Bullet Id: A Virtual Bullet Identification For Forensic Ballistics Students

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Abstract: Forensic science educators have long argued for the use of more innovative approaches in forensic teaching. The lockdown has forced individuals and departments to embrace these views with speed. In this regard, the researcher would want to designed and develop the bullet ID system for forensic ballistics students. This study will be conducted using the Agile Software Development Methodology. According to Stackify (2017), Agile Methodology is an approach that is people-focused, results-focused to software. It involves planning, self-organization, and short delivery times. It's flexible, fast, and aims for continuous improvements in quality. It abandons the risk of spending months or years on a process that ultimately fails because of some small mistake in an early phase. It relies instead on trusting employees and teams to work directly with customers to understand the goals and provide solutions in a fast and incremental way. The Bullet ID is a promising educational tool that will help both the instructors and students in their learning activities specially in the field of forensic ballistics. This new learning technology will bridge the gap between face-to-face and online classes.

Keywords: Bullet, Identification, System, Mobile, Application

1. Introduction

The global outbreak of COVID19 has spread around the world, affecting most countries and territories. The outbreak was first identified in December 2019 in Wuhan, China. Countries around the world have warned the public to be cautious. Community care strategies include washing hands, wearing masks, staying away from large gatherings and gatherings. Confinement and stay-at-home strategies have been suggested as a necessary measure to flatten the curve and control disease transmission (Sintema, 2020). Bhutan first announced the closure of schools and academies and reduced opening hours in the second week of March 2020 (Kuensel, 2020, March 6). A total nationwide lockdown is in place from August 1, 2020 (Palden, 2020). Meanwhile, movements have been allowed, offices have begun to operate, schools and colleges have reopened for certain levels, and continued with online courses for those who need it. others. More than 170,000 children in Bhutan in grades PP-XII are, today, affected by the closure of schools. The impact is significant and has impacted learning this school year or even more in the days to come. Some schools, colleges and universities have stopped teaching face-to-face. There is an urgent need to innovate and implement alternative education and assessment strategies. The COVID19 pandemic has given us the opportunity to pave the way for the birth of digital learning (Dhawan, 2020). Sumitra 2021, highlights a number of shortcomings such as weak online teaching infrastructure, teachers' limited exposure to online teaching, lack of information, unfavorable environment for online learning at home, public degree and academic excellence in terms of higher education. In terms of delivering course material, universities were required to devise solutions for three typical types of session: the traditional styled lecture, seminars, and practical sessions. Arguably lecture delivery offered the fewest issues, where online video conferencing platforms designed for such activities exist. A combination of live and asynchronous pre-recorded approaches provided flexibility for students, taking into account the pressures created by the pandemic, 'key worker' statuses and volunteering initiatives, meaning that it is not viable to expect students to attend online sessions at set times. Whilst pre-recording content carries an up-front cost, the benefit of having a static, replay-able resource for students to digest in their own time and capacity is seen as of-value. Of course, many lecturers and students alike seek to encourage positive interaction in their lecturing sessions, and indeed such approaches have long since been seen as of benefit to students and their learning. As a result, many institutes will have supplemented recordings with shorter, live question and answer styled sessions to confirm understanding, address any confusion and possibly of most importance, to see their students, check on well-being and simply talk to them. It is important that following the imposed lockdown, academics do no simply disappear from interacting in real time with students, and technology offers a stop-gap solution at this time. (Hackathorn et al., 2012) Seminar and practical sessions provide somewhat of a challenge. At the crux of their value lies the ability for students to consolidate knowledge by 'doing' and 'using' the knowledge they have acquired. Work by Erana-Rojas et al. 2019 noted that 89% of their students found that practical session broadened their perspective of forensic sciences and 93% understood forensic processes better. Particularly in the context of forensic science and all its sub-disciplines, students need to apply best practices, seek evaluation of their performance and understand the context of any techniques by using them. Furthermore, practical sessions develop the necessary psychomotor skills required in many aspects of forensic analysis. Basic wet laboratory skills such as weighing, pipetting, and microscope slide making, along with DNA swabbing and fingerprint recovery techniques, for example, are important in many aspects of forensic science. Yet often, forensic science equipment must stay within its lab environment due to health and safety, immobility, expense and licensing issues meaning that the lab cannot be 'brought to the student at home'. Regardless of the method and platform, universities and their academics are encouraged to maintain communication with their students. What would once have been face-to-face, a knock at the office door or a two-minute post-lecture chat, has turned into a computational request for communication. This has the potential to have opposing effects and likely depends on the student in question. Furthermore, the lack of immediate

response could encourage an exercise of research skills fostering a more independent approach. On the other hand, what is lacking is the connection and to some extent the opportunity for organic discussions around the questions. The type of student here is important, those that favor independent research will likely thrive, while those that benefit from interaction and talking things through to process ideas and knowledge may find themselves out of their comfort zone or, worse, left behind. Additionally, those once visible indicators of students in need of both study and well-being support are no longer there, meaning that it is vital that we continue to be available in order to identify and address any warning signs. Flexibility is key here, ensuring students have multiple opportunities to seek support which in some cases means non-traditional hours-for-contact. Forensic education in India was largely delivered via the Zoom and Webex applications following instructions and training given to faculty and students. Over time and with continued use of the application, teachers and learners became accustomed to this virtual approach. Regular lectures were arranged using this application for all the learning hours. For Indian students, the most important advantage of this approach was the fact that lectures could occur in real-time, keeping the students engaged in educational activities and completion of the curriculum as per the schedule. The disadvantages varied from place to place, but included: being unable to confirm the student's attendance, difficulties in achieving active engagement of students, internet connectivity issues, deliberate or inadvertent disturbances such as unnecessary voices and annotations over the display screen, and there were a few students who were deprived of the education resource materials. Few universities developed and offered learning cellphone application with 3D technology to medical students. Videos generated prior to the pandemic depicting faculty performing and explaining such things as autopsies emphasized important findings and were shared with the students in a way which maintained confidentiality yet initiated interactions and discussion. Institutional support was also extended to support increased subscription to various e-learning modules, e-books, e-library access, additional international journals, etc. to provide the students with multiple new learning modalities in their homes. Understanding mental stress under lockdown and curfew mentorship sessions were arranged on regular interval and individual basis (Wenjun et al., 2020). As in India, UK forensic courses adopted a range of online tools to support students up to, and into, the examination period. These included Microsoft Teams, Webex, Zoom, as well as Blackboard Collaborate and Padlet. WhatsApp, Facebook and similar social media apps were used significantly less by comparison. The live delivery of seminars still occurred alongside a blended approach of prerecorded or written content, seminar tutor delivery, time for independent student work, and facilitated group discussions. For example, students were asked to watch a video demonstrating a forensic technique posted on the virtual learning platform or read a document such as a court statement ahead of the live seminar session. Some theoretical content was discussed by the seminar tutors, then the students were assigned a task to work on independently for a short period of time. The session was then resumed and students would be asked to share their work via the chat box of the platform used, or to share their screen with other members of the seminar class, and a facilitated group discussion took place. This broke up the time spent in the online session, encouraged engagement with the learning, and enabled fruitful group discussion. A particular example of this approach was the delivery of a simulated courtroom exercise to replace a physical session of cross examination within a mock courtroom. Rather than requiring students to give evidence and be cross examined in the virtual environment in which they may have felt uncomfortable, a scripted cross examination of a crime scene investigator was written and 'performed' by seminar tutors live to the class via an online platform. This gave the students the opportunity to interact in real time with the cross-examination process, identify good practice and areas for improvement (which had been written into the script), and consider, based upon their own written statements, how they would have responded to some of the probing questions asked by the barrister. In another example, the adaptation of anatomy bone labs into online worksheets supplemented by Sketchfab (https://www.sketchfab.com). Traditionally, these bone labs are run face-to-face where small groups of students worked together to lay out the skeleton and over three sessions study the structure and function of the human skeleton, specifically looking at the features forensic anthropologists use to estimate biological profiles: biological sex, stature, age, and life history. Without home access to human remains or replicas, these lab sessions instead made use of online repositories of 3D digital models via sketchfab.com with an accompanying digital worksheet containing links to the 3D models and questions to be answered. Feedback from such sessions indicated that, whilst students miss the face-to-face contact of traditional seminars, they feel more able to contribute to discussions and have enjoyed the interactive nature of delivery, and staff have reported increased level of engagement via the chat box facility and a greater amount, and depth of questioning in relation to the taught material (Mayne and Green, 2020). In the Philippines, remote learning reveals a digital divide among Filipino students (Santos, 2020). This current situation in remote learning may most possibly exacerbate existing inequalities and may translate to barriers in online learning. For example, a cross-sectional study conducted nationwide reported that thirty-two percent (32 %) and twenty-two percent (22%) out of 3, 670 Filipino medical students surveyed have difficulties adjusting to new learning styles and do not have reliable internet access, respectively (Baticulon et al., 2020). For some, it may present difficulty to purchase a facilitative learning device to easily tune in to online classes and immediately turn in assignments in the online system (Santos, 2020). Despite the efforts to make education accessible for all, many difficulties are still confronting Filipino university students in the practice of distance education. Forensic science educators have long argued for the use of more innovative approaches in forensic teaching. The lockdown has forced individuals and departments to embrace these views with speed. In the post-pandemic world, another transition will be expected as people move to a hybrid learning framework with physical distancing. In this regard, the researcher would want to designed and develop the bullet ID system for forensic ballistics students.

2. Main Body

This study is conducted to develop a mobile application which will be named as the Bullet Identification System (Bullet ID). Specifically, it will seek answers to the

following problems.

1. What framework can be designed in the Bullet Identification System?
3. What features can be integrated in the proposed system?
4. What is the perceived benefit of using Bullet ID?

2.1 Framework Used to Design the Bullet Identification System

This section explained the framework that was used to design the Bullet Identification System (Bullet ID) and the specified process of the system. The Bullet ID is designed from a Front-End Javascript Framework. This is an open-source and free to use framework under the MIT License. It is one of the frameworks used in developing mobile applications that are compatible with Android ad IoS. The requirements for developing the application's software component are, at least Windows 10 for the operating system. The platform for development is Front-end Javascript. The tools needed is Android SDK, React Native and ADT. The technology used is JAVA and the debugger is Instabug. The developer also used Android API as emulator. In running the app on a device, the minimum hardware requirements are at least operating system that is needed is i3 or higher. The RAM should be a minimum of 4GB and 256GB for SSD. For running on a device, the gadget must be any phone or tablet running on Android 7.0/IOS 6.0 or higher with disk space of 17.30 MB (at the least). The Bullet ID designed is shown in Figure 1. The system was built using this lay-out. This framework used User Interface (UI) elements. The researcher decided to use a front-end framework because the Bullet ID do not need a server's database. The Bullet ID's main function is to identify what type of firearm was used to discharge the sample (fired bullet). The system provides a browser-based interface. The user inputs all the needed data and the result are also displayed in the browser. The main building blocks of the system is shown below.

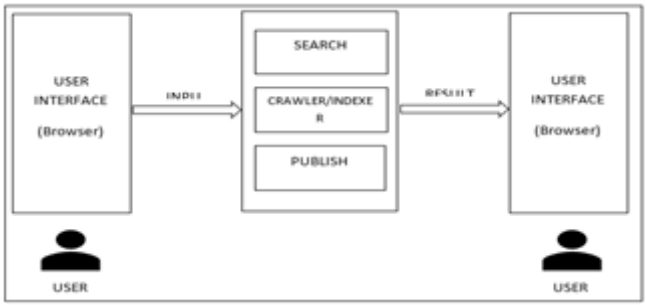

Figure 2. System Architecture

The different components in the architecture are:

User Interface (Browser)

The user interface provides a simple lay-out and search interface. The search interface provides for user to access the camera, gallery comparator and class characteristics interface of the BIS. The administrative console functions are hidden from the general end-users who only input data to the system and get the result of the search.

Figure 2. User Interface

Publish Module

An existing data source like the number of lands grooves, depth of groove, twist of rifling, width of lands, pitch of rifling, and the caliber is first registered with the system. It will serve as the database of the system. The search system builds up its own information base when a data source is initially registered (published) with it.

Crawler/Indexer

The list of data source like the number of lands grooves, depth of groove, twist of rifling, width of lands, pitch of rifling, and the caliber that needs to be search-enabled is given as input to the crawler with the configuration parameters specific to each of the data sources (through the publish module). The crawler takes the input data source, scans through the tables and the data available in each of the given data source and builds up its own information base and creating certain index information about the data source and computing the data source statistics. The important index information stored about the data includes:

- The caliber/bore diameter of the bullet
- The direction of twist or twist of rifling
- The number of lands and grooves
- The width of lands and grooves.

Search/Query Processor

Search component takes care of fetching the right information from the participating data source(s), given the search words/numbers, based on the index information. For a given set of words/numbers, the search component provides interfaces to retrieve matching data from a set of published data source, and selectively identify the data that need to be searched within each data source identified based on the index information. The specific interfaces include for a given set of words/numbers:

- Find all the matching data like the number of lands grooves, depth of groove, twist of rifling, width of lands, pitch of rifling, and the caliber
- Find all data in the data source that contain all or most of the words/numbers.

Use Case Diagram

A use case diagram is used to specify the functionality of the system from the point of view of a user. Each use case describes a logical task that may be performed by a user. It mainly shows the interaction between the system and the

outside world. The figure below shows that after the user input all the required data and click the search, the system will simultaneously fetch all the data from the data sources. After all these tasks were conducted, the system will now show the result of the query. Therefore, this use case diagram will serve as a guide for the developer in designing and developing the mobile application. In this regard, the user and the readers will easily understand the flow and how the app is working.

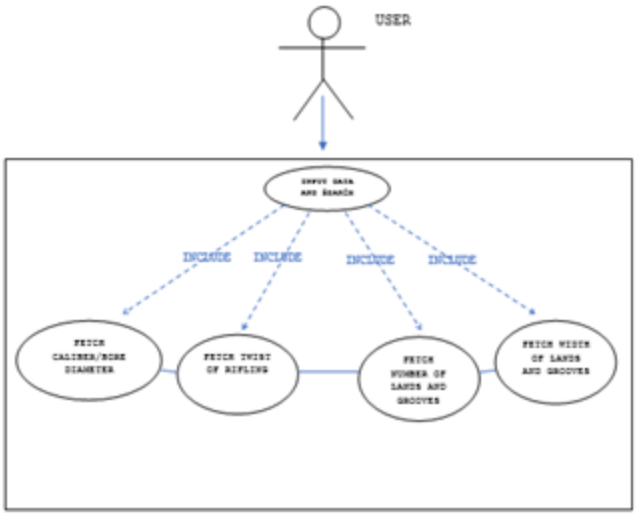

Figure 3. Use Case Diagram

2.2 Integrated Features in the Proposed System

Photo Capturing: This feature enables the user to capture images of the bullet by allowing the app to access the phone's camera. This feature is essential because the main objective of the app is to identify the firearm by examining the characteristics of the captured bullet.

Figure 4. Photo Capturing

Gallery View: This will enable the user to store the images in the phone's gallery taken from the camera. The user will access the gallery whenever he/she wants to conduct examination of the direction of twist or when comparing two fired bullets to identify Individual Characteristics.

Figure 5. Gallery View

Comparator View: This feature will enable the user to use app to simulate the feature of the Bullet Comparison Microscope. The user will open this interface whenever he/she wants to compare two fired bullets to examine or identify Individual Characteristics.

Figure 6. Comparator View

Class Characteristics Interface: This feature will enable the user to access an interface where he/she can input all the needed data such as the caliber/bore diameter of the fired bullet, the direction of twist or twist of rifling, the number of lands and grooves, the width of lands and grooves. After putting all the data, the user will be able to click the search button. Thereafter, the system will match the input data to the data source stored in the app to identify what make or type of firearm the bullet was fired.

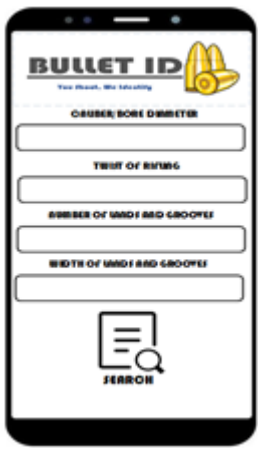

Figure 7. Class Characteristics Interface

Result Box: This feature will enable the user to view the result of the search. This is needed because the user will use the result in formulating his observation and conclusion. Observation/Conclusion Textbox: This feature will enable the user to write his observation and conclusion on the examination he/she conducted.

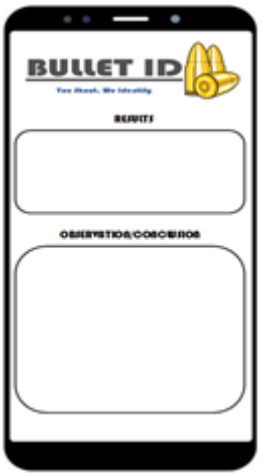

Figure 8. Result Box and Observation/Conclusion Textbox

2.3 Benefit of Using BIS

Learning and innovation go hand in hand. In this era of innovation, a lot of things are getting evolved and so is education. As a user, BIS provides a new learning experience that would be useful in distant learning specially during pandemic or catastrophe where face-to-face education is not possible. It provides digital activities that engage the user to enhance his knowledge and skills in identifying firearms in the comfort of their homes using only a mobile device. As compared with other system related to firearms identification that mostly are web-based, the BIS is a mobile application that can be access even offline. In this regard, students with no laptops or computers can be able to use this innovation with the use of their mobile phones. A mobile phone can make a lot of tasks easy for the users and also saves a lot of time.

5. Conclusion

The introduction of BIS in the education sector will lead to the introduction of new learning methods. The activities or tasks available on the BIS will indulge the students into a healthy thought process and help them understand things from a different perspective. Similarly, the trend in education is changing there is a digitalization wave into education. E-Learning is the new need for the students. E-Learning mobile apps are getting popular day by day and that is due to its uniqueness of making learning fun for students.

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Author Profile

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