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Enhancing Online Learning: Role Of Attention Detection Systems in Fostering Student Concentration

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Abstract

Online education is an inevitable trend. With just a smartphone, a tablet, or a personal computer, anyone, from teenagers to middle-aged individuals, from schoolchildren to workers, can access any free or paid courses in every aspect of society from economics, politics, literature, history, etc. foreign languages; Learners are free to choose lecturers, duration, time, space, and learning concepts as long as it suits their needs. However, online education still harbors many limitations, especially the issue of student distraction during online learning. This article elucidates the impact of online learning on student focus and analyzes the necessity of an attention detection system when studying online. Through surveys, the results indicated that up to 82.57% of students frequently lose focus when engaging in online learning, and 100% of opinions from education experts concur on the limitations of online learning. Based on these analyses, we provide insights into the necessity of developing and the crucial characteristics of an attention detection system to support learners in online education.

Keywords: *Online Education, Student Concentration, Attention Detection System, Distractions, Education Experts*

INTRODUCTION

Online learning is a growing trend in the future. The rapid boost in the number of participants in distance learning and online credentials has attracted attention and investment in infrastructure and learning equipment from both governments and businesses. After the COVID-19 pandemic in 2020, online learning has evolved from being an option to a mandatory form of education, with online lectures, virtual classroom interactions, digital materials, online assignments, and assessments becoming commonplace. On the other hand, the widespread penetration of the internet in recent years, reaching every corner of the world from the most modern cities to remote mountains and desolate deserts, coupled with improving socio-economic conditions and harsh natural environments, as well as day-to-day enhancing internet connectivity quality, has made online education more accessible and affordable. It meets the demands of almost all users, especially students without income.

The inevitable development of online learning stems from its irreplaceable advantages (Xhaferi, 2020):

Location Independence: Learners determine their study location, allowing students to choose where they learn.

Flexible Study Time: Learners can organize study schedules according to personal preferences.

Self-paced Learning: Students have control over the speed of learning, enabling them to set their own learning pace.

These advantages have led to lower costs for online learning compared to traditional classes because of reduced expenses on transportation, accommodation, and infrastructure construction (e.g., schools, classrooms). Because there is no need to go to school, time, cost, location, and even learning content can be freely chosen

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flexibly, fewer people drop out of school, and online learning is more popular, meeting the needs of many people with different ages, occupations, and learning styles. This opens up more learning opportunities for everyone, particularly students and learners in rural and economically disadvantaged areas or anyone eager to explore and learn (Gilbert, 2015).

Despite the opportunities and conveniences, online learning still faces numerous limitations. Students are not able to ensure internet connections, lack of infrastructure, or technological devices to join an online class. According to data from the World Economic Forum's COVID-19 Action Platform in 2020, only 34% of students in Indonesia have computers for school use, while nearly 25% of students in the United States from low-income families lack computers. Online learning lacks direct interaction, limiting the ability to convey information through body language and negatively affecting communication effectiveness. Assessing online learning outcomes is often challenging because teachers have limited direct interaction with learners (Anderson, 2004). Additionally, sensory stimuli such as noise, vibrations, and digital devices become distracting factors for online learners (Aivaz & Teodorescu, 2022).

There are two major factors affecting the quality of online learning: learner autonomy and the influence of external factors. The first factors influencing online learning outcomes include consistency in online course design, flexibility in online learning, learning environment, study time, learning motivation, technological devices, and internet connectivity. The second factor affecting the quality of online learning mainly comes from the learners themselves. Aspects such as teacher-student interaction, student-teacher interaction, learner autonomy, initiative, and discipline significantly impact learners' perceptions of online learning (Kim et al, 2005).

The question is, how can we minimize the negative impacts and enhance the positive effects of these factors on online learning outcomes? Various solutions have been proposed and implemented, bringing about progressive changes in online education. Learner autonomy and learning motivation are crucial determinants of the success of online courses (Matuga, 2009). Ensuring teachers have basic knowledge of using technological devices and online technical operations, along with collaborative management of students' electronic devices by teachers and parents, is essential (Mayadas, 2009). Thus, it is necessary to organize offline instructional training to ensure learners can flexibly combine online and traditional learning, not limited by the lack of face-to-face interaction when learning online. Additionally, interactive video usage requiring learners to respond during learning can enhance two-way interaction between teachers and learners. (Xu et al, 2020)

For online learning, the use of instructional videos is becoming increasingly common. Video quality is improving in both form and content; however, a major drawback is the lack of synchronous interaction between teachers and learners in lecture videos, potentially causing learner distraction. This is one of the most significant disadvantages of online learning, as it hinders students' sustained attention during online learning sessions (Xu et al., 2020). Online learning easily distracts learners with supporting learning devices, social media, or other websites (Szpunar et al., 2013). Thus, intervention measures are encouraged to help learners maintain focus in online classes (Gillick & Magoulias, 2020).

This paper expressed the necessity of concentration detection system for online learners. We aim to clarify the following objectives:

The current situation of student's distractions by mentioning the causes and level of distraction caused by external factors (sounds, light, lecture quality) in online learning.

Is a concentration detection system necessary for online learning? What functions should such a system have?

Propose the implementation and application of a concentration detection system for online learners in practice, with proposed functions tailored to the characteristics and needs of online learning.

LITERATURE REVIEW

In the past, online learning primarily served students unable to attend on-campus courses. Course materials were disseminated via postal services, and interactions with instructors occurred through correspondence. The University of Illinois developed Plato (logic coded for automated instructional activities) using the Illiac I computer in the early 1960s. The 1970s witnessed the advent of graphical user interfaces employing screens and mice, marking the onset of personal computing. The inception of the internet for military purposes heralded the embryonic stage of the World Wide Web. By the 1980s, online learning had expanded, enabling individuals to study specific subjects on their personal computers from home. The online course was developed by the New Jersey Institute of Technology and the university. In the mid-1980s, many libraries at universities began to allow direct access to course content. By the early 1990s, some universities started offering online courses tailored for students unable to attend due to geographical or time constraints. In 1994, the first online private high school, Compus High, was established, offering personalized online courses and accredited degree programs. In the 2000s, educational service providers explored the opportunities presented by new technologies such as web browsers, email, HTML documents, media players, and low-fidelity audio/video streaming to expand the use of online education in business settings. Workers sought to enhance their knowledge, skills, and personal development through access to online degree programs.

The US Department of Education conducted a study in 2008 showing that during the 2006–2007 school year, approximately two-thirds of both public and private high schools participated in student financial aid programs related to programs and courses offered by distance learning facilities, and about 77% of enrollment in credit-taking courses is oriented toward online learning. In the 2010s, social media platforms gained increasing prominence across various domains, leading to a burgeoning trend of online learning via social media platforms such as YouTube, iTunes, and MOOCs, which gradually transformed the landscape of education development. Today, online learning has evolved into eLearning 2.0 (EL2), leveraging the advantages of Web 2.0 applications in education. Web 2.0 serves as a collaborative learning platform where users share educational content with others through collaboration and mobile device utilization. EL2 is also defined as Web 2.0 applications purported to empower learners in the learning process. Presently, online education spans all levels of education worldwide (Bari et al., 2018). It is anticipated that by the year 2026, the global online education market will surge from USD 200 billion in 2019 to USD 375 billion (Ejdys, 2021).

Distraction is an inevitable phenomenon in achievement-related activities. In 2020, due to the impact of the COVID-19 pandemic, many students commenced online learning as a necessity, ushering in millions of first-time online learners. Online learners are inherently prone to distraction (Gillick & Magoulias, 2020). Several studies have proposed solutions to mitigate the adverse effects of factors influencing online learning. Specifically:

Online learners require adequate resources and necessary support to complete learning tasks (Rizal et al., 2019).

Learning spaces need to be intelligently designed, free from distractions, and conducive to learning and concentration (Carling, 2020; Erickson, 2018).

Employing creative learning methods may involve creating presentations and sharing videos on Padlet or creating posters in Adobe Spark Post. Classes may have a shared Instagram for uploading exercise images. There are no limits to creativity in online learning. (Gillick & Magoulias, 2020).

Students should limit their habitual media use (Gillick & Magoulias, 2020).

Students need to learn how to use "brain breaks" to break the monotony of sitting in front of screens. Caregivers can support this by guiding students in meditation, yoga, jogging, snacking, drawing, or simply going outside. Research on Brain Breaks has shown a positive correlation between resting after learning, focus, and strict scores. (Rizal, 2019)

Lecturers are well-trained and supported by training institutions on online teaching (Lauterborn, 2020).

The limitations of these methods are subjective and lack statistics on how online learners will become distracted during online learning. Therefore, this paper proposes clarifying this issue quantitatively by deploying and developing a feature set for a concentration detection system for students attending online lectures to lay the groundwork and reference for future system development, experimentation, and real-world application.

METHOD

The paper uses the quantitative research method and the qualitative research method to assess the need for using a system to examine the degree of distraction of lecturers and students in online learning. quantitative analysis. Applying these two approaches is mostly done to address the questions:

Is it necessary to propose a system to analyze the level of distraction for learners (students) when participating in online learning?

Is it feasible to apply a student concentration detection system in online learning?

If there is a need and feasibility for a system to analyze the level of distraction from online teachers and learners, what functions should that system provide?

In the first aspect, the quantitative method is applied to 304 students of HUST from first year to last year, majoring in engineering. The form is an online survey conducted using the Microsoft Form tool. The content of the survey was the need to use a system to analyze the level of learner distraction. The aim is to gather learners' opinions on the practicality of implementing and deploying a system within an online learning setting. Specifically, the objectives include:

Assessing the existing level of learner distraction during online learning sessions.

Investigating the impact of online learning conditions on learners' ability to maintain concentration.

Determining the necessity of a system for analyzing learner distraction levels and identifying desired functionalities from the learners' perspective.

Evaluating learners' willingness to adhere to the system's requirements during its usage.

To evaluate the survey results, a 5-level Likert scale was used to determine the respondent's level of agreement with: 1-Strongly disagree; 2- Disagree; 3- Neutral; 4- Agree; 5- Strongly Agree. Convention based on the mean value of the Anderson scale (1988): Strongly disagree (1.00 - 1.80); Disagree (1.81 - 2.60); Neutral (2.61 - 3.40); Agree (3.41 - 4.20); Strongly Agree (4.21 - 5.00). (Anderson, 1988). As for the question related to how online learning conditions affect the learner's concentration level, the 5-level Likert scale has specific differences towards the learner's concentration level with 1- Very frequently distracted; 2- Frequently distracted; 3- Occasionally distracted; 4- Rarely distracted; 5 - Never distracted. Convention based on the average value of the Anderson scale (1988): Very frequently distracted (1.00 - 1.80); Frequently distracted (1.81 - 2.60); Occasionally distracted (2.61 - 3.40); Rarely distracted (3.41 - 4.20); Never distracted (4.21 - 5.00). (Anderson, 1988).

After collecting a sufficient number of survey samples, we proceeded to data processing using Microsoft Excel to store the data, create charts, and then utilized SPSS software for data analysis. Specifically, we filtered out low-quality responses and input the collected data into Excel. Subsequently, we imported the data into SPSS for statistical analysis and the computation of relevant values.

In the second aspect, for the qualitative method, we consulted 22 Hanoi Polytechnic University lecturers (teachers) with expertise in the fields of information technology, education or both. The format implemented is an indirect interview with a set of questions prepared using the Google Form tool to collect answers from lecturers in written form. Key issues raised include:

How does distraction affect students' academic performance?

Is it necessary to introduce a system to improve the level of distraction in students?

Suggestions on necessary features of the system

What is the feasibility of implementing and deploying the system for online learning?

FINDING AND DISCUSSION

The quality of the lecture and the learning environment affect the concentration level of students when watching online lectures

Table 1: The Degree of Influence External Factors Have on Learners' Concentration Levels

Content	Mean ± SD	Percentage of students losing concentration (%)
Students lose concentration while watching online lectures	2.91 ± 0.86	82.57%
When encountering a lecture that is difficult to understand	3.10 ± 1.09	66.78%
When the lecture is interrupted	2.68 ± 1.00	81.58%
When the lecture sound quality is bad	2.64 ± 1.02	77.96%
When the lesson design is not attractive	2.76 ± 0.96	80.92%
When the lecture duration is too long (>15 minutes)	2.72 ± 1.01	80.58%
When the space to watch online lectures lacks light	2.97 ± 0.99	73.69%
When there is noise around the study area	2.68 ± 0.99	82.23%
For good lectures, good sound, scientific lecture design	3.85 ± 1.03	34.54%

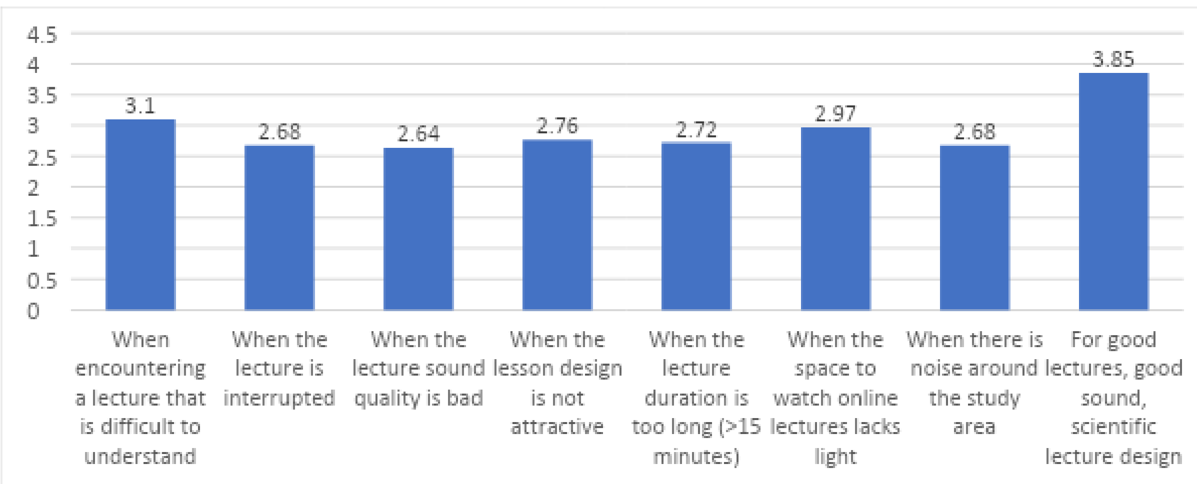

Figure 1: The level of influence of causes on students' concentration when studying online

Our study reveals that the majority of students (82.57%) occasionally experience distraction while attending online lectures (2.91 ± 0.86). There are various reasons that cause students to become distracted during online learning. Over 80% of students occasionally experience distraction due to surrounding noise, interruptions during lectures, unengaging lecture designs, lengthy lecture durations, and poor audio quality. Poor audio quality of lectures is identified as the most significant factor contributing to student distraction during online lectures, with an average score of 2.64 ± 1.02. Poor audio quality leads to much higher levels of distraction compared to encountering difficult-to-understand lectures (3.10 ± 1.09). The majority of students rarely experience distraction when engaging in high-quality, well-designed lectures with good audio (3.85 ± 1.03). This indicates that students face numerous distracting factors that hinder their concentration during online learning; however, this can be improved by enhancing the quality of lectures and implementing supportive solutions to help students focus better during online learning.

Students need to use the attention level analysis system when watching online lectures

Table 2: Students' Understanding of the Concentration Detection System in Online Learning

Content	Yes		No	
	n	%	n	%
Have you ever heard of systems that analyze concentration levels when studying online?	236	77.63%	68	22.37%

Have you ever used attention analysis systems when studying online?	254	83.55%	50	16.45%

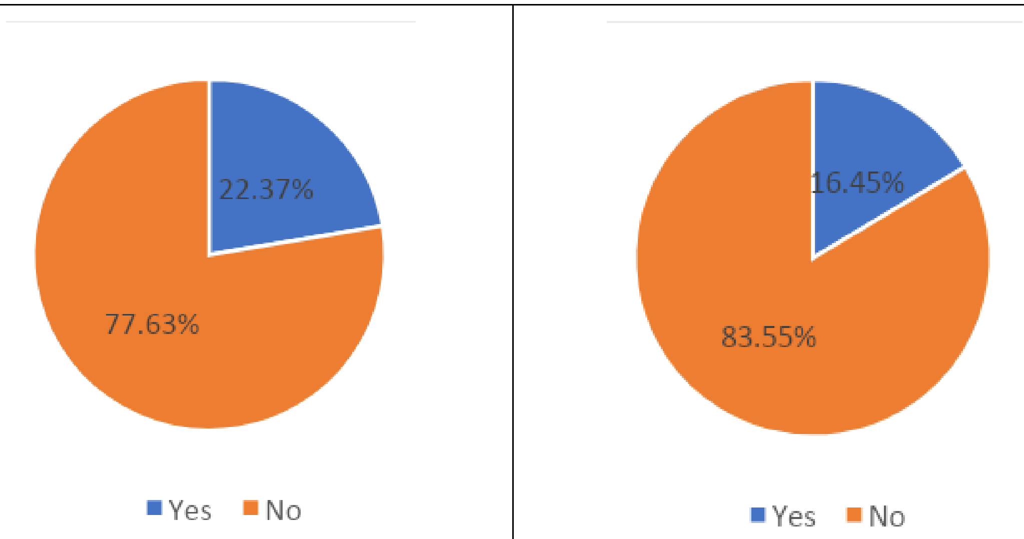

Fig. 2.1. Students' comprehension of the online learning concentration detection system.

Fig 2.2. Student utilization level of the concentration detection system in online learning.

Figure 2: Assessment of concentration detection system in online learning

Fig 2 indicates that the majority of students are unfamiliar with and have not utilized concentration detection systems in online learning, accounting for 77.6% and 83.6%, respectively. The number of students who have never heard of the system is 3.5 times higher (236/68) than those who have. Similarly, the number of students who have never used the system is more than 5 times higher (254/50) than those who have. This reflects students' limited understanding of concentration detection systems in online learning. Students have had few opportunities to interact with and utilize these systems to address issues of distraction during online lectures.

Despite the low awareness and usage of concentration detection system in online learning, our study reveals that most students desire a system for analyzing concentration levels while attending online lectures, with an average agreement rating of 3.82 ± 1.09 (Table 3.1). The demand for such a system among students is substantial. Therefore, it is imperative to propose the development of a concentration detection system for students during online lecture attendance, analyzing specific essential features of the system and the user acceptance level as a basis for testing, evaluation, deployment, and future application of the system.

Features desired with the system

Table 3: Students' desired level of necessary features of the system

Content	Mean± SD	Percentage of student agreement (%)
Students want a system to analyze concentration levels while watching online lecture	3.82 ± 1.09	66.45%
The system responds when students lose focus while watching online lectures	3.76 ± 1.07	63.16%
The system stores a history of your level of distraction	3.73 ± 1.01	62.50%
The system analyzes the influence of concentration/distraction on learning outcomes	3.81 ± 1.09	63.50%
The system has feedback on concentration levels using a specific scale	3.76 ± 1.07	64.80%
The system is integrated to remind students while they follow online lectures	3.69 ± 1.15	59.54%
Average student expectations for proposed features.	3.75 ± 1.10	62.70%

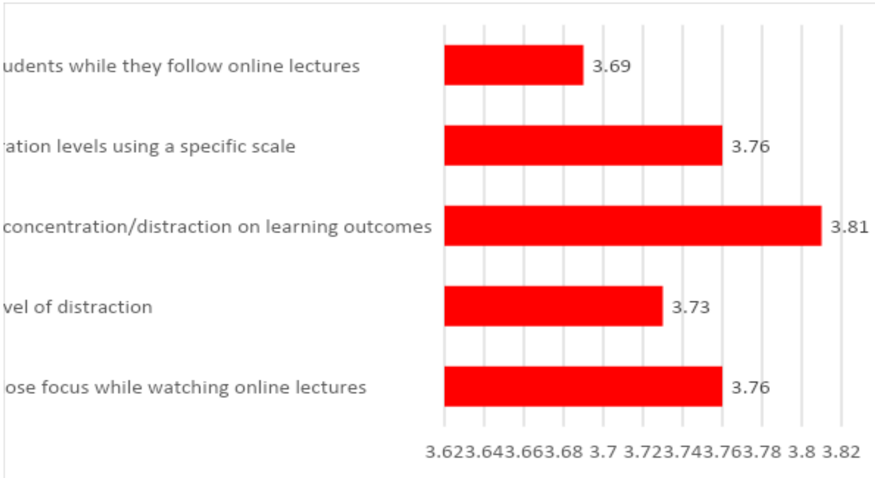

Figure 3: Student feedback on proposed system features

Through Table 3, the results indicate that the majority of students (62.70%) agree with all the proposed features of the system, with an average score of 3.75 ± 1.10. The level of desire among students for the system to provide feedback when they lose concentration during online lectures is equivalent to their desire for the system to provide feedback using specific metrics, both averaging 3.76 ± 1.07. The desire for the system to incorporate reminders for students during online lectures is the lowest, with an average score of 3.69 ± 1.15. This partly reflects students' concerns about the system infringing on their privacy rights. The desire for the system to analyze the impact of concentration/distraction levels on academic performance is the highest, with an average score of 3.81 ± 1.09. This demonstrates strong support from students for the system's feature of analyzing the impact of concentration/distraction levels on academic performance during online learning.

Additionally, our study synthesized some proposed additional features desired by students to further expand the necessary features of the concentration analysis system for students during online lectures that the research team previously proposed. Specifically:

The system should provide suggestions and support on how users can improve their concentration during learning.

The system should analyze the frequency of their distractions during different stages of the lecture.

The system should have summary dashboards after a period (weekly, monthly, annually) summarizing the quality of concentration during online learning, along with praise or advice.

Reminder notifications could be made fun, interesting, or humorous (like Duolingo).

There could be a "top learners" leaderboard for those who are least distracted during the week or month.

Based on the statistical data and student feedback collected, we have developed specific features for the concentration analysis system for students during online lectures (Table 4).

Table 4: Feature set of the student concentration detection system during online lectures

Functional requirements	Non-functional requirements
- Collect user data without disrupting the online learning process. - Notify users of their concentration status. - Identify most cases of lack of concentration, with the ability to update new cases. - Aggregate and analyze the concentration status of learners.	- The system does not affect the internet connection for the lesson. - The system can be used anytime, anywhere. - The system ensures the security of user information. - The system provides analysis and feedback to users immediately when they lose concentration. - Capable of high integration into online systems - The system must accurately reflect the user's concentration/distraction status.

Student acceptance of the system

Table 4: Student acceptance level of the system

Content	Mean ± SD	Percentage of student agreement (%)
Allowing the system to use the camera during online lectures	2.95 ± 1.10	30.27%
Allowing the system to display message notifications	3.63 ± 1.07	61.3%
Allowing the system to emit sound notifications	3.53 ± 1.08	53.60%
Allowing the system to store data on one's concentration level	3.50 ± 1.08	53.30%
Allowing the system to notify one's lack of concentration to the teacher during online classes	3.15 ± 1.13	38.48%
Allowing the system to notify one's lack of concentration to classmates during online classes	3.04 ± 1.22	36.19%
Average student acceptance level	3.30 ± 1.34	54.57%

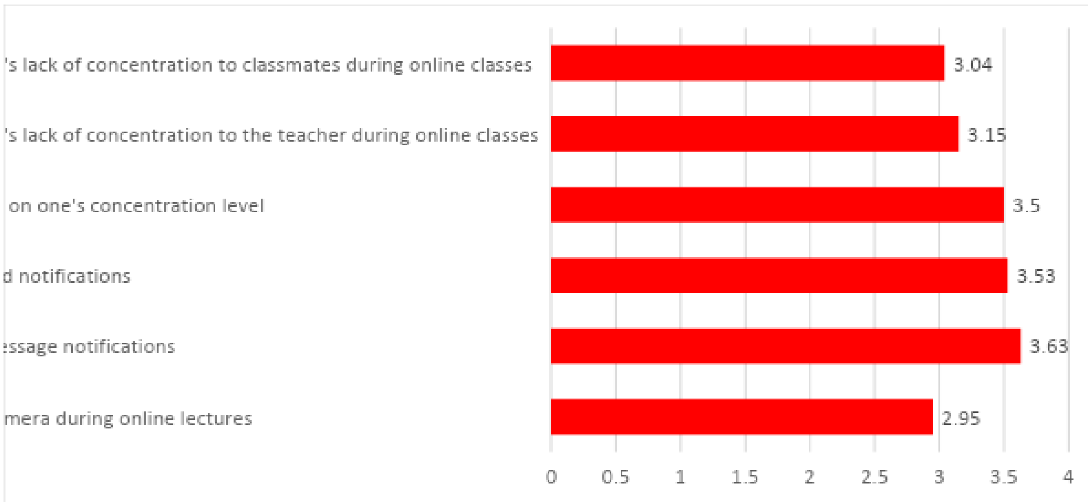

Figure 4 : Students' acceptance level when using the system

Our research reveals that the majority of students are in favor of the system's requirements, averaging a neutral score of 3.30 ± 1.34. Most students agree to allow the system to display message reminders, emit sound notifications, and store data regarding their concentration levels, with average scores of 3.63, 3.53, and 3.50, respectively. The majority of students have no objections to the system notifying their teachers or peers about their focus status during online lectures, or to the system's use of cameras during online class monitoring, with average scores of 3.15, 3.04, and 2.95, respectively.

However, significant discrepancies exist in students' acceptance levels for specific system requirements. The highest level of acceptance is observed for allowing the system to display message reminders (3.63 ± 1.07), which is 1.32 points higher than the acceptance level for allowing the system to use cameras for online lecture monitoring (2.95 ± 1.10). The proportion of students agreeing to message reminders is twice as high as those agreeing to camera usage and 1.7 times higher than those agreeing to the system notifying peers about their focus status during online lectures, and 1.6 times higher than those agreeing to notify teachers. This discrepancy reflects students' consideration of the impact of each system requirement on personal privacy rights.

System Feasibility

As mentioned in section 3 to evaluate the feasibility and the necessity of a concentration detection system in online learning environments, we surveyed the opinions of 22 lecturers teaching in the fields of information technology and educational technology. Regarding the first aspect, lecturers in information technology believe that the system can be fully implemented using computer vision technologies to track facial expressions, eye movements, and student expressions.

Regarding the second aspect, lecturers in educational technology unanimously agree on the necessity of the system. They emphasize that "by reminding learners, the system will contribute to enhancing the learning experience, reducing boredom, and improving learning outcomes."

CONCLUSION

In this study, we conducted a survey aimed at clarifying the cause of distraction during students' online learning. The results of the survey showed that about 82.57% of students participating in online lectures were influenced by objective factors such as background noise, sound quality of lectures, lighting, design of lectures, lesson content, and interruptions in the lecture transmission process. Additionally, despite the substantial demand for concentration detection systems among students participating in online learning, information about these systems remains limited, with over 70% of students unaware and over 80% of students never having used such systems during online learning. This presents a significant opportunity for the development and implementation of new educational technologies to improve the online learning experience and enhance teaching efficiency. Therefore, through surveying student opinions, we have proposed several important criteria that a concentration detection system must meet. This aims to support the development of more advanced educational technologies, thereby improving the effectiveness of online learning and creating a more positive learning environment for students. However, for a concentration detection system to be truly effective, it must be built and validated in the real-world environment of online learning. Moreover, validating the system in real-world settings will help identify its strengths and weaknesses, enabling adjustments and improvements to optimize its performance.

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