



Automated Control and Delivery System for Science Practical Instructions to Public Schools

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Abstract

Background. The dispatch of practical instructions to schools and supervisors before the actual conduct of the practical examination over the years has not received the same level of attention as given to the movements of people and goods and, therefore, is prone to challenges. However, the process could be automated using artificial intelligence. Previous studies have investigated the effects of automation on the control and delivery of goods in the transport management sector.

Objectives. This study assessed science teachers' challenges and readiness for automated practical instruction control and delivery systems.

Materials and methods. The study adopted an ex post facto design and recruited one hundred science teachers. Science Teacher Readiness for Automated Practical Instruction Control and Delivery ($r = 0.83$) was used to collect data, which were analysed descriptively.

Results. There are more male (73%) science teachers than female (27%). 84% of the respondents listed cost as one of the challenges, and 83% indicated resistance to change and technical difficulties, ethical issues (67%), and integration with the existing system (65%). The science teachers are moderately ready (64%). In comparison, 24% are lowly ready, and 12% are highly prepared to deploy an automated practical instruction control and delivery system.

Conclusion. Automation for delivering practical science instructions has more significant benefits than the manual method; however, science teachers are ready for its deployment despite its challenges. Therefore, efforts should be geared towards overcoming the inherent difficulties so that the benefits can be thoroughly enjoyed.

Keywords: automation, artificial intelligence, science teachers, practical instructions, readiness and delivery system.

Introduction

Premium value have been put on practical works in the field of science; chemistry, physics, data processing, food and nutrition, animal husbandry, agricultural science, basic electronics, basic electricity and biology among others by education stakeholders. Many works have indicated importance of practicals to include development of laboratory competence and science knowledge, appreciating scientific concepts and theories (Schwchow, Zimmerman, Croker & Hartig, 2016; Fadzil & Saat, 2013). Students achieve a deeper level of understanding by finding things out for themselves and by experimenting with techniques and methods that have enabled the secrets of our bodies, our environment, and the whole universe – to be discovered. Practical help to promotion of students' positive attitudes and enhancement of motivation for effective learning in science (Okam & Zakari, 2017).

With a consequent effect, students' academic achievement can be influenced by positive attitude toward the importance of practical work (Hinneh, 2017).

The goals of practical work are to improve students' understanding, develop their skills in solving problems and understanding the nature of science, by replicating the actions of scientists. Sotiriou, Bybee and Bogner (2017) state that: "While solving a scientific problem, students should act like a scientist and follow scientific processes." Practical work can motivate students, stimulate their interest in teaching and learning, enhance the learning of scientific knowledge, give them experience in using scientific knowledge and widen their way of thinking. Several reasons exist for taking practicals in science subjects in schools. For some it is to encourage accurate observations and descriptions, for others, it is to change theories into real-life application, to keep the interest of students in scientific studies and promote a logical and reasoning method of thought. In fact, practical work helps to improve students' scientific knowledge (Ajeyalemi, 2011).

The study of all scientific subjects (chemistry, physics, and biology) placed vital role on experiments in laboratories. However, Abrahams and Millers (2008) were of different views of teaching domiciled in the laboratories. Laboratory-based teaching is an inefficient teaching method and cannot represent scientific inquiry properly, were some of the demerits mentioned that direct lecturing should have been taught. Also, practical work create rote learning where students only adhere to teachers' instructions and they do not need to be creative or think to process the information.

Despite the importance of practical examinations and the preceding practical instruction delivery to schools, the control and delivery system is poor. This is made evident by late dispatch of the instruction forms, late or non-delivery of forms to the supervisor by staff at the custodial point, loss / non-delivery of forms to the schools by the supervisors and delivery of forms to unauthorized persons by the supervisors. Meanwhile, delivery of essential goods and services like practical instructions is vitally important for smooth conduct of respective practical examinations in those subjects. This presupposes that a novel control and delivery system be introduced to dispatch practical instructions to schools and supervisor. Observably, the use of portal (automated practical instructions control and delivery system) seems to be effective for control and service delivery. However, the readiness by the school science teacher is another area that needs exploration.

A portal (automated practical instructions control and delivery system) is a platform that could be accessed and interacted with by authorized users (school representatives, administrator user and staff agents). The portal will hold the instructions in electronic format securely until the preset time for access by the verified users. A prepared electronic message is dispatched to the school reps using their pre-registered information taken while registering on the portal once initially set timing conditions are triggered. The instructions can thereafter be downloaded by the school reps in time for adequate preparations for the examinations.

While Ubulom and Wokocho (2017) advanced the need for the introduction of CBT in Nigerian education system as necessary for the elimination of impersonation, special centres and cheating, the reality on ground is a far cry from what they advocated for. Faster dispatch demands by E-commerce clients are on the increase with attending service quality. These changes driven by e-commerce has brought business opportunities to the logistics service providers, especially couriers handling parcel and goods delivery to each customer's home quickly and reliably in small batches (Jinadu, Oyaremi and Rufai, 2021).

Changes in techniques and number of examination centres make it more challenging than ever to manage practical instructions in a fast, simple and secure way. This calls for introduction of a technology-based control mode into the delivery system of practical instructions to schools called automation or better put artificial intelligence AI. Artificial intelligence refers to the field of computer science that involves creating computer programs capable of imitating intelligent behavior and ideally enhancing human-like abilities (Naqvi, 2020). Artificial intelligence, a swiftly expanding discipline, encompasses the development of intelligent robots capable of emulating human thought processes and actions, finding utility in diverse areas such as medical diagnosis, self-driving cars, and educa-

tion where delivery of practical instructions to schools can be automated (Wardat, Tashtoush, AlAli & Jarrah, 2023).

Automation is the technology by which a process or procedure is accomplished without human assistance. It is implemented using a program of instructions combined with a control system that executes the instructions. To automate a process, power is required, both to drive the process itself and to operate the program and control system. Although automation can be applied in a wide variety of areas, it can be applied to dispatch practical instruction manuals as it is proposed in this automated practical instruction development.

Automated practical instruction control and delivery system is a portal that could be accessed and interacted with by authorized users (school reps, admin user and staff agents). The portal will hold the instructions in electronic format securely until the preset time for access by the verified users. A prepared electronic message is dispatched to the school reps using their pre-registered information taken while registering on the portal once initially set timing conditions are triggered. The instructions can thereafter be downloaded by the school reps in time for adequate preparations for the examinations. The dates (timing) of the papers are set and the instructions are uploaded onto the portal by the staff agents. School Reps create their profiles with which they gain access to the portal to download the instructions exactly from date assigned (at least two weeks) to the conduct of the examination.

In an automated delivery system, the user can transmit instructions for the robot to go to two distinct workstations. At the first workstation, it retrieves an object, and at the second, the robot delivers this object. The user is given a simple program that asks for two workstation numbers. This information is then sent out through the PC's serial communications port, and through an IR transmitter, for the robot to detect. From the foregoing, it is logical to state that automated practical instruction control can affect delivery system of practical instructions because AI powered tools in educational assessment can be beneficial in various ways, including enhancing the assessment process's accuracy, speed, and efficiency such as assessment process involving practical instruction delivery to school. However, there seems to be a prominent challenge likely to be associated with using the said automation which is teachers' readiness.

The lack of stakeholder participation in developing AI tools for education can be a significant challenge in AI adoption. When AI tools are developed without input from educators, students, parents, and other stakeholders, the resulting tools may not be tailored to the specific needs of the education system. This can lead to a lack of relevance or adoption of AI tools in classrooms. According to Luckin and Cukurova (2019), developers of AI have limited knowledge about learning sciences and insufficient pedagogical understanding for the successful integration of AI into teaching. Consequently, AI developers frequently overlook the expectations of teachers, who are the end-users of AI in education (Cukurova & Luckin, 2018). Teachers are highly important in AI-based teaching (Seufert, Guggemos & Sailer, 2020; Jinadu & Balogun, 2020) therefore, it is essential to take their opinions, past experiences, and expectations into account to ensure the successful integration of AI in schools (Holmes, Bialik & Fadel, 2019).

The movement of practical instructions to schools and supervisor occurs in every examination period. However, such

movements have not received the same level of attention as that given to the movements of people, goods and freights. The cutting list (instruction to schools and supervisors) for such papers are packaged and dispatched to the various schools offering the respective subjects in most cases two (2) weeks before the scheduled time of the actual examination. This is to ensure the smooth conduct of the examination by affording the schools the opportunity to make available all items required for the various experiments to be carried out. These instructions are currently processed and dispatched to participating schools manually. The supposed movement of the practical instructions is hampered with a lot challenges in terms of late dispatch, late delivery, non-delivery or wrong delivery to unauthorised persons. Other disadvantages of the traditional delivery system such dispatch cost of the practical instruction papers borne by the examination bodies and allowances for custodians, coordinators, collators and other staff.

This process as described could be automated to maximize resources as well as cater for the inefficiencies that could arise from human errors. This is purely a case of artificial intelligence where computer is charged a task meant for human being. Previous software developments have investigated the effect of automation on control and delivery of goods in transport management sector. Others have investigated the automation of people and freight management in the western world. How the automation can be adapted to improve the delivery system of practical instructions to schools and supervisors needs to be investigated. It is imperative and believed that a portal designed for such transition can ease the delivery whereby it will be accessed and interacted with by authorized users such as school representatives, administrator user and staff agents. The portal will hold the instructions in electronic format securely until the preset time for access by the verified users. It is against this background that this study assessed science teachers' readiness for automated practical instructions control for delivery system.

The study will provide answers to the following questions:

What is the profile of science teachers in Oyo state?

What are the challenges inherent in the deployment of automated practical instruction control and delivery?

What is the level of readiness of science teachers for deployment of automated practical instruction control and delivery?

Materials and methods

Study Participants

The study used ex-post facto design. This design became necessary because it allowed the researchers to collected data as they are supplied. The target population for this study comprised all science teachers in public schools in Oyo state Nigeria. Multi-stage sampling procedure was adopted to select sample. Oyo state has ten educational zones. In the first stage, simple random sampling was used to select five zones out of the ten zones in the state. In the second stage, simple random sampling was used to select five schools each from the selected zones. In the third stage, simple random sampling was used to select four teachers each from each of the school chosen making one hundred teachers that participated in the study.

Study Organisation

Science Teacher Readiness for Automated Practical Instruction Control and Delivery (STRAPICS) was used to collect data. STRAPICS was developed by the researcher to measure science teachers' challenges and readiness for automated practical instruction control and delivery. It consists of two sections A, B and C. Section A sought participants' demographic information, Section B is on challenges of deploying automated practical instruction control and delivery and section C is on science teachers readiness for deploying automated practical instruction control and delivery. The initial scale thirty four items where participants were asked to select as it applies to them. These items were subjected to pilot testing using teachers who were not part of the final sample for the study.

Statistical Analysis

The content validity was established by given the draft to psychometricians and other test item developer experts. To determine the reliability of the instrument, the internal consistency of the scale was obtained using Chronbach's Alpha which yielded a value of 0.83. The researcher monitored the data collection exercise. Frequency count and percentage were used to analyse the data. The issue of ethical consideration was observed by ensuring that the participants were free to respond without cohesion. They were also free to withdraw from participation in the research exercise at any stage where they feel uncomfortable with the process. Their identities were protected from any unforeseen or potential danger in line with data protection and governance as entrenched by the Nigeria Communication Commission (NCC) of the Federal Ministry of Community and Digital Economy policy, as they were taken as anonymous by not requesting or recording their identities. And lastly, the data collected were treated with confidentiality and solely for research purpose only.

Results

Research Question 1: What is the profile of the science teachers in Oyo state?

Table 1. Profile of Science Teachers in Oyo State

Variable	Frequency	Percentage
Age		
Below 40 years	40	40.0
41-50 years	47	47.0
51-60 years	13	13.0
Total	100	100.0
Gender		
Male	73	73.0
Female	27	27.0
Total	100	100.0
Area of Specialisation		
Agricultural science	25	25.0
Biology	25	25.0
Chemistry	25	25.0
Physics	25	25.0
Total	100	100.0

Table 1 shows the descriptive statistics of the profile of the respondents (science teachers in Oyo state). The result revealed that 47 (47%) of the teachers in Oyo state are between 41-50 years of age, 40 (40.0%) are below 40 years of age and 13 (13%) are 51-60 years of age. Of these age brackets, 73 (73%) are male and 27 (27%) are female science teachers. 25 (25%) each of the respondents are teachers for the Agricultural science, Biology, Chemistry and Physics.

Research Question 2: What are the challenges inherent in the deployment of automated practical instruction control and delivery?

Table 2. Challenges of Deploying Automated Practical Instruction Control and Delivery

S/N	Challenges	Very sure	Sure	Not sure	Unsure
1	Cost	84 84%	-	16 16%	-
2	Resistant to change	83 83%	-	1 1%	16 16%
3	Technical difficulties	83 83%	-	16 16%	1 1%
4	Integration with existing system	65 65%	1 1%	16 16%	18 18%
5	Ethical issue	67 67%	16 16%	16 16%	1 1%

Table 2 presents the challenges inherent in the deployment of automated practical instruction control and delivery system. The table revealed that 84 (84%) of the respondent indicated that very sure cost is one of the challenges, and the remaining 16 (16%) indicated not sure to the statement to the same statement. 83 (83%) of the respondents indicated that very sure many science teachers are resistant to change and the remaining 17 (17%) indicated not sure to the statement. The table also shows that 83 (83%) responded that very sure technical difficulties is another challenge for deployment of automated practical instruction control and delivery system and 17 (17%) indicated not sure to the statement. 67 (67%) indicated very sure ethical issue is another challenge and 16 (16%) indicated not sure to the same statement. Also, 65 (65%) of the respondents indicated that very sure integration with existing system is yet another challenge as against 16 (16%) of the respondents who indicated not sure to the same statement.

Research Question 3: What is the level of readiness of science teachers for deployment of automated practical instruction control and delivery?

Table 3. Readiness of Science Teachers for Deploying Automated Practical Instruction Control and Delivery System

S/N	Level	Frequency	Percentage
1	Low	24	24.0
2	Moderate	64	64.0
3	High	12	12.0
4	Total	100	100.0

Table 3 shows the level of readiness of science teachers for deployment of automated practical instruction control

and delivery. The table revealed that 64 (64%) of the science teachers are moderately ready for the deployment of automated practical instruction control and delivery system while 24 (24%) are lowly ready and 12 (12%) are highly ready despite the prevailing challenges for the deployment.

Discussion

Result on the profile of the respondents (science teachers in Oyo state) revealed that 47 there more teachers who are between 41-50 years of age than below 40 years of age and 51-60 years of age. Of these age brackets, there more are male than female science teachers. The finding on the challenges inherent in the deployment of automated practical instruction control and delivery system revealed that many of the respondent indicated that very sure cost is one of the challenges, and the remaining indicated not sure to the statement to the same statement. The table also shows that more responded that very sure technical difficulties is another challenge for deployment of automated practical instruction control and delivery system and few indicated not sure to the statement. Many indicated very sure ethical issue is another challenge and few indicated not sure to the same statement. Also, many of the respondents indicated that very sure integration with existing system is yet another challenge as against few of the respondents who indicated not sure to the same statement.

The finding of this study is in tune with that of Luckin and Cukurova (2019) who reported that developers of AI have limited knowledge about learning sciences and insufficient pedagogical understanding for the successful integration of AI into teaching. Consequently, AI developers frequently overlook the expectations of teachers, who are the end-users of AI in education. These are sure challenges of implementing automation in school system.

The result on the level of readiness of science teachers for deployment of automated practical instruction control and delivery revealed that majority of the science teachers are moderately ready for the deployment of automated practical instruction control and delivery system while some are lowly ready and few are highly ready despite the prevailing challenges for the deployment. The result of this study corroborates that of Seufert, Guggemos & Sailer, (2020) who found out that teachers are highly important in AI-based teaching and learning process and therefore essential to take their readiness for advancement of artificial intelligence in schools to higher level. Therefore, their opinions, past experiences, and expectations must be taken into account to ensure the successful integration of AI in schools.

Conclusions

The use of automation in science practical instruction delivery and education, in general, has benefits over manual delivery, as seen by the science teachers in Oyo state battle ready for its deployment despite the challenges beset it as espoused in the discussion. This implies that whenever the public examination bodies are set to deploy automated practical science instruction to schools and supervisors, the science teachers are ready to adopt it. It is therefore recommended that efforts be geared towards overcoming the inherent

challenges like making automation less costly, creating more awareness of the benefit of AI, and securing data protection, among others, so that the benefits can be fully enjoyed. Also, science teachers who are highly ready for automation should be motivated. In contrast, moderately and lowly-ready others should be encouraged to avert the shortcomings of manual delivery and adopt the global best practices.

Conflict of interest

There are no conflicts of interest whatsoever.

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Автоматизована система контролю та доставки наукових практичних інструкцій для державних шкіл

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 6 с., 3 табл., 17 джерел.

Історія питання. Розсилка практичних інструкцій школам і керівникам перед фактичним проведенням практичного іспиту протягом багатьох років не приділяла такого ж рівня уваги, як переміщенню людей і товарів, і, отже, схильна до про-

блем. Однак процес можна автоматизувати за допомогою штучного інтелекту. У попередніх дослідженнях вивчався вплив автоматизації на контроль і доставку вантажів у секторі управління транспортом.

Цілі. У цьому дослідженні оцінювалися проблеми та готовність учителів природничих наук до автоматизованих систем контролю та проведення практичних інструкцій.

Матеріали та методи. У дослідженні був прийнятий дизайн постфактум і залучено сто вчителів природничих наук. Готовність вчителя природничих наук до автоматизованого контролю та проведення практичних інструкцій ($r = 0,83$) використовувалася для збору даних, які аналізувалися описово.

Результати. Вчителів природничих наук чоловіків (73%) більше, ніж жінок (27%). 84% респондентів назвали вартість однією з проблем, а 83% вказали на опір змінам і технічні труднощі, етичні проблеми (67%) та інтеграцію з існуючою системою (65%). Вчителі природничих наук помірно готові (64%). Для порівняння, 24% мають низьку готовність, а 12% – високу готовність розгорнути автоматизовану систему контролю та надання практичних інструкцій.

Висновок. Автоматизація надання практичних наукових інструкцій має більш значні переваги, ніж ручний метод; однак вчителі природничих наук готові до його впровадження, незважаючи на труднощі. Таким чином, зусилля повинні бути спрямовані на подолання притаманних труднощів, щоб можна було повною мірою насолоджуватися перевагами.

Ключові слова: автоматизація, штучний інтелект, викладачі природничих наук, практичні інструкції, система готовності та доставки.

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