GAMIFICATION AS A PEDAGOGICAL STRATEGY FOR IMPROVING STUDENT ENGAGEMENT AND COMPETENCY ACQUISITION IN ELECTRICAL AND ELECTRONIC TRADES EDUCATION AT TECHNICAL COLLEGES

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Abstract

Electrical and electronic trades are considered among the most challenging subjects because of their nature, which involves calculations and practical activities. This perception is largely attributable to the teaching methods employed in delivering these subjects. The integration of gamification into technical and vocational education represents a transformative shift in pedagogical practice, particularly within the domain of electrical and electronic trades in Nigeria Technical Colleges. This study examined the theoretical frameworks, empirical evidence, and practical implications of gamification as a pedagogical strategy for enhancing students' engagement and competency acquisition in electrical and electronic trades programmes at Nigerian Technical Colleges. The paper identifies key gamification elements including points, badges, leaderboards, simulation-based challenges, and narrative-driven problem-solving elements that demonstrably improve learner motivation, psychomotor skill development, and cognitive retention in trade-specific contexts. The study proposes a contextually responsive Gamified Technical Competency Framework (GTCF) for implementation in Nigerian Technical Colleges. Findings affirm that when gamification is purposively aligned with TVET curriculum standards and competency benchmarks, it yields significant gains in student engagement and practical skill mastery. The paper concludes with targeted recommendations for curriculum developers, Nigeria technical college administrators, and policymakers.

Keywords: Gamification, Pedagogical Strategy, Student Engagement, Competency Acquisition, Electrical and Electronic Trades, Technical Colleges, TVET, Nigeria

Introduction

The development and growth of any nation depend on the quality of education given to its citizens. This is the kind of education that equips individuals to become self-reliant and acquire all the skills needed to fit into the labour market. Such forms of education include STEM and Technical and Vocational Education and Training (TVET). TVET is one of the education systems in Nigeria which, if effectively implemented, enhances the human capital development agenda, serving as the primary channel and pathway through which the nation's industrial and technological workforce is produced. TVET can be implemented at different levels of education, particularly at Nigeria technical colleges. Nigeria technical colleges stand as one of the key institutions reliable and adequate for the delivery of TVET. Technical colleges are

designed and mandated to equip learners with practical and other relevant trade competencies. One of the most relevant trades offered at Nigeria technical colleges is electrical and electronic trades. The electrical and electronic sector is a critical area given its growing relevance to national infrastructure development and the emerging digital economy (Federal Republic of Nigeria, [FRN] 2014; UNESCO-UNEVOC, 2021). Electrical and electronic trades serve and occupy a special place in the development of any nation.

Electrical and electronic trade is acknowledged as an important aspect of national development. A pervasive concern in Nigerian Technical Colleges is the persistent decline in student engagement, motivation, and practical skill acquisition. Research has revealed that the basic teaching method employed at the technical college level is a teacher-centred method, where students are passive receivers of knowledge who neither contribute nor engage actively in the classroom. As Olaitan (2020) and Nwosu and Ezema (2022) observed, "Instructional delivery in these institutions remains largely dominated by conventional didactic methods chalk-and-talk lectures, rote memorisation, and passive observation which are poorly suited to the hands-on, problem-solving demands of technical trades." The chances of an electrical and electronic trade graduates being employable or self-employed are undermined by the gap between classroom instruction and workshop competency.

It is therefore an important step to fill this gap by providing an alternative, effective, and student-centred pedagogy that enables students to be active, engaged, and contributing members of the teaching and learning process in the classroom. One of the teaching pedagogies that could address this gap is gamification.

Against this backdrop, gamification broadly defined as the application of game design elements and mechanics into non-game contexts has emerged as an innovative, student-centred pedagogical strategy globally. Merriam-Webster (2026) define gamification as the process of adding games or game-like elements to something (such as a task) to encourage participation. At different stages and levels of the education system, gamification has been linked to improved motivation, engagement, technical and 21st century skill mastery, particularly in STEM and TVET disciplines (Ukgoda, 2025; Coelho et al., 2025; Ortiz-Rojas et al., 2025; Mirmotahari et al. 2025). The application of gamification within trade-specific technical education, however, remains underexplored, particularly in the Nigerian TVET context. This paper addresses this gap by systematically examining the theoretical bases, empirical evidence, and practical implications of gamification as a pedagogical strategy for improving student engagement and competency acquisition in electrical and electronic trades education at Nigerian technical colleges.

Theoretical Framework

Looking at gamification critically, one might be compelled to agree that it is not theoretical in nature when applied to education. Nevertheless, when it is studied more closely, there are established theories and models that can be used to explain its application in electrical and electronic trades education. The following theories underpin the study: Self-Determination Theory (SDT), Flow Theory, Behaviourist and Constructivist Learning Theories, and the

Competency-Based Education (CBE) Framework.

Self-Determination Theory (SDT)

Self-Determination Theory (SDT), propounded by Deci and Ryan (1985, 2000), is a macro-theory of human motivation that explains how intrinsic and extrinsic motivations influence behaviour, engagement, and performance. The theory posits that individuals are naturally inclined toward growth, mastery, and psychological integration when their fundamental psychological needs are satisfied. These core needs are autonomy, competence, and relatedness. There is a deep relationship between SDT and gamification, as its elements align directly with these three core needs. Points and badges provide immediate feedback that reinforces a student's sense of competence; gamified environments, which support autonomy, give students the choice to learn at their own pace and in their own time; and collaborative or competitive game structures cultivate relatedness. In electrical and electronic trades at Nigeria technical colleges, where concepts are frequently perceived by learners as abstract or disconnected from real-world experience, gamification's ability to situate learning within engaging, self-referential narratives is particularly significant (Ryan & Deci, 2000; Mekler et al., 2017). Gamification helps make electrical and electronic trades more engaging and contextually relevant, allowing students to participate fully in all teaching and learning processes both in physical and remote learning environments.

Behaviourist and Constructivist Learning Theories

Behaviourist and Constructivist Learning Theories provide another relevant theoretical framework for this study. When gamification is well structured and applied effectively, it provides students with visible indicators of their progress and rewards them through points, badges, and leaderboards that reflect behaviourist principles of reinforcement and operant conditioning (Skinner, 1938), providing extrinsic motivational scaffolding that can, when gradually faded, give way to intrinsic engagement. Concurrently, simulation-based and problem-based game tasks are deeply constructivist, requiring learners to actively build and test knowledge schemas through authentic, contextualised practice.

Competency-Based Education (CBE) Framework

Nigeria's National Board for Technical Education (NBTE) mandates a competency-based approach to technical trades curriculum delivery. Gamification aligns naturally with CBE principles: gamification and CBE focused on the outcome, they both are built on repetition of tack until you master it, scaffolded practice, and allows students to progress on their own and at their individual's rate. Gamified platform allows students to be assessed without pen-and-paper. Norton, (2008) NBTE, (2019) "gamified assessment tools such as simulation-based performance tasks can serve as valid, authentic measures of occupational competency, replacing or supplementing conventional pencil-and-paper assessments that poorly reflect real-world trade demands".

Core Gamification Mechanics in Electrical and Electronic Trades Education

Gamification as earlier explained is the application of game-based mechanics to a non-game situation to enhance

teaching and learning. For the purpose of this study, we distinguish between structural gamification (the application of game mechanics to existing content) and content gamification (the redesign of content itself using game principles). Both have meaningful applications in electrical and electronic trades instruction. These mechanics includes: point, badges and leaderboards.

Points, Badges, and Leaderboards (PBL)

Points, badges, and leaderboards are the most commonly used and often criticized gamification mechanics. Points is used to measure the level at which students performed on specific tasks, such as correctly wiring a three-phase motor simulation. Badges is another gamification mechanics that shows the level of achievement of the student. It shows as a symbolic proof recognition for achieving competency milestones, for example, badges are given when a student becoming a "Circuit Diagnosis Specialist." Leaderboard is a gamification mechanics that is awarded to student whenever they partake in a competition or collaborative work. Leaderboards create social comparisons that can encourage competitive learners. However, relying too heavily on points, badges, and leaderboards can increase extrinsic rewards while reducing or undermining intrinsic motivation. Deci et al. (1999) noted that excessive extrinsic rewards can harm intrinsic motivation, a phenomenon known as the "over justification effect." In the electrical and electronic trade, using points, badges, and leaderboards is more effective when focused on mastery rather than just performance.

Points, badges, and leaderboards are common gamification elements used to improve students' participation and motivation during learning activities. In electrical and electronic trades education, points are awarded to students based on their performance in practical and classroom activities such as wiring circuits, identifying electrical faults, or completing workshop tasks correctly. Through points, students are able to monitor their progress and understand how well they are performing in different activities. Badges are also used as symbols of achievement or recognition whenever students successfully complete specific tasks or demonstrate mastery of practical skills. For example, a student may receive a badge for successfully diagnosing electrical faults or completing a practical wiring exercise. Leaderboards, on the other hand, display students' rankings during competitions or group activities and encourage healthy competition among learners. The use of points, badges, and leaderboards helps to make learning more interesting and engaging for students. Learners become more active during lessons because they are motivated to perform well and achieve recognition for their efforts. These gamification elements also encourage students to participate fully in both theoretical and practical activities. However, excessive dependence on rewards may reduce students' intrinsic motivation. According to Deci et al. (1999), too much focus on external rewards can make students learn mainly for rewards instead of genuine understanding. Therefore, in electrical and electronic trades education, points, badges, and leaderboard should focus more on skill mastery and competency development rather than competition alone.

When properly applied, points, badges, and leaderboards can improve students' confidence, participation, and practical skill acquisition. Students

become more willing to engage in practical activities because they receive immediate feedback and recognition for their performance. As a result, these gamification elements create an interactive and motivating learning environment that supports effective teaching and learning in electrical and electronic trades in technical colleges.

Simulation-Based Learning Games

Electrical and electronic concepts can be simulated by developing a local gamified platform or modules or by adopting the existed platforms such as: Multisim, Proteus, Tinkercad, and purpose-built virtual laboratories allow learners to manipulate circuit components, test hypotheses, diagnose faults, and observe consequences. The gamified environment accommodates students to effectively carried out their experimental activities in a risk-free, repeatable, and immediate feedback-rich environment. There will not be physical hazards, risk or any physical infrastructure. These simulations embody core game principles (challenge, feedback, interactivity, narrative) while directly developing the psychomotor and cognitive competencies central to electrical and electronic trades (Papastergiou, 2009; Hussein, 2015; Ebenuwa-Okoh & Adakole, 2021). When students are engaged in an activity that look similar to the real environment, its increases their motivation, engagement, performance, retention, and interest.

Simulation-based learning games contribute greatly to effective teaching and learning in electrical and electronic trades education. They provide students with a practical and interactive environment where they can practice wiring, circuit construction, fault diagnosis, and other technical operations without exposure to physical danger or equipment damage. These simulations also allow students to repeat tasks several times until mastery is achieved. As a result, learners become more confident, motivated, and engaged in practical activities. Simulation-based learning also improves students' understanding of abstract concepts and enhances both cognitive and psychomotor skills required in electrical and electronic occupations.

Simulation-based learning games involve the use of virtual platforms and interactive environments that allow students to practice electrical and electronic activities in a safe and controlled setting. These simulations may be developed locally or adopted from existing platforms such as Multisim, Proteus, and Tinkercad. Through these platforms, students can construct circuits, test electrical connections, diagnose faults, and observe outcomes without exposure to physical danger or equipment damage. Simulation-based learning provides students with opportunities to practice repeatedly until they achieve mastery of technical skills. Simulation games are important in electrical and electronic trades education because they improve students' understanding, motivation, and practical performance. In addition, Hussein (2015) and Ebenuwa-Okoh and Adakole (2021) explained that simulation environments improve students' retention, engagement, and practical competencies in technical education. Students become more confident when they are allowed to practice practical tasks several times in a risk-free environment.

Furthermore, simulation-based learning games help students to understand abstract concepts more easily because they combine theory with practical activities. Learners can perform wiring exercises, troubleshoot faults, and

test circuits repeatedly until they fully understand the procedures involved. This method also encourages active participation and learner-centred instruction since students are directly involved in the learning process. Consequently, simulation-based learning games contribute significantly to the development of cognitive and psychomotor skills required in electrical and electronic occupations.

Narrative and Quest-Based Learning

This is another approach and environment in gamification whereby students are presented with real-world situations, challenges, or problems that need to be solved. For example: 'Your community's power grid has failed; diagnose and restore it within 60 minutes.' In this scenario, students transform abstract technical content into purposeful, contextualised problem-solving. Quest-based structures decompose complex trade competencies into sequenced, achievable missions, providing learners with clear goals, progressive challenge, and a sense of narrative agency. Barata et al. (2013) and Su and Cheng (2015) revealed that "the approach is particularly effective for developing higher-order competencies such as fault diagnosis, systems thinking, and project planning, which are increasingly demanded by the electrical industry." It allows students to study, break down challenges into different stages, and work through them step by step. As the student progresses, feedback and rewards are given to them, reinforcing their motivation to persist and improve.

Narrative and quest-based learning contribute to students' problem-solving abilities and active participation in learning activities. By presenting lessons in the form of missions, challenges, or real-life technical problems, students become more interested and emotionally connected to the learning process. This approach encourages learners to think critically, analyse situations carefully, and apply technical knowledge in solving practical problems. It also helps students to complete complex tasks step by step while receiving feedback and rewards that motivate them to continue learning. Through this process, learners develop persistence, creativity, and confidence in handling electrical and electronic tasks.

Narrative and quest-based learning is a gamification approach where students are presented with real-life situations, missions, or challenges that require practical solutions. In electrical and electronic trades education, learners may be asked to solve problems such as restoring a faulty power supply system or repairing electrical installations within a specific period. This approach helps to transform abstract classroom concepts into meaningful and practical learning experiences. Through quests and missions, complex technical tasks are broken down into smaller and achievable stages, making learning easier and more interesting for students. Narrative and quest-based learning improve students' motivation, problem-solving abilities, and participation during lessons. Learners become emotionally connected to the activities because the lessons are presented in the form of realistic challenges and missions. Su and Cheng (2015) explained that this approach is effective in developing higher-order skills such as fault diagnosis, critical thinking, systems analysis, and project planning. These skills are important in electrical and electronic trades because technicians are often required to solve practical problems in real work environments.

In addition, narrative and quest-based learning encourages students to think critically and apply technical knowledge in solving practical problems step-by-step. As students progress through the various missions, they receive feedback and rewards that motivate them to continue learning and improving. This process also helps learners to develop persistence, confidence, and creativity in handling technical tasks. Therefore, narrative and quest-based learning creates an engaging and interactive environment that enhances effective teaching and learning in electrical and electronic trades education.

Collaborative and Competitive Game Structures

Gamification has an environment that encourages teamwork and collaborative activities. This collaborative game structure makes it suitable for electrical and electronic trade subjects in technical colleges. Collaborative structures such as workshop-floor game challenges, where groups must collectively install and test an electrical distribution board, foster teamwork, communication, and peer learning competencies essential to professional trade practice. Competitive structures motivate high-achieving learners and create visible benchmarks for aspiration. The literature suggests that a hybrid approach cooperative team competition (inter-group competition with intra-group collaboration) yields the most consistent motivational and learning benefits (Johnson & Johnson, 1989; Sung & Hwang, 2013). Collaborative learning improves the teamwork skills of individuals, which are applicable in real-life situations.

Collaborative and competitive game structures contribute significantly to the development of teamwork and communication skills among students in electrical and electronic trades education. Collaborative activities encourage students to work together in solving technical problems, sharing ideas, and assisting one another during practical exercises. This promotes peer learning and strengthens interpersonal relationships among learners. On the other hand, competitive activities motivate students to improve their performance and participate actively in classroom tasks. The combination of cooperation and competition creates an engaging learning environment that prepares students for real workplace situations where teamwork, communication, and performance are highly important.

Collaborative and competitive game structures are important gamification strategies used to improve teamwork, communication, and active participation among students. In electrical and electronic trades education, collaborative activities involve students working together in groups to solve technical problems, perform practical tasks, or complete workshop activities. For example, students may work together to install and test electrical systems or troubleshoot faults during practical lessons. Collaborative learning encourages peer interaction, idea sharing, and cooperation among learners, which are important skills required in technical occupations. Competitive game structures also motivate students to participate actively in classroom and workshop activities. Learners become more interested in practical tasks when they are given opportunities to compete with one another in a healthy manner. Competition encourages students to

improve their performance and strive for excellence during learning activities.

Furthermore, collaborative and competitive game structures help students to develop workplace-related competencies such as teamwork, leadership, communication, and problem-solving skills. Through collaboration, learners are able to learn from one another and improve their understanding of practical concepts. Competition also promotes confidence, determination, and active participation during lessons. The combination of collaborative and competitive activities therefore creates a motivating and engaging learning environment that prepares students for real-life electrical and electronic work situations.

Empirical Evidence: Gamification and Trade Education Outcomes

There is a need to review the empirical evidence and research on gamification in electrical and electronic trades education at technical colleges. This section synthesizes findings across key outcome variables.

Student Engagement and Motivation

There are many studies that show positive and significant improvements in student motivation and engagement through the application of gamification in teaching and learning at different levels of the education system. Hamari et al. (2014) conducted a systematic review titled Does Gamification Work? The review comprised 24 peer-reviewed studies and found that gamification had significant positive effects on motivation, engagement, and enjoyment. In a related study focused on vocational and technical education contexts, Dichev and Dicheva (2017) reviewed 221 gamification papers and revealed that the findings were consistent, with the majority supporting a motivational gain, particularly in subjects that learners perceived as abstract or difficult. Electrical and electronic trade students frequently perceived these concepts as abstract, complex, and difficult.

Cognitive and Knowledge Outcomes

Student motivation and engagement alone do not determine the effectiveness of a pedagogical approach. There is a need to review its effectiveness in terms of cognitive and knowledge outcomes as well. Studies examining gamification's impact on knowledge acquisition and retention in technical subjects revealed that the results were encouraging. Su and Cheng (2015) reported significant improvements in science knowledge retention in mobile gamified learning environments. In electrical engineering education, Hussein (2015) found that simulation-based gamified instruction produced significantly higher post-test scores than conventional instruction on circuit analysis tasks, with particularly strong effects for low-prior-knowledge learners. Ebenuwa-Okoh and Adakole (2021), in a study conducted across Nigerian technical colleges, reported that gamified instructional approaches yielded a 34% improvement in mean scores on Basic Electricity theory assessments compared to conventional methods.

Psychomotor and Practical Competency Outcomes

One of the challenges of electrical and electronic trades at the technical college level is the acquisition of psychomotor and practical skills. Studies have revealed that the application of gamification improves students' practical and psychomotor skills. Evidence

suggests that simulation-based gamification is practically effective: designing and constructing working circuits, installing components, practising wiring diagrams, and diagnosing faults repeatedly in a virtual environment before transitioning to live-panel work has been shown to accelerate psychomotor skill development and reduce workplace accidents in training contexts (Papastergiou, 2009; Ibiam et al., 2020). It is worth noting that gamification or gamified simulation only complements physical workshop practice but does not replace it.

Attendance and Persistence

The marking of attendance is one of the most important aspects of teaching and learning, because it is one of the key criteria for determining students' progress. Several studies have noted improvements in attendance, course persistence, and task completion rates in gamified learning environments. Dominguez et al. (2013) found that students in gamified learning environments submitted more assignments and achieved higher scores on practical exercises than those in control groups, though some evidence suggested that low-performing students may disengage if game mechanics create social comparison anxiety. Gamification helps both teachers and students to track their progress, monitor attendance, and record how often tasks were completed.

A Proposed Gamified Technical Competency Framework (GTCF) for Nigerian Technical Colleges

It is necessary to propose a gamified framework applicable to Nigerian technical colleges, specifically within electrical and electronic trades. The framework is drawn from the theoretical and empirical literature reviewed above and is informed by the specific contextual realities of Nigerian technical colleges. This paper proposes a five-component Gamified Technical Competency Framework (GTCF) for integrating gamification into electrical and electronic trades in technical colleges. The five components are: competency mapping, progressive challenge design, multimodal feedback systems, collaborative quest structures, and reflective mastery assessment.

Competency Mapping: One of the main goals of electrical and electronic trades is to provide skilled manpower that will be able to use their competencies to design, develop, and construct things that are useful to society. Competency mapping aligns gamified tasks explicitly with NBTE competency standards and trade occupation profiles. In developing the gamified tasks, each mission targets a specific unit of competency, such as wiring a single-phase motor, tracing a fault in a circuit, reading electrical diagrams, and constructing circuits using different methods.

Progressive Challenge Design: It is necessary to ensure that teaching and learning flow from simple to complex, from known to unknown. With this approach, students will be motivated to complete any task or project. Progressive Challenge Design structures gamified content using graduated difficulty to maintain flow and prevent disengagement. It is applicable as introductory circuit challenges progress to complex fault-diagnosis scenarios and full installation projects, starting from the identification of elements and components through troubleshooting, repair, and testing. These processes motivate students to complete any

project they begin because there is visible progress.

Multimodal Feedback Systems: In electrical and electronic trades, it is important to receive instant feedback. Multimodal Feedback Systems combine immediate digital feedback from simulation software with instructor and peer feedback loops. This is demonstrated through automated simulation error reports supplemented by teacher debriefs and peer review of wiring diagrams.

Collaborative Quest Structures: Collaborative learning is one of the most effective learning approaches, in which students share different ideas and work together to achieve a goal. Collaborative quest structures employ team-based game missions that mirror real-world trade project structures. Groups collectively plan, install, test, and troubleshoot an electrical installation that is scored on accuracy, safety compliance, and teamwork.

Reflective Mastery Assessment: The ability of students to master a task depends on the number of times they repeat such activities. Electrical and electronic trade is a field of study that needs mastery of all domains. Reflective mastery assessment replaces or supplements conventional tests with mastery-based game assessments that permit repeated attempts. Students re-attempt simulation fault-diagnosis challenges until mastery criteria are met, with each attempt logged for portfolio evidence.

At the technical college level, students are prepared to be self-employed, employable, and useful to themselves and society. It is also clear that there are challenges related to infrastructure, including physical, digital, and other technical facilities. Electrical and electronic trade subjects, which are among the backbones of all trades, should be taught in such a way that they are meaningful and prepare students for the real world. The teaching methods and pedagogy adopted should represent the actual activities of the real world. The proposed GTCF is deliberately designed for contextual adaptability. In resource-constrained technical colleges lacking digital infrastructure, the proposed GTCF can be integrated into a locally developed gamified module or platform that is aligned with NBTE curriculum standards. Such a module or platform would require no digital technology. As institutional capacity grows, digital simulation tools can be progressively integrated without disrupting the framework's pedagogical architecture.

Discussion

Based on the review conducted in this paper, there is a need to discuss the findings and suggestions in detail regarding gamification as a pedagogical strategy in electrical and electronic trades education at Nigerian technical colleges. Several cross-cutting themes warrant discussion.

Based on the findings of this review, it is evident that gamification improves motivation; however, its effectiveness is not intrinsic to the game mechanics themselves but is contingent on purposive pedagogical design. The application of points and other game mechanics can only motivate learners for a while but do not on their own develop students' cognitive and psychomotor domains in electrical and electronic trades. Kapp (2012) explained that the mere addition of points or badges to existing instructional activities termed 'pointsification' yields minimal

educational benefit and may actively undermine motivation. Genuine gamification requires the deliberate re-engineering of learning experiences around game principles of challenge, narrative, feedback, and agency. This insight has direct implications for how gamification is introduced to technical college teachers, who must be equipped with design competencies, not merely technological ones.

The condition of Nigeria technical colleges is pathetic, which needs critical intervention. Therefore, there is a need to empirically study the environment and develop gamified packages that are suitable for and can be integrated into Nigerian culture and context for easy adaptation and application. The Nigerian context imposes specific conditions on gamification design that global literature does not fully address. The intersection of resource scarcity, large class sizes, examination pressure, and cultural orientations toward authority and collectivism requires that internationally developed gamification models be critically adapted rather than uncritically adopted. The GTCF proposed in this review represents one such adaptation, though further empirical validation in specific Nigerian technical college settings is urgently needed.

Finally, the long-term sustainability of gamification initiatives in Nigeria technical colleges requires systemic institutionalisation: embedding gamified pedagogy in official curriculum documents, incorporating gamification design into teacher education programmes, establishing industry-linked gamified competency benchmarks, and creating institutional communities of practice among technical trade teachers. Isolated, project-based gamification pilots, however successful, rarely survive beyond their initial champions without this structural scaffolding.

Conclusions

This review has demonstrated that gamification, when theoretically grounded, contextually adapted, and purposively designed, represents a powerful pedagogical strategy for addressing the persistent challenges of student disengagement and inadequate competency acquisition in electrical and electronic trades education at Nigerian technical colleges. The convergence of self-determination theory, flow theory, constructivist learning principles, and competency-based education frameworks provides a robust theoretical foundation for gamification in this context, while empirical evidence — though still thin in the Nigerian TVET-specific literature consistently supports gamification's motivational and cognitive benefits.

The proposed Gamified Technical Competency Framework (GTCF) offers a practical, scalable, and contextually responsive implementation structure that can be adopted progressively by institutions at different levels of technological readiness. Its deliberate alignment with NBTE competency standards ensures that gamification serves, rather than subverts, the core mandate of technical trades education.

Recommendation

On the basis of this review, the following recommendations are offered:

1. The National Board for Technical Education (NBTE) and the Federal Ministry of Education should formally recognise gamification as an approved pedagogical strategy within the national TVET curriculum framework and develop accompanying teacher resource

packs and professional development modules.

2. Technical college administrators should establish pilot gamification programmes in electrical and electronic trades departments, beginning with offline game-based activities and simulation software, and supported by robust monitoring and evaluation mechanisms.
3. TVET teacher education institutions should integrate gamification design and digital pedagogical competencies into pre-service and in-service training curricula for technical trade teachers.
4. Researchers should prioritise rigorous experimental and quasi-experimental studies examining gamification outcomes in Nigerian technical college settings to build the local evidence base.
5. Industry stakeholders, including the Electricity Distribution Companies (DISCOs), the Nigeria Electricity Regulatory Commission (NERC), and electrical contractors, should collaborate with technical colleges to develop industry-validated, gamified competency benchmarks that reflect real-world trade demands.
6. Gamification design in technical colleges should explicitly incorporate gender-responsive and culturally contextualised elements to ensure equitable engagement across all learner groups.

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