Creating, Implementing, and Evaluating Forensics Activities Kits in a Remote Learning Modality

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Abstract: The COVID-19 pandemic resulted in many learning institutions switching from the traditional face-to-face instruction to remote learning. This study highlights the use of a low-cost and low-tech forensics activities kit for an introductory forensics lecture course that was taught remotely during the Spring 2021 semester. Each student in the course received a forensics activities kit which included a packaging evidence kit, fingerprinting kit, handwriting/chromatography kit, and a blood spatter kit. At the end of the semester, students were surveyed for feedback regarding the kits. The majority of students agreed that the individual kits were effective activities for learning the respective material. All students agreed that overall, the kits helped them to further understand the forensics concepts as well as increased their confidence in understanding the material. This study suggests that low-cost, low-tech, instructor-assembled forensics kits are effective hands-on activities for students and should be considered when developing a remote or distance education course. Further research into using hands-on activities kits within virtual forensics courses should be explored.

Keywords: forensics, activities kits, hands-on, remote learning, distance education, low-cost, low-tech

Introduction

In April 2020, the COVID-19 pandemic disrupted the education of approximately 1.5 billion students worldwide (1). Early in the pandemic, many classes that were typically taught in a face-to-face setting needed to shift to a remote learning modality. Remote learning, or distance education, is a type of online instruction that occurs when a course is taught virtually, without any face-to-face instruction, during set class meeting days and times (2). As the pandemic continued, many classes remained online for more than a year (3,4).

The shift to a remote learning modality presented various opportunities as well as challenges for educators and students (5-7). A recent study by Mukhtar et al. surveyed faculty and students regarding the advantages and limitations of online learning during the COVID-19 pandemic (7). One limitation noted was the disruption to hands-on activities in classes such as laboratories and clinicals (7). A faculty member commented, "*in anatomy, the study through models was good. But hands-on training is not possible, the student will not be able to understand properly. Skills need actual hands-on training"* (7). Students also expressed frustration with the loss of hands-on activities while learning online during the pandemic. According to a 2020 study conducted by Shim and Lee, many college students reported that one of the shortcomings of remote learning was the constraints on practicals and experiments (5).

Faculty and student dissatisfaction regarding the loss of hands-on activities within a remote setting is understandable as numerous educational research and theorists, including Piaget and Bruner, have shown that "learning by doing," especially within the sciences has many advantages (8). The Society for College Science Teachers position is that, "laboratory experiences should be related to and integrated within the conceptual flow of every science course" (9).

The students surveyed during Shim and Lee's research suggested conducting face-to-face classes for hands-on activities (5). However, during the pandemic, this was not safe or feasible due to a variety of reasons including adherence to social distancing guidelines, maximum room capacities, and the availability of large on-campus laboratory spaces that adhered to de-densification requirements. Science instructors whose courses had included hands-on activities or laboratory investigations were faced with the problem of how to continue to provide these practical learning opportunities to students, even though the course was being taught online. This paper discusses how to overcome this challenge by presenting a case study highlighting the

creation, implementation, and evaluation of an instructor-assembled forensics activities kit. This kit allowed students in an introductory forensics lecture course to participate in hands-on activities while in a remote learning modality during the COVID-19 pandemic.

Materials and Methods

Salisbury University is a public university located on the Eastern Shore of Maryland. At Salisbury University, *Biology 105: Science and Society* "introduces the non-biology major to the broad principles, fundamental ideas, and new discoveries in biology that significantly affect the human being's present and future existence" (10). A variety of *Biology 105* course topics are offered such as "The History of Spice," "Insects and Human Society," "The History of Zoos," and "Forensics."

The goal of the *Biology 105 Forensics* course is to introduce forensic science with an emphasis on processing the crime scene and the evidence recovered during an investigation. *Biology 105 Forensics* is a lecture course with a class size of no more than 20 students. This lecture course typically meets two days per week for one hour and fifteen minutes each time. *Biology 105 Forensics* has been taught in three different modalities. During the Fall 2019 semester, the course was taught face-to-face. In this format, all students met in the classroom for the duration of the class time. During the Fall 2020 semester, the course was taught in a hybrid format in which students met for the first day of class each week online synchronously. On the second day, half of the class would meet for the first half of the meeting time in the classroom, and then the second half of the class would meet for the second half of the meeting time in the classroom. This allowed for de-densified face-to-face instruction that followed social distancing guidelines. During the Spring 2021 semester, the course was taught remotely. In this format, all students met online synchronously during class time.

The instructor created forensics activities kits prior to the start of the Spring 2021 semester (**FIGURE 1**). After the add/drop date, students picked up a kit from the instructor on campus or received a kit by mail. The students were not charged an additional fee for the kits. Also, students were not required to return the kits to Salisbury University at the end of the semester.

The forensics activities kit contained several smaller kits: a packaging evidence kit, a fingerprinting kit, a handwriting/chromatography kit, and a blood spatter kit.

FIGURE 1 ***Individual forensics activities kits prepared for the Spring 2021 semester.*** *These individual kits (packaging evidence, fingerprinting, handwriting/ chromatography, and blood spatter kits) were then assembled into a large-padded mailer envelope for each student*

All of the contents were contained within a large padded mailer envelope. Individual kit contents were contained within separate resealable storage bags.

The activities kit also contained various papers such as a general directions sheet, graph paper for crime scene sketches, printer paper for a pharmacy fold, a copy of a Federal Bureau of Investigations (FBI) Applicant Fingerprint Card on printer paper, a document to examine various handwritings and practice forgeries, and a document to record blood spatter data.

Packaging Evidence Kit

The packaging evidence kit contained the following items: a piece of fabric with simulated blood, a piece of evidence tape, a biohazard sticker, a small manila envelope, an evidence identification label, a small piece of a rubber band, and a piece of printer paper (**FIGURE 2**). The rubber band was packaged in a small resealable storage bag within the kit to keep it from being lost.

Students used kit items to practice packaging a piece of mock evidence by placing the fabric with simulated blood into the manila envelope. They sealed the envelope using the evidence tape, and affixed a biohazard sticker to the envelope along with a completed evidence identification label. Additionally, students practiced packaging the mock trace evidence, a segment of a rubber band, by creating a pharmacy fold using the supplied piece of printer paper. Students were asked to supply tape to seal the pharmacy fold.

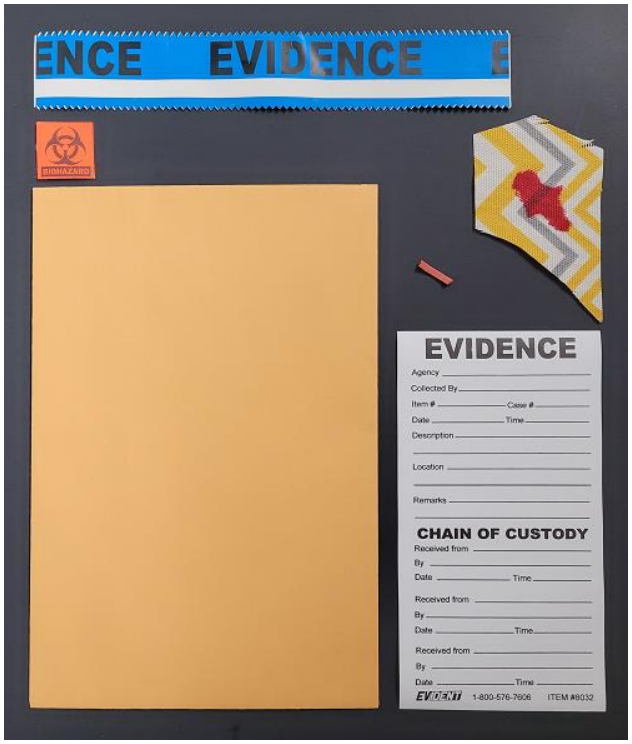

FIGURE 2 ***Components of the packaging evidence kit.*** *This kit contained the following items: a piece of evidence tape, a biohazard sticker, a small manila envelope, an evidence identification label, a small piece of a rubber band, a piece of fabric with simulated blood, and a piece of printer paper (not shown).*

Fingerprinting Kit

The fingerprinting kit contained the following items: a piece of clay, a small plastic magnifying glass, a copy of an FBI Applicant Fingerprint Card on printer paper, and an ink pad (**FIGURE 3**). The piece of clay was packaged in a small resealable storage bag within the kit to preserve the clay and separate it from the other components.

Using this kit, students practiced creating and viewing plastic fingerprints by impressing their fingers into the clay. Then, students used the magnifying glass to view the friction ridge pad impressions.

Again, using the magnifying glass, students created and viewed latent prints by pressing a finger onto the magnifying glass. During the remote class, students also watched as the instructor deposited latent prints onto a glass pane within a door. The students then watched as the instructor used oblique lighting to locate the fingerprints and magnetic powder to develop the prints. The instructor then demonstrated how to recover the prints using latent fingerprint tape and a fingerprint card.

Additionally, students created patent fingerprints by applying ink from the ink pad to their fingers and then applying this to a copy of an FBI Applicant Fingerprint Card. Lastly, students classified each of their fingerprints as a loop, whorl, or arch.

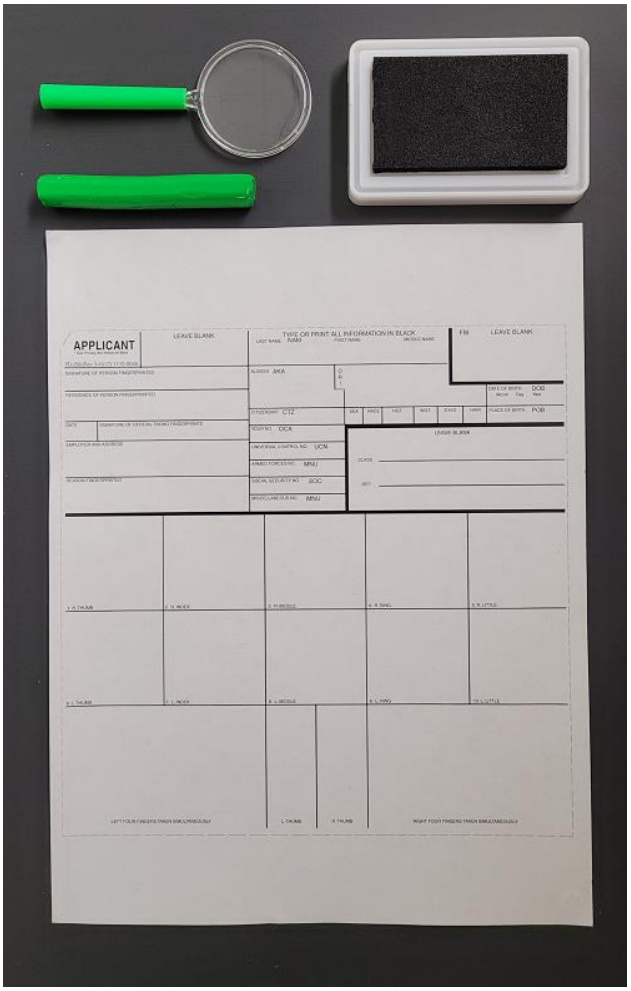

FIGURE 3 ***Components of the fingerprinting kit.*** *This kit contained a small plastic magnifying glass, a piece of clay, a copy of an FBI Applicant Fingerprint Card on printer paper, and an ink pad.*

Handwriting/Chromatography Kit

The handwriting/chromatography kit contained a 15 mL conical tube with a piece of chromatography paper located inside of it. On the chromatography paper was a line drawn with a black marker approximately 1/4 from the bottom of the paper. The kit also contained a small weigh boat, a disposable transfer pipette, and a line from Sherlock Holmes from *The Adventure of the Blue Carbuncle* written in various handwriting (**FIGURE 4**). Students supplied the water for this activity.

During this hands-on activity, students investigated chromatography and handwriting. They were provided background on a mock bank robbery where a note was recovered. It was requested that the mock evidence be processed to determine which type of marker was used to

write the note. Students were advised that their chromatography paper contained the ink that was used in the bank robbery note.

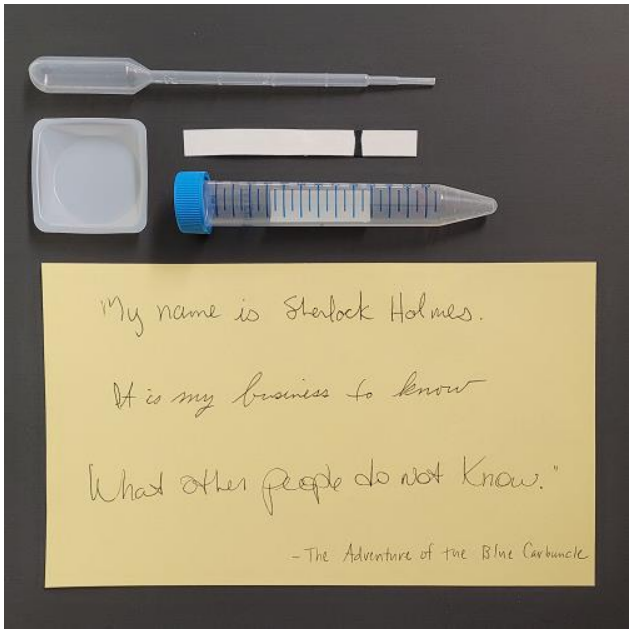

FIGURE 4 ***Components of the handwriting/chromatography kit.*** *This kit contained a disposable transfer pipette, a weigh boat, a 15 mL conical tube with a piece of chromatography paper located inside of it. On the chromatography paper, there was a line drawn with a black marker approximately 1/4 from the bottom of the paper. The kit also contained a piece of paper with a line from The Adventure of the Blue Carbuncle.*

First, students removed the chromatography paper from the conical tube. Then, they filled the small weigh boat with water. Using the disposable transfer pipette, students transferred water from the weigh boat to the conical tube, filling it with 2 mL of water. They placed the chromatography paper back into the conical tube and placed the tube in an upright position.

Prior to class, the instructor used six different black markers (including the same marker that was used to write the note and student's chromatogram) to create six chromatograms, one for each marker. In class, the instructor placed five of the chromatograms in conical tubes containing isopropyl alcohol; however, the sixth chromatogram (that was the same marker that was used to write the note and student's chromatogram) was placed in water.

While waiting for the instructor's and students' chromatograms to develop, students practiced writing the sentence, "The quick brown fox jumped over the lazy dog." The students wrote this sentence with their dominant hand, non-dominant hand, and also with their dominant hand in all capital letters. These sentences allowed students to view various elements of their handwriting such as spacing, slanting, and lettering. Next, students placed a piece of paper or notebook under the paper and re-wrote the sentence to view an example of indented writing.

Students also viewed a piece of paper in the kit that contained a line from Sherlock Holmes in The *Adventure of the Blue Carbuncle* (11). Students practiced forging the writing on each line. Students then reflected on how natural writing, a subconscious task, differs from mimicked writing. The instructor advised students that this activity was used to illuminate forgeries and that copying someone's writing is not acceptable.

Lastly, students revisited the chromatograms. The instructor presented the chromatograms to the class that had developed for the six black markers. Students observed the chromatograms and identified the correct marker that wrote the note by comparing the separation that they viewed within their chromatogram to the known chromatograms that the instructor had prepared.

After the experiment, the instructor advised the students that the solvents within the known conical tubes were not all the same. The instructor explained that it wasn't possible to send isopropyl alcohol through the United States Postal System and that many markers are not water soluble. Therefore, in order to view separation of the marker dyes, isopropyl alcohol was used for five of the inks. The instructor further explained that the marker that was used to draw the line on the chromatography paper included within the student's chromatography kit was water-soluble which was why water was used as the solvent.

Blood Spatter Kit

The blood spatter kit contained the following items: a 15 mL conical tube with instructor-made simulated blood, a disposable pipette, an index card, a piece of wood, a piece of tile, a piece of carpet, a piece of fabric, a ruler, and a document to record blood spatter data (**FIGURE 5**). The conical tube containing the simulated blood was placed in a separate resealable storage bag within this kit.

Students used this kit to view blood spatter on different surfaces. Using the ruler, simulated blood, and a pipette, students dropped blood from approximately 10 cm and 30 cm above the various surfaces (tile, fabric, paper, wood, and carpet). Students recorded the diameter of each drop as well as any observations about the drops. Students compared the size of the blood droplets which were dropped closer to the surface versus farther away.

FIGURE 5 ***Components of the blood spatter kit.*** *This kit contained a ruler, a piece of wood, a piece of tile, a piece of carpet, a piece of fabric, a 5×8 inch index card, a disposable transfer pipette, a 15 mL conical tube with simulated blood, and a document to record blood spatter data (not shown).*

Hazards and Safety Precautions

The forensics activities kit included directions for the kit which reminded students of general safety precautions. The directions advised that only the forensic student should use the kit during the appropriately scheduled class time. Since there were minimal safety risks, personal protective equipment (PPE) was not included in the kit as the contents consisted of nonhazardous forensic supplies and household materials. Students were informed that the blood within the kits was simulated, but could possibly stain skin, clothing, or work surfaces, and therefore, they should wash immediately if a spill occurred. Additionally, the instructor provided specific directions that pertained to each kit during the respective activity.

Items were chosen for each kit to minimize safety hazards. The ink pad used was a non-toxic ink pad. All of the blood material was simulated either using a red marker or using a mixture of water, corn starch, corn syrup, and food coloring. Within the mixture, the food coloring was used to create the appearance of blood, while the corn starch and corn syrup were used to increase the viscosity so that it was similar to blood. The magnifying glasses used were plastic, not glass. Also, the chromatography kit did not contain any solvents which could be flammable.

Student Surveys

To obtain feedback regarding the forensics activities kits, students were asked to complete a short survey at the end of the semester once all the activities within the kits had been completed. Student participation was voluntary. If a student completed the survey, 2 extra credit points were awarded for the semester.

Using a Likert response scale, students were asked to think about each of the forensics activities kits and to select their level of agreement with the following statements:

- The packaging evidence kit (included envelope, fabric with simulated blood, evidence tape, evidence label, trace evidence- piece of rubber band, and a piece of paper for a pharmacy fold) provided an effective activity for learning how to package evidence properly.
- The fingerprinting kit (included clay, magnifying glass, ink pad, and FBI Applicant card) provided an effective activity for learning about different types of fingerprints and fingerprint patterns.
- The handwriting and chromatography kit (included handwriting samples, pipette, weigh boat, conical tube, and chromatography paper with ink) provided an effective activity for comparing handwriting samples and writing instruments.
- The blood spatter kit (included simulated blood, pipette, ruler, tile, wood, fabric, and paper) provided an effective activity for viewing and comparing blood droplets that originated from various heights onto different surfaces.

Using a similar Likert response scale, the survey also asked students to think about all the forensics activities kits as a whole and to select their level of agreement with the following statements:

- Overall, the forensics activities kits helped me to further understand forensics concepts.
- Overall, my confidence in understanding the forensics concepts increased due to using the forensics activities kits.
- Overall, the forensics activities kits contained all of the supplies that I needed to conduct the activities.

Lastly, students were asked if they believed any additional supplies or kit activities would help to strengthen the delivery of these forensics concepts. If the students answered yes, they were asked to describe their thoughts on additional supplies or kit activities.

This survey study was approved by Salisbury University's Institutional Review Board.

Results

Ten out of the seventeen Spring 2021 *Biology 105 Forensics* students completed the survey.

For each of the individual kits, the majority of students strongly agreed or agreed that the kits were effective activities for learning the material. Regarding the packaging evidence kit, 70% strongly agreed and 30% agreed that the kit provided an effective activity for learning how to package evidence properly. Similarly, 70% strongly agreed and 30% agreed that the fingerprinting kit was an effective activity for learning about different types of fingerprints and fingerprint patterns. Regarding the handwriting and chromatography kit, 50% strongly agreed, 40% agreed, while 10% disagreed that the kit provided an effective activity for comparing handwriting samples and writing instruments. Lastly, 70% strongly agreed and 30% agreed that the blood spatter kit provided an effective activity for viewing and comparing blood droplets that originated from various heights onto different surfaces (**FIGURE 6).**

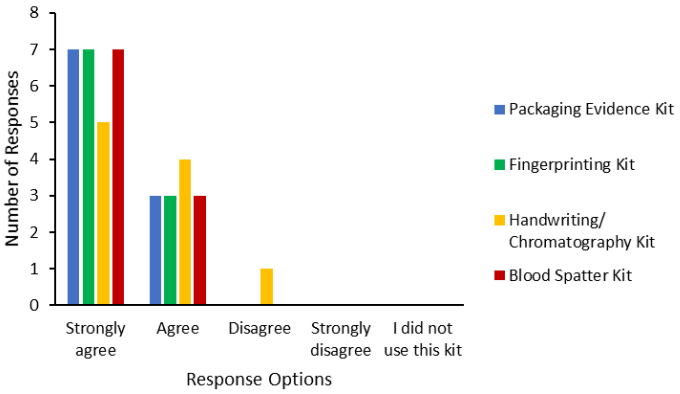

FIGURE 6 *Student responses regarding the effectiveness of individual forensics activities kits in learning the material.*

In considering all the forensics activities kits as a whole, all the students strongly agreed or agreed with the survey statements. Eighty percent of the students strongly agreed and 20% agreed that overall, the forensics activities kits helped them to further understand forensics concepts. Similarly, 80% strongly agreed and 20% agreed with the statement, "Overall, my confidence in understanding the forensics concepts increased due to using the forensics activities kits." Lastly, 90% strongly agreed and 10% agreed that the forensics activities kits contained all of the supplies that I needed to conduct the activities (**FIGURE 7**).

When students were asked if they believed any additional supplies or kit activities would help to strengthen the delivery of these forensics concepts, one student suggested including a kit with pieces of a gun such as the barrel as well as the different impressions that are made by it in order to better understand the topic of firearms.

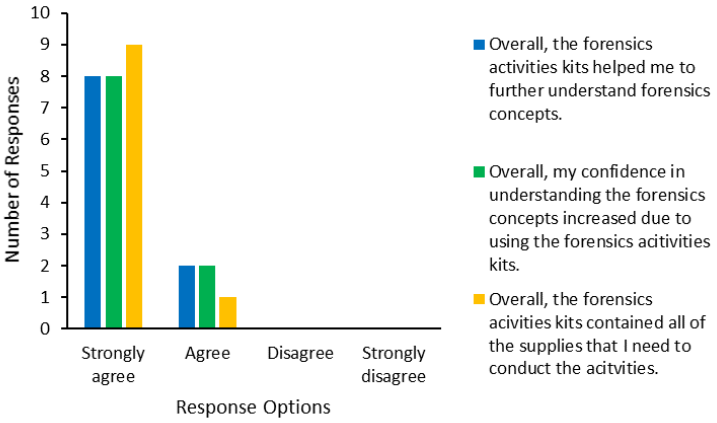

FIGURE 7 *Student responses when considering the overall forensics activities kit.*

Discussion and Conclusion

The forensics activities kits provided students with a hands-on experience while in a remote setting, which were useful even in a lecture course. Student survey responses overwhelmingly agree that individual kits were effective activities in learning the respective forensics material. Possible explanations for these survey responses are that the activities kits reinforced theoretical lecture material, increased student focus and engagement, and/or piqued student interest in the subject matter. These possible mechanisms would need to be further explored with future research.

With regard to kit supplies, most students agreed that the kit contained all of the resources that were needed. The only suggestion was that pieces of a firearm be included in the kit which is valid; however, for a variety of reasons, it is not logistically possible to include these items safely within a kit.

The forensics activities kits used in this study were basic kits that could easily be assembled by an instructor. Preparing and packaging the kits took approximately one week. This time did not include designing the kits which can be quite time intensive when considering backward designing a course, especially in a remote setting. The forensics activities kits were prepared for a nominal cost. All of the kit supplies as well as the storage baggies and large padded mailer envelope cost approximately $9.00 per student. Supplies bought for the kits were purchased through Salisbury University's Biology department. The kits provided all students with equal access to the hands-on materials needed for the class which is crucial for any course, including those offered remotely (12). Alternatively, an instructor could purchase kits from an

educational science supply company. Several of these companies offer forensics kits for the classroom; however, few offer commercial kits intended for the individual learner in a remote setting, and many of those can be rather costly. As a result, instructors could consider creating low-cost, low-tech, hands-on activities kits based on a variety of forensics topics for their remote courses.

Studies on hands-on activities used in online learning settings exists for a variety of science subjects (13-20). Moreover, some studies have shown that students who are in a distance education course with hands-on activities perform as well or better than students learning in a face-to-face setting (19-21). However, there is a research gap in studying these hands-on activities specifically within forensics as there appears to be limited literature related to the subject matter (21-23). While this study has limitations with regard to a relatively small sample size (n=10) and students' self-reporting, it can serve as a starting point for future research centered around the implementation and evaluation of hands-on activities that are designed specifically for a remote forensics course. The focus of future studies could compare outcomes of forensics courses with face-to-face instruction and hands-on activities to that of remote instruction with activities kits. Furthermore, the implementation of hands-on activities kits within a remote forensic science majors' course could be explored. Lastly, when creating and using forensic activities kits within a remote course, instructors should consider the potential impacts regarding Forensic Science Education Programs Accreditation Commission (FEPAC) program accreditation.

While the COVID-19 pandemic presented numerous challenges within higher education, it also offered educators the opportunity to thoughtfully reimagine their courses in an online setting. This study suggests that it is possible to successfully develop and implement low-cost, low-tech, hands-on activities within a remote forensics class. When necessary, this may be a feasible alternative to traditional face-to-face instruction.

Acknowledgements

The author wishes to express her gratitude to the following individuals for their support and assistance with this study: Dr. Kim Quillin, Dr. Sarah E. J. Winger, Dr. F. Les Erickson, Dr. Victor Miriel, Ms. Sandy Ramses, Mrs. Krispen Laird, Capt. Victor Bunting, Jr., and Salisbury University's Spring 2021 *Biology 105 Forensics* student survey participants.

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