female academics should be properly re-trained on the use of IT tools for them to understand the place of IT tools for the implementation of FA.

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Conflict of Interest

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References

- Ali, A., & Elmahdi, I. (2001). The wired Professor: A collaborative learning experience in one-on-one mentoring. *Journal of Computing in Teacher Education*, 18(2), 68-73. <http://doi.org/10.1080/10402454.2001.10784436>
- Ackermans, K., Rusman, E., Nadolski, R., Specht, M., & Brand-Gruwel, S. (2021). Video-enhanced or textual rubrics: Does the Viewbrics' formative assessment methodology support the mastery of complex (21st century) skills? *Journal of Computer Assisted Learning*, November, 2020, 1-15. <https://doi.org/10.1111/jcal.12525>
- Baylor, A. L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms? *Computers and Education*, 39(4), 395-414. [https://doi.org/10.1016/S0360-1315\(02\)00075-1](https://doi.org/10.1016/S0360-1315(02)00075-1)
- Bernholt, S., Ronnebeck, S., Ropohl, M., Koller, O., & Parchmann, I. (2013). ASSIST ME. Report on current state of the art in formative and summative assessment in IBE in STM. *ASSIST-ME Report Series Number*, 1-2.
- Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7-74. <https://doi.org/10.1080/0969595980050102>
- Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, 21(1), 5-31. <https://doi.org/10.1007/s11092-008-9068-5>
- Black, P., & Wiliam, D. (2018). Classroom assessment and pedagogy. *Assessment in Education: Principles, Policy and Practice*, 25(6), 551-575. <https://doi.org/10.1080/0969594X.2018.1441807>
- Elmahdi Ismail, Al-Hattami Abdulghani, & Fawzi, H. (2018). Using Technology for Formative Assessment to Improve Students' Learning. *TOJET: The Turkish Online Journal of Educational Technology*, 17(2), 182-188. <https://eric.ed.gov/?id=EJ1176157>
- Gaylard, B. Z. (2015). Online formative assessment in higher education: Its pros and cons. *Electronic Journal of E-Learning*, 13(4), 228-236.
- Caldwell, J. (2007). Clickers in the large classroom: Current research and best-practice tips. *CBE Life Sci Education*, 6(1), 9-20. <http://doi.org/10.1187/cbe.06-12-0205>
- Damick, J. (2015). Implementing technology in an algebra classroom. MA thesis, NY: State University of New York.
- Danielson, C. (2011). *Enhancing professional practice: A framework for teaching*, (2nd ed). Alexandria, VA: ASCD.
- EDU SUMMIT (2015). The value of ICT in formative assessment in support of learning in the 21st Century. *International summit on ICT in Education*.
- Ejimonye, J. C., Onuoha, J. C., Ugwuanyi, C. S., Eneogu, N. D., Ugwuanyi, B. E., & Ogbuehu, S. N. (2020a). Effectiveness of Two-Dimensional Animation Technique in Enhancing Students' Motivation in Quantitative Economics Concepts. *International Journal of Future Generation Communication and Networking (IJFGCN)*, 13(1), 27-38. <https://doi.org/10.33832/ijfgcn.2020.13.1.03>
- Ejimonye, J. C., Ugwuanyi, C. S., Okeke, C. I. O., & Nwoye, M. N. (2020b). Two-Dimensional Animation and

- Students' Achievement in Mathematical Economics: Implications for Science Teaching. *International Journal of Engineering Research and Technology*, 13(6), 1220-1230. <https://doi.org/10.37624/IJERT/13.6.2020.1220-1230>
- Elmahdi, I., Al-Hattami, B., & Fawzi, H. (2018). Using technology for formative assessment to improve students' learning. *TOJET: The Turkish Online Journal of Educational Technology*, 17(2), 1-8.
- Eze, K. O., Ugwuanyi, C. S., & Okeke, C. I. O. (2020). Extent of the Upper Basic Education French Language Curriculum Content-Delivery with Technologies in Nigerian Secondary Schools. *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)*, 10(4), 311-318. <https://doi.org/10.24247/ijmperdaug202027>
- Ezema, V. S., Okenyi, E. C., & Ugwuanyi, C. S. (2021). Assessment of the extent of community involvement in the funding of primary schools in Enugu state, Nigeria: Implications for further research. *International Journal of Mechanical and Production Engineering Research and Development*, 10(1), 91-98. <http://www.tjprc.org/publishpapers/2-67-1611554947-8IJMPERDFEB20218.pdf>
- Ezeaku, F. N., Onu, E. A., Agu, P. U., Edikpa, E. C., Nwafor, B. N., Ozioko, A. N., & Ugwuanyi, C. S. (2021). Appraisal of quality assurance measures in the management of secondary schools and its implication on science, technology, engineering and mathematics education. *International Journal of Mechanical and Production Engineering Research and Development*, 10 (1), 159-170. <http://www.tjprc.org/publishpapers/2-67-1612434030-IJMPERDFEB202115.pdf>
- Fawzi, H. (2010). Bleeding edge challenges: Limits on using CALL in EFL classrooms at the tertiary level. In Egbert, J. (2010). CALL in limited technology contexts, *CALICO*, 9, 227-239.
- Heritage, M. (2007). Formative Assessment: What Do Teachers Need to Know and Do? *Phi Delta Kappan*, 89(2), 140-145. <http://doi.org/10.1177/003172170708900210>
- Herman, J. L., Osmundson, E., Ayalya, C., Schneider, S., & Timms, M. (2005). The nature and impact of teachers' formative assessment practices. *Paper presented at the Annual meeting of the American Educational Research Association*. Montreal, Quebec, Canada.
- Irons, A. (2008). Enhancing learning through formative assessment and feedback. Key guides for effective teaching in higher education series (Vol. 39). Abingdon: Routledge. http://doi.org/10.1111/j.1467-8535.2008.00890_9.x
- Irving, K. (2015). Technology-assisted formative assessment. In M. J. Urban and D. A. Falvo (Eds.), *Improving K-12 STEM education outcomes through technological integration* (380-398). <http://doi.org/10.4018/978-1-4666-9616-7.ch017>
- Looney, J. (2010). Making it Happen: Formative Assessment and Educational Technologies. Thinking Deeper Research Paper n.1, part 3. Promethean Education Strategy Group.
- Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in higher education*, 31(2), 199-218. <https://doi.org/10.1080/03075070600572090>
- Nyberg, E., & Olander, M. H. (2015). A Study of Formative Assessment Strategies in Teachers' School-Based In-Service Training. *International Journal of Learning, Teaching and Educational Research*, 11(1), 53-74.
- Okeke, C. I. O., Okeke, C. C., & Ugwuanyi, C. S. (2020). Intervention strategies that can support young adults' transition into positive fatherhood: implications for Science, Technology, Engineering and Mathematics Education. *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)*, 10(3), 8585-8596. <https://doi.org/10.24247/ijmperdjun2020816>
- Okeke, C. I. O., Ugwuanyi, C. S., & Mufutau, M. A. (2020). Stakeholders' Views on Engaging Fathers in Early Childhood Care and Education. *Journal of Human Ecology*, 71(1-3), 177-186. <https://doi.org/10.31901/24566608.2020/71.1-3.3233>
- Okenyi, E. C., Ngwoke, A. N., Ezema, V. S., Aneke, A. O., Asogwa, H. E., & Ugwuanyi, C. S. (2021). Assessment of the perceived impact of home information and communication technology on pupils' social skills development. *International Journal of Mechanical and Production Engineering Research and Development*, 10(1), 67-78. <http://www.tjprc.org/publishpapers/2-67-1611120431-6IJMPERDFEB20216.pdf>
- Onah, E. N., Ugwuanyi, C. S., Okeke, C. I. O., Nworgu, B. G., Agwagah, U. V. N., Ugwuanyi, C. C., Obe, P. I., Nwoye, M. N., & Okeke, A. O. (2020). Evaluation of the Impact of Computer-Assisted Instruction on

- Mathematics and Physics Students' Achievement: Implication for Industrial Technical Education. *International Journal of Engineering Research and Technology*, 13(7), 1786-1794. <https://doi.org/10.37624/IJERT/13.7.2020.1786-1794>
- Panero, M., & Aldon, G. (2016). How Teachers Evolve Their Formative Assessment Practices When Digital Tools Are Involved in the Classroom. *Digital Experiences in Mathematics Education*, 2(1), 70-86. <https://doi.org/10.1007/s40751-016-0012-x>
- Shirley, M. L., & Irving, K. E. (2015). Connected Classroom Technology Facilitates Multiple Components of Formative Assessment Practice. *Journal of Science Education and Technology*, 24(1), 56-68. <https://doi.org/10.1007/s10956-014-9520-x>
- Spector, J. M., Ifenthaler, D., Sampson, D., Yang, L. J., Warusavitarana, A., Dona, K. L., Eichhorn, K., Fluck, A., Huang, R., Bridges, S., Lu, J., Ren, Y., Gui, X., Christopher, C., Diego, J. S., Gibson, D. C., Spector, J. M., Ifenthaler, D., Sampson, D., ... Fluck, A. (2016). International Forum of Educational Technology & Society Technology Enhanced Formative Assessment for 21st Century Learning Linked references are available on JSTOR for this article : Technology Enhanced Formative Assessment for 21st Century Learning. *International Forum of Educational Technology & Society Is Collaborating with JSTOR to Digitize, Preserve and Extend Access to Journal of Educational Technology & Society*, 19(3), 57-71.
- Ugwuanyi, C. S., Nduji, C. C., Gana, C. S., Nwajiuba, C. A., Ene, C. U., Okeke, A. O., Eseadi, C., & Okeke, C. F. (2019b). Effectiveness of flipped classroom instructional technology model in enhancing students' achievement in physics. *International Journal of u- and e- Service, Science and Technology*, 12(4), 37-46.
- Ugwuanyi, C. C., Nwachukwu, W. C., Ugwuanyi, C. S., Okeke, C. I. O., Nworgu, B. G., Nwoye, M. N., Odo, I. O., Okeke, A. M., Inweregbuh, O. C., Osakwe, I. J., & Idoko, J. U. (2020). Perceived impact of the use of internet resources on undergraduate students' academic achievement in Mathematics: Implication for Physics and Engineering Teaching. *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)*, 10(4), 359-368. <http://dx.doi.org/10.24247/ijmperdaug202031>
- Ugwuanyi, C. S., Okeke, C. I. O., Nnamani, P. A., Obochi, E. C., & Obasi, C. C. (2020a). Relative effect of animated and non-animated powerpoint presentations on physics students' achievement. *Cypriot Journal of Educational Science*, 15(2), 282-291. <https://doi.org/10.18844/cjes.v15i2.4647>
- Ugwuanyi, C. S., Nduji, C. C., Elejere, U. C., & Omeke, N. E. (2020c). Effect of Flipped Classroom and Think Pair Share Strategy on Achievement and Retention Among Senior Secondary School Physics Students. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 52(2), 136-148. <https://www.gssrr.org/index.php/JournalOfBasicAndApplied/article/view/11250/5681>
- Ugwuanyi, C. S., & Okeke, C. I. O. (2020). Enhancing University Students' Achievement in Physics using Computer-Assisted Instruction. *International Journal of Higher Education*, 9(5), 115-124. <https://doi.org/10.5430/ijhe.v9n5p115>
- Ugwuanyi, C. S., Okenyi, E. C., Ezema, V., & Amoke, C. (2020d). Effect of digital game-based learning on achievement of primary school pupils in sciences in Enugu State, Nigeria. *Journal of Educational Research on Children, Parents & Teachers*, 1(1), 35-44.
- Ugwuanyi, C. S., Ugwuanyi, C. C., Ezenwa-Nebife, D. C., Gana, C., Ene, C., Oguguo, B. C., Ikeh, F. E., Okeke, A. O., Nwoye, M. N., Obi, C. N., Anyaegbu, C., & Agah, J. J. (2019b). Assessment of the efficacy of information and communication technology tool on achievement of students in physics and mathematics: A case of repeated measures. *Journal of Engineering and Applied Sciences*, 14(13), 4541-4546. <https://doi.org/10.36478/jeasci.2019.4542.4546>
- Ugwuanyi, C. S., Agah, J. J., Onah, E., Ugwuanyi, C. C., Ikeh, F. E., Okeke A. O., Ene, C., & Oguguo, B. C. (2019c). Information and communication technology (ICT) capacity building needs for twenty first century classroom instructional delivery: perceptions of science and mathematics teachers. *Journal of Engineering and Applied Sciences*, 14(1), 270-274. <https://doi.org/10.36478/jeasci.2019.270.274>
- Ugwuanyi, C. C., Nwachukwu, W. C., Ugwuanyi, C. S., Okeke, C. I. O., Nworgu, B. G., Nwoye, M. N., Odo, I. O., Okeke, A. M., Inweregbuh, O. C., Osakwe, I. J., & Idoko, J. U. (2020). Perceived Impact of the Use of Internet Resources on Undergraduate Students' Academic Achievement in Mathematics: Implication for Physics and Engineering Teaching. *International Journal of Mechanical and Production Engineering Research and*

Development (IJMPERD), 10(4), 359-368. <http://dx.doi.org/10.24247/ijmperdaug202031>

Rushton, A. (2005). Formative assessment: a key to deep learning? *Medical Teacher*, 27(6), 509-513. <http://doi.org/10.1080/01421590500129159>

Wan, M. (2005). Standards Unit. Improving learning in mathematics: challenges and strategies. Produced by the Department for Education and Skills Standards Unit.

Wiliam, D. (2000). An overview of the relationship between assessment and the curriculum. In D Scott (Ed.) (2000) *Assessment and the Curriculum* (pp. 165-181). Greenwich, CT: JAI Press.

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