'WHO DONE IT?' A Multidisciplinary Mobile Device Forensics Framework: From Theory To Practice with Intermediate Students

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Abstract— It is essential to initiate a curriculum concerning mobile device forensics and law enforcement in the intermediate grades in Mississippi using a facet of multidisciplinary subjects: biology, chemistry, computer science, criminology, and physics. The students participated in engaged teams who gathered the evidence (critical thinking), analyzed the evidence (deductive reasoning), and drew conclusions (inference) in a story-based scenario entitled *"Cyberbullying Mobile Device Criminal Investigation."* This research presents cyberbullying while bringing awareness to the law enforcement community by understanding digital forensics; furthermore, it shows how STEM and Criminology are presented to intermediate students by solving a middle school mystery based on a multidisciplinary framework. By including a multidisciplinary curriculum in this process, students developed an appreciation of the interrelatedness between the STEM Sciences and Liberal Arts Education.

Keywords— Jackson State University, mobile device forensics curriculum, electronic Crime Scene Investigation (eCSI), cyberbullying

I. INTRODUCTION

Cyberbullying is defined as an intentional aggressive Due to the unique characteristics of digital media, online harassment varies from traditional to conventional, with no restrictive audiences, perpetrator anonymity, or limited restrictions on the time or location in which aggressive behavior can occur [29]. Vast publications in higher education have expounded on cyberbullying, and [29] defines it as an intentional aggressive behavior conducted repeatedly with unequal power between perpetrators and victims while using electronic technology as its medium. Cyberbullying is a different form of harassment that occurs through online humiliation, intent to harass or threaten an individual, which can include shameful SMS/MMS messages, vicious rumors through social media, or posting embarrassing notions or images of an individual.

In modern times, technology has emerged, which makes cybercrime a straightforward and swift act to commit. According to a study, 95% of adolescents aged twelve to eighteen benefit from a smartphone in 2022. Of that number, 53% have a smartphone by the time the pre-teen reaches eleven, and by the age of twelve, that number increases to 69%. One in five eight-year-olds' possess a smartphone as the ownership has grown substantially over the past four years among all adolescent ages [14, 17, 20].

Another survey provided by the Cyberbullying Research Center states that almost 37% of middle and high schoolers had been harassed online in 2019, a loftier percentage reported since the organization began tracking cyberbullying ten years ago. Adolescents' state of mind may be significantly impacted and could alter how these individuals perceive the world. Social media enlightens students to compare themselves to others, which can be detrimental to one's mental health [11].

As a result, this paper deals with cyberbullying while bringing awareness to the law enforcement community by understanding digital forensics and how STEM and Criminology are related to intermediate students by solving a middle school mystery based on the multidisciplinary framework. The paper is organized as follows: Section II is a literature review on criminology and computer science, specifically mobile device forensics, and discusses fingerprint and footwear impressions and deoxyribonucleic acid (DNA) forensics in a criminal investigation; section III describes the methodology for evaluating intermediate students based on critical thinking and deductive reasoning, and Section IV details the conclusions.

II. LITERATURE REVIEW

Computer Science and Criminology are united when extracting evidence from a mobile device, be it GPS, chip, IoT, laptop, smartphone, or any portable computer. In order to retrieve the evidence from a device, law enforcement must obtain a warrant for the potential suspect's possessions. Once law enforcement salvages a mobile device, it is apprised by the chain of custody and stored as evidence. After this occurs, then it is up to the forensic examiner to interpret if there is any evidence on that device using forensics tools such as XRY®, Paraben®, Autopsy®, Cellebrite®, or any other mobile device forensics tool commercially or open-source.

A. Criminology

1. Fingerprint Forensic Impressions

Fingerprints are the oldest biometric identification known as it is simplistic, unique, and inexpensive, but their distinctive features on the skin aid in determining a potential suspect's finger used for criminal activity. Fingerprints are exact and significant in that they will be identical throughout our lifespan. Prints are formed once fingerprints touch a surface leaving ridges that merge with blood, grease,

ink, dirt, or some oil substance, and therefore, an individual can discern the fingerprint visually [32].

Fingerprints form ridges and patterns that aid in gripping an object. There are generally three categories in which fingerprint patterns are formed: arches, loops, and whorls. These categories can be found in about 5%, 60% - 70%, and 25% - 35% of all fingerprint patterns encountered, respectively. An arch pattern is curved like a hill in layperson's terms. In a loop pattern, there is at least one core, one delta, and a ridge count or an upside-down U. Additionally, loops have lines that enter and exit on parallel sides of the print. The whorl pattern contains at least two deltas meaning the fingerprint has circles that spiral that exit dissimilarly on either side of the print; hence, whorls happen to a bull's eye [32].

2. Footwear Forensic Impressions

Shoe print analysis, or footwear impressions, can be skillfully obtained by law enforcement if an individual has participated in a crime and the subject were the wearers of that potential shoe. Law enforcement has evidence of what occurred before, during, and after the alleged crime depending on shoe print forensics. Footprint impression evidence contains two categories: class characterization and identifiers of footwear. Class characterization can include: 1) type of tread, 2) movement of the human, and 3) size of footwear. Identifiers of footwear precedent would be: 1) unique wear patterns, 2) defects in sole impressions, and 3) contents of scrapings from parts of the sole [16].

3. Deoxyribonucleic Acid Forensics (DNA)

Deoxyribonucleic acid is the building block for the human body, so each cell contains it. DNA is a part of an individual's blood, saliva, skin, hair, and bone; consequently, it does not change throughout the lifetime of the human. In order to extract DNA from human cells, the biologist must expose the cell and nuclear membranes, separating the DNA from the other types of biological molecules in human cells [28].

In criminology, DNA evidence is vital since no two humans have similar DNA profiles except identical twins. Collecting DNA compared to known samples of DNA plays a significant role in a potential suspect at a crime scene. If no suspect exists as far as DNA is concerned, law enforcement has to construct a DNA profile and position this structure in the FBI's Combined DNA Index System (CODIS). In doing this action, law enforcement can identify a potential suspect if an individual is placed into law enforcement's system [28].

B. Computer Science

1. Mobile Device Forensics

Mobile Device Forensics is a branch of digital forensics depicting the recovery of digital evidence or data from a mobile device under forensically sound conditions [1]. Although the definition portrays a mobile device as a cell phone or smartphone, it can relate to any digital device that pertains to internal memory and communication ability, including PDA devices, GPS devices, and tablet computers [22]. The mobile device forensics processes involve validation, preservation, identification, collection, analysis, interpretation, and preservation while documenting throughout the process. [3, 6, 27]

Law enforcement and mobile device forensics are closely associated when interpreting digital crime for evidence. For instance, in September 2012, Christian Aguilar was a freshman at the University of Florida who disappeared after being last seen with Pedro Bravo at a local Best Buy®. Aguilar's remains were found three weeks later, buried in a shallow grave more than sixty miles west of Gainesville, FL, and law enforcement suspected that Bravo had some guilt. Additional evidence provided blood in Bravo's vehicle and one of Aguilar's possessions, his backpack. Furthermore, these friends attended the same high school, so the potential motive was that Bravo was unsettled with Aguilar since Aguilar began a relationship with Bravo's ex-girlfriend. The forensics examiner obtained a warrant for Bravo's cellphone, which contains an image of Siri based on the Facebook® application that read, "I need to hide my roommate." Bravo was located far west after Aguilar vanished, and the examiner determined the usage of the flashlight application over an hour after the disappearance based on the geolocation at the time of Aguilar's departure. Despite being friends, Bravo was pronounced guilty of first-degree murder of Christian Aguilar in August 2014 [10].

To further complicate this issue, some users have minuscule or no online communication, and it can be complex to locate the said person. Mr. Phillip Welsh was employed as a taxicab dispatcher and used technology daily, but he refrained from using any digital device in his personal life. He relied on landlines, typewriters, and hand-written letters, so he had no online communication even though his family would prompt him to try novel technologies. Welsh lived alone, so he did not report to work one day, and as a result, he was found murdered at his home in Silver Springs, Maryland. Due to the lack of digital evidence such as text messages, emails, or web history, the murder of Philip Welsh remains unsolved, with investigators having no way of determining Welsh's whereabouts. [10]

2. Automated Analysis versus Manual Analysis

Automated analysis is the analytical capability to detect relevant anomalies, patterns automatically, and trends, i.e., the workstation implements the analysis for the user by utilizing a digital forensics tool [25]. In contrast, manual analysis is the inspection and evaluation of a mobile device executed by hand or manually instead of electronically [5]. Manual analysis is vital as this state does not have law enforcement agencies centered in Jackson, MS, with the means to examine evidence due to limitations such as funding, resources, and other mechanisms that are not feasible. Given these events, a scenario involving a Cyberbullying Criminal Middle School Mystery, a misdemeanor, can be achieved using manual analysis. Given the number of mobile devices versus the number of mobile device forensics examiners in the state, the hypothesis proposed is to probe misdemeanors using mobile devices from a computer scientist's viewpoint.

III. METHODOLOGY

The Jackson State University's Department of Electrical Engineering, Computer Engineering, and Computer Science advocates the development of an electronic Crime Scene Investigation (eCSI) Program, patterned by the popular television series CSI, which educates intermediate students on their problem-solving, reasoning, and deductive skills while ascertaining mobile device forensics in an effort to increase underrepresented students' appeal to the STEM sciences.

Table 1: Mobile Device Forensics Framework

Components	Quality Standard
1) Potential of engaging students of diverse academic backgrounds	Learning experiences are designed to engage the imaginations of students of diverse backgrounds.
2) Degree of STEM Integration	Learning experiences are carefully designed to aid students in integrating knowledge and skills from STEM.
3) Connections to Non-STEM Disciplines	Learning experiences help students in connecting STEM knowledge and skills with Criminology.
4) Integrity of the Academic Content	Learning experiences are content-accurate, anchored to relevant content standards, and focused on foundational skills critical to future learning.
5) Quality of Cognitive Task	Learning experiences challenge students to develop higher-order thinking processes through inquiry, problem-solving, creative thinking, and inference skills.
6)Individual Accountability in a Collaborative Culture	Learning experiences require students to learn independently and collaboratively using interpersonal skills.
7) Nature of Assessments	Learning experiences require students to demonstrate knowledge and skills through performance-based tasks.
8) Connections to STEM Careers	Learning experiences place students in a learning environment that aid students in understanding and considering the STEM sciences as a career choice.
9) Application of Mobile Device Forensics Design	Learning experiences require students to demonstrate knowledge and skills fundamental to the Mobile Device Forensics Design Process.
10)Quality of Mobile Device Integration	Learning experiences will provide students with hands-on knowledge using multiple technologies. (MSAB® forensic tool, Paraben ED : E3® forensics tool, Android mobile devices, iPhone mobile devices)

The methodology for this research is as follows:

1. **Identify intermediate students for eCSI Mobile Device Detectives' Forensics Summer Camp 2022,**
2. **Master the middle school student's knowledge in critical thinking, deductive reasoning, and inference skills based on a mobile device mystery.**
3. **Demonstrate the middle school student's knowledge in critical thinking, deductive reasoning, and inference skills based on a mobile device mystery.**
4. **Implement the middle school student's knowledge in critical thinking, deductive reasoning, and inference skills based on a mobile device mystery.**

In the summer of 2022, the investigators revised a framework with activities adapted from [18] in Tables 1 and 2, respectively. In Table 1, a Mobile Device Forensics Framework of quality standards have been associated with numbered components.

Table 2: Mobile Device Forensics Curriculum Adapted From the Mobile Device Forensics Framework

Title	Summary	Quality Standards
Rebus Puzzles Activity	Solve small cryptographic puzzles that use critical thinking and deductive reasoning skills to infer its meaning	1, 2, 4, 5, 6, 7
Guest Speaker/ Mentoring Activity	Develop a mentoring activity where the middle school students will become acquainted with academic near-peer mentors for one year.	1, 2, 4, 6, 8
Fingerprint Activity	Understand what a fingerprint is, examine what fingerprint structures allow no one fingerprint is identical, and why it is essential to criminology. Participants explored their fingerprints in a hand-on-activity.	1, 2, 3, 4, 5, 6, 7, 8, 9
Footwear Impressions Activity	Understand what a footprint is, determine the shoe size of the impression and what height that person is based on that footprint, identify the shoe's origin and why it is crucial to criminology. Participants examined their shoe prints in a hand-on-activity.	1, 2, 3, 4, 5, 6, 7, 8, 9
DNA Activity	Understand what DNA is and its structure, determine that the students have a minuscule probability of their DNA matching another student's DNA, and why it is vital to criminology. Participants examined their DNA in a hand-on-activity.	1, 2, 3, 4, 5, 6, 7, 8, 9
Mobile Device Forensics Activity	Determine the mobile device forensics tools that could aid the examination and why it is needed in criminology.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Cyberbullying Criminal Investigation Activity	Solve the researcher's scenario involving cyberbullying in a middle school featuring fingerprints, footprints, DNA, and mobile device evidence.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Mobile Device Forensic Poster Activity	Develop a one-week summary of the Mobile Device Forensics Summer Camp based on what the students learned.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Option 1: Buzzword Junior Word Game Activity/ Mathological Liar Game Activity [12, 29]	Execute specific tasks with precision and critical thinking skills/Solve the mystery by determining whether the students' math fits the suspect's alibi.	1, 2, 4, 5, 6, 7
Option 2: STEAM Robot/Playstix/ Tumble Trax Magnetic Run Game Activity [15]	Create and execute specific tasks with little or no precision, speed, and precision that require the students to think creatively.	1, 2, 4, 5, 6, 7

Table 2 details our Mobile Device Forensics Detectives' Summer Camp Curriculum with a summary of either understanding, determining, solving, creating, executing, or developing activities throughout the camp. By using a framework, the researchers were able to determine the correct standards that correlate with the K - 12 standards of both public and private schools. The following is the investigators' study on creating a framework for K-12 public

and private schools to model when the curriculum contains digital forensics.

- **Identify intermediate students for the eCSI Mobile Device Detectives' Forensics Summer Camp**

Twenty-five middle school students were able to attend summer camp with the aid of their parents. There were policies and procedures that the Leadership Team had to adhere to due to SARS COVID-19. When the students entered the Engineering Building on JSU's campus, two Mobile Device Forensics Mentors checked the students' temperatures daily. At least four times a day, the students enter the restroom to cleanse their hands thoroughly.

As soon as the scholars entered the classroom, the researchers offered them three options: Either wear the mask provided to the students at home, wear the mask provided for them at the University, or wear the face shields given to the students by the Mobile Device Forensics Leadership Team. As of yet, pupils from the Mobile Device Forensics Detectives' Summer Camp 2022 have not been affected by COVID-19 [9].

[4, 13, 19, 23] suggests a three-step teaching environment routine, a structured, systematic, and effective modeling technique in the 'I do,' 'We do,' and 'You do' processes. These activities are based on guided practice in which "instructors pull back, and the learners step forward," as defined by [21]. 'I Do' is the first process where instructors provide a benchmark for students by demonstrating several tasks while the pupils observe. 'We Do' operates with respect to the instructors, along with students achieving a specific task in combination. 'You Do' is the final step in the process, allowing students to validate each task without assistance from the instructor. As such, this experiment correlates the 'I do,' or master, 'We do,' or demonstrate, and 'You do' or implement these approaches.

- **Master the intermediate student's knowledge in critical thinking, deductive reasoning, inference skills based on a middle school mobile device mystery/'I Do' Approach,**

The instructors and mentors demonstrate how problem-solving, deductive reasoning, and inference skills are utilized while lecturing about criminology from a computer scientist's perspective.

The instructors provided near-peer mentors from JSU's Computer Science Undergraduate and Graduate Departments to aid the students in their academic careers. Intermediate students enhanced their problem-solving, deductive reasoning, and inference skills by assigning Rebus puzzles daily and improved their acronyms skills by matching common and uncommon abbreviations [9], Buzzword Junior Word [12], and Mathological Liar games [30].

1. Cyberbullying Middle School Mystery Lecture
In order to solve an East Side Middle School Cyberbullying Mystery or any criminal investigation, documentation is fundamental. Chain of custody is requisite in criminology; therefore, the forensics examiner must be detailed regarding pre and post-evidence(s) signatures. The examiner must also be aware that receipt or dispersal of evidence with signatures needs to be documented thoroughly. Proceeding through the evidence on Day One through Day Five, gloves were vital when pertaining to intermediate students as to not place their fingerprints, shoe prints, or DNA on any object.

2. Fingerprint Forensics Impressions Lecture - Day One
In this lecture, students had to understand and examine the fingerprint structure, allowing that no one fingerprint is akin, and question the various items an individual can touch that leave fingerprints. Following were some critical questions pondered by the students on fingerprinting from Day One: Where do the pattern lines begin and end? Which direction do fingerprints face? Why do we have fingerprints? How are fingerprints formed? Why are fingerprints necessary for forensic investigators?

3. Footwear Forensics Impressions Lecture - Day Two
The pupils mastered what a shoe print is, determined the shoe size of the footprint, and identified the shoe's origin based on a shoe print assignment, but the tutees were unfamiliar with the height of a suspect based on that shoe print. The examiner had to demonstrate her shoe plus mathematical equations and confirm that her height correlated with her shoe size. The following were some critical questions that the students from Day Two contemplated: How does an individual's shoe print differ from an individual's friends? Why are shoe prints important to forensics investigators?

4. Deoxyribonucleic Acid Forensics Lecture - Day Three
It was difficult for middle school students to understand DNA, which embodies a cell's basic building block structure, so the examiner presented her DNA from Ancestry®. The estimation was that her ethnicity is Mexican, African, Indian, Scotland, Ireland, and Norwegian. Several students did not understand why people are considered a racial ethnicity. The examiners attempted to explain the ethnicities of humans and from what source DNA is, which leads to differences between race and ethnicity. On that same token, the investigators explained that DNA is a self-replicating material that is present in nearly all living organisms as the main constituent of chromosomes. It is the carrier of genetic information. She also told the students that 70% of human DNA was like an acorn worm. Now understanding what DNA is and its structure, the students were asked, "What are some items that your body touches?" Miscellaneous students varied their answers such that one student said, "your sheets," another student said, "your clothes," and another student said whatever an individual touches! The scientists reminded them about sweat, saliva, teeth, hair, blood type, and bone all having DNA. Some questions asked to the students from Day Three were: How does an individual's DNA differ from an individual's friends? Why is DNA important to forensics investigators?

Figure 1: Student Fingerprint Card from Day One

Figure 2: Student Footwear Impressions from Day Two

5. Smartphone Forensics - Day Four
After defining what a mobile device and mobile device forensics are and the differences between automation and manual analysis, casting light on the methods the users need to perform mobile forensics on the phone manually, it was articulated to the youngsters that automated mobile device tools are pricey. The instructors told the students that manual analysis is feasible when investigating the East Side Middle School Cyberbullying Mystery based on this theory.

Forensic examiners must inspect a smartphone for fingerprints during a crime, but efforts are made to inspect the smartphone logistically for the identity of the owner, locale information, emails, habits, interests, network information, call logs, text messages, contacts, images, and web browsing history [7, 8]. Using the students' smartphones, the researchers provided the pupils with a worksheet where the students had to detail their network information, one text message, one social media message, and one phone number from the smartphones' memory. In turn, the tutees presented the smartphone activity to the mentors. The mentors provided the students with a filled-in sheet that was not their own and based on the responses given, the pupils inferred to whom the document belonged. The following were some notable smartphone forensics questions the students had to answer from Day Four: How does an individual's smartphone differ from an individual's friends? Why is a smartphone important to forensics investigators? How does geolocation assist investigators in determining which suspect was detected at a specific location and time of day?

- **Demonstrate the intermediate student's knowledge in critical thinking, deductive reasoning, inference skills based on a middle school mobile device mystery/'We Do' Approach**

The instructors, mentors, and intermediate students conducted various hands-on experiments to assist with the East Side Middle School Cyberbullying criminal investigation, which evaluates the "We Do" theory.

1. Fingerprint Impressions Hands-on Activity
The students needed the following items to craft the fingerprints of individuals: a sheet of typing paper, a graphite pencil, a fingerprint card, clear tape, a Magnifier + Flashlight APP2U on Play Store for Android (optional), or a Magnifying Glass + Flashlight on App Store for iPhone (optional) [24].

For this activity, the students wrote illegibly or doodled on a sheet of typing paper about 2 x 2 inches leaving no places visible. The researchers communicated to the students to place the flesh of the right index finger on the doodle. With the mentors' assistance, the students placed the masking tape over the flesh of the tutees' right index finger. Taking the masking tape from the students' index fingers and placing the tape from the right index fingerprint on the fingerprint card demonstrated the index finger's ridges, which the scholars repeated until the fingerprint card had ten identical fingerprints. The following were some key questions that the students were asked: How many loops, whorls, or arches does an individual have in their right/left thumb, index, middle, ring, and little fingers?

2. Footwear Impressions Hands-on Activity
The students needed the following items to facilitate the footprints of individuals: old shoes, cooking spray, cocoa powder, two sheets of typing paper, one small paintbrush, one pair of gloves, and a Magnifier + Flashlight from Day One (optional) [26].

The mentors poured an aggregate amount of cocoa powder on each student's typing paper in this synopsis. Using a paintbrush, the students scatter the cocoa powder onto the sheet. With the tutees' gloves in use, the researchers relay to the students to mist the sole of the shoe with vegetable oil and position the sole in cocoa powder on the students' sheet. Using the other sheet, the scholars took the sole from the cocoa powder and pressed it down onto the second typing paper, essentially making a photocopy of that image. The following were some key questions asked to the students: What is the name of the manufacturer? What is the model of the shoe? What is the shoe size of the suspect?

3. DNA Double Helix Hands-on Activity
The students needed the following items to master the DNA of individuals: two teaspoons of sports drink, one small cup with a top, two drops of dishwashing liquid, two teaspoons of alcohol (which the mentors should handle), one stir stick, and Magnifier + Flashlight from Day One (optional) [31].

In this scenario, the instructors told the students to cleanse their hands thoroughly before handling elements of the DNA components, and the mentors presented each student with a plastic cup. Within that cup, students measured two teaspoons of sports drink, swishing by mouth for one minute and releasing it into that cup. The scholars placed two drops of dish soap into the cup, stirring them gently. The researchers placed isopropyl alcohol in the freezer for several hours, and the mentors measured two teaspoons of chilled isopropyl alcohol for each student. With the mentors' assistance, the students gently poured the liquid down the sides of the cup, covered the cup with the lid, and gradually combined the ingredients. Using the stir stick, students could distinguish swirls of their DNA. The students asked the following questions: Why did we use isopropyl alcohol? Why did we use dishwashing liquid?

4. Smartphone Hands-on Activity
Using the pupils' imagination, students had to sketch a smartphone that was thirty years from today's date where they had some exciting suggestions such as containing memory functions without a charge, or the memory functions could be in one's comprehension so individuals could perform functions like SMS/MMS messages simply by doing so with no devices available. One group was ingenious in that smartphones would be as tall as some buildings. Since skyscraper smartphones are improbable, the group's intuitiveness will aid in creativity and sensibly thinking as adolescents mature.

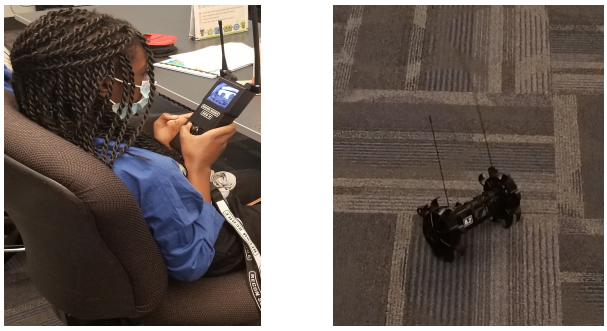


Figure 3: Student Controls a 'throwbot' (see Figure 4) with a ViewScreen.

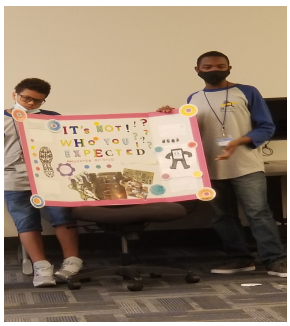
5. United States Marshal Service Visited JSU eCSI Mobile Device Forensics Detectives' Summer Camp

Two Deputy U.S. Marshals, from Hattiesburg and Jackson, MS, came and spoke to the middle school students about Mobile Device Forensics and what role smartphones portray in catching the individual. The students enjoyed seeing how the U.S. Marshals function and the Deputes showed the researchers and students 'throwbots', which is a robotic camera that can be thrown into a residence or a room (See Figures 3 and 4). There are 94 federal judicial districts, the District of Columbia, the Commonwealths of Puerto Rico and the Northern Mariana Islands, and the two territories of the United States. U.S. Marshals Service offices are based on the organizational structure of the Federal District Court system. Mississippi is divided into two judicial districts referred to as the Northern and Southern Districts of Mississippi. For the Northern District, court is held in Oxford, Aberdeen, Ackerman, Corinth, Clarksdale, and Greenville, and in the Southern District, court is held in Jackson, Meridian, Natchez, Vicksburg, Biloxi, Gulfport, and Hattiesburg. Mark B. Shepherd was appointed to serve as the United States Marshal by President Donald J. Trump and currently serves as the U. S. Marshal for the Southern District of Mississippi [2].

- **Implement the middle school students' knowledge in critical thinking, deductive reasoning, and inference skills based on a mobile device mystery/'You Do' Process**

The intermediate students conducted Cyberbullying Criminal Investigation Activities that used fingerprints and footwear impressions, DNA, and mobile device evidence, master in the 'I Do' 'We Do' processes, to capture the suspect, which evaluates the 'You Do' theory.

The researchers separated the students into four groups with four resource centers: fingerprint, shoe print, DNA, and smartphone analysis. Each group combined their knowledge, critical thinking, deductive reasoning, and inference skills as they were able to interpret the suspect for that resource center. For instance, there were several fingerprints on the wall and several fingerprints on the table. However, only one fingerprint would be identical to one fingerprint on the wall. The suspects were identical in each instance as they pertained to fingerprints, footwear impressions, and DNA, narrowing it to three cyberbullying suspects. Then, the scholars completed a mobile device forensics email experiment based on the smartphones given. Based on all the forensics evidence, 100% of the tutees knew who did the crime or, in essence, "Who Done It" and presented Mobile Device Forensic posters saying such.



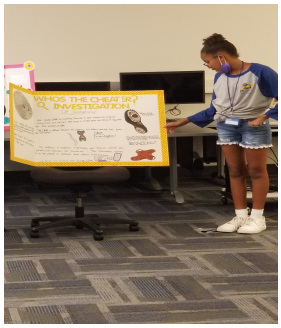


Figure 5 and Figure 6: Mobile Device Forensics Detectives' Who Done It? Posters

IV. Conclusion

The scholars took part in JSU's Mobile Device Forensics Detectives' Summer Camp, which centered on solving an East Side Middle School Cyberbullying Investigation through critical thinking, deductive reasoning, and inference skills associated with fingerprint, footwear impressions, DNA, and mobile device forensics analysis. Pupils mastered the lectures involving the four forensics' techniques and demonstrated various hands-on activities involving a law enforcement fingerprint card, a coco powder footwear impression, a DNA double helix, and a smartphone forensics activity. Two U.S. Marshals visited our summer camp and told the students how an investigator could seize a criminal using a mobile device. On the final day, the middle school students implemented what they had learned on the previous days to discover "Who Done It."

Mobile device forensics will serve as a rigorous recruitment tool to STEM, especially computer science and computer engineering, because programming is the number one fixation that deters students from majoring in computing. This mobile device curriculum has the potential to bridge the gap between the K-12 community and students struggling in the STEM sciences by developing methods of a forensics examiner from a computer scientist's perspective. Providing successful role models who are also underrepresented minorities will establish a foundation for the students' further interest in STEM education and make this research necessary.

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