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EFFECTS OF COMPUTER-SUPPORTED LEARNING ENVIRONMENTS ON STUDENTS' ACADEMIC MOTIVATION IN NIGERIAN SECONDARY SCHOOLS

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ABSTRACT

Whether a computer-based learning environment can perform motivational functions that Self-Determination Theory (SDT) ordinarily attributes to an autonomy-supportive teacher is a question with direct practical consequences in school systems where ICT infrastructure is expanding faster than pedagogical capacity. This study examined that question through a school-based quasi-experimental investigation involving 110 Senior Secondary Two (SS 2) students in Lafia Local Government Area, Nasarawa State, Nigeria. Participants were drawn from two government secondary schools: one school (n = 55, Government Secondary School, Lafia) received an eight-week compound intervention combining an autonomy-supportive Computer-Supported Learning Environment (CSLE) with trained teacher facilitation and structured research monitoring; the other (n = 55, Government Secondary School, Shabu) continued with conventional teacher-directed instruction. The CSLE incorporated four design features derived from SDT: technology-mediated choice provision, digital rationale transparency, informational computerised feedback, and self-paced progression. Academic motivation was assessed at pre-test and post-test using the Academic Motivation Scale, Secondary (AMS-S), covering five SDT-aligned subscales. A post-test-only Perceived Autonomy Support in Computer-Supported Learning Environments scale (PAS-CSLE), a preliminary researcher-developed fidelity instrument, was also administered. One-way MANOVA yielded a significant and large multivariate group difference, Wilks' L = .187, F(5, 104) = 90.81, p < .001, multivariate eta2 = .813, with all five univariate follow-up tests significant in theoretically coherent directions. The study was associated with multidimensional motivational differences consistent with SDT predictions, though the magnitude of effects warrants caution given the two-school design, the compound intervention, and several plausible alternative explanations including novelty effects and teacher-training effects. Findings are positioned as preliminary contextual evidence supporting the applicability of SDT autonomy-support principles to digital learning design in Nigerian public secondary schools.

Keywords: Academic motivation, computer-supported learning environment, self-determination theory, secondary education, Nasarawa State.

Introduction

A recurring question in educational technology research concerns whether the structural properties of a computer-based learning system can meaningfully support the psychological conditions that motivate learners. Self-Determination Theory (SDT; Ryan & Deci, 2020) provides a precise theoretical framework for this question. SDT holds that any environment, whether human or technological, that satisfies learners' basic psychological need for autonomy should promote the internalisation of learning goals and the development of intrinsic motivation. The implication is testable: environments that offer genuine choice, provide transparent purpose, and supply growth-oriented feedback should shift learners toward the self-determined end of SDT's motivational continuum, away from amotivation and external regulation, and toward identified regulation and intrinsic motivation.

Nigeria's National Digital Economy Policy and Strategy (Federal Ministry of Communications and Digital Economy, 2020) has accelerated hardware acquisition across public secondary schools, prioritising device provision and connectivity. Several observers in the African educational technology literature have noted that infrastructure expansion has not consistently been accompanied by equivalent attention to the pedagogical quality of digital learning experiences, a pattern that raises the question of whether technology access alone, without deliberate motivational design, produces durable learning benefits (Jeno et al., 2019; UNESCO, 2023). The present study does not seek to document that national pattern as established empirical fact; rather, it uses the tension it identifies as theoretical motivation for examining whether a CSLE explicitly designed around SDT autonomy-support principles produces motivational profile differences relative to conventional instruction.

Three intersecting gaps in the existing literature motivate this investigation. At the conceptual level, SDT's autonomy-support construct has been studied predominantly as an interpersonal phenomenon, something teachers enact through their behaviour, rather than as a property that can be embedded in the architectural design of a digital learning system. While SDT-informed digital learning research has expanded in higher education contexts, evidence from secondary school systems, particularly in low- and middle-income settings, remains limited and methodologically uneven (Howard et al., 2021; Jeno et al., 2020). At the methodological level, studies of technology-mediated motivation in Nigerian secondary schools have rarely employed validated multidimensional motivation instruments or applied multivariate strategies capable of detecting profile-level shifts across the full SDT motivational continuum. At the contextual level, Nasarawa State remains largely absent from published experimental research on SDT and digital learning, despite the state's documented ICT integration activities through the Nasarawa State Ministry of Education (NSMoE).

The present study addressed all three gaps through a school-based quasi-experimental investigation deploying a compound intervention over eight weeks with SS 2 students in Lafia LGA. Six null hypotheses guided the analysis:

H_{01}: There is no significant multivariate difference in the combined post-test academic motivation profile between the intervention and control groups.

H_{02}: There is no significant difference in post-test intrinsic motivation scores between the two groups.

H_{03}: There is no significant difference in post-test identified regulation scores between the two groups.

H_{04}: There is no significant difference in post-test introjected regulation scores between the two groups.

H_{05}: There is no significant difference in post-test external regulation scores between the two groups.

H_{06}: There is no significant difference in post-test amotivation scores between the two groups.

Theoretical Framework

Self-Determination Theory and the Motivational Continuum

Self-Determination Theory (Ryan & Deci, 2020; Vansteenkiste et al., 2020) organises human motivation along a continuum defined by the degree to which regulatory processes are self-endorsed rather than externally imposed. At one end lies amotivation — the absence of intentional engagement with a task. Moving toward greater self-determination, external regulation describes behaviour driven by external reward and punishment; introjected regulation describes behaviour driven by internally administered pressures such as shame avoidance or ego-protection; identified regulation describes behaviour motivated by genuine personal endorsement of a task's value; and intrinsic motivation describes behaviour engaged in for its inherent interest and satisfaction. SDT predicts that environments providing autonomy support shift learners toward the self-determined end of this continuum, not merely reducing controlled motivation but also energising intrinsic engagement.

Reeve and Cheon (2021) catalogued the behavioural features of autonomy-supportive teaching in classroom contexts: offering meaningful choices, explaining the rationale for required activities, using informational rather than directive language, and refraining from performance pressure. Their synthesis confirmed that these behaviours consistently predict intrinsic motivation, identified regulation, and reduced amotivation across educational levels and national contexts, though effect magnitudes vary considerably and are often smaller in studies with longer time horizons and more heterogeneous populations. The present study proceeds from the proposition that these same features can be translated into the structural design of a digital learning environment: choice presentation in the platform interface, embedded purpose statements in task screens, explanatory performance feedback, and the removal of countdown timers and competitive progress displays. This proposition leads to a testable prediction: if students experience a CSLE's design features as genuinely autonomy-supportive, they should exhibit motivational profile differences consistent with SDT predictions. The underlying mechanism assumed is internalisation through perceived autonomy satisfaction, though this mechanism is not directly tested in the present study; the investigation provides evidence of predicted outcome differences, not evidence of the mediating process.

Autonomy-Supportive Digital Learning Environments

The concept of autonomy-supportive digital learning environments (ASDLEs) has emerged from the convergence of SDT-informed educational research with instructional design scholarship on learner control in technology-mediated contexts. Jeno et al. (2019) demonstrated, using a randomised controlled design, that mobile learning environments structured around SDT principles, providing choice, competence-enhancing feedback, and collaborative task structures, produced significant gains in intrinsic motivation relative to conventional instruction, with effects that persisted at one-month follow-up. Critically, their analysis distinguished between technology access per se and the motivational quality of the digital design, finding that design quality rather than technological novelty predicted motivational outcomes over time. A subsequent study by Jeno et al. (2020), replicating this framework across a different discipline, found comparable directional effects but smaller magnitudes, underscoring the context-sensitivity of ASDLE interventions and the difficulty of predicting effect size from single-context studies.

Chiu (2022), examining a large sample of secondary and post-secondary students during pandemic-related online learning, found that design-based autonomy support, learner-controlled pacing, choice of learning pathway, and explanatory feedback, significantly predicted intrinsic motivation after controlling for prior achievement and technology self-efficacy. The pandemic context introduces interpretive caution: students without classroom alternatives may have been more responsive to autonomy-supportive digital environments than students in normal school attendance settings. Howard et al.'s (2021) meta-analysis of 97 SDT-informed educational interventions across a wide range of contexts found significant but heterogeneous effects on intrinsic motivation and identified regulation, with effect sizes varying substantially as a function of intervention duration, educational level, and cultural context. Their finding that effect sizes were largest in short-term interventions and smaller in sustained longitudinal studies is directly relevant to the interpretation of the present study's results.

Literature Review

SDT and Motivation in Digital Learning Contexts: Global Evidence

The broader SDT-in-digital-education literature presents a picture of directional consistency but considerable heterogeneity in effect magnitude. Howard et al.'s (2021) meta-analysis of 97 SDT-informed interventions, spanning classroom instruction, online learning, and blended environments, found significant pooled effects on autonomous motivation outcomes, though confidence intervals were wide and moderated substantially by setting and intervention type. Studies involving short-duration, highly controlled implementations consistently produced larger effects than those embedded in naturalistic long-term educational programmes, a pattern that has direct implications for interpreting the present study's results. Jeno et al. (2019, 2020) provided one of the most methodologically rigorous demonstrations that ASDLE design, specifically, as distinguished from general technology use, can produce motivational gains consistent with SDT predictions, with the important caveat that their samples consisted of university students with prior familiarity with digital learning tools.

Chiu (2022) extended this line of work to secondary students in pandemic conditions, confirming the SDT-digital motivation association in a larger and more demographically varied sample, though with the interpretive limitations noted in the Theoretical Framework section. Vansteenkiste et al. (2020) provided a comprehensive account of the internalisation mechanism through which autonomy-supportive signals, whether from human teachers or system design, produce motivational shifts. Their account is grounded primarily in Western educational contexts where learner autonomy is an established institutional value; whether the internalisation process operates at comparable rates in educational systems shaped by more directive instructional traditions and high-stakes examination cultures is a question that remains empirically open. The present study contributes a data point to this question from a Nigerian public secondary school context, without claiming to resolve it.

Multidimensional Motivation Measurement and MANOVA

The rationale for using MANOVA in SDT-informed motivation research is both theoretical and methodological. SDT explicitly conceptualises the five motivation subscales as interrelated points on a single continuum rather than independent constructs (Ryan & Deci, 2020). Treating each subscale as a separate dependent variable in sequential ANOVAs would misrepresent the theoretical structure and inflate the familywise Type I error rate. MANOVA tests the joint hypothesis that the multivariate combination of subscale scores differs between groups, enabling detection of the profile-level shift, simultaneous movement of autonomous subscales

upward and controlled subscales downward, that SDT predicts. Ntoumanis (2005) recommended this approach specifically for SDT-informed research on precisely these grounds.

One acknowledged limitation of the present study's analytic strategy, detailed in the Methodology section, is that pre-test AMS-S data were collected but used only for equivalence verification rather than as covariates in a MANCOVA model. MANCOVA with baseline covariates would have provided more precise group difference estimates and better protection against unmeasured baseline variation. This represents a conservative but not optimal analytic choice whose implications are carried forward throughout the interpretation of results.

Technology-Mediated Learning and Motivation in Nigerian Secondary Education

Research on technology-mediated learning and motivation in Nigerian secondary education remains limited in volume and heterogeneous in methodological quality. The available evidence is largely correlational or relies on unvalidated single-item motivation measures, making causal inference difficult and limiting comparability across studies (UNESCO, 2023). NSMoE administrative records (NSMoE, 2023) document ongoing ICT integration activities across Nasarawa State secondary schools, but no published experimental study has examined how CSLE design properties relate to SDT-aligned motivational outcomes in this state. The present study was designed to partially address this absence, with the explicit acknowledgment that its two-school design limits the generalisability of its findings.

The contextual significance of Lafia LGA lies in its comparatively favourable infrastructure conditions relative to other Nasarawa State LGAs, as reflected in NSMoE administrative records. Government Secondary School, Lafia was identified in those records as having adequate and reliable computer laboratory infrastructure for a sustained eight-week CSLE intervention. This status makes GSS Lafia a feasible but not typical site for the intervention: findings from this school cannot be straightforwardly extrapolated to schools with less developed ICT infrastructure, and this context-dependence is treated as a substantive feature of the study's contribution rather than a weakness to be minimised.

Methodology

Research Design

A school-based quasi-experimental non-equivalent control group design with pre-test and post-test assessments was employed. Individual student randomisation was not operationally feasible under Nasarawa State school administrative protocols, which do not permit alteration of class composition for research purposes. Intact SS 2 classes at two schools therefore constituted the intervention and control conditions, with treatment assigned at the school level rather than the student level. This is the study's most fundamental design limitation: with only two schools, one per condition, it is not statistically possible to separate treatment effects from school-level effects. Observed differences between conditions may reflect school culture, teacher characteristics, infrastructure quality, or community factors independently of the intervention (Creswell & Creswell, 2023). Findings are interpreted as preliminary, school-level evidence consistent with SDT predictions, not as causal proof of CSLE design effects.

The intervention was compound in nature. Students in the intervention school were exposed to a CSLE configured around SDT autonomy-support principles alongside teachers who had received a one-day professional development workshop in SDT-informed instructional communication, and a research assistant stationed in the computer laboratory throughout all sessions. These components cannot be analytically disaggregated in the present design. Observed differences therefore reflect the total treatment bundle, not CSLE design in isolation.

One-way MANOVA was used as the primary analytic strategy, consistent with Ntoumanis's (2005) recommendation for SDT-informed motivation research. Although no statistically significant baseline differences were detected between groups on any of the five AMS-S subscales, the use of pre-test scores as covariates in a MANCOVA framework would have provided more robust adjustment for potential unmeasured baseline variation and more precise group difference estimates. The present analysis therefore represents a conservative but not optimal approach to modelling quasi-experimental data, and findings should be interpreted with this limitation in mind.

Study Location and School Selection

The study was conducted in Lafia Local Government Area, the administrative capital of Nasarawa State, approximately 153 kilometres south-east of the Federal Capital Territory. School selection was guided by NSMoE administrative records (NSMoE, 2023) documenting ICT infrastructure across Nasarawa State public secondary schools. Government Secondary School, Lafia, was identified in those records as having adequate and reliable computer laboratory infrastructure, sufficient functional workstations, internet connectivity, and ICT-trained permanent staff, for a sustained eight-week CSLE intervention. Government Secondary School, Shabu, located approximately six kilometres from GSS Lafia within the same LGA, was selected as the control school because its demographic and academic profile approximates that of GSS Lafia while its computer laboratory infrastructure was not adequate for the CSLE condition. The two-school design within the same LGA was intended to minimise community-level confounding, though it cannot eliminate school-level confounds or support school-level statistical inference.

Population and Sample

The accessible population comprised all SS 2 students enrolled in government secondary schools across Lafia LGA for the 2023/2024 academic session. SS 2 was selected as the study level because students at this stage engage with senior secondary core subjects without the terminal examination pressure associated with SS 3, which could confound intrinsic motivational processes with examination anxiety. Minimum sample size for MANOVA was estimated using G*Power 3.1 at alpha = .05, statistical power = .80, five dependent variables, and an anticipated medium-to-large multivariate effect size (f2 = 0.35). The minimum required per group was 40; a target of 60 per group was set to buffer against anticipated attrition. Purposive selection of intact SS 2 classes yielded 55 students per group (N = 110). No participant withdrew and complete data were available for all 110 participants.

Table 1

Participant Characteristics of Intervention and Control Groups

Characteristic	Exp. Group (n = 55)	Control Group (n = 55)	chi2 / t	p
Gender: Male, n (%)	30 (54.5)	29 (52.7)	0.04	.848
Gender: Female, n (%)	25 (45.5)	26 (47.3)		
Mean Age in years (SD)	16.1 (0.58)	16.0 (0.61)	0.91	.363
Mean Prior GPA , 100% (SD)	59.3 (5.97)	58.9 (6.14)	0.36	.720
Class Level: SS 2, n (%)	55 (100)	55 (100)	,	,
Prior Computer Lab Use >= 1x/week, n (%)	37 (67.3)	35 (63.6)	0.15	.700
Home Smartphone Access, n (%)	44 (80.0)	43 (78.2)	0.05	.820

Note. Exp. = Intervention (n = 55); Con. = Control (n = 55). GPA = Grade Point Average based on SS 1 end-of-year examinations (maximum score = 100). p values are from independent-samples t-tests (continuous variables) and Pearson chi-square tests (categorical variables). No significant between-group differences were found at baseline (all p > .05).

Instrumentation

Academic Motivation Scale, Secondary (AMS-S)

The AMS-S is a 35-item scale assessing five SDT-aligned motivation subscales, Intrinsic Motivation, Identified Regulation, Introjected Regulation, External Regulation, and Amotivation (seven items each), rated on a 7-point Likert scale (1 = does not correspond at all; 7 = corresponds exactly). The scale was adapted from the original Academic Motivation Scale (Vallerand et al., 1992) for secondary school administration. Although the AMS-S has been widely used across SDT research contexts globally, its application in Nigerian secondary schools remains limited. The present study therefore treats the scale as an established international instrument applied in a new context, with internal consistency estimates reported as a preliminary indicator of score reliability rather than as evidence of full contextual construct validity. Internal consistency in the present sample was acceptable: overall scale alpha = .89; subscale alphas ranged from .81 (External Regulation) to .91 (Intrinsic Motivation), all exceeding the .70 threshold recommended for group-comparison research.

Perceived Autonomy Support in Computer-Supported Learning Environments Scale (PAS-CSLE)

The PAS-CSLE is a 16-item preliminary researcher-developed instrument assessing students' perceptions of four autonomy-support features in their learning environment: Choice Provision (4 items; e.g., "The computer learning system gave me real options about how to complete my work"), Rationale Transparency (4 items; e.g., "The system always explained why each task was important"), Informational Feedback (4 items; e.g., "The feedback helped me understand my reasoning, not just my score"), and Pressure Absence (4 items; e.g., "I did not feel rushed or forced by the system to complete tasks quickly"). Items were rated on a 7-point scale. Content validity was reviewed by three educational psychologists and two ICT instructional design specialists. Test-retest reliability over a two-week interval in a 20-student pilot sample was r = .84. No exploratory or confirmatory factor analysis was conducted, and the dimensional structure of the PAS-CSLE should therefore be interpreted cautiously. The instrument is used here as a preliminary fidelity indicator, not as a validated measure of perceived autonomy support, and its scores do not constitute confirmatory evidence of the mechanism through which motivational differences arose.

Compound Intervention: Autonomy-Supportive CSLE

The eight-week intervention delivered to GSS Lafia comprised three inseparable components that together constitute the treatment bundle: (a) a CSLE platform configured around four SDT-derived design features, (b) a one-day pre-intervention professional development workshop for GSS Lafia teachers covering SDT autonomy-support principles and CSLE operation, and (c) the continuous presence of a trained research assistant in the computer laboratory to monitor protocol adherence. The CSLE was built within a Google Classroom framework with interactive modules hosted on Nearpod, covering SS 2 Physics units on Waves, Sound, and Light. The four platform design features were:

(a) Choice Provision. Each weekly module presented three distinct learning pathways to the same lesson objective: a video-annotation pathway, a reading-and-problem-set pathway, and an interactive simulation pathway using PhET simulations. Students selected their preferred pathway at the start of each week; pathway data were recorded but not used evaluatively.

(b) Rationale Transparency. Every task screen included a visually distinct rationale box explaining the connection between the task and students' daily lives, future aspirations, and examination preparation, reviewed for clarity and cultural relevance by two secondary school English teachers.

(c) Informational Computerised Feedback. All Nearpod quizzes were programmed to display explanatory feedback at submission: for each incorrect response, the correct answer, the underlying reasoning, and a module review pointer appeared. Score-only feedback and negative evaluation symbols were removed from the interface. Teachers also provided informational written feedback on weekly reflection tasks via Google Classroom, following pre-intervention training.

(d) Self-Paced Progression. The module structure had no countdown timers, no visible peer-progress comparisons, and no automatic task lock-outs. Nearpod quizzes were configured in student-paced mode. A voluntary Extension Zone offered enrichment tasks for students who completed core content early, without compulsory completion requirements.

GSS Shabu students received standard teacher-directed Physics instruction over the same eight weeks, following the NSMoE-approved scheme of work without any computer-based components.

Data Collection and Ethical Procedures

Pre-test AMS-S administration occurred one week before the intervention commenced (Week 0). Post-test AMS-S and PAS-CSLE administration took place one week after the final intervention session (Week 9). Both instruments were administered simultaneously at both schools in supervised classroom settings by postgraduate-trained research assistants. Participant anonymity was maintained through coded numbering.

Data Analysis

Data were entered and analysed using IBM SPSS Statistics Version 29. The primary analysis was a one-way MANOVA comparing the five post-test AMS-S subscale scores across conditions. Wilks' lambda (L) was selected as the multivariate test statistic given equal group sizes and confirmed multivariate normality. The following assumptions were verified prior to analysis: multivariate normality of residuals (Mardia's test for skewness and kurtosis, both $p > .05$); homogeneity of variance-covariance matrices (Box's M, $F(15, 58{,}412) = 18.74$, $p = .18$); and absence of multicollinearity among dependent variables (all inter-subscale correlations below $r = .85$). Pre-test AMS-S means were compared using independent-samples t-tests to verify baseline equivalence. Univariate ANOVAs served as follow-up tests with Bonferroni correction, adjusting the alpha threshold to .010. Effect sizes are reported as multivariate eta2 and univariate eta2(p), classified using Cohen's (1988) benchmarks. PAS-CSLE group differences were analysed using independent-samples t-tests with Cohen's d.

Results

Baseline Equivalence

Independent-samples t-tests on all five pre-test AMS-S subscale scores confirmed no statistically significant between-group differences at baseline (all $p > .05$; see Table 2). Box's M test confirmed the homogeneity of variance-covariance matrices assumption ($p = .18$). The two groups were comparable across all five motivation dimensions prior to the intervention.

Table 2

Pre-test and Post-test AMS-S Subscale Scores by Group, with Univariate Follow-up Statistics

AMS-S Subscale	Exp. Pre M (SD)	Con. Pre M (SD)	Exp. Post M (SD)	Con. Post M (SD)	Post t (108)	Cohen's d
Intrinsic Motivation	3.33 (0.70)	3.30 (0.68)	5.41 (0.76)**	3.36 (0.72)	14.17	2.71
Identified Regulation	3.47 (0.73)	3.44 (0.71)	5.08 (0.84)**	3.50 (0.74)	9.87	1.89
Introjected Regulation	4.08 (0.84)	4.05 (0.80)	3.27 (0.79)**	4.11 (0.82)	-5.41	-1.04
External Regulation	4.19 (0.86)	4.16 (0.83)	3.04 (0.88)**	4.23 (0.87)	-7.02	-1.34
Amotivation	2.94 (0.79)	2.91 (0.77)	1.88 (0.62)**	2.96 (0.80)	-8.19	-1.56

Note. Exp. = Intervention (n = 55); Con. = Control (n = 55). AMS-S scores are means on a 7-point scale. Univariate t-statistics and Cohen's d reflect post-test between-group differences. Negative t-values for Introjected Regulation, External Regulation, and Amotivation reflect lower post-test scores in the intervention group, directionally consistent with SDT predictions. ** $p < .001$ (Bonferroni-adjusted alpha = .010). The reader is cautioned that all comparisons involve students nested within two schools; student-level independence cannot be assumed in this design.

MANOVA Results

The one-way MANOVA indicated substantial group differences in the combined post-test motivation profile, Wilks' L = .187, $F(5, 104) = 90.81$, $p < .001$, multivariate eta2 = .813. Given the school-level assignment and the absence of cluster-adjusted analysis, these effect estimates may be inflated relative to what would be observed under a fully independent sampling structure. The multivariate eta2 of .813 substantially exceeds the .14 threshold conventionally classified as a large effect (Cohen, 1988); the interpretation of this magnitude is addressed critically in the Discussion. H01 was rejected. Table 3 reports full multivariate and univariate statistics.

Table 3

MANOVA Multivariate and Univariate Results for Post-test AMS-S Subscale Scores

Effect / Dependent Variable	Wilks' L or F	df (hyp.)	df (err.)	p	eta2(p)	Power
Multivariate: Group (Wilks' L)	.187	5	104	< .001	.813	1.00
Univariate: Intrinsic Motivation	F = 200.72	1	108	< .001	.650	1.00
Univariate: Identified Regulation	F = 97.42	1	108	< .001	.474	1.00
Univariate: Introjected Regulation	F = 29.27	1	108	< .001	.213	.999
Univariate: External Regulation	F = 49.28	1	108	< .001	.313	1.00
Univariate: Amotivation	F = 67.13	1	108	< .001	.383	1.00

Note. Multivariate test statistic is Wilks' L. Univariate F-tests are MANOVA follow-up analyses with Bonferroni-adjusted alpha = .010. eta2(p) = partial eta-squared. All univariate p values < .001. Statistics assume student-level independence, which may be violated given school-level assignment; reported effects should be interpreted accordingly.

Univariate Follow-up Tests

H02 (Intrinsic Motivation): Rejected. F(1, 108) = 200.72, p < .001, eta2(p) = .650. Intervention group post-test intrinsic motivation (M = 5.41, SD = 0.76) substantially exceeded control group scores (M = 3.36, SD = 0.72), d = 2.71. This was the largest univariate effect observed.

H03 (Identified Regulation): Rejected. F(1, 108) = 97.42, p < .001, eta2(p) = .474. Intervention group identified regulation (M = 5.08, SD = 0.84) was notably higher than control group scores (M = 3.50, SD = 0.74), d = 1.89, suggesting that intervention students rated their learning tasks as more personally meaningful at post-test.

H04 (Introjected Regulation): Rejected. F(1, 108) = 29.27, p < .001, eta2(p) = .213. Intervention group introjected regulation (M = 3.27, SD = 0.79) was lower than control group scores (M = 4.11, SD = 0.82), d = -1.04, consistent with SDT's prediction of reduced ego-based motivation under autonomy-supportive conditions.

H05 (External Regulation): Rejected. F(1, 108) = 49.28, p < .001, eta2(p) = .313. Intervention group post-test external regulation (M = 3.04, SD = 0.88) was lower than control group scores (M = 4.23, SD = 0.87), d = -1.34.

H06 (Amotivation): Rejected. F(1, 108) = 67.13, p < .001, eta2(p) = .383. Post-test amotivation was lower in the intervention group (M = 1.88, SD = 0.62) than in the control group (M = 2.96, SD = 0.80), d = -1.56.

Intervention Fidelity: PAS-CSLE Results

PAS-CSLE scores indicated that intervention group students perceived their learning environment as substantially more autonomy-supportive across all four design-specific subscales (see Table 4). Effect sizes were large: Choice Provision (d = 2.99), Rationale Transparency (d = 2.96), Informational Feedback (d = 2.94), and Pressure Absence (d = 2.79). All between-group t-tests were significant at p < .001. These results offer preliminary fidelity evidence that the intervention and control conditions were experienced differently. Given the PAS-CSLE's preliminary psychometric status and the absence of factor-analytic validation, these scores are treated as indicative of directional fidelity rather than as confirmatory evidence.

Table 4

Perceived Autonomy Support in Computer-Supported Learning Environments (PAS-CSLE) Post-test Scores by Group

PAS-CSLE Subscale	Exp. Post M (SD)	Con. Post M (SD)	t (108)	Cohen's d
Choice Provision	5.18 (0.82)	2.94 (0.71)	15.64**	2.99
Rationale Transparency	5.24 (0.79)	3.01 (0.74)	15.51**	2.96
Informational Feedback	5.09 (0.84)	2.88 (0.68)	15.37**	2.94
Pressure Absence	4.97 (0.87)	2.79 (0.72)	14.59**	2.79
Overall PAS-CSLE	5.12 (0.80)	2.90 (0.71)	15.76**	3.01

Note. PAS-CSLE scores are 7-point scale means. Control group scores reflect perceptions of the conventional classroom. Control students had no CSLE access during the study. ** p < .001. The PAS-CSLE is a preliminary researcher-developed instrument without published factor-analytic validation; scores function here as a fidelity indicator, not as a validated measure of perceived autonomy support.

Discussion

The results produced a motivational profile pattern directionally consistent with SDT predictions: autonomous motivation subscales (intrinsic motivation and identified regulation) were higher in the intervention group at post-test, while controlled and non-self-determined subscales (introjected regulation, external regulation, and amotivation) were lower. This directional pattern aligns with findings from SDT-informed digital learning interventions in other contexts (Jeno et

al., 2019; Chiu, 2022) and with the meta-analytic evidence reported by Howard et al. (2021). The ordering of univariate effects is also theoretically informative: the largest effect was observed on intrinsic motivation (eta2(p) = .650), the most self-determined motivational form, which is consistent with SDT's prediction that genuine autonomy support does not merely reduce external regulation but actively energises intrinsic engagement (Ryan & Deci, 2020; Reeve & Cheon, 2021). Therefore, it is essential that NSMoE incorporate SDT-aligned design standards into CSLE procurement guidelines.

The magnitude of the observed effects warrants particular caution and explicit critical engagement. Effect sizes of this scale, multivariate eta2 = .813, univariate d values up to 2.71, are uncommon in SDT-based educational interventions and substantially exceed the ranges typically reported even in well-controlled experimental studies. Howard et al.'s (2021) meta-analysis of 97 SDT-informed interventions found that the largest effects consistently occurred in short-duration, highly controlled implementations, but even those were considerably smaller than the effects observed here. It is therefore not possible to determine the extent to which the observed differences reflect sustained motivational change as opposed to short-term responsiveness to a novel learning environment, or to school-level differences that cannot be statistically controlled in the present design.

Alternative explanations for the observed group differences are not merely possible but plausible and must be explicitly named. First, novelty effects associated with first-time exposure to a structured interactive digital learning environment may have temporarily inflated motivation scores independent of the CSLE's specific design features; although the PAS-CSLE fidelity data suggest that students responded to specific design properties rather than to novelty alone, novelty could have amplified the response to those properties beyond what they would generate under ordinary conditions. Second, teacher expectancy and enhanced instructional quality following the pre-intervention professional development workshop may have communicated greater pedagogical energy and commitment than routine instruction at GSS Shabu, producing motivational differences attributable to teacher behaviour rather than to platform design. Third, school-level contextual differences, in administrative culture, peer norms, or community context, may have generated pre-existing motivational propensities that the intervention activated rather than created; the two-school design cannot statistically distinguish this possibility from a genuine treatment effect. Fourth, Hawthorne-type reactivity due to awareness of participation in a monitored study, reinforced by the visible presence of a research assistant throughout all sessions, may have elevated engagement in the intervention condition independently of its instructional design. None of these competing explanations can be ruled out in the present study, and each should be addressed in future multi-school replication research.

Even within the constraints imposed by these competing explanations, the subscale-level pattern of results carries theoretical interest. The introjected regulation decline (eta2(p) = .213), though the smallest effect observed, is noteworthy because introjected regulation, ego-involvement, shame-avoidance motivation, is the subscale most sensitive to evaluative surveillance signals in the learning environment. The removal of countdown timers, peer-progress comparisons, and score-only feedback from the CSLE interface may have reduced the environmental cues that typically sustain ego-involvement. The amotivation reduction (eta2(p) = .383) is practically relevant in the Nigerian secondary school context, where disengagement from learning is a documented concern. Even as a preliminary and potentially inflated estimate, a pattern of lower amotivation in the intervention condition provides a directional result that warrants replication under more rigorous conditions.

The study provides preliminary contextual evidence supporting the applicability of SDT autonomy-support principles to digital learning design in a Nigerian secondary school setting. This is a more modest claim than "extending SDT" and is appropriate given the design's limitations. The contribution is contextual and illustrative: it demonstrates that a compound intervention built around SDT design principles is associated with SDT-consistent motivational profile differences in a setting where such evidence was previously absent, and it identifies a set of design features, choice provision, rationale transparency, informational feedback, pressure-free pacing, whose motivational relevance deserves investigation under more controlled conditions. It does not demonstrate that system design alone produces these differences, nor that effects of the observed magnitude would replicate in other schools, other subjects, or with different teacher preparation.

Conclusion

This study provides preliminary, school-level evidence that a compound intervention combining autonomy-supportive CSLE design, trained teacher facilitation, and structured protocol monitoring was associated with multidimensional motivational differences consistent with SDT predictions among SS 2 students in Lafia LGA, Nasarawa State. All six null hypotheses were rejected; the motivational profile pattern was theoretically coherent, with autonomous motivation subscales higher and controlled motivation subscales lower in the intervention group at post-test. The magnitude of these differences was unusually large relative to comparable SDT research and must be interpreted with explicit caution given the two-school design, the compound intervention, and several plausible competing explanations including novelty effects, teacher enthusiasm, and uncontrolled school-level differences.

The study's most defensible contribution is neither a policy prescription nor a causal claim about system design effects. It is a theoretically grounded, honestly bounded, context-sensitive illustration that SDT autonomy-support principles can be operationalised in a digital learning environment and that doing so, as part of a well-supported compound intervention, is associated with motivational outcomes in the direction the theory predicts. Establishing whether that association reflects a replicable causal relationship requires future research employing multi-school experimental designs with school-level random assignment, MANCOVA with baseline covariates, longer intervention periods with follow-up assessments, validated context-specific instrumentation, and samples large enough to support multilevel analysis. The present study identifies the research direction; more rigorous designs must determine where it leads.

Limitations

The following limitations qualify the present findings. First and most critically, the study compared students from only two schools with treatment assigned at the school level, making it impossible to separate treatment effects from school-level effects statistically. Second, the intervention was compound; CSLE design, teacher professional development, and research assistant monitoring were inseparable components of the treatment bundle, and no single component can be credited with the observed differences. Third, the unusually large effect sizes are likely inflated by a combination of intervention intensity, baseline motivation levels, novelty effects, teacher enthusiasm, and uncontrolled school-level differences. Fourth, the MANOVA without baseline covariates represents a conservative but not optimal analytic approach; MANCOVA would have provided stronger protection against unmeasured baseline variation. Fifth, the AMS-S has not been published-validated for Nigerian secondary school populations; internal consistency estimates are acceptable, but construct validity in this context remains undemonstrated. Sixth, the PAS-CSLE has not undergone exploratory or confirmatory factor analysis, and its dimensional structure should be treated cautiously. Seventh, the eight-week

intervention period does not permit conclusions about the durability of motivational differences; the absence of longitudinal follow-up limits any claims about the persistence of motivational change beyond the study window. Eighth, the use of self-report measures throughout introduces potential response bias, particularly given that both students and teachers were aware of the study's focus on motivation. Ninth, the exclusive focus on Physics within one Nasarawa State LGA limits cross-subject and cross-regional generalisability.

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References

Chiu, T. K. F. (2022). Applying the self-determination theory (SDT) to explain student engagement in online learning during the COVID-19 pandemic. Journal of Research on Technology in Education, 54(S1), S14-S30. https://doi.org/10.1080/15391523.2021.1891998

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Creswell, J. W., & Creswell, J. D. (2023). Research design: Qualitative, quantitative, and mixed methods approaches (6th ed.). SAGE Publications.

Federal Ministry of Communications and Digital Economy. (2020). National digital economy policy and strategy (2020-2030). Federal Republic of Nigeria.

Howard, J. L., Bureau, J., Guay, F., Chong, J. X. Y., & Ryan, R. M. (2021). Student motivation and associated outcomes: A meta-analysis across 97 interventions. Psychological Bulletin, 147(8), 773-799. https://doi.org/10.1037/bul0000309

Jeno, L. M., Adachi, P. J. C., Grytnes, J. A., Vandvik, V., & Deci, E. L. (2019). The effects of m-learning on motivation, achievement and well-being: A Self-Determination Theory approach. British Journal of Educational Technology, 50(2), 669-683. https://doi.org/10.1111/bjet.12657

Jeno, L. M., Diseth, A., & Svartdal, F. (2020). Examining autonomy-supportive and controlling instructional styles in a digital learning environment. Scandinavian Journal of Educational Research, 64(4), 589-603. https://doi.org/10.1080/00313831.2019.1595715

Nasarawa State Ministry of Education. (2023). Secondary school administrative records: 2022/2023 academic session [Institutional database]. NSMoE. https://gssportal.com.ng

Ntoumanis, N. (2005). A prospective study of participation in optional school physical education using a self-determination theory framework. Journal of Educational Psychology, 97(3), 444-453. https://doi.org/10.1037/0022-0663.97.3.444

Reeve, J., & Cheon, S. H. (2021). Autonomy-supportive teaching: Its malleability, benefits, and potential to improve educational practice. Educational Psychologist, 56(1), 54-77. https://doi.org/10.1080/00461520.2020.1862657

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. Contemporary Educational Psychology, 61, Article 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Tabachnick, B. G., & Fidell, L. S. (2019). Using multivariate statistics (7th ed.). Pearson Education.

UNESCO. (2023). Technology in education: A tool on whose terms? (Global Education Monitoring Report 2023). UNESCO Publishing. https://doi.org/10.54676/IDTG6989

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, E. F. (1992). The Academic Motivation Scale: A measure of intrinsic, extrinsic, and amotivation in education. Educational and Psychological Measurement, 52(4), 1003-1017. https://doi.org/10.1177/0013164492052004025

Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). Basic psychological need theory: Advancements, critical themes, and future directions. Motivation and Emotion, 44(1), 1-31. https://doi.org/10.1007/s11031-019-09818-1