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Development of an Attention Aware Learning Enforcement System for Virtual Classroom

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Abstract - **The increasing adoption of virtual classrooms has intensified challenges related to learner distraction, limited supervision, and reduced engagement during online learning sessions. Traditional e-learning platforms largely depend on instructor intervention, which are often insufficient in large or distributed learning environments. This study presents the design and evaluation of an Attention-Aware Learning Enforcement System for virtual classrooms, aimed at collecting learners' distraction details, analysing them and counselling learners to help reduce subsequent distraction occurrences. The proposed system integrates three core enforcement modules: a compulsory class test module, an Artificial Intelligence (AI)-enabled counselling module and a Global System for Mobile Communications (GSM)– Dual-Tone Multi-Frequency (DTMF) call module. At the end of the class, the system collects captured distraction details and triggers enforcement actions on all the students detected with incident(s) of prolonged distraction. The compulsory class test is used to retain and engage the learners after class teaching, while learners are required to undergo AI-driven query and counselling session, with successful interaction serving as a prerequisite for test access. The GSM–DTMF phone calls provides a backup when the AI-driven counselling fails, with successful interaction serving as alternative prerequisite for test access. Performance evaluation results demonstrate high system reliability, with an overall enforcement success rate exceeding 90%, and a notable reduction in the need for human instructor intervention. The findings indicate that this learning enforcement system offers a scalable, intelligent, and effective approach to improving learner attention in virtual classrooms, particularly in resource-constrained and connectivity-challenged environments.**

Keywords - Learning Enforcement, Virtual Classroom, Learner Attention, GSM–DTMF, Artificial Intelligence (AI) Counseling, Online Learning Supervision.

I. INTRODUCTION

The expansion of digital learning technologies has significantly transformed educational delivery, enabling teaching and learning to take place beyond the confines of the traditional classroom. Virtual classrooms and online learning platforms now provide learners with unprecedented flexibility and access to educational resources. However, this shift has also introduced new challenges, particularly in the area of learning supervision and enforcement. According to [1], instructors often have limited visibility into learners' behavior, attention levels, and participation, making it difficult to ensure effective engagement and compliance with instructional expectations in online environments.

Learning enforcement refers to the systematic monitoring and guidance of learners' activities to ensure that learning objectives are being met. In physical classrooms, enforcement occurs naturally through direct observation, immediate feedback, interpersonal interaction, and direct instructions. In contrast, online learning environments require technological support to replicate these supervisory and enforcement functions [2]. Without adequate supervision, learners may become distracted, disengaged, or inconsistent in their participation, which can negatively impact learning outcomes and academic performance.

[3] posits that advances in educational technology, learning analytics, and artificial intelligence have enabled the development of automated and semi-automated enforcement mechanisms for virtual classrooms. These mechanisms can track learner activity, identify patterns of disengagement, and trigger timely interventions to support re-engagement. Rather than replacing instructors, technology-supported learning

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enforcement complements human oversight by reducing cognitive workload and enabling scalable monitoring in large or distributed classes.

In this context, learning enforcement plays a critical role in enhancing accountability, sustaining learner attention, and improving the overall effectiveness of online education. By integrating monitoring, feedback, and intervention tools into virtual classroom systems, learning enforcement provides a structured framework for supporting learners and ensuring meaningful participation in technology-mediated learning environments.

A. Motivation

Online learners are exposed to numerous sources of distraction, including mobile devices, social media, and non-academic online activities. Conventional virtual learning platforms provide limited supervisory capabilities and rely heavily on learner self-regulation, which may not be sufficient for all learners [4]. The motivation for Artificial Intelligence (AI)-enabled learning enforcement lies in its potential to improve learner engagement, sustain attention, and enhance learning outcomes in virtual classrooms. By integrating intelligent monitoring, adaptive intervention, and supportive feedback, AI-enabled counselling provides a scalable and effective solution for managing learner behaviour and participation in modern online education systems.

B. Aim

This work aims to develop an AI powered online learning enforcement system that interfaces with learners without requiring continuous human intervention. It will leverage machine intelligence to analyse learner interaction data, detect patterns of distraction, predict disengagement and provides counselling.

C. Conceptual Framework

Attention aware in this context refers to the ability to detect if a user is focused and generates reaction accordingly. Attention Aware features on iPhone and iPad models with Face ID utilize the TrueDepth camera to detect if a user is actively looking at the screen and adjust device behaviour accordingly. Learning enforcement refers to the pedagogical concept of reinforcement in education, often involving AI for tasks.

D. Theoretical Framework

Two theories were considered in the course of this work which are:

1) Media Richness Theory: According to [5], Media Richness Theory states that communication effectiveness depends on matching task complexity with appropriate communication media. AI counselling offers conversational depth when compared to static prompts and GSM voice calls provide richer communication when web interaction fails

2) Cognitive Load Theory: According to [6], Cognitive Load Theory asserts that learning effectiveness depends on managing the amount of mental effort imposed on learners. Excessive extraneous load can hinder learning. In our design, enforcement is applied selectively to avoid overload.

II. RELATED WORKS

Smart classrooms represent the convergence of pedagogy and technology, utilizing AI, Internet of Things (IoT), and cloud computing to enhance teaching and learning. Early work in online learner participation highlights how reduced face-to-face supervision can lead to disengagement and lower achievement outcomes, necessitating enhanced monitoring and interaction strategies [7] Among recent advancements, Large Language Models (LLMs) such as OpenAI's GPT, Google's PaLM, and Meta's LLaMA, have emerged as transformative tools. These models, trained on massive datasets, can understand, generate, and interact with human language, making them valuable in educational contexts. [8] integrated GPT-4 as a Socratic tutor. In their design, LLMs can act as AI tutors, answering student queries, guiding problem-solving, and providing explanations. [9] found that LLMs reduced teacher grading time by 40% while maintaining feedback quality. Their system was able to generate, grade, and provide feedback on student essays, short answers, and code. [10] emphasized that personalization by LLMs increased student satisfaction in online learning platforms. GSM-based technologies on the other hand have been applied across a range of classroom designs for different purposes, while automated telephone calls are commonly used to inform parents of student absences. Research reported in [11] indicates that integrating automated calls into early warning systems can increase student attendance by approximately 10–15%. Calls triggered by behavioural infractions or academic risk indicators allow for timely intervention. Further findings from [12] suggest that parents are more inclined to take corrective measures after receiving an automated call rather than an email, attributing this to the immediacy and more personal nature of voice messages. In situations such as emergencies or school closures, automated calling systems play a vital role in large-scale communication, with their speed and reliability frequently highlighted as major advantages over alternative communication channels [13].

A. Review Extract

Several system designs have been able to use AI in tutoring, supervision, and attention management in online and virtual classroom environments. While effective, many designs operate continuously during instruction and do not integrate enforcement logic or conditional access control to assessments. Designs using Dual-Tone Multi-Frequency (DTMF) input have been applied in tele-education and remote assessment systems, enabling learners to interact with automated systems via keypad responses. However, most existing GSM-based designs focus on content delivery rather than learning enforcement.

B. Research Gap

There is a great need to reduce instructor workload while maintaining effective oversight in an online class. Automated, intelligent enforcement systems can handle initial interventions, allowing instructors to focus on instructional design, feedback, and learner support.

III. DESIGN METHODOLOGY

This work adopted Object Oriented Analysis and Design Methodology and it was developed using python programming Flask framework running on Ubuntu Operating System. Three

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modules were built to achieve the design. They are; Compulsory Test Module, AI Interaction Counselling Module, and GSM DTMF Module. Finally, an intel core i5 microprocessor was used for deployment. The following materials were used:

1) SIM 800L GSM Module
2) USB to TTL CH340 Module
3) Power Module
4) SIM Card of ISP of Choice
5) Microprocessor

A. System Architecture

Fig. 1 below shows the system architecture with the modules (coloured in blue) and its communication channels. This system is NOT designed as a standalone system, rather to be integrated in an existing virtual class with attention monitoring feature, similar to the design by [14]. The learning enforcement is primarily to indulge only with learners who were recorded to be distracted during the class teaching and learning session. The virtual classroom will be structured in such a way that a compulsory test is administered at the end of the teaching session, which a successful completion confirms attendance and no student can return to take the test after end of class.

Adequate time is given from the end of teaching to the end of class, to enable students interact with the system before writing the test. Failure to write the test will lead to forfeiture of the assigned marks.

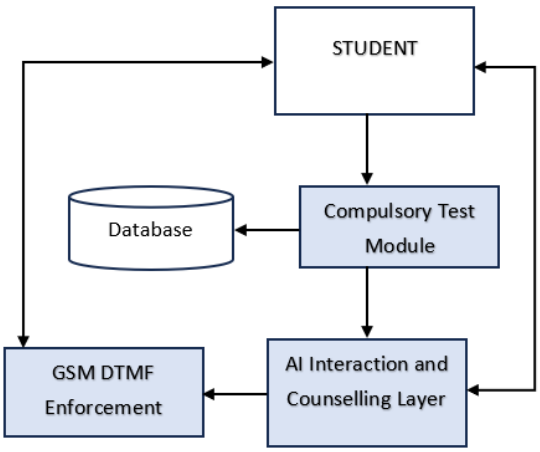

Fig. 1. Learning Enforcemet Architecture

Design Logic Summary

- Learning enforcement is not continuous; it is end-of-class triggered.
- Attempting the compulsory test triggers the AI Interaction and Counselling.
- Successful AI interaction is mandatory before test access.
- GSM DTMF serves as a fallback verification channel when AI interaction fails.

B. System Flow Chart

Fig. 2 below shows the system architecture with the modules.

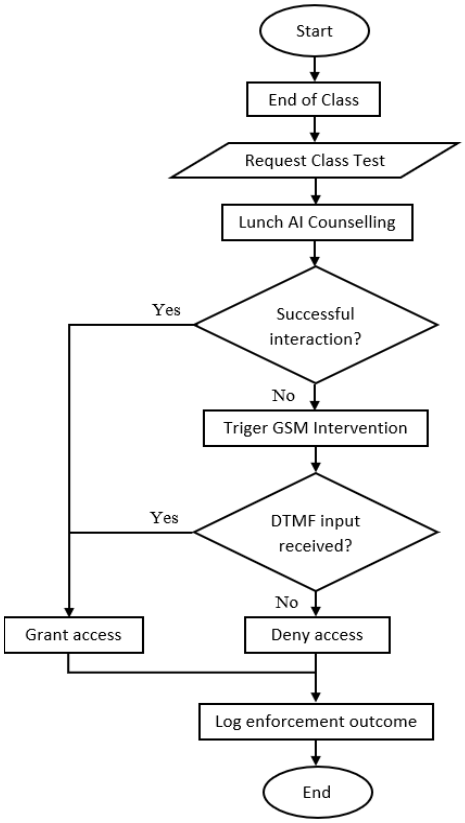

Fig. 2. System Flow Chart

Fig. 2 shows the flowchart of the learning enforcement system. This system starts at the end of the class session. When the student attempts to take the compulsory test, the decision control checks if the students was recorded to be distracted during the class. If the student was not distracted the system grants access to the test. Otherwise, the AI counselling is triggered. In the situation the distracted student successfully engages with the AI counselling, access is also granted to take the test. Otherwise, the GSM intervention is triggered. If required GSM DTMF inputs are received, access is granted for the student to take test. Otherwise, access is denied and at the end, the enforcement outcome is logged. The teacher can review and make use of the enforcement outcome for further action.

C. System Use Case

Fig. 3 below is the use case diagram, illustrating how the users interact with the system.

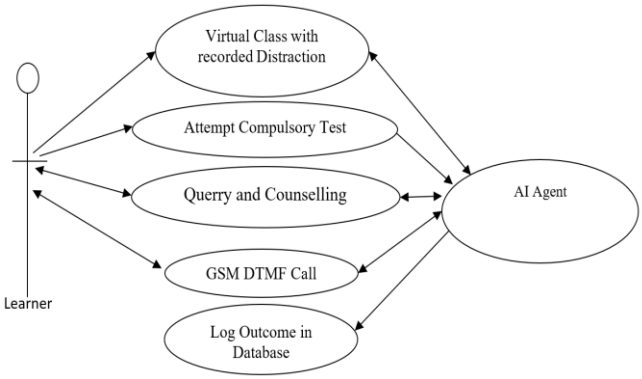

Fig. 3. System Use case

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Fig. 3 illustrates how the users of the system associate with the system.

The learner does the following:

1) partakes in the virtual class with attention monitoring/distraction detection.
2) attempts to take the compulsory test
3) responds to the AI query
4) provides the GSM call DTMF inputs

The System does the following:

5) receives request from learner to take the compulsory test
6) queries the virtual class for any recorded distraction against the learner.
7) queries the learner about the reason for distraction
8) counsels the learner based on query outcome.
9) Places a GSM call across to the learner.
10) Logs the enforcement outcome.

D. Sequence Diagram

Fig. 4 below details the sequential flow of the learning enforcement system.

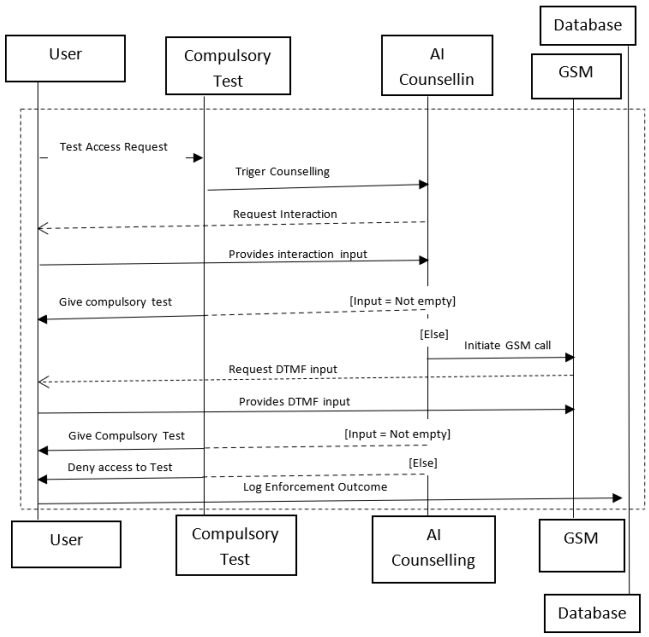

Fig. 4. System Sequence Diagram

Interaction Flow:

1) The Learner attempts to take the compulsory test at the end of the class.
2) The Decision & Escalation Control Module intercepts the request.
3) The module triggers the AI Counselling Module.
4) The AI Counselling Module engages the Learner in an interactive counselling session.
5) The Learner responds to the AI counsellor.
6) The AI Module forwards the interaction outcome to the Decision Module.
7) If the interaction is successful, access to the class test is granted.
8) If the learner fails to respond or disengages, the Decision Module triggers the GSM DTMF Module.
9) The GSM Module places an automated call to the Learner.
10) The Learner confirms engagement using DTMF keypad input.
11) The GSM Module sends the response to the Decision Module.
12) The Decision Module validates attention and either grants or denies test access.

IV. System Implementation

The system was integrated into a virtual class design by [14]. The implementation is broken down in same three design modules as detailed below.

A. Compulsary Class Test Implementation

It is assumed that available virtual classrooms should have an existing test module. Therefore, the design recommends that the existing test module is made compulsory and adopted. However, a logic should be put in place to use an attempt to take test in triggering the AI Counselling Module below.

B. AI Counselling Module Implementation

The AI Counselling Module serves as the first level of learner support. Once a distracted learner attempts to take test, the module initiates an interactive dialogue interface with the learner. Using natural language processing techniques, the system poses inquiry-based prompts to understand the learner's state and provides supportive guidance aimed at restoring focus in subsequent classes. This module emphasizes learner-cantered intervention by encouraging self-regulation and accountability rather than applying punitive enforcement.

While implementing the AI Counselling Module, Chat GPT Large Language Model API was used. The set of instructions below was given to the system to guide its interaction with the students

System:

You are a Learning Enforcement Officer. Your role is to:

1) Strictly investigate why the student is not paying attention in class.
2) Ask direct, probing questions to uncover root causes (distractions, personal issues, lack of interest).
3) Enforce accountability—do NOT teach or solve problems for them.
4) Guide them to self-reflect and commit to actionable steps.
5) Maintain a firm but professional tone. Do not be overly friendly.

Example of Supervisors Script:

- *"Why were you distracted in class today?"*
- *"What specific actions will you take to improve focus?"*
- *"This is your responsibility. How will you ensure it doesn't happen again?"*

Fig. 5 below shows a running interface between the AI Counselling Officer and the distracted learner. The interaction interface was developed using HTML, CSS, and a PHP framework.

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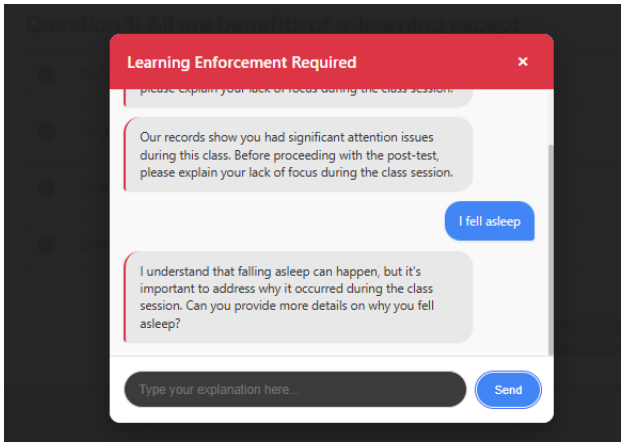

Fig. 5. AI Counselling Interface

C. GSM DTMF Call Module Implementation

The GSM DTMF Module provides an alternative re-engagement channel when the AI counselling web-based interactions fail or when learners remain unresponsive to the AI inquiry. The system automatically places a phone call to the learner and requests confirmation of attention through keypad input. Learners respond by pressing designated keys on their mobile phones, generating DTMF signals that confirm awareness and providing reasons for their distraction and willingness to re-engage. This module enhances system reliability, particularly in environments with unstable internet connectivity

The implementation can be achieved using cloud GSM service providers, but our region has restrictions working with most of the providers. Hence, to achieve the new system, we created some basic hardware connectivity as details in Fig. 6 below.

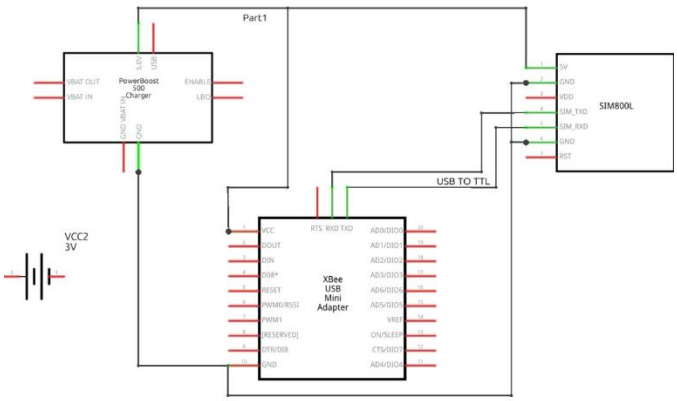

Fig. 6. GSM Module Circuit Diagram (Ekwegh's Field Work)

Fig. 6 shows the circuit diagram, illustrating the hardware connectivity (SIM800L GSM Module, Serial port access permissions and USB to TTL CH340 Module) while Fig. 7 below shows the physically connected hardware.

Fig. 7. Connected GSM Module (Ekwegh's Field Work)

This module receives signal on failed AI Counselling Module and places automated call to the learner. The module receives inputs as detailed in the DTMF interaction flow below.

DTMF Interaction Flow:

DTMF Menu 1: Awareness Confirmation
Voice Prompt: *"You were identified as distracted during the class session. Are you aware of this distraction?"*
DTMF Options:
Press 1 → Yes, I am aware
Press 2 → No, I am not aware
System Action:
Logs awareness level
Proceeds to cause identification

DTMF Menu 2: Cause of Distraction
Voice Prompt: *"Which option best describes the cause of your distraction? Please select one."*
DTMF Options (Maximum Five):
Press 1 → Mobile phone calls or notifications
Press 2 → Internet or system connectivity issues
Press 3 → Environmental noise or interruptions
Press 4 → Fatigue or loss of concentration
Press 5 → Personal or emotional concerns
System Action:
Records distraction cause
Uses data for analytics and AI counselling personalization

DTMF Menu 3: Commitment to Future Attention
Voice Prompt: *"Will you ensure that you remain attentive and avoid distractions in future classes?"*
DTMF Options:
Press 1 → Yes, I will ensure better focus
Press 2 → I am not sure
System Action:
Updates learner compliance profile
Determines need for further intervention

DTMF Menu 4: Human Counsellor Escalation
Voice Prompt: *"Would you like to speak with a human counsellor for further guidance?"*
DTMF Options:
Press 1 → Yes, connect me to a counsellor
Press 2 → No, continue without counselling
System Action:

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If Yes, flags learner for human counsellor follow-up
If No, concludes enforcement session

DTMF Interaction Termination
Final System Message: *"Thank you for your response. Your participation has been recorded. You may now proceed according to system instructions."*

V. SYSTEM TESTING

The system was tested both in modules and as a fully integrated system on 100 learners. Airtel Nigeria 4G Network (GSM and internet service providers) was used.

A. AI Counselling Testing

The AI Agent was extensively evaluated to determine its performance considering its unstructured nature.

TABLE I. DISTRACTION INQUIRY ACCURACY TEST

Performance Metric	Result
Correct distraction inquiry initiation	99%
Context-appropriate inquiry prompts	96%
False inquiry initiation	< 1%
Missed inquiry events	< 1%

TABLE II. RESPONSE TIME AND LATENCY TEST

Parameter	Value
Inquiry prompt generation time	1–2 seconds
Counselling message delivery latency	< 3 seconds
End-to-end enforcement response	3–5 seconds
Conversational session duration	30–120 seconds

TABLE III. RELIABILITY AND ETHICAL COMPLIANCE TEST

Reliability Metric	Result
AI service availability	98%
Response consistency	High
System failure rate	< 3%

B. GSM DTMF Testing

TABLE IV. GSM DTMF PERFORMANCE TEST RESULT

Metric	**Result**
DTMF input recognition accuracy	97%
Average response time	4.2 seconds
Successful interaction completion rate	94%
Call drop rate	3%

C. Integration Testing

TABLE V. INTEGRATION TEST RESULT

NOTE: The Test Case ID is coded with the acronym Learning Enforcement, which stands for LE Counselling System.

Test Case ID	**Test Scenario**	**Action**	**Expected Output**	**Actual Output**	**Status**
LE-01	Initialize AI Counsellor	Leaner attempts to take compulsory test	Learning counsellor initializes	AI Counselling interface pops up with a query	Pass
LE-02	Leaner responds to query.	Learner types and sends response using the interface.	Learners' response sends successfully	Response delivers	pass
LE-03	Reply to students' response	Analyse students answer and reply	Provides further reply to answers by students	Replied successfully	Pass
LE-04	Context retention	Student asks sequential questions	AI Counsellor should maintain context	Context retained correctly	Pass
LE-05	Student counselling	Student provides reason for distraction	Counsel students on how to reduce distraction and remain focused in class	Counsel students successfully	Pass
LE-06	Terminate AI Counsellor	Student clicks the Accept recommendation button	AI Counsellor closes	AI Counsellor closes successfully	Pass
LE-07	Initialize GSM DTMF call	Learner does not respond to AI query	GSM DTMF initializes	GSM DTMF call is placed to the learners' number	Pass
LE-08	Learner makes input to the DTMF query	Learner presses the button corresponding to chosen DTMF option	Input acceptance and proceed to nest question	Input accepted and DTMF proceeded to next question	Pass
LE-09	Terminate GSM DTMF call	Learner presses the button to answer last question	DTMF reads out the final system message and closes	GSM DTMF call closes successfully	Pass
LE-10	Access granted to take class test	Learner responds to either AI Counsellor or GSM DTMF query	Access granted to take class test	Access successfully granted to take class test	Pass
LE-11	Access denied to take class test	Learner fails to respond to either the AI Counselling nor the GSM DTMF call	Access denied to take class test	Access successfully denied to take class test	Pass

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D. Merit of the New System

The new system poses the following;

1) Improved Learner Engagement: The system actively addresses learner distraction using AI counselling and GSM–DTMF interactions, leading to sustained attention and improved participation during subsequent virtual classes.
2) Automated Supervision: By minimizing the need for manual instructor intervention, the system enables scalable supervision, making it suitable for large and distributed virtual classrooms.
3) Structured Behavioural Accountability: Compulsory AI counselling as a prerequisite for assessment access enforces accountability and discourages habitual distraction among learners.
4) Learner-Centered Intervention: The AI counselling module engages learners on peculiarities through inquiry and reflection rather than punitive measures, promoting self-regulation and positive behavioural change.
5) Applicability in Resource-Constrained Settings: The system is well-suited for developing regions where mobile phone penetration is high but broadband internet availability is limited. In that case, they can rely mainly on the GSM Module for enforcement.

E. Constraint of the New System

The system is disadvantaged as follows;

1) Dependence on Detection Accuracy: Incorrect distraction detection may trigger enforcement actions for attentive learners, potentially causing unnecessary delays for them.
2) AI Counselling Limitations: The effectiveness of AI counselling depends on the quality of conversational models and may not fully replicate human empathy or contextual understanding.
3) Limited Expressiveness of DTMF Input: DTMF keypad responses are restricted to predefined options, which may not capture exact learner explanations.
4) Resistance to Enforcement: Some learners may perceive enforced supervision as intrusive or controlling, affecting acceptance and satisfaction.
5) System Integration Overhead: Integrating the enforcement system with existing virtual classroom platforms may require customization and additional development effort and cost

CONCLUSION

This study presented the design and evaluation of an AI-enabled Learning Enforcement System for virtual classrooms, developed to address the growing challenge of learner distraction and limited supervision in online learning environments. The system integrates Compulsory class test initiation, AI-driven counselling and GSM–DTMF interactive supervision, within a unified enforcement framework to ensure timely learner accountability. Findings from the evaluation indicate that the system is effective in enforcing subsequent learner attention, and reducing the need for continuous human instructor intervention. The system uses compulsory class test to initiate AI-driven counselling, while the GSM–DTMF module offered a reliable fallback communication channel in cases of unstable internet connectivity. Additionally, the AI counselling module, implemented as a compulsory prerequisite for assessment access, promoted reflective engagement and self-regulation among learners. The modular architecture of the system enhances scalability, flexibility, and adaptability to different virtual classroom settings. Despite certain limitations related to detection accuracy, network reliability, and user acceptance, the overall results demonstrate that automated learning enforcement is a viable and effective approach to improving learner engagement in virtual classrooms. In conclusion, the proposed Learning Enforcement System contributes a novel supervision paradigm that shifts online learning from passive participation to active accountability. The system lays a strong foundation for future research and development in intelligent learning supervision, automated counselling, and adaptive enforcement strategies for next-generation virtual learning environments

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