

Research on a Trustworthy Digital Learning Roll Call System

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Abstract

Since the New Coronavirus Pneumonia (COVID-19) outbreak in 2019, it has seriously threatened people's health, life, and lifestyle. As a result, universities and colleges worldwide have changed their teaching methods from physical to digital teaching. However, this digital teaching model has generated many problems that have never existed before. For example, how to effectively ensure student participation in learning and monitor student attendance. In particular, the reliability of the digital roll call results has been questioned by many. In order to understand the above problems and explore ways to improve, this paper organizes and analyzes a large number of literature and research materials and attempts to propose a specification of a trusted digital learning roll call system that meets expectations. We also propose a guideline for developing and implementing the trusted digital teaching system.

Keywords: Digital Roll Call System; Digital Teaching; Learning Management Systems (LMS)

1 Introduction

The digital roll call system refers to the ability to provide students with online sign-in, automatic, or manual roll call during teaching activities. This system can help teachers grasp students' attendance and absence in real-time. Teachers can use various roll call methods on the digital learning platform. In addition to the methods mentioned above, teachers can also use an APP with a roll call function to assist in obtaining students' attendance. The primary purpose of implementing roll call is to enable teachers to grasp students' attendance and un-

derstand their learning status instantly. In addition to being used as a reference for teaching design, it can also promote students' attendance and participation in learning and can be used as a reference for learning guidance.

From the observation of literature and practice, it is generally believed that the roll call implementation will help students attend and improve their learning effectiveness. Therefore, the roll call mechanism is regarded as one of the critical tasks of instructional design. Furthermore, scholars Zhu *et al.* [42], after comparing physical and online courses, believe that student attendance is positively related to improving students' performance. Their analysis of the literature found that many studies have shown that attendance and participation are the main factors affecting student learning outcomes [12, 17, 20].

Higher test scores and better test scores are often associated with higher or lower attendance levels [9]. Nieuwoudt's research pointed out that the most significant impact on learning achievement is the time students learn in digital learning systems [30]. Therefore, most teachers attach great importance to the attendance of students. Especially in digital teaching, in order to prevent students from being absent or lazy, thus reducing their motivation for learning and making their learning performance poor, roll call is listed as one of the teaching design items [1].

The roll call method has also developed from the traditional pen and paper login to the browser-based digital roll call. Digital teaching is being implemented in large numbers. How to give full play to the motivation of guiding students to participate actively and learn independently to improve the reliability of digital roll call is a research topic that needs to be discussed in depth at this stage.

2 Literature Review

2.1 The Relationship between Student Attendance and Learning Outcomes

From past literature, Rogers [32] and Golding [19] used observational methods to investigate the correlation between student attendance and performance, and their findings were positive. Other experimental studies have pointed out that a clear attendance policy can improve student attendance and achievement [40]. Westerman *et al.* argue that attendance represents a particularly effective measure of behavior and an important factor affecting performance. After studying the relationship between attendance and performance in business management higher education classrooms, they found that attendance was positively correlated with test scores; the negative impact of absenteeism was more pronounced for lower-performing students than for higher-performing students; absence was associated with The cumulative average grades of students showed a negative correlation [38].

Most other studies on the relationship between attendance and academic performance have shown a strong relationship between student attendance and test scores. Scholars such as Brokowski & Dempsey [4], Chan *et al.* [6], Cohn & Johnson [10], and other scholars all believe that a mandatory attendance policy significantly reduces the absentee rate and improves students' test scores. Cohn & Johnson [10] compiled five-year student absence data in a higher education institution and found that the relationship between student attendance and learning performance was consistent throughout the five years. The above literature shows a significant relationship between students' learning effectiveness and attendance rate; the higher the attendance rate, the better the academic performance—conversely, the lower the attendance rate, the worse the learning effect. The research on the relationship between attendance rate and learning effectiveness is summarized in Table 1.

In order to understand whether there are differences in the attendance rate and test scores of students in different courses, Fadelelmoula [15] analyzed the impact of students' class attendance on their final exam scores in four courses in the second semester of the 2016-2017 academic year at Almaarefa College. Attendance in these courses is mandatory, and students must be above 75% attendance to sit for final exams. The study results found that attendance rates for all courses were positively correlated with final exam scores. In addition, Corbin *et al.* [11] found that students who regularly participated in class achieved higher scores in exams. Finally, Thomas & Higbee argue that although the strength of the relationship between attendance and test scores is debated, observations have shown a positive correlation between classroom attendance and student performance across multiple disciplines, including science, mathematics, physics, psychology, and information technology [36].

2.2 Reasons for Student Absenteeism Behavior

The above literature showed that "students' attendance rate in class is positively correlated with test scores". Student absenteeism has come under the spotlight since Covid-19 sparked a flood of online classes. Many scholars try to find out the reasons to find a solution to the problem. Huimin *et al.* [23] reviewed the literature and stated that autonomous motivation, controlled motivation, self-efficacy, and teaching quality are critical factors for college students to participate in courses. When any of the four factors is weak, students' motivation to participate is also low. Bulach [5] and Ghosh *et al.* [18] pointed out that students' trust in digital learning courses is an essential factor affecting their participation in courses. Trust in digital learning is defined as "the degree to which students are willing to rely on digital learning systems and how teachers or educational institutions take adequate measures to help students increase their confidence in using digital learning systems [5, 18]. Students' confidence in the digital learning management system, including the trust of teachers and schools, can influence attendance. In addition, students' trust in a teacher determines how students are willing to accept the teacher's teaching [39]. Therefore, trust is also a necessary condition for achieving good learning outcomes.

In addition to the viewpoints in the above literature, there are many reasons for college students to miss classes. For example, course type, learning motivation, number of students, influence by peers, class time, teacher factors, etc. [16]. Devadoss & Foltz [13] believe that students miss classes for various reasons. Absenteeism is a significant problem for many higher education institutions and a primary concern for educators. The study points out that two factors contribute to absenteeism: Background factors, such as learning patterns, background, employment, and the practicality of course content. The other is behavioral factors, including attitudes to participating in learning and personal characteristics [33]. Blerkom pointed out that the most common reasons cited by students for absenteeism were boredom, illness, clashing with other classes, or social activities [2]. The results of Chenneville and Jordan [7] showed that the reason for absenteeism is that many college students do not fully understand the impact of absenteeism on their grades. Bond [3] pointed out that students' participation in the classroom is affected by factors such as teachers, curriculum, technology, family, peers, and individuals. It can be seen from the above literature that scholars have different views on the reasons for college students' absenteeism. These articles are summarized in Table 2 according to the literature.

2.3 Related Research on Digital Roll Call Systems

In recent years, due to the impact of Covid-19, with the change from face-to-face to online teaching, the re-

Table 1: Research on the relationship between attendance rate and learning effectiveness

Research Scholars	Research Results
Zhu <i>et al.</i> [42]	The degree of rigor with which teachers set attendance and achievement standards is positively associated with improved student attendance and performance.
Gump [20], Dalelio [12], Gbadamosi [17]	Attendance and classroom participation are significant factors that affect student learning outcomes.
Clump <i>et al.</i> [9]	Higher test scores are often associated with higher or lower attendance rates.
Nieuwoudt <i>et al.</i> [30]	The most significant impact on learning achievement is the time students spend on the digital learning system.
Rogers [32], Golding [19]	The correlation between student attendance and academic performance is positive.
Westerman <i>et al.</i> [38]	Attendance rates are positively correlated with test scores. The negative impact of absenteeism was more pronounced for lower-performing students than for higher-performing students. Absence was negatively correlated with the student's cumulative performance average.
Brokowski & Dempsey [4], Chan <i>et al.</i> [6], Cohn & Johnson [10]	Mandatory attendance policies have significantly reduced absenteeism and improved student test scores.
Cohn & Johnson [10]	The relationship between student attendance and academic performance remained consistent over the five years.

Table 2: Reasons for college students' absenteeism

Research Scholars	Reasons for Students' Absenteeism
Huimin <i>et al.</i> [23]	Autonomous motivation, controlled motivation, self-efficacy, and teaching quality are critical factors for college students to participate in courses.
Bulach [5] and Ghosh, <i>et al.</i> [18]	Students' willingness to use digital learning management system factors, including teachers' and schools' trust, will influence attendance.
Wooten & McCroskey [39]	The student's trust in the teacher determines the degree to which the student is willing to accept the teacher's teaching.
Friedman <i>et al.</i> [16]	There are many reasons for college students to miss classes. For example, course type, motivation to learn, number of students, exposure to peers, class time, and teacher characteristics.
Sawon <i>et al.</i> [33]	Two factors cause absenteeism: First, background factors—for example, study mode, the background of origin, current employment, and practicality of course content. The second is behavioral factors, including attitudes toward participating in learning and personal characteristics.
Blerkom.[25]	The most common reasons students cited for absenteeism were boredom, illness, running with other classes, or attending social events.
Chenneville & Jordan. [7]	Reasons for truancy: Many college students do not fully understand the impact of truancy on their grades.
Bond. [3]	Student engagement in the classroom is influenced by teachers, curriculum, technology, family, peers, and individuals.

liability of digital roll call has become an issue that schools and teachers want to break through. Many studies have shown that in implementing digital teaching, although teachers use a variety of roll-call methods, each roll-call method has advantages and disadvantages [8, 14, 21, 22, 24–29, 31, 34, 35, 37, 41]. For example, scholars Tigang & Xiaodan [35] surveyed the current stage of university education. They concluded that teachers commonly use the following types of roll call methods: verbal roll call, sign-in or login, fixed seat mapping, online homework, photographing, fingerprint recognition, face recognition, blueprint Bud scanning, radio frequency identification (RFID), application software (APP), and QR code, and other methods.

Othman *et al.* [31] pointed out that the traditional approach is time-consuming, error-prone, and risks losing records. Thanks to the development and advancement of various networks, recording and reporting student attendance can already be fully automated. For example, the Interactive Student Attendance Management System (ISAMS) records student attendance through barcode scanning. The interaction of students and lecturers or the transfer of files can also be processed instantaneously [26], thus simplifying the process of attendance [22]. Long and Hao [27] proposed using visual programming (VB) to develop a roll call function software that randomly selects a student for roll call. And the roll call results will be automatically saved to the Excel table. It can make the final statistical work more accessible and more interesting, but it can also significantly reduce the burden on teachers. Islam *et al.* [24] designed an android application to collect student attendance and store it in a database. This attendance record is then emailed to students and parents. However, teachers still have to manually mark students' attendance records and store their roll call results in the database, consuming time and effort [29].

Mittal *et al.* [28] believe that the traditional online roll call may be replaced or fraudulent, whether it is student login, manual check-in, or scanning ID. Jayant and Borra [25] proposed the concept of a cloud intelligent roll call system. Feature detection and face recognition using the Viola-Jones object detection framework. But according to the actual measurement, the accuracy is only about 40% [28]. Chintalapati & Raghunadh [8] and Dongliang [14] proposed to combine face detection and face recognition to achieve more accurate roll call accuracy.

Many other scholars [37, 41] proposed the concept of combining Radio Frequency Identification (RFID) and the Internet of Things (Internet of Things, IoT) for online roll call. If RFID and IOT are combined and cloud storage is used, the read data can perform better [34]. For example, Guohui & Ruisheng [21] proposed an IoT service architecture consisting of five units, including users, RFID tags (Tag) attached to places and objects, RFID reading of mobile devices, internet, and back-end system. These units constitute an accurate digital roll call system.

2.4 Comprehensive Summary and Analysis

Based on the viewpoints of the above literature, the digital roll call system generally used by teachers of various universities at present can achieve the purpose of roll call. Still, it has different advantages and disadvantages regarding correctness and efficiency (as shown in Table 3). The selection of the appropriate roll-call method must be based on the organization's environmental planning and facilities and equipment as the basis for selecting the roll call method.

We can find from Table 3 that although the traditional oral roll call method is time-consuming and troublesome, it is the most accurate and reliable and can achieve the purpose and function of roll call. The roll call method of barcode scanning can simplify the roll call process and process the interaction between teachers and students or file transfer in real-time. The implementation process is simple and convenient, but individual scanning and manual inspection are required, and it is difficult to prevent students from cheating or replacing. Using visual programming (VB) software for roll call has the advantage that the roll call results will be automatically stored in an Excel table and can also be automatically counted at the end of the period. Still, they can only be randomly selected and cannot be used for simultaneous roll calls by multiple people, which is the most significant disadvantage. The way to use the android application to collect student attendance, the attendance record will be emailed to students and parents for the record. But teachers still have to manually mark students' attendance records and store the results in the database, wasting time and effort. The advantages of face detection and face recognition roll call are convenient, fast, time-saving, and not accessible for students to impersonate or replace. The disadvantage is that the recognition effect is affected by resolution and face changes, resulting in recognition errors. There is also the issue of student privacy. The roll call system combining RFID and IoT has the advantages of convenience, speed, and time-saving, and students are not easy to impersonate or replace. However, it is susceptible to interference or contamination, resulting in reading failures.

3 Results and Discussion

3.1 Advantages and Disadvantages of Digital Roll Call System

Due to the impact of Covid-19, the type of teaching has changed from face-to-face to digital courses in a hurry. How to correctly, effectively, and quickly make remote roll calls has become a research topic everyone is concerned about. Many scholars have invested in research, hoping to find the best method. In this paper, through various literature discussions and research results, the existing system does not have a convenient and effective roll call system,

Table 3: Comparison of different digital roll call systems

Roll calling methods	Advantages	Disadvantages
Verbal roll call [31, 35]	Accurate, reliable, and students cannot impersonate or cheat.	Time-consuming, hassle, and delays in-class time.
Barcode Scanning [22, 26]	Simplify the roll call process and handle real-time teacher-student interaction or file transfer.	Individual scans and manual inspections are required, making it challenging to prevent student fraud or impersonation.
Using Visual Programming (VB) software [27]	The roll call results will be automatically saved in an Excel spreadsheet. The student attendance rate can be automatically counted at the end of the semester.	The software can only randomly select one person but is not used for multiple people to take roll calls simultaneously.
Using an android app to collect student attendance [24]	Attendance records are then emailed to students and parents.	Teachers still have to manually mark students' attendance records and store the results in the database.
Feature detection and face recognition using the Viola-Jones object detection framework [25, 28]	Convenient, fast, time-saving, and not accessible for students to impersonate.	The recognition effect is affected by the resolution and face change, causing errors. There are also privacy concerns.
Combining face detection and face recognition [8, 14]	It can achieve the accuracy of roll call more accurately, conveniently, and quickly, save time, and it is not easy for students to impersonate.	The recognition effect is affected by the resolution and face changes caused by errors. There are also privacy concerns.
A roll call system combining RFID and IOT [21, 34, 37, 41]	Convenient, fast, time-saving, efficient, and not easy to an impostor.	Vulnerable to interference or smears, causing read failures.

is fast, and can prevent fraud. However, no matter which roll-call method is adopted, it has its shortcomings. Some roll call methods are fast and convenient but lack accuracy. Some roll call methods require additional software or hardware to perform. The common disadvantage of all roll call methods is that the roll call system cannot prevent fraud entirely.

3.2 Study Limitations

- 1) The literature sources collected in this article are mainly monographs, academic studies, journal papers, seminar papers, and Internet articles. However, since the practice has not been implemented, there are inevitably some omissions in the integrity of the data. Thus the research results cannot be used as comprehensive inferences.
- 2) From the literature, it is found that some views and designs are the author's conception, lack verification by empirical research, and it is not easy to judge their practicality.
- 3) This article only discusses the methods and effects of digital roll call. In addition, these studies only focus on the results of establishing a digital roll call mechanism and have not discussed more important administrative support, such as roll call policy, roll

call system, software and hardware equipment, and information technology training for teachers.

3.3 Suggestions for Future Research

In response to the problems described in Subsection 3.2, it is suggested that we can add digital roll call methods such as practical observation and in-depth interviews to the research on related topics to understand the situation of implementing digital roll calls at the teaching site. At the same time, the roll call policy, roll call system, software and hardware equipment, and information technology training for teachers are included in the research scope to make the research results more complete.

The following are evaluation criteria for good and trusted digital learning roll call system:

- 1) Correctness: Accurately roll call classroom students to avoid impostors.
- 2) Privacy: Only students and lecturers know about the roll call behavior. Students or others not in the class cannot infer whether other students are present in the course.
- 3) Efficiency: The shorter the roll call time, the better it cannot affect class time.
- 4) Equipment: No additional hardware or software equipment is required. Many students own and use

mobile phones, so it is acceptable to use mobile phones or tablet computers as a trusted digital learning roll call system user device. Developing and using APP software is necessary, but students install the APP only once, not every class.

- 5) Verifiability: Attendance information must be carefully preserved. If future students doubt that the information is correct, there needs to be a mechanism to verify it.
- 6) Statistics and notification: Statistics students' attendance rate and notify students of attendance information.

How to develop a trusted digital learning roll call system that meets the above evaluation criteria is a future essential research topic.

4 Conclusion

The digital roll call aims to make up for the sense of alienation between teachers and students because they are located in different places. And promote students' active participation and active learning in order to achieve teaching goals. Therefore, digital roll call is essential when implementing digital course activities. This paper aims to explore the reliability of digital roll call and find a correct and effective roll-call method through the sorting and analysis of various literature.

The study results found that no matter how digital roll call was performed, satisfactory results could not be achieved. Accordingly, this paper proposes the viewpoint of "integrating roll call into teaching content". That is to say, teachers incorporate roll call into teaching activities in teaching design and use lively and interesting real-time question and answer, asking students to share exciting life stories, problem-solving experience, views on cases, etc., to replace the rigid and severe roll call process. This technique of making the name invisible can make the course more vivid and achieve the purpose of the roll call. It is a method of roll call that teachers and students are willing to accept.

Finally, we propose some evaluation criteria for designing an excellent and trustworthy digital learning roll call system. Future research must develop a trusted digital learning roll call system that meets these evaluation criteria.

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Biography

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