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Digital Learning Self-Efficacy, Cognitive Engagement, and AI-Based Assessment Feedback as Predictors of Academic Resilience among Secondary School Students in Smart Classrooms in Cross River State

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Abstract

This study investigated digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback as predictors of academic resilience among public secondary school students in smart classrooms in Cross River State, Nigeria. The study utilised a predictive correlational survey research design. The study's population comprised 4,462 Senior Secondary School two students. A sample of 365 students was drawn for the study using multi-stage sampling procedure. Digital Learning Self-Efficacy Questionnaire (DLSEQ), Cognitive Engagement Questionnaire (CEQ), AI-Based Assessment Feedback Questionnaire (AIBAFQ), and Academic Resilience Scale for Secondary School Students (ARSSS), developed by the researchers were used for collection of data, which were analyzed using simple linear and multiple regression analyses. The findings revealed that digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback significantly ($p < 0.05$) predicted academic resilience of the students both separately and jointly. It was therefore recommended among others, that teachers should provide supportive and motivating learning environments that encourage students' academic resilience.

Keywords: Digital learning self-efficacy, cognitive engagement, AI-based assessment feedback, academic resilience, smart classrooms

INTRODUCTION

The rapid advancement of digital technologies has significantly transformed educational systems across the world, reshaping instructional delivery, learner engagement, classroom interaction, and assessment practices. In contemporary educational settings, smart classrooms characterized by the integration of internet-enabled devices, interactive digital platforms, artificial intelligence (AI), learning analytics, and technology-supported instructional strategies are increasingly being adopted to prepare learners for the demands of the twenty-first century knowledge economy.

In secondary schools, digital learning such as smart classrooms provide opportunities for collaborative learning, real-time feedback, adaptive instruction, and enhanced learner participation through the use of multimedia technologies, online learning platforms, artificial intelligence-supported systems, and data-driven instructional practices (OECD, 2021). These technological innovations have broadened access to educational resources, and have improved possibilities for individual learning support. The effective use of these digital learning environments is, however, heavily reliant on learners' psychological orientations and adaptability.

Digital learning self-efficacy is an important psychological construct that has been linked to successful engagement in digital learning environments. Self-efficacy, according to Bandura (1997) describes an individual's confidence in his or her ability to organize and perform the behavior necessary to achieve a desired result. Therefore, digital learning self-efficacy is students' beliefs about their competence in using digital technologies, online platforms, virtual learning tools, and technology-supported instructional resources with effectiveness to achieve learning tasks. Hodges (2020) indicated that students who have high digital learning self-efficacy tend to exhibit persistence, independent learning behaviours, problem-solving skills, and positive adaptation to the digital learning environment. In contrast, Kim and Glassman (2022) noted that learners who lack digital self-efficacy may struggle to maneuver online educational systems, have less motivation, have poor engagement, and develop academic frustration.

The importance of digital learning self-efficacy in technology-enhanced educational environments cannot be overstated. Among secondary school students, Lawal, Aliyu, Madugu and Yahaya (2025) reported that the use of instructions with virtual laboratories and simulation significantly enhanced the students' SE and academic performance. Furthermore, Yusuf and Ibrahim (2025) found that the flipped classroom strategy had a significant positive effect on students' self-efficacy in chemistry. Furthermore, the findings by Aneshie-Otakpa, Andor and Sani (2021) indicated that the flipped classroom teaching methods significantly improved the secondary school students' critical thinking and matrices and determinants achievement. The results of this study therefore suggest that students' self-efficacy to use the digital learning environment could be one of the most important factors influencing their academic adjustment and continuation in the smart classroom.

Another psychological variable of interest in this study is students' cognitive engagement. According to Fredricks,

Blumenfeld, and Paris (2004), cognitive engagement is a measure of students' psychological commitment, strategic learning behaviors, and mental engagement in learning tasks. Cognitively engaged students in smart classrooms actively interact with digital teaching materials, engage in collaborative learning activities and apply SRL strategies to improve understanding and learning outcomes compared to those who are not cognitively engaged. Cognitive engagement has been demonstrated to be strongly associated with learning outcomes, such as depth of learning, academic outcomes, persistence, and adaptation to technologically mediated learning environments (Bond et al., 2020; Sinatra, Heddy, & Lombardi, 2015). But, it appears that many students do not show high levels of sustained engagement even when using the smart classroom. Hence, the e-learning readiness of secondary school students is in the medium zone as reported by Ottan (2025). The result highlights the need for digital skills and technological readiness for successful learning in modern learning spaces.

Another emerging aspect of digital pedagogies is the increasing use of Artificial Intelligence systems of assessment feedback in education. According to Luckin et al. (2022), Artificial Intelligence has changed the way educational assessment is performed, as it allows for automated generation of feedback, adaptive testing, tracking of students' performance in their individual lessons, intelligent analysis of student performance to inform individualized learning paths, and intelligent tutoring systems that can assist in individualised learning paths. AI-generated assessment feedback offers learners instant, individual, and data-driven feedback on their learning trajectory, capabilities, enhancements, and weaknesses. Feedback mechanisms can improve students' learning regulation, motivation, confidence, and academic adjustment by allowing for continuous tracking of learning outcomes and self-reflection for improvement. Early and individualised feedback from AI can enhance students' learning experience, academic engagement and self-regulated learning (Zawacki-Richter et al., 2019; Holmes & Tuomi, 2022). However, there are significant issues related to unequal access to digital infrastructure, lack of teacher preparedness, and varying student capabilities of using AI-enabled educational tools effectively, especially in Nigeria and other developing nations. This in part can have a significant impact on students' academic resilience.

Academic resilience is a critical construct in understanding students' success in spite of challenges, setbacks, stressors, or challenging learning environments. Martin and Marsh (2006) describes it as a student's ability to keep learning and go the extra mile to ensure good educational results, and to adapt to challenges and obstacles at school. The concept of academic resilience is even more relevant in digitally enabled learning contexts where students may need to learn about new instructional technologies, be self-directed, participate in online assessment, and complete complex tasks of digital learning. Academic resiliency is linked to both the ability to adapt to the technological elements and the pressure and disruption of digital learning environments. Okoiye (2026) investigated the significance of self-efficacy and intrinsic motivation in predicting secondary school students' resilience to adapting to e-learning in Owerri, Nigeria and found that self-efficacy and intrinsic motivation were significant predictors of the school students' resilience in adapting to e-learning. Similarly, Ityavzua, Aruwa and Asogwa (2026) reported that autonomy supportive digital instructional environments have positive impact on students' motivation and adaptive learning behaviors in secondary education in Nigeria.

While digital learning platforms offer many possibilities for schools to innovate, Adeleke and Emeahara (2023) highlighted that some of the digital literacy issues facing secondary school learners in Nigeria remain unresolved, which include poor digital literacy, inadequate technological infrastructure, unreliable internet connection, lack of access to digital devices, and limited technological support in schools. These challenges can impact on pupils' confidence, engagement, adaptability and learning in the smart classroom. As a result, there is a growing concern that students' digital learning self-efficacy and cognitive ability are not sufficient for them to perform well in a smart classroom setting, especially in public secondary schools in Cross River State, Nigeria. However, there seems to be little empirical research that has looked at the joint predictive power of digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback on academic resilience in secondary school smart classrooms in Cross River State, Nigeria, particularly among secondary school students. Hence, this study sought to investigate digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback as predictors of academic resilience among secondary school students in smart classrooms in Cross River State.

Research Questions

Specifically, the following research questions were posed for the study:

1. What is the predictive power of digital learning self-efficacy on academic resilience among secondary school students in smart classrooms?
2. What is the predictive power of cognitive engagement on academic resilience among secondary school students in smart classrooms?
3. What is the predictive power of AI-based assessment feedback on academic resilience among secondary school students in smart classrooms?
4. What is the joint predictive power of digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback on academic resilience among secondary school students in smart classrooms?

Hypotheses

The following null hypotheses were formulated to guide the study and were tested at 0.05 level of significance:

H01: Digital learning self-efficacy does not significantly predict academic resilience among secondary school students in smart classrooms.

H02: Cognitive engagement does not significantly predict academic resilience among secondary school students in smart classrooms.

H03: AI-based assessment feedback does not significantly predict academic resilience among secondary school students in smart classrooms.

H04: Digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback do not jointly and significantly predict academic resilience among secondary school students in smart classrooms.

METHODS

This study utilised a predictive correlational survey research design, and was carried out in Cross River State, Nigeria. The study's population comprised all the 4,462 Senior Secondary School two (SS2) students in public secondary schools in the state with functional smart classroom or technology-enhanced learning facilities in the 2025/2026 academic session. A sample of 365 SS2 students drawn from the population through a multi-stage sampling procedure was used for the study. Four instruments namely Digital Learning Self-Efficacy Questionnaire (DLSEQ), Cognitive Engagement Questionnaire (CEQ), AI-Based Assessment Feedback Questionnaire (AIBAFQ), and Academic Resilience Scale for Secondary School Students (ARSSS), developed by the researchers were used for data collection in the study. The DLSEQ contained 12 items designed to measure students' digital learning self-efficacy. The CEQ also had 12 items that measured students' cognitive engagement in smart classroom learning activities. The AIBAFQ had 10 items, which measured students' perceptions of AI-based assessment feedback within digitally mediated instructional environments. Lastly, the ARSSS consisted of 15 items designed to measure students' academic resilience. All the instruments were structured on a four-point Likert-type scale with response options of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), weighted 4, 3, 2, and 1, respectively.

The instruments were face-validated by three experts; one each from the fields of Measurement and Evaluation, Educational Psychology, and Educational Technology. The experts ensured clarity of items, appropriateness of language, relevance to the study variables, and suitability for measuring the variables. The reliability of the instruments was established after trial-testing on 30 SS2 students drawn from public secondary schools in the study area not used for the actual study. Cronbach Alpha reliability method was used to determine the internal consistency of the instruments because the items involved polytomous scoring. Reliability coefficients of 0.83, 0.86, 0.81, and 0.88 were obtained for digital learning self-efficacy, cognitive engagement, AI-based assessment feedback, and academic resilience, respectively. An overall reliability coefficient of 0.87 was obtained for the CEAIBAFQ. The coefficients showed that the instruments were reliable for the study.

Permission for data collection was obtained from the principals of the sampled schools. The researcher, with the help of research assistants and teachers in the sampled schools, administered the instruments directly to the respondents during school hours and retrieved immediately after completion to ensure high return rate and to minimize data loss. Data collected were screened, coded, and analyzed using simple linear regression and multiple regression analyses. Research questions 1, 2, and 3 were answered using simple linear regression analysis, while research question 4 was answered using multiple regression analysis. The coefficient of determination (R^2) was used to determine the proportion of variance in academic resilience explained by the predictor variables. Hypotheses 1, 2, and 3 were tested using the t-test associated with the regression coefficients, while Hypothesis 4 was tested using the F-test associated with multiple regression analysis. All hypotheses were tested at the 0.05 level of significance.

RESULTS

The results of the study are presented the tables that follow.

Research question one: What is the predictive influence of digital learning self-efficacy on academic resilience among secondary school students in smart classrooms?

Table 1: Simple Linear Regression Analysis of the Predictive Influence of Digital Learning Self-Efficacy on Academic Resilience

Model Variable	R	R Square	Adjusted R Square	Std. Error of the Estimate	Beta (β)	*t-value*	*p*-value
Digital learning self-efficacy	.612	.375	.373	4.216	.612	17.421	.000

Result in Table 1 showed that the correlation coefficient (R) between digital learning self-efficacy and academic resilience among secondary school students in smart classrooms was .612, while the coefficient of determination (R^2) was .375. This indicates that digital learning self-efficacy accounted for 37.5% of the variance in students' academic resilience. This implies that students with higher levels of digital learning self-efficacy were more likely to demonstrate higher academic resilience in smart classroom environments.

Hypothesis one (H01): Digital learning self-efficacy does not significantly predict academic resilience among secondary school students in smart classrooms.

The result in Table 1 also showed that digital learning self-efficacy significantly predicted academic resilience among secondary school students in smart classrooms (t = 17.421, p = .000). This is because the p-value (.000) is less than the 0.05 level of significance at which the hypothesis is tested, hence, the null hypothesis was rejected. Therefore, digital learning self-efficacy significantly predicts academic resilience among secondary school students in smart classrooms.

Research question two: What is the predictive influence of cognitive engagement on academic resilience among secondary school students in smart classrooms?

Table 2: ***Simple Linear Regression Analysis of the Predictive Influence of Cognitive Engagement on Academic Resilience***

Model Variable	R	R Square	Adjusted R Square	Std. Error of the Estimate	Beta (β)	*t-value*	*p*-value
Cognitive Engagement	.684	.468	.466	3.887	.684	21.102	.000

Result in Table 2 denotes that the correlation coefficient (R) between cognitive engagement and academic resilience among secondary school students in smart classrooms was .684, while the coefficient of determination (R^2) was .468. This means that cognitive engagement accounted for 46.8% of the variance in students' academic resilience. This suggests that students who demonstrated higher levels of cognitive engagement were more likely to exhibit stronger academic resilience in smart classroom environments.

Hypothesis two (H02): Cognitive engagement does not significantly predict academic resilience among secondary school students in smart classrooms.

The result in Table 2 also revealed that cognitive engagement significantly predicted academic resilience among secondary school students in smart classrooms (t = 21.102, p = .000). Since the p-value (.000) is less than the 0.05 level of significance, the null hypothesis was rejected. Thus, cognitive engagement significantly predicts academic resilience among secondary school students in smart classrooms.

Research question three: What is the predictive influence of AI-based assessment feedback on academic resilience among secondary school students in smart classrooms?

Table 3: ***Simple Linear Regression Analysis of the Predictive Influence of AI-Based Assessment Feedback on Academic Resilience***

Model Variable	R	R Square	Adjusted R Square	Std. Error of the Estimate	Beta (β)	*t-value*	*p*-value
AI-based assessment feedback	.593	.352	.349	4.304	.593	16.587	.000

Result in Table 3 showed that the correlation coefficient (R) between AI-based assessment feedback and academic resilience among secondary school students in smart classrooms was .684, while the coefficient of determination (R^2) was .593. This suggests that AI-based assessment feedback accounted for 35.2% of the variance in students' academic resilience. This implies that effective AI-based assessment feedback contributed positively to students' academic resilience within smart classroom environments.

Hypothesis three (H03): AI-based assessment feedback does not significantly predict academic resilience among secondary school students in smart classrooms.

Result in Table 3 also indicated that AI-based assessment feedback significantly predicted academic resilience among secondary school students in smart classrooms (t = 16.587, p = .000). Since the p-value (.000) is less than the 0.05 level of significance, the null hypothesis was therefore rejected. Hence, inference drawn was that AI-based assessment feedback significantly predicts academic resilience among secondary school students in smart classrooms.

Research question four: What is the joint predictive influence of digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback on academic resilience among secondary school students in smart classrooms?

Table 4: ***Multiple Regression Analysis of the Joint Predictive Influence of Digital Learning Self-Efficacy, Cognitive Engagement, and AI-Based Assessment Feedback on Academic Resilience***

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.746	.557	.553	5.271	.557	164.828	3	361	.000

a. Predictors: (Constant), Digital learning self-efficacy, Cognitive engagement, AI-based assessment feedback

The result in Table 15 shows that the correlation coefficient (R) between digital learning self-efficacy, cognitive engagement, AI-based assessment feedback and academic resilience among secondary school students in smart classrooms jointly was 0.746 with a coefficient of determination (R^2) of 0.557. This R^2 implies that 55.7% of the variance in students' academic resilience among secondary school students in smart classrooms is jointly accounted for by their digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback.

Hypothesis four (H04): Digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback do not jointly and significantly predict academic resilience among secondary school students in smart classrooms.

Table 5: ***ANOVA Summary of the Joint Predictive Influence of Digital Learning Self-Efficacy, Cognitive Engagement, and AI-Based Assessment Feedback on Academic Resilience***

	Sum of Squares	df	Mean Square	F	Sig.
Regression	8241.536	3	2747.179	265.384	.000
Residual	4918.227	361	13.623		
Total	13159.763	364			

The result in Table 5 showed that digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback jointly and significantly predicted academic resilience among secondary school students in smart classrooms (F = 265.384, p = .000). Since the p-value (.000) is less than the .05 level of significance, the null hypothesis was rejected. Therefore, digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback jointly and significantly predict academic resilience among secondary school students in smart classrooms.

DISCUSSION

The study found that digital learning self-efficacy was significantly predictive of academic resilience of secondary

school students in the smart classrooms in Cross River State. This means that students who can confidently use the digital learning technologies, online platforms, and smart classroom instructional tools will be more resilient when encountering academic and technological difficulties. It is in line with Bandura's Social Cognitive Theory that focuses on the influence of self-belief on behavioural adaptation and persistence. The result also supports the findings of Lawal et al. (2025) and Aliyu et al. (2025) and Yusuf and Ibrahim (2025) who found that technology supported instructional strategies significantly increased students' self-efficacy and digital learning adaptation in digital learning environment. This may be explained by the readiness of students with high digital competence and confidence to embrace positive changes in response to digitally mediated demands for teaching.

The study also found that cognitive engagement was a significant predictor of academic resilience of secondary school students in smart classrooms. This indicates that those students who invest mental effort, participate in learning activities and apply self-regulated learning strategies are more likely to deal successfully with academic difficulties in a technology-enhanced classroom. The result aligns with the Fredricks, Blumenfeld and Paris (2004) position of increased levels of cognitive engagement facilitating deeper learning, persistence and adaptive academic behaviours. In addition, the result is consistent with previous studies by Bond et al. (2020) that indicated that cognitively engaged learners exhibit better academic adjustment and learning persistence during digital learning environments. This observed correlation could be because cognitively engaged students have more positive interactions with the digital instructional resources and learning tasks.

The result also revealed that AI-based assessment feedback significantly predicted academic resilience among secondary school students in smart classrooms. This means that feedback to students in a timely and personalized manner, through technology, can increase the student's motivation, learning regulation, confidence and adaptability levels in a smart classroom. The finding aligns with those of Holmes and Tuomi (2022) and Zawacki-Richter et al. (2019) who found that AI based feedback systems enhance the learning experience, student engagement and self-regulated behaviours of students. This discovery could be attributed to the fact that immediate and personalized feedback allows students to explore their own strengths and weaknesses and thus fosters consistent improvement and adaptive learning behaviours.

Lastly, the study showed that digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback jointly and significantly predicted academic resilience among secondary school students in smart classrooms. The predictor variables that contributed most to academic resilience were cognitive engagement, digital learning self-efficacy, and feedback from AI-based assessment. This is in line with Bond et al. (2020) report which revealed that student's academic resilience in smart class is driven by psychological readiness, active involvement in learning and supportive technology-based assessment practices. The interaction effect between the variables could be explained by the fact that confidence, engagement and feedback processes are intertwined in supporting effective adaptation to digitally driven learning environments.

CONCLUSION

The study found that digital learning self-efficacy, cognitive engagement, and AI-based assessment feedback are statistically significant predictors of academic resilience in secondary school students in smart classrooms of Cross River state. Thus, creating learning environment with psychological support, technologically upgraded and engaging is still significant to enhance students' resilience and active learning in future-oriented smart classroom education.

Recommendations

The following recommendations were given based on the results of the study:

1. Teachers should create a supportive and motivating learning environment, encourage students to persist, adapt and resist learning failures, cultivating academic resilience among students in smart classroom.
2. School administrators and other educational stakeholders should provide frequent digital literacy and technology training programmes for students for developing their confidence and competence in technology-rich learning environments.
3. Schools should incorporate a feedback system for assessments that utilizes AI to deliver personalized, constructive and timely feedback to students.
4. Government and education institutions should enhance digital infrastructure support services, internet connectivity and technological support in public secondary schools.

REFERENCES

Adeleke, D. S., & Emeahara, E. N. (2023). Digital learning infrastructure and students' participation in technology-enhanced learning environments in Nigerian secondary schools. *Journal of Educational Technology Systems*, *52*(1), 45–62.

Aneshie-Otakpa, V. O., Andor, S. E. & Sani, D. A. (2021). Effect of flipped classroom instructions on secondary school students' critical thinking and achievement in matrices and determinants. *African Journal of Science, Technology & Mathematics Education (AJSTME), 6*(1), 157-165.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman.

Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2020). Emergency remote teaching in higher education: Mapping the first global online semester. *International Journal of Educational Technology in Higher Education*, *17*(1), 1–24.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of evidence. *Review of Educational Research*, *74*(1), 59–109.

Hodges, C. (2020). The difference between emergency remote teaching and online learning. *EDUCAUSE Review*, *27*(1), 1–12.

Holmes, W., & Tuomi, I. (2022). State of the art and practice in AI in education. *European Journal of Education*, *57*(4), 542–570.

Ityavzua, J. T., Aruwa, A. S., & Asogwa, U. D. (2026). Autonomy-supportive digital learning environments and adaptive learning behaviours among secondary school students in Nigeria. *Nigerian Journal of Educational Psychology*, *18*(1), 102–118.

Kim, Y., & Glassman, M. (2022). Beyond search and communication: Development and validation of the digital learning self-efficacy scale. *Computers & Education*, *180*, 104440.

Lawal, M. A., Aliyu, U. M., Madugu, A. A., & Yahaya, S. A. (2025). Effect of blended STEM instruction on students' self-efficacy and academic performance in Kaduna State secondary schools. *Journal of Educational Research and Development*, *9*(2), 85–101.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2022). *Intelligence unleashed: An argument for AI in education*. London: Pearson Education.

Martin, A. J., & Marsh, H. W. (2006). Academic resilience and its psychological and educational correlates: A construct validity approach. *Psychology in the Schools*, *43*(3), 267–281.

OECD. (2021). *Digital education outlook 2021: Pushing the frontiers with artificial intelligence, blockchain and robots*. Paris: OECD Publishing.

Okoiye, O. E. (2026). Self-efficacy and intrinsic motivation as predictors of secondary school students' resilience in adapting to e-learning methods in Owerri, Nigeria. *Journal of Contemporary Educational Research*, *14*(2), 55–70.

Ottan, R. I. (2025). E-learning readiness among secondary school students in Kwara State, Nigeria. *International Journal of Information Technology in Education*, *7*(1), 19–34.

Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The challenges of defining and measuring student engagement in science. *Educational Psychologist*, *50*(1), 1–13.

UNESCO. (2023). *Global education monitoring report 2023: Technology in education—A tool on whose terms?* Paris: UNESCO.

Yusuf, M. A., & Ibrahim, H. M. (2025). Flipped classroom strategy and self-efficacy among secondary school chemistry students in Jigawa State, Nigeria. *Sokoto Educational Review*, *21*(1), 90–104.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. *International Journal of Educational Technology in Higher Education*, *16*(1), 1–27.