RESEARCH ARTICLE

Simplifying Complex Wireless Intelligence and Security Education: An Outcome-Based Blended Learning Approach for Mobile Engineering

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Abstract

The growing complexity of wireless communication systems and mobile security threats demands a new generation of engineers capable of operating at the intersection of intelligent wireless infrastructure, software-defined radio (SDR), and mobile AI. This paper proposes an intelligent mobile security education platform that integrates AI-driven learning analytics, SDR-based practical interfaces, and cloud-based wireless simulation environments within an Outcome-Based Education (OBE) and Cognitive Load Theory (CLT) framework. The platform transforms passive learners into active creators of wireless security content via Student-Generated Multimedia (SGM), while AI dashboards monitor cognitive readiness and adapt task difficulty in real time. Inclusive design extends platform accessibility through wearable biometric sensors and AR-assisted visualization of 3D wireless signal data. A pilot study was conducted with two student cohorts ($n = 13$ per group) to evaluate the SGM component of the platform within a blended learning delivery model. The active multimedia group achieved a 76.9% pass rate (10/13) against 23.1% (3/13) in the traditional control group, with a statistically significant and large effect ($t(24) = 3.28$, $p = 0.003$, Cohen's $d = 1.29$). These results provide preliminary evidence that the platform's intelligent, active-learning approach substantially improves training outcomes for mobile wireless security engineering. Full empirical validation of the AI analytics, AR/VR laboratory, and 5G/IoT edge-computing modules is planned for future work.

Keywords: wireless intelligence and security (WIS), mobile security education platform, AI-driven learning analytics, software-defined radio (SDR), intelligent wireless training systems, outcome-based education (OBE).

1 Introduction

The transition from emergency remote teaching back to physical classrooms has exposed a profound educational rift in higher education. STEM students after COVID-19 pandemic showed decreased classroom attendance and diminished self-directed learning capabilities [1]. Traditional pedagogical

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models which depend on professors transferring knowledge to students directly, fail to provide students with required skills needed to understand Wireless Intelligence and Security. The digital transformation which the pandemic brought demands organizations to develop flexible learning spaces that utilize advanced technologies [2]. Active learning development requires a complete redesign of mobile engineering education because existing systems block students from acquiring essential skills needed for professional engineering work [3]. Engineering students in contemporary times possess cognitive patterns that continue to develop through their continuous media content exposure. Engineering students who engage with digital multimedia environments can build stronger mental models through the combined use of visual and auditory instructional channels [4]. Students who attend traditional lectures that fail to acknowledge their digital media usage patterns will experience cognitive disengagement along with post-pandemic motivational deficits. This paper is based on an original framework which integrates Outcome-Based Education (OBE) and Cognitive Load Theory (CLT) in the link between two educational methods. The framework decreases the "intrinsic load" of wireless operational tasks by organizing activities through cognitive demand control which reduces the need for mental resources required to perform complicated tasks. The proposed framework allows cognitive alignment through the use of an asynchronous and synchronous active pedagogical structure, enabling the implementation of high-fidelity and blended learning [5]. The theoretical content is removed from the classroom and situated into the digital modules, freeing up space for design critiques and PBL sessions that engage with real-world security challenges via SDR interfaces [6]. The dual-track delivery system educates technical knowledge while also building vital transversal competencies such as interdisciplinary collaboration and oral communication, consistent with the key characteristics identified in design-based learning approaches [7]. By embedding evidence-based multimedia design principles—including signaling, segmenting, and modality—into the platform's AI-driven content delivery layer, the framework reduces extraneous cognitive load and produces mobile security engineers equipped with both wireless system competencies and Industry 4.0 transferable skills [8].

2 Related Work

The emergence of Outcome Based Education (OBE) from conventional teaching approaches has made the implementation of OBE a global norm for quality assurance in higher education. Mahrishi et al. [9] stated that the present OBE systems are presently better supporting the United Nations Sustainable Development Goals (SDGs) due to its requirement of providing education which is inclusive and equitable and maintains high standards of quality. The study shows that the engineering programs make a direct link between the theoretical knowledge and practical skills through the assessment of some learning outcomes. The mobile engineering study program is about studying protocols and the students need to show their ability to apply knowledge and solve difficult problems that are needed to build robust and secure communication systems.

A post-pandemic educational environment has given rise to an academic conflict, as traditional STEM pipeline metaphors are insufficient. The National Academies of Sciences, Engineering, and Medicine [10] argues that engineering education needs to be flexible as today's students have different educational requirements and social needs. Their work suggests that there are certain requirements for students to be able to successfully navigate their way through their academic path in the existing STEM pathway. To be successful, educational programs must create positive learning experiences that bridge across three distinct learning environments—online, in-person, and community-based spaces. Wireless security education needs to evolve from isolated exercises teaching technical skills to methods that enable students to connect their technical skills to the functioning of complete socio-technical environments. The new approach of the OBE model is a fundamental transformation for the OBE model as it integrates ongoing evaluations and continuous student assessment throughout their academic journey. Chiu [11] introduce the concept of "Real-time Competency Tracking" stating that traditional static assessments do not capture the innovation value of a student's journey. Dynamic feedback systems and professional competitions help engineering students learn critical skills for solving technical challenges typical for recent graduates. The Wireless Intelligence framework also supports the continuous assessment of students' ability to configure automated network systems in response to real-time security incidents, assisting their compliance with industry standards for

Industry 4.0.

The final step in this transformation process is to remove the technical barriers that traditionally separate the different engineering disciplines in engineering education. Chen et al. [12] demonstrate that engineering education has progressively shifted beyond isolated technical instruction toward integrative problem- and project-based learning environments that cultivate both professional knowledge and transferable skills. However, research indicates that security education must be delivered through pedagogical methods that consider the varying cognitive skills and social assets that marginalized students have as their "Resistance Capitals." The wireless security curriculum is made more accessible by educational institutions that go beyond "technical silos" to include complete systems in their curriculum. The future of secure mobile engineering relies on technical systems that require different ways of thinking to better protect against more sophisticated cyber threats that use different attack ways.

3 Theoretical Foundations

The Cognitive Load Theory (CLT) and Outcome Based Education (OBE) are the theoretical underpinnings of the study to develop a curriculum that aligns with engineering professional competencies. A Blended Learning model delivers this psychological and structural base through its digital capabilities which Digital Natives use to create knowledge actively. The framework achieves total accessibility through its Community Cultural Wealth theory inclusion which transforms student diversity and resilience into strategic resources for solving complex wireless security problems.

3.1 Outcome-Based Education (OBE)

Outcome-Based Education (OBE) represents a widely adopted approach to engineering education system design, grounded in best practices that align curriculum, instruction, and assessment around measurable student outcomes. OBE is designed with the goal of having students demonstrate specific skills and knowledge at the conclusion of some designated learning experience. As an approach which emphasizes development of measurable learning outcomes, OBE plays on how students demonstrate achievement of theoretical knowledge and professional competencies rather than pursue content or the delivery of instructional materials. Based on the curriculum framework given by OBE, which is an outcome based approach, it allows the designers of curriculum to design the educational programs for students learning as they learn skills that are vital for wireless intelligence and security work. The Educational Blocks system allows teachers to prepare pre-structured learning paths which help learners acquire specific learning outcomes. The system ensures graduates have both international engineering attributes and practical skills to operate in mobile engineering and in cybersecurity.

3.2 Cognitive Load Theory (CLT)

The CLT framework will also help explain what students do when they process difficult information (CLT). The subject of wireless communication and security systems involves interacting with abstract mathematics (other than formulas) that students must understand and connect within a complicated hierarchical structure of the design process, resulting in high cognitive demand for the learners. Poor instructional design may increase cognitive load and the learning process can become inefficient. To tackle this issue, the proposed approach uses Mayer's multimedia learning principles to facilitate cognitive processing. Signalling is where you use visual and auditory cues to guide students towards the most important pieces of knowledge. Visual integration strengthens the formation of higher quality mental models, because it presents graphical information paired with concurrent audio narration. This principle divides complex topics into smaller instructional units to ensure that students can develop their understanding in a sequential manner. The modality principle suggests that longer retention times are achieved when narration and diagrams convey information via separate channels (the auditory and the visual channel) helping to reduce split-attention problems. In digital learning spaces, pause-and-review features also provide additional help for students who on average may need extra time processing information presented quickly, as shown Figure 1.

3.3 Kolb's Experiential Learning Theory

The practical and interactive parts of the proposed framework find their roots in Kolb's Experiential Learning Theory, which defines learning as a process whereby knowledge is created through the transformation of experience followed by reflection. The student first participates in concrete experiences that take the form of multimedia content, simulations

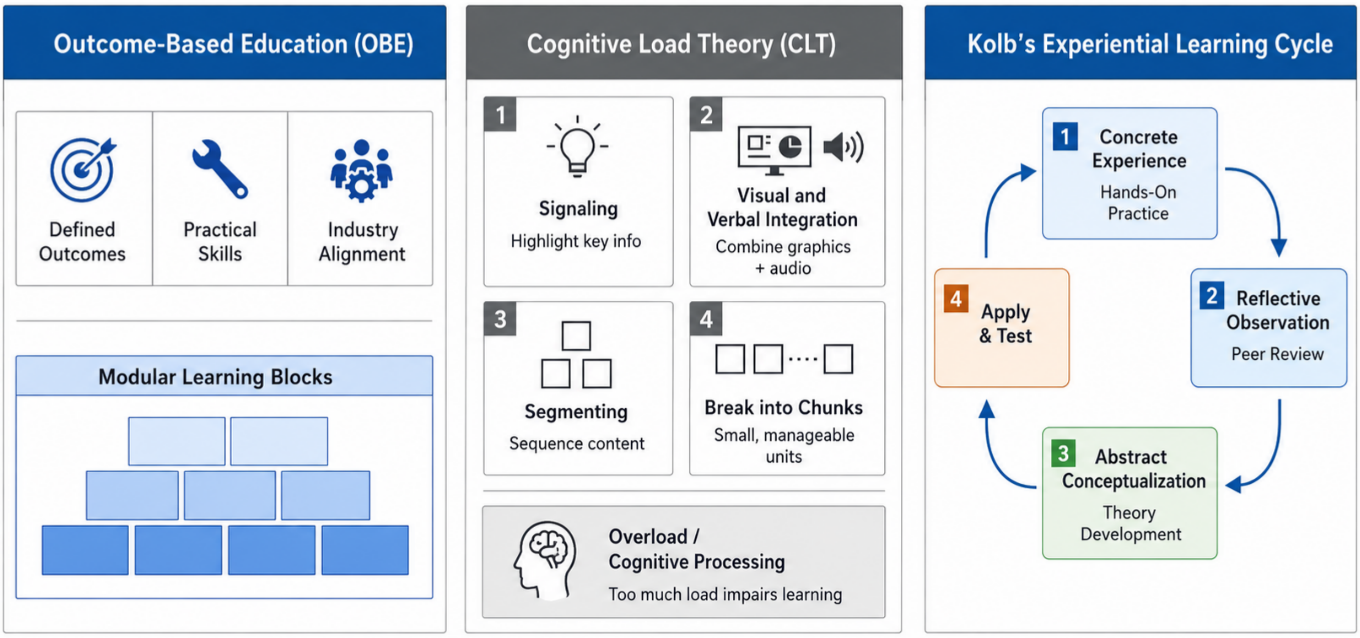

Figure 1. Theoretical foundation of the proposed WIS education framework.

and virtual labs that model real world wireless and security situations. Then begin reflective observation by examining those experiences through discussion, peer review and feedback. Abstract conceptualization helps students relate their observations with fundamental principles of engineering, and gain theoretical insights. Finally, active experimentation enables learners to relate with the gained knowledge in real-world problems, for example, as a mobile network designer or as a cyber threat analyst. The learning cycle framework supports deeper understanding, active learning, critical thinking and continual skill-building in the context of Wireless Intelligence and Security education through the alignment of educational activities as illustrated in Figure 1.

4 Integrated Pedagogical Framework

4.1 Blended Learning and the Flipped Classroom

The suggested framework is based on a teaching model that changes from traditional teaching where teachers act as "Information Providers" to their new role as "Learning Facilitators." The transition toward active learning methods becomes essential for wireless intelligence and security education because students must learn through active participation to grasp complex concepts. Blended learning combines both asynchronous and synchronous learning methods to enable students to study theoretical material which includes wireless protocols and encryption mechanisms and threat models through pre-recorded lectures and simulations and digital resources at their own learning speed. The approach enables students to spend classroom time on advanced educational tasks which include problem-solving and case study analysis and group discussions. The flipped classroom model establishes a framework which ensures that students learn core material before attending class while class time is dedicated to practical application of concepts through activities like secure mobile network configuration and cyberattack pattern analysis. The methodology enables students to achieve deeper understanding through peer interaction while developing their ability to think critically, as illustrated in Figure 2.

4.2 Personalized and Demand-Based Education

The proposed approach uses a personalized just-in-time teaching method to cater to the varied academic backgrounds and learning speeds of mobile engineering students. It has a three stage process for adapting educational content to the student's need. First, an initial diagnostic assessment is conducted at the beginning of the course to evaluate students' knowledge of networking, programming, and basic cybersecurity. The results provide a basis for instructional planning. Second, educational blocks are adaptively selected according to the diagnostic outcomes and the learning needs of the group. For instance, students with less knowledge of networking might take further foundation modules before proceeding to advanced topics in wireless security. Third, through classroom polling systems anonymous

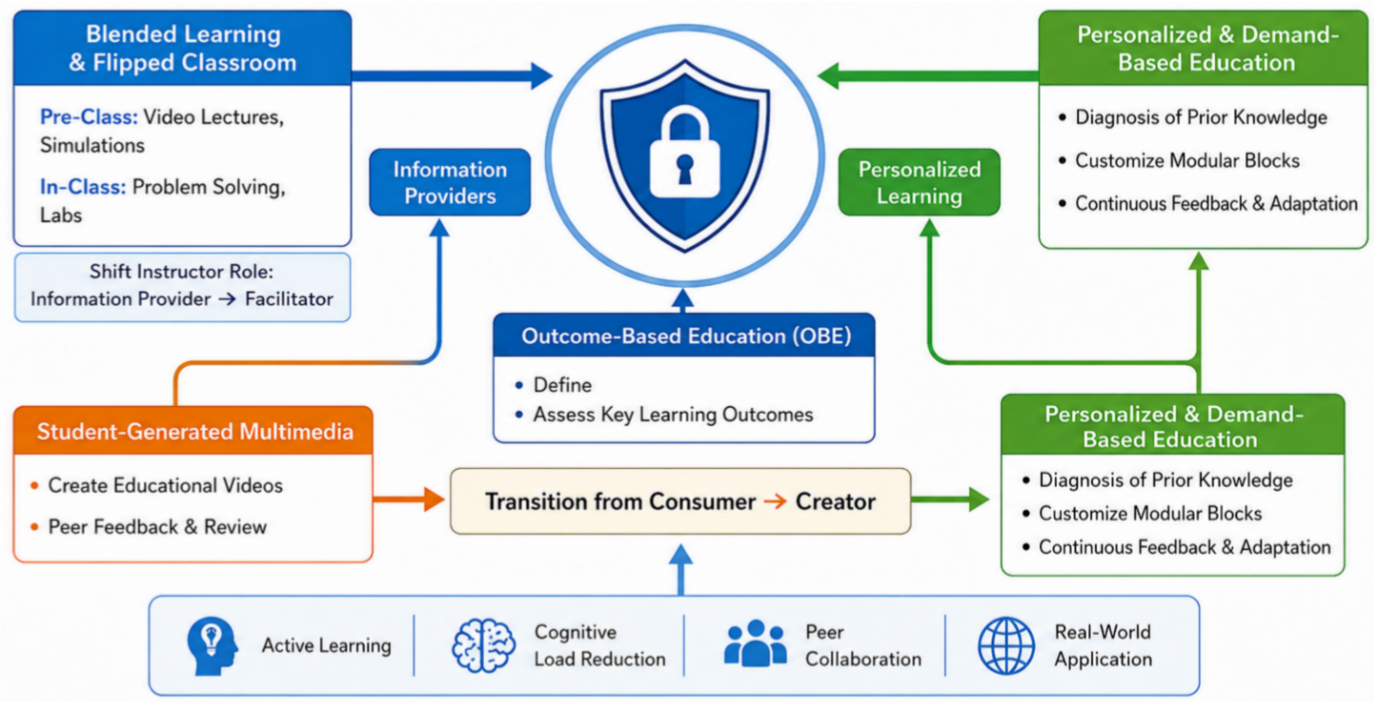

Figure 2. Workflow of the OBE-based blended learning and SGM intervention.

Table 1. Implementation outcomes for student-generated multimedia approach.

Metric	Active Multimedia Group ($n = 13$)	Traditional Control Group ($n = 13$)
Final Pass Rate	76.9% (10 Passed)	23.1% (3 Passed)
Average Grade (/10)	6.0 (SD = 2.1)	3.6 (SD = 1.6)
Exceptional Grades	2 students (9.5–10.0)	0 students
Student Satisfaction	81% Positive	N/A

feedback is gathered continuously, enabling students to express opinions on the pace, difficulty, and understanding of the lessons. Such feedback helps instructors to adapt teaching strategies, keep students focused and reduce learning gaps. This adaptive process assists in adjusting the instructional content to the student readiness and assists in better learning outcomes as shown in Figure 2.

4.3 Student-Generated Multimedia (SGM) Content

Students gain understanding based on what they have created as interest-based learning media that they can utilize for their own study sources. The education system allows students to transition from just consumers of information to producers of their own learning materials! The students will prepare short instructional videos that will cover intrusion detection systems and wireless encryption standards and mobile threat analysis. In order to do this they first need to develop some theoretical knowledge that they then demonstrate and then explain their ideas to others. SGM supports Peer Feedback Literacy by teaching students to evaluate their classmates using defined criteria. While the process encourages students to work together and reflect on their learning, it also improves evaluative judgment skills.

Table 1 illustrates the results of the Active Multimedia Group and the Traditional Control Group (13 students in each group). The active multimedia group had a higher pass rate of 76.9% (10 students) than the control group with 23.1% (3 students). The mean grade in the multimedia group (6.0) compared to that in the classic academic course-providing group was also higher (3.6). Two of the multimedia group students earned a top grade between 9.5 and 10.0 while none of the control group students fell into that range. Among students, the multimedia group also enjoyed positive ratings with 81% giving favorable feedback.

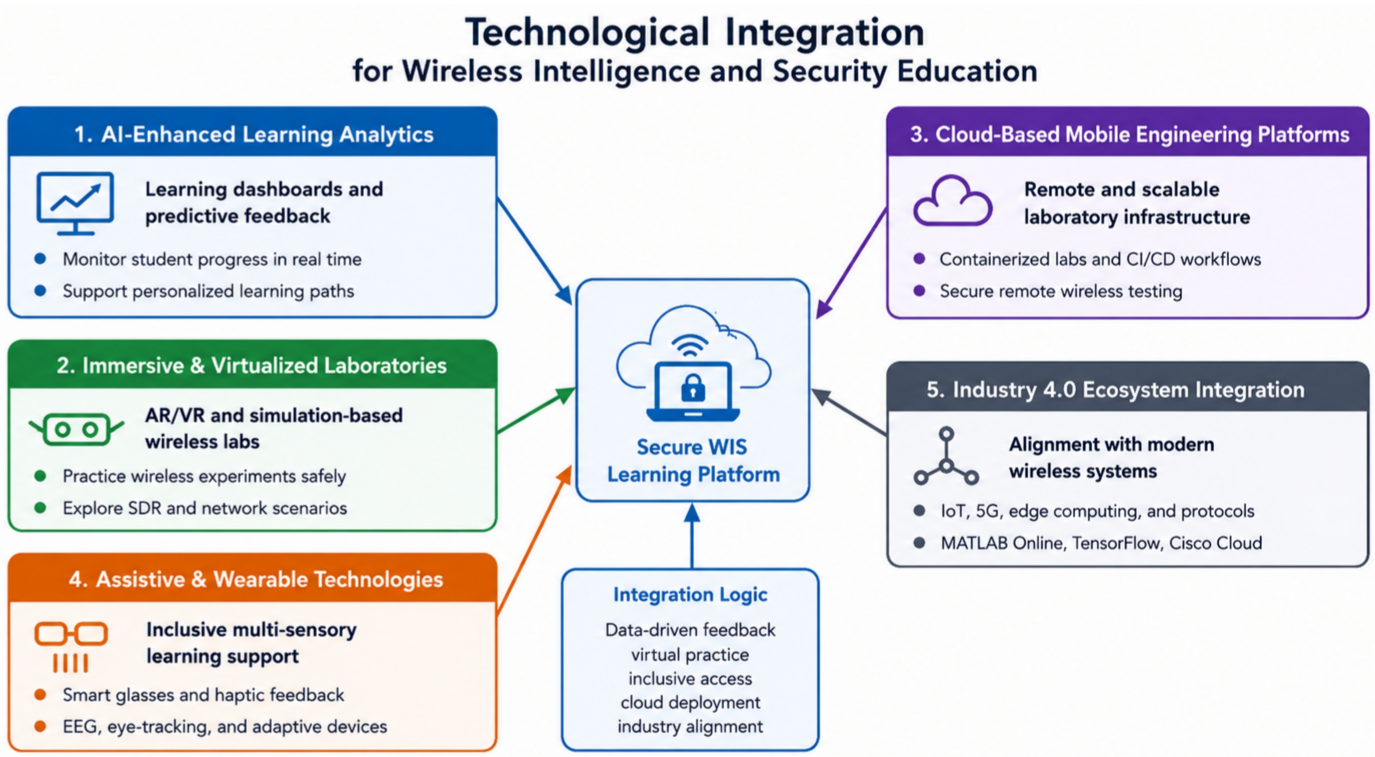

Figure 3. Proposed Education 4.0 technology extensions for WIS education.

These findings indicate that the Student-Generated Multimedia approach may facilitate better learning outcomes and student engagement in the pilot cohort.

5 Technological Integration

The empirical pilot study evaluates the student-generated multimedia component of the proposed platform. The following technological modules—AI-driven analytics, AR/VR laboratories, cloud-based wireless simulation, and wearable biometric interfaces—constitute the full platform architecture and are described here as designed system components ready for staged deployment, with empirical validation planned in subsequent phases.

Technological integration is the core differentiator of the proposed intelligent mobile security education platform. Each module directly addresses a recognized challenge in wireless systems training: the need for real-time cognitive adaptation, cost-effective SDR-based experimentation, scalable remote laboratory access, and accessible multi-sensory signal interaction.

5.1 AI-Driven Learning Analytics for Education 4.0

Artificial intelligence technology can improve educational outcomes by monitoring student progress in real-time with personalized feedback. AI tools which operate through Learning Management Systems (LMS) can assess student behavior by tracking their performance in simulations and their time spent on tasks and their collaboration with others. The collected information permits the system to create automatic formative assessments while designing customized educational pathways for students. AI dashboards create student groups according to their cognitive readiness which enables instructors to adjust wireless intelligence task difficulty in real time. This approach enhances learning efficiency while decreasing the teaching workload, shown as Figure 3.

5.2 Immersive AR/VR and Virtualized Laboratories

While Augmented Reality (AR) and Virtual Reality (VR) can visualize signal propagation, antenna radiation patterns, and network interference to aid in exploration of advanced wireless technologies. These tools are used to create a training environment with the objective of developing practical skills in students when combined with virtual laboratories and Software-Defined Radio (SDR) simulations, providing a safe and cost-effective training environment. For example, real-time maps of frequency bands and flows of encryption could be seen in AR interfaces, while a VR laboratory could include shared workspaces that would make it easier to do cybersecurity training, testing or experimentation of networks. They can also provide a platform for advancing your learning by designing an experimental model of what a real live wireless system would look like and simulating its performance using the authentic channel conditions. The combination of these tools brings theoretical wireless ideas closer to practical engineering.

5.3 Cloud-Based Mobile Engineering Platforms

Cloud computing is able to support mobile engineering education by provide remote access scalable learning and laboratory environments. And students can experiment with wireless algorithms using containerized environments and a remote lab infrastructure, then deploy their work from anywhere. Students are also introduced to CI/CD workflows and system integration with real-testing environments found in the professional engineering practice, thanks to cloud-based platforms. Additionally, those platforms can facilitate collaborative debugging with real-time monitoring and automatic logging of student interactions for ongoing performance assessment, as illustrated in Figure 3.

5.4 Assistive and Wearable Technologies for Inclusive Learning

Assistive and wearable technologies can convert complex wireless data into multi-sensory learning inputs to enhance accessibility in engineering education. Head-worn devices may include AR glasses that allow spatial understanding and visualization of 3D wireless models. The gloves mentioned are haptic devices that can provide a tactile sensation and enable signals like these to interact with the system in some way. Other types of biometric wearables include EEG sensors and heart-rate sensors and might also monitor cognitive engagement and the intensity of stress levels. These technologies can also level the playing field for diverse learners and lead to more equitable participation in complex technical learning environments.

5.5 Integration with Industry 4.0 Technologies

The framework aligns with Industry 4.0 ecosystems by incorporating IoT, 5G, and edge computing technologies. The students apply their learning through practical work which includes smart city networks and secure vehicles communication and drone systems. The program enables students to learn mobile engineering through its integration of industry-standard platforms which include MATLAB Online and Cisco Networking Cloud and TensorFlow.

6 Inclusive Teaching Practices

The Education 4.0 paradigm positions inclusive pedagogy as a fundamental requirement for effective engineering education. The framework uses five core dimensions which Singh and Kittur synthesized to direct inclusive teaching practices which include identity-based connections and technology-driven inclusivity and student interest integration and active skill development and systemic barrier resolution. The dimensions provide Wireless Intelligence and Security (WIS) education with accessible and equitable education which meets the diverse needs of all learners.

6.1 Strategies for Marginalized Students

The framework employs specific methods to help underrepresented and diverse students achieve greater engagement, confidence, and academic success. It utilizes two key approaches to support students in building resilience and professional identity when confronting negative stereotypes. Additionally, the framework enables learners to draw upon their personal and cultural experiences as strengths in engineering. The human-centered engineering approach engages students with real-world human challenges, fostering their understanding of social responsibility and ethical behavior. Through these challenges, students learn how their work impacts people and what ethical obligations they hold. The framework also incorporates Universal Design for Learning (UDL) principles to ensure learning materials are accessible to all students. For example, live captioning supports students with hearing difficulties, while 3D tactile models help visually impaired learners grasp abstract wireless concepts through hands-on experience. Furthermore, Student-Generated Multimedia (SGM) offers flexible content that students can revisit as needed, benefiting those with attention difficulties such as ADHD. Collectively, these inclusive teaching methods create a robust pedagogical foundation that enables all students to participate, contribute, and succeed in wireless intelligence and security education.

7 Implementation Roadmap: The Lego-Lab Concept

The "Lego-Lab" concept creates a modular framework which educational institutions can use to implement their pedagogical model for Wireless Intelligence and Security (WIS) education. Educational institutions can create their own curriculum through this system which

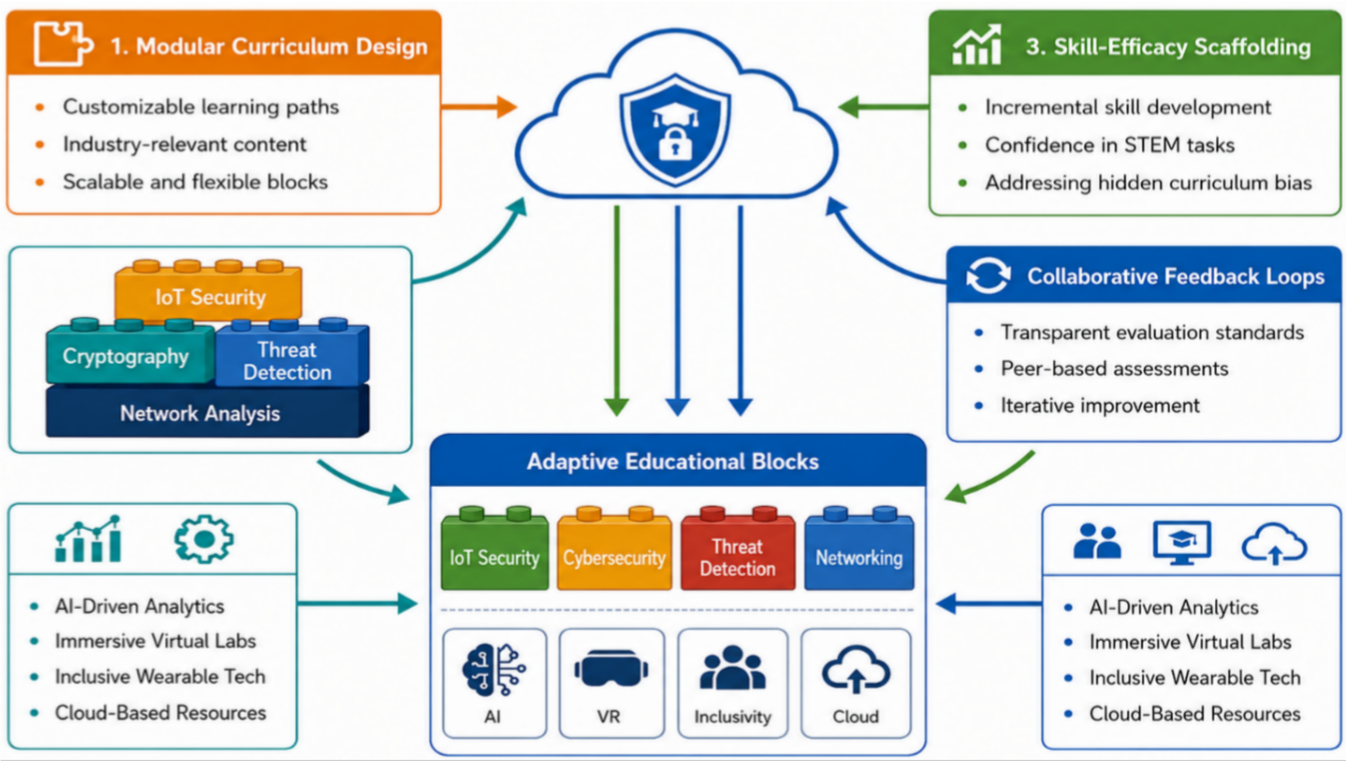

Figure 4. Lego-Lab modular architecture for WIS curriculum implementation.

provides Educational Blocks that work together with Lego-based design principles. The Educational Blocks enable flexible curriculum development through their ability to combine different educational elements which include specific competencies that students must learn and develop, shown as Figure 4.

7.1 Modular Curriculum Design

The Lego-Lab concept is built upon modular curriculum design, which means complex topics are split into smaller educational blocks that can be taught in isolation. Blocks are designed with each specifying a set of learning outcomes, which can be assessed by one or more forms, and competencies that should be acquired. This setup enables institutions to amend their learning resources as wireless tech, like 5G safety and IoT threats, develops. Moreover, the feed enables tailored learning by adapting content to student profiles and institutional goals. Furthermore, the modular nature facilitates interdisciplinary learning through integration with wireless security information from AI-powered cybersecurity and mobile network analytics. Therefore, this paper proposes to develop a four-main-block Wireless Security course comprising Network Fundamentals, Encryption Techniques, Intrusion Findings, and Real-Time Threat Analysis. The blocks are self-contained and can be updated, swapped, or stacked independently of one another when course development needs arise.

7.2 Skill-Efficacy Scaffolding

Skill-Efficacy Scaffolding is the framework where students learn to become confident in their abilities and efficient at resolving intricate engineering challenges. The learning process enables students to develop necessary soft skills, and the technical skills are developed through structured, hands-on activities. This process involves the following: STEM Self-Efficacy: The learner starts with simple simulations and moves up through progressively more difficult tasks that culminate in configuring a live network, thus building confidence. How: Students will begin developing self-advocacy skills by talking about how to ask for resources or request questions while recognizing their learning needs. Address Hidden Curriculum: Standards for collaboration and evaluation are not well defined; making these standards explicit helps create an equitable environment for all learners. Students learn to problem-solve individually after emerging from scaffolding approaches in the training phase. They have to be trained in this skill set to be able to work in wireless intelligence systems.

7.3 Feedback Loops of Collaboration

The Lego-Lab framework builds a learning environment in support of open and continuous educational development by means of Collaborative Feedback Loops. They examine educational material and take part in self-evaluation exercises. Students take part in peer assessment exercises. The system comprises the following main elements: Structured peer review: Students review each other's projects (e.g., multimedia content, security simulations) with the aid of standardized rubrics. Clearly Defined Grading Criteria: Students' work is evaluated using a clear and consistent grading rubric. This helps students understand what is expected from them before they submit their work and allows instructors to assess each submission fairly and transparently. Continuous Iteration: Feedback is used to refine both student outputs and instructional strategies. The system creates professional responsibility through its requirement that students generate work which can be assessed by all members of the educational community. The program develops critical thinking skills and communication abilities and team-oriented problem-solving methods which the cybersecurity and mobile engineering sectors consider essential.

8 Results

8.1 Study Design, Group Formation, and Assessment Methodology

The experimental component of this study was conducted as a pilot comparison between an Active Multimedia Group and a Traditional Control Group. Each group included 13 students from the same institutional context and the same broad course area. Full random assignment was not applied because the study used available course groups; therefore, possible selection bias is acknowledged as a methodological limitation. To reduce instructional bias, both groups followed the same course outcomes, core syllabus, and final assessment structure.

Similar course levels, similar academic backgrounds and the same learning outcomes for both cohorts were used to achieve group equivalence. The active group received the student-created multimedia intervention in the blended learning approach while the control group received the traditional lecture-based format. The same final grade scale and the same outcome-aligned assessment criteria were used for both groups.

The key outcome indicators in the assessment methodology were final pass rate, average grade, exceptional grades, and student satisfaction. The academic performance was studied through grade comparison. The pass rate and satisfaction were used as the supporting indicators of learning engagement. The study was performed on a small sample size, so the findings are only preliminary and are not intended to be definitive proof of general effectiveness.

The empirical evaluation was done as a small-scale pilot study, not as a large-scale validation of the whole framework. Thus, the results should be considered as preliminary evidence for the possible utility of the student-generated multimedia intervention. The results show positive learning effects for the cohort studied but are not to be taken as conclusive evidence of general effectiveness across institutions, courses, or student populations.

The Active Multimedia Group's pass rate is more than three times the control group's pass rate, showing that students have a better understanding and retention of difficult wireless and security concepts. This means that students performed better academically and the average grade improved considerably. The framework has the potential to benefit average learners as high-achieving students in the experimental group obtained exceptional academic results. The research findings show that students satisfied with their studies achieve higher academic performance in STEM subjects, demanding advanced learning skills. The results of the research showed that a combination of blended learning and student-generated content leads to better educational outcomes in Wireless Intelligence and Security programs, as reflected in both the average grade comparison (Figure 5) and the final pass rate comparison (Figure 6).

8.2 Statistical Significance Analysis

An independent-samples t-test was conducted to compare the final grades of the Active Multimedia Group and the Traditional Control Group. Because the study used a small pilot sample, the statistical findings are reported with effect size and interpreted cautiously.

- Active Group: Mean = 6.0, SD = 2.1, $n = 13$
- Control Group: Mean = 3.6, SD = 1.6, $n = 13$

The difference in mean grade was 2.4 points on a 10-point scale.

$$t(24) = 3.28, \quad p = 0.003 \qquad (1)$$

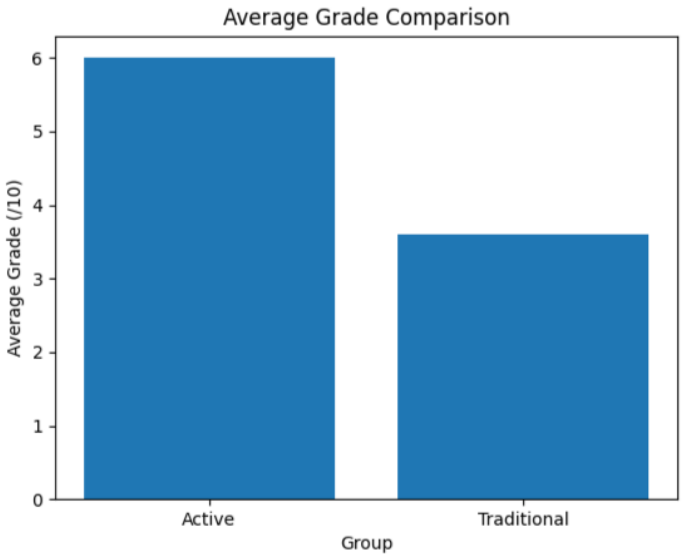

Figure 5. Comparison of average grades between active multimedia and traditional groups.

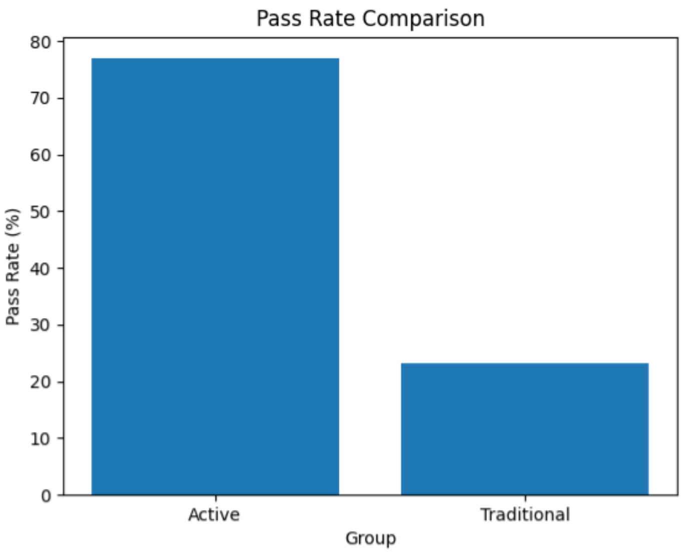

Figure 6. Comparison of final pass rates between active multimedia and traditional groups.

$$\begin{gathered}\text{Cohen's } d = 1.29; \\ 95\% \text{ CI for mean difference} = [0.89, 3.91]\end{gathered} \tag{2}$$

These results indicate a statistically significant and large effect size, suggesting that the student-generated multimedia approach substantially improved learning outcomes compared to traditional instruction.

Assumption check

Both groups used the same grade scale and equal sample sizes. The variance ratio based on the reported standard deviations was approximately 1.72, which did not indicate severe variance imbalance; however, because of the small sample size, normality and equal-variance assumptions should be interpreted cautiously. The active multimedia group showed a statistically higher average grade than the traditional control group in the observed cohort. The large effect size suggests a meaningful difference in this pilot sample, but the result should not be treated as broadly generalizable without larger multi-institutional validation.

8.3 Limitations and Future Work

This study has several limitations. The empirical examination, as well as the pilot experiment for the study itself, were undertaken on a limited sample of only 26 students with 13 in each group of active multimedia and traditional control. Secondly, the sampling consisted of all participants from one institution only, which may impose limitations in generalizing the findings. A third limitation is that the study only examined student-produced multimedia aspects of the proposed framework and not every technological component in the overall larger Education 4.0 model. Future studies should utilize a larger sample from multiple institutions, stronger randomization procedures, and longitudinal and comparative methodologies to evaluate other components of the proposed framework.

Moreover, only one SGM was studied in this pilot evaluation, implying that the proposed components using AI analytics, AR/VR, cloud-based and wearable technologies should be further empirically evaluated.

9 Conclusion

This paper presented an intelligent mobile security education platform that integrates AI-driven learning analytics, SDR-based practical modules, cloud wireless simulation, and wearable biometric interfaces within an Outcome-Based Education and blended learning architecture to address the growing demand for competent wireless intelligence and security engineers. Through modular curriculum design and student-driven multimedia and adaptive learning strategies, the framework addresses core challenges arising in pedagogically delivering advanced engineering concepts to students. The Lego-Lab exemplifies the possibilities for schools that implement Educational Blocks, customized learning paths created to align with institutional and market needs. The learning environment becomes both dynamic and accessible to students from different backgrounds because of three elements which include AI-driven analytics and virtual laboratories and inclusive teaching methods. The comparative study shows that student performance and engagement and satisfaction rates experienced substantial progress. The statistical analysis shows that the student-generated multimedia component, a core element of the proposed framework, is associated with improved student outcomes and not from random events. The students achieved better academic results through higher pass rates and grades and they developed better critical thinking and practical skills and collaborative abilities. This research demonstrates that highlights the potential of integrating blended pedagogy, student-generated content, and inclusive design. Future work will focus on empirically evaluating the proposed Education 4.0 technologies to realize the full potential of the model.

Data Availability Statement

Data will be made available on request.

Funding

This work was supported without any funding.

Conflicts of Interest

The authors declare no conflicts of interest.

AI Use Statement

The authors declare that no generative AI was used in the preparation of this manuscript.

Ethical Approval and Consent to Participate

This study involved analysis of anonymized, de-identified student grade data collected during standard course assessments as part of normal academic operations. No intervention outside routine curriculum delivery was applied to identifiable individuals, and no sensitive personal data were collected. In accordance with institutional policy at Daffodil International University, studies of this nature that use only routinely collected, de-identified academic performance data are classified as exempt from full Institutional Review Board (IRB) oversight.

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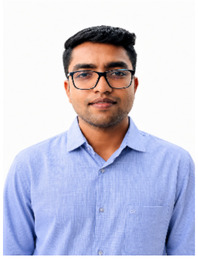

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