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# Students' feedback on the use of low-cost, portable and safe hands-on tools in teaching and demonstrating noise pollution at a historically black university (HBCU)

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**ABSTRACT**

*Dynamism of using pedagogy to teach concepts related to noise engineering at undergraduate level can fuel leaners desire to find a career opportunity in the field. This study aimed to investigate the impact of low-cost, portable, and safe hands-on tools used in teaching and demonstrating noise pollution at a historically black university (HBCU). The study was conducted among undergraduate students at one HBCU, and feedback was obtained regarding the device and the pedagogy using a 5-scale Likert questionnaire. The purpose of the study was to improve teaching pedagogy by assessing the impact of the tools on teaching and learning. The feedback from the students showed that the tool was well accepted and provided learners with an advantage in understanding noise pollution. Additionally, the engagement of students in class improved because of the use of the tool. The findings suggest that the use of low-cost, portable, and safe hands-on tools can enhance the teaching and learning of noise pollution and other related topics. This study highlights the importance of evaluating teaching and learning pedagogy to improve the quality of education.*

## 1. INTRODUCTION

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Among the core component of a pedagogical process of teaching and learning is feedback. Hattie and Timperley [1] described feedback as an information provided as data or consequence in response to an understanding or performance. Feedback serves as a means of improving a pedagogical approach and it serves both learners and instructors in shaping the process. Kabir and Rahman [2] posited that learners utilize feedbacks to improve their academic performances. In order to promote the growth of self-sufficient learners and oversee the progress, assessment and self-regulation of their learning, a common tool is feedback [3]. Also, Fawad and Manarvi [4] argued strongly that feedbacks aid instructors to reshape and improve on their pedagogical delivery. It is essential to note that feedbacks do not authenticate the standard of the process but present itself as a means towards attaining a formal standard of delivery. Hence, Hattie and Timperley [1] emphasized that feedbacks can either be positive or negative but drives an overall improvement into the process.

Incorporating technological tools which are portable, safe and low-cost into the teaching and learning process tend to serve the need of current trend in global education. In a meta-analysis of 110 studies related to the use of mobile devices in learning, Sung et al., [5] found that there was a significant effect of using hand-held devices more than using laptops and when learners are engaged in a self-inquiry learning, they effect was significantly higher than when used along with lecturers, or as a game-based learning. However, Sung et al. [5] argued that use of mobile devices in learning is not in itself a singular tool to achieve high performance in learning. Therefore, to effectively maximise the educational advantages of mobile devices, there is a requirement for more extensive developments in instructional design.

Experiment-centric pedagogy (ECP) serves as an instructional design for teaching and learning concepts in STEM. As described by Owolabi et al. [6], ECP is a practical approach to teaching that involves the use of affordable and secure portable, devices (mobile or others) in a range of learning environments, such as classrooms and student labs, to actively involve students. Connor et al. [7] posited the need to adapt a better methodology of teaching concepts in the engineering filed due to massive switch observed among first year undergraduates as a result of non-matching teaching pedagogy. In a later finding, Connor et al. [8] found better students engagement and learning outcomes when learners utilize a mobile studio to learn concepts in electrical engineering. In another finding, Ladeji-Osias et al. [9] reported that learners had better performance post-implementation of the experiment -centric pedagogy in teaching concepts in different STEM fields. Therefore, this study seeks to present the findings of learners’ feedback on the use of mobile and hands-on devices in learning concepts related to noise engineering in a historically black college and university (HBCU) in the United States.

## 2. METHODOLOGY

This study present the findings of surveys conducted among undergraduates who took part in the use of a hands-on device and also a mobile device in learning concepts related to noise engineering at one HBCU in the United States. The implementation of the experiment was incorporated into the instructional design for one module in the course taught in Fall terms of 2021 and 2022. Figure 1 below represents the instructional design used for the implementation of the pedagogy.

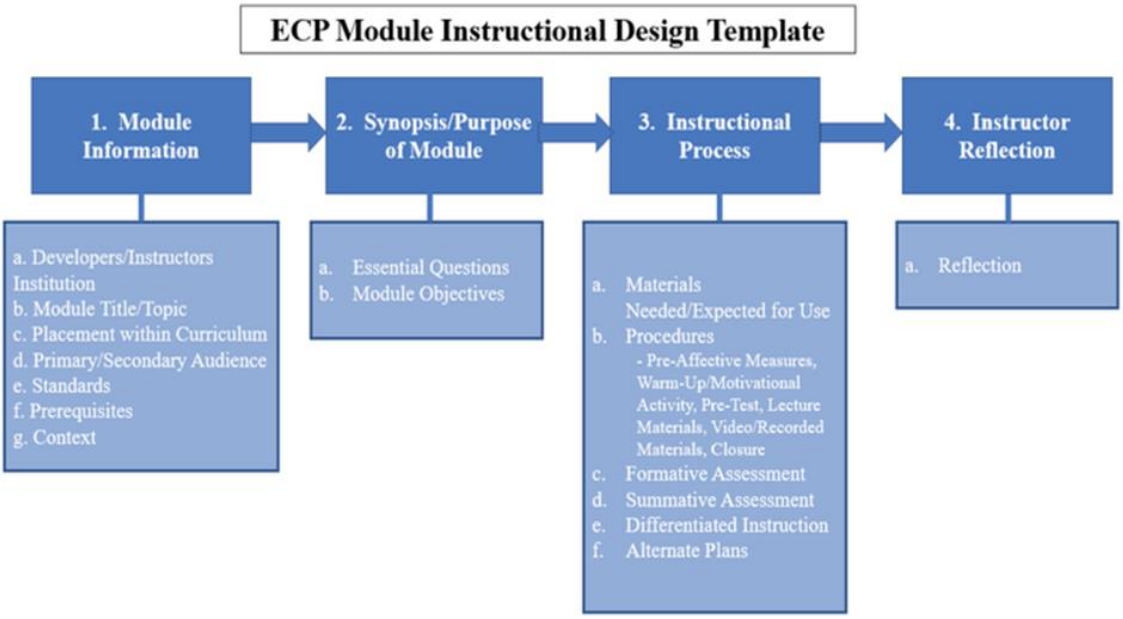


Figure 1: ECP module instructional design

### 2.1. Noise Detection Experiment

The highway engineering class of Fall 2021 and 2022 was used as the sample study. Averagely, about 15 students enrolled for the course each of the terms. In Fall 2021, a low-cost, safe and portable hardware device was used in conjunction with laptop device to understand and compare sound levels in various locations. Figure 2a shows the analog sound sensor, an ADALM 1000 (M1K) used for the experiment. The sensor is connected to the M1k, which was in turn connected to the laptop and a excel spreadsheet was used for recording sound level sin decibels. In Fall 2022, a phone application was installed on learners phone which they took around to capture sound levels at different locations (Figure 2b shows phone application logo).

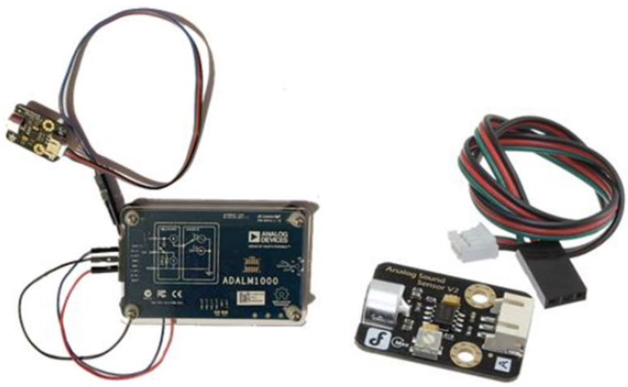


Figure 2a: Noise Experiment Laboratory Equipment


Figure 2a: Noise Experiment Phone Application

According to the instructional design, the related concepts were explained by the instructor prior the learners' conducting the experiment. The instructor worked the first two simple trials with the learners' before the learners had to continue the process.

## 2.2. Data Collection and Analysis

Data collection was done used a self-developed questionnaire to collect learners' perception on the use of the devices in learning concepts related to noise engineering. The questionnaire collected their socio-demographic characteristics, perceptions on the use of devices, learning experience, and impact of ECP on learning. The gender, race/ethnicity represents the socio-demographic, a 6 items 5-scale Likert (which were scored as 1- strongly disagree, 2- disagree, 3- undecided, 4-agree, 5-strongly agree) to collect responses on perceptions of the use of devices, a 4 items 5-scale Likert (which were scored as 1- strongly disagree, 2- disagree, 3- undecided, 4-agree, 5-strongly agree), and 9 items 5-scale Likert (which were scored as 1- strongly disagree, 2- disagree, 3- undecided, 4-agree, 5-strongly agree). The study compare responses when hardware devices were used in Fall 2020 and when mobile devices was used in Fall 2021. Data analysis was conducted after the data was cleaned and 37 responses were found fit. The data was recoded for clarity purposes. All strongly disagree, disagree and undecided was recoded as 0, agree was transformed to 1, and strongly agree was transformed to 2. Descriptive statistics among which were frequency, simple percentages, mean, and standard deviation was used to compare the responses. Inferential analysis was conducted using t-test and at confidence level of 95%.

## 3. RESULTS AND DISCUSSION

The result presented in Table 1 revealed that over the two terms, there were more male than female learners (75.0% vs 22.0%). Also, about 4.0% of learners identified themselves as neither male nor female in Fall 2021. In total, there were 94.4% of Black/African American in the present study.

Table 1: Socio-demographic profile of learners

| Gender | Non-mobile Sensors | Mobile Sensors | Total |
|---|---|---|---|
| | N (%) | N (%) | N (%) |
| | | | |
| Female | 0 (0.0) | 8 (32.0) | 8 (22.2) |
| Male | 11(100.0) | 16(64.0) | 27(75.0) |
| Others | 0(0.0) | 1(4.0%) | 1(2.8) |
| Total | 11 (30.56) | 25(69.44) | |
| Ethnicity/Race | | | |
| Black/African-American | 11 (100.0) | 23(92.0) | 34(94.4) |
| White/Caucasian | 0(0.0) | 2(8.0) | 2(5.6) |

The result presented in Table 2 showed that the mean perception of learners on the use of hands-on devices to learn concept related to noise engineering as well as the statistical significance test. The result showed that learners scored hardware hands-on devices more than they scored mobile hands-on devices. The score on use of Arduino, M1K, M2k or mobile apps was relevant to my academic area was significantly higher when learners used hardware's in the learning environment (1.09±0.70) than when they used mobile applications (0.52±0.71). there was no significant difference in their perceptions on other items ($p<0.05$).

Table 2: Mean Comparison of Student Perceptions of the Process of Use of personal instruments

| Items | Non-mobile Sensors (N=25) | Mobile Sensors (N=11) | t-test | p-value |
|---|---|---|---|---|
| | Mean±SD | Mean±SD | | |
| The Arduino, M1K, M2k or others provided opportunities to practice content | 1.27±0.65 | 0.80±0.76 | 1.91 | 0.069 |
| The use of Arduino, M1K, M2k or others reflected course content | 1.00±0.77 | 0.92±0.76 | 0.29 | 0.78 |
| The use of Arduino, M1K, M2k or mobile apps was relevant to my academic area | 1.09±0.70 | 0.52±0.71 | 2.24 | 0.04 |
| The use of Arduino, M1K, M2k or others reflected real practice | 1.18±0.60 | 0.72±0.74 | 1.97 | 0.06 |

| | | | | |
|---|---|---|---|---|
| The time allotted for Arduino, M1K, M2k or others use was adequate | 1.09±0.80 | 0.80±0.77 | 1.11 | 0.28 |
| The use of Arduino, M1K, M2k or others suited my learning goals | 1.09±0.70 | 0.56±0.82 | 1.99 | 0.06 |

Feedback of learners on the impact of the hands-on devices and their learning as well as statistical test was presented in Table 3. Overall, the mean scores revealed that the learners agreed that hands-on learning have impact on their learning experience. Learners who used hardware's in class setting scored the items higher than learners that utilized mobile devices. This further showed that learners had better learning experience when they used non-mobile devices to learn the concepts taught. There was no significant difference in the responses of learners in the two categories ($p>0.05$). These findings align with previous research that has shown the benefits of hands-on learning in enhancing student engagement, motivation, and comprehension [10].

Table 3: Mean comparison of feedback of impact of hands-on devices on learning

| Items | Non-mobile Sensors (N=25) | Mobile Sensors (N=11) | t-test | p-value |
|---|---|---|---|---|
| | Mean±SD | Mean±SD | | |
| My knowledge has increased because of the use of devices (Arduino, M1K, M2k or others) | 1.18±0.87 | 0.72±0.73 | 1.53 | 0.15 |

| | | | | |
|---|---|---|---|---|
| My confidence in the content area has increased because of the use of devices (Arduino, M1K, M2k or others) | 1.09±0.83 | 0.76±0.66 | 1.17 | 0.26 |
| The hands-on devices (Arduino, M1K, M2k or others) is important in my preparation for my future career | 0.81±0.98 | 0.48±0.65 | 1.05 | 0.31 |
| Using the devices (Arduino, M1K, M2k or others) motivated me to learn the content | 1.09±0.83 | 0.56±0.65 | 1.88 | 0.08 |

Table 4 presented the feedbacks on impact of the pedagogy on the general teaching and learning process. The findings indicated that overall, there was an impact on learners' experience. Among such areas of impact is interest development, motivation, problem solving skills and aiding in recalling course content. Several studies have reported the positive impact of active learning pedagogies on students' academic performance and learning experience. For instance, Freeman et al. [11] conducted a meta-analysis of 225 studies and found that active learning pedagogies led to better exam performance and lower failure rates compared to traditional lecture-based teaching.

Table 4: Feedback on the impact of experiment-centric pedagogy on learning

| Items | Non-mobile Sensors (N=25) | Mobile Sensors (N=11) | t-test | p-value |
|---|---|---|---|---|

| | Mean±SD | Mean±SD | | |
|---|---|---|---|---|
| Helped me to develop skills in problem solving in this subject area | 1.09±0.83 | 0.72±0.61 | 1.33 | 0.20 |
| Think about problems in graphical/pictorial or practical ways | 0.73±0.90 | 0.84±0.62 | 0.38 | 0.71 |
| Learn how electric circuits are used in practical applications | 1.00±0.89 | 0.40±0.65 | 2.01 | 0.63 |
| Recall course content | 1.00±0.89 | 0.64±0.63 | 1.21 | 0.25 |
| Using such devices help improve grades | 0.82±0.98 | 0.48±0.65 | 1.05 | 0.31 |
| Develop confidence in content area | 0.91±0.94 | 0.68±0.63 | 0.74 | 0.47 |
| Become motivated to learn course content | 1.00±0.89 | 0.56±0.65 | 1.47 | 0.16 |
| Develop interest in the subject area | 1.00±0.89 | 0.68±0.63 | 1.08 | 0.30 |
| Using such devices help complete lab assignments | 1.18±0.75 | 0.72±0.61 | 1.79 | 0.09 |

## 4. CONCLUSION

The present study presented the feedback of learners when instructed with hands-on devices in a highway engineering course. The concept taught with the devices was detection and measurement of noise pollution in transportation infrastructure. This was done using the experiment-centric pedagogy which serves as an integration of technology with traditional learning with the learner as the focus.

This study utilized two types of hands-on devices in different terms to carry out the implementation of the experiment design – mobile application and non-mobile application (noise sensor and ADLAM sensor). The goal of the pedagogy was to improve learners motivation and academic performance. The result of the study revealed that there was a positive reception of the use of hands-on devices among the learners. The feedback indicated that learners tend to engage more and benefit more non-mobile devices than mobile devices in learning the concept. In addition, the results suggest that educators and instructional designers should carefully consider the choice of learning devices when designing and implementing hands-on activities in the classroom. It is worth noting that while the mean scores were generally positive, some learners expressed reservations about the effectiveness and practicality of using hands-on devices in certain contexts (e.g., in large classes or in situations where the devices were not functioning properly). The lack of significant difference in the responses of learners using mobile and non-mobile devices may be due to various factors, such as the similarity in the design and functionality of the devices used, or the relatively small sample size of the study. Further research could explore these factors in more detail.

## ACKNOWLEDGEMENT

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