Journal of Online Learning Research (2018) **4**(3), 263-294

Integrating Online Instruction and Hands-on Laboratory Activities for Summer Learning for Students of Color: A Design Case in Forensic Science

DOUGLAS ELRICK
Iowa State University
dgelrick@iastate.edu

JIAQI YU
Iowa State University
jiaqiyu@iastate.edu

CONSTANCE HARGRAVE
Iowa State University
cph@iastate.edu

The popularity of TV shows such as Crime Scene Investigation (CSI) has generated high school students' interest in forensics. Yet, forensic science is not commonly accessible to students, and especially students of color who often attend under-resourced high schools. This article presents the design, development, and evaluation of an online forensics course created for high school students of color who were part of an informal science, technology, engineering, and mathematics (STEM) educational development program. Two essential elements guided the course design: the target learners (high school students of color) and integrating online instruction and hands-on laboratory activities involving real-world forensic analyses. The design of the online course provided a STEM content-rich, self-directed, informal learning environment that effectively engaged high school students of color in meaningful forensics learning during the summer.

Online instruction provides a much needed and educationally appropriate means of facilitating teaching and learning for many K-12 environments, both formal and informal. Yet, the potential of online education for informal K-12 learning has not been fully developed (Sackey, Nguyen & Grabill, 2015). In this article, we present a design case of the design, development, and evaluation of an online forensics course tailored to high school students of color who were part of an informal science, technology, engineering and mathematics (STEM) educational development program. The paucity of science curriculum materials designed to be culturally relevant to students of color and the need to enhance K-12 students of color access to quality STEM content (Lee & Buxton, 2008) were motivating factors for the development of the forensics course.

Using the Analysis, Design, Development, Implementation, Evaluation (ADDIE) model (Molenda, 2003), we designed and developed an online forensics course to meet the needs of students within the context of an informal STEM educational development program. The ADDIE model was selected because it is a basic and widely accepted model. It also has a successful history of allowing students to meet intended goals by incorporating an evaluation phase to allow for improvements (Wang & Hsu, 2009). We centered the design of the course on the following two elements: the target learners (high school students of color) and integrating online instruction with hands-on laboratory activities. In the implementation of the course, gamification elements were employed to support and encourage engagement. Course evaluation data indicated that students made significant gains in their knowledge of forensic science, and the course design effectively increased students' understanding and interest in forensics.

The design case begins with an overview of the background, instructional problem, and the goals of the course. The section of design and development highlights the processes and rationale used for key decisions regarding the production of the course. The description of the course implementation provides details about the instructional operations of the course. Finally, the evaluation processes and results are presented along with major course modifications based upon student and instructor feedback.

BACKGROUND: CONTEXT, LEARNERS, AND INSTRUCTIONAL CONTENT

The national emphasis on preparing K-12 students in STEM has resulted in the need for a new and innovative curriculum that teaches both core content and increases students' interests in and motivation to pursue careers in STEM fields (U.S. Department of Education, 2016). This emphasis on STEM educational experiences has grown beyond formal classroom education to include informal education programs.

Providing students with access to current and relevant STEM content is a challenge for both formal and informal educational programs (STEM Education Coalition, 2016). This is particularly the case for students of color in K-12 schools (Lee & Buxton, 2008) and informal educational programs (National Research Council, 2009). In the U.S., historical and structural inequalities at societal and institutional levels have produced unequal educational opportunities for students based upon their race (Riley, Foster, & Serpell, 2015). For example, as compared to white students, students of color experience higher rates of school suspension, have less access to high-level math and science courses, are disproportionately underrepresented in talented and gifted classes, are more likely to attend schools with inexperienced teachers, and are more likely to attend schools that have law enforcement officers and no counselors (U.S. Department of Education, 2016). Merely being a student of color makes one at risk of not succeeding in school (Larson, 2010).

Online instruction is one method to provide equitable learning opportunities by providing K-12 students access to high-quality STEM instructional materials (Lee & Buxton, 2008). Many communities offer a variety of summer educational experiences for K-12 students, such as those focused on robotics, solar energy, multimedia design, web design, and/or game design. Often these are enrichment experiences that center on experiential learning and exposure to information not typically available, or available to a limited degree, in the K-12 school curriculum. Outside of the confines and conventions of formal education, summer learning is generally casual with less emphasis on traditional measures of performance (Vantassel-Baska, Landau, & Olszewski, 1984), yet it is critically important in stopping and reducing the summer learning loss. Students not engaged in educational endeavors during the summer tend to lose significant portions of the knowledge and skills they acquired during the school year. This loss is often more significant for students of color (Quinn & Polikoff, 2017).

The online curriculum designed and evaluated in this study was developed to address the learning needs of high school students of color engaged in Growing Students in Science, Technology, Engineering and Mathematics (G-STEM) (pseudonym). G-STEM is an extra-curricular, university-led collaborative program involving STEM corporations, high school teachers, and students and families of color (Hargrave, 2015). Started in the 1990s through a National Science Foundation grant, G-STEM is housed at a large, midwestern research university funded by STEM corporations, philanthropic foundations, the university and private donors. G-STEM operates like a face-to-face, after-school club, with academic and participation expectations, that equips and empowers students to pursue degrees in STEM fields

(Hargrave, 2015). Annually, 400 students participate in G-STEM, approximately 60% Latino and 30% African American. G-STEM students represent 19 schools from three school districts, two rural and one urban (Rollins, Hargrave, & Romero-Hernandez, 2018). Students who completed the five-year pre-college G-STEM program earned four-year scholarships to study in STEM fields.

Students in G-STEM are expected to complete a minimum of 40 hours of summer learning in any type of learning environment. The aim of the 40-hour requirement was to redress the summer learning loss often experienced by students of color (Quinn & Polikoff, 2017). Although there were many traditional face-to-face educational opportunities for G-STEM students (through the program and in the community), most programs did not offer flexible scheduling. Because of student work schedules and family travel plans, it was difficult for G-STEM students to participate in the face-to-face summer educational programs.

Due to the 40-hour summer learning obligation, the need for quality program options has given rise to the need for developing interesting and challenging opportunities. This requires an understanding of what may pique the curiosity and motivations of high school students. With that, the popularity of TV shows such as Crime Scene Investigation (CSI) has generated public interest in forensics, including among high school students (Slater & Jain, 2011). An advantage of a course in forensic science is that students are exposed to a wide variety of scientific fields, such as chemistry, biology, and physics, and in an arena that helps maintain their interests. However, forensic science is typically not accessible to students, especially students of color who often attend under-resourced high schools (Darling-Hammond, 2007; U.S. Department of Education, 2016). Although many online forensics courses are available to the public (e.g., courses from Outschool, www.outschool.com), these courses often do not provide the structure of integrating hands-on activities that meets high school students' developmental needs in informal learning contexts (Outschool, 2018). Most require students to employ academic discipline and intellectual independence to engage in learning entirely on their own (Bettinger & Loeb, 2017). Additionally, these courses rarely offer hands-on, laboratory experience (Bettinger & Loeb, 2017). Thus, existing online forensics courses did not meet the needs of the students in this context.

INSTRUCTIONAL PROBLEM

The G-STEM program needed a way for students to learn forensic science as an extension of their interests, in a structured environment that fostered academic independence, and allowed students to explore the content without the pressure of school performance measures. Also, providing

G-STEM students with online instruction had the potential to provide students access to high-quality STEM content and meet their summer scheduling needs. The online forensics curriculum was designed to address the need for the following:

- content-rich and experiential learning for high school students of color;
- flexible scheduling to accommodate students' work and travel schedules;
- independent learning among high school students (in preparation for college); and
- STEM instruction within the summer learning context (i.e., de-emphasize traditional academic performance measures, enable significant knowledge acquisition, and generate interest in the content).

DESIGN AND DEVELOPMENT

While there were many factors that influenced the design and development of the forensics course, we focused this paper on two key factors: the target learners (high school students of color) and integrating online instruction and hands-on laboratory activities involving real-world forensic analyses. Our discussion of the design and development includes design considerations for the audience, decisions about the online format, efforts to ensure the course content aligned with national standards, and rationale for selecting course topics.

Design Considerations: Target Learners, Subject Matter Expert as Instructional Designer, and Instructor Role

Gaining access to forensics expertise can be a formidable challenge for K-12 educators wanting to develop practical and relevant lessons for their students. We employed a forensics practitioner both as a Subject Matter Expert (SME) and instructional designer. In this section, we discuss design considerations for the intended audience and the combination of the SME and instructional designer roles.

Target learners

The target learners, high school students of color, comprised an essential design consideration. Today's high school students represent the first generation born in the 21st century. These students, typically, have always known a wired world with smartphones, wireless internet, Bluetooth connections, and social media (Cilliers, 2017). The racial demographics of today's youth presents a 21st-century reality: children of color comprised more than 50% of the nation's K-12 public school students (NCES, 2014). Much of the shift in school demographics is due to the growth of Latino and African

American populations, yet Latino and African American students are often labeled as inferior in comparison to their white counterparts, especially on standardized test performance (Darling-Hammond, 2007; Dudley-Marling, 2015). These demographic and social realities point to the importance of and need to design instruction, especially STEM content (Lee & Buxton, 2008), tailored to youth of color.

We designed this forensics course to meet the needs of students of color by incorporating culturally relevant content. Children of color, as a group, do not necessarily learn differently than any other group of children. However, societal racism creates macro- and micro-level contexts in which opportunities, resources, and support for students of color are limited and/or denied (Riley, Foster, & Serpell, 2015). On a micro-level in the classroom, this racial reality manifests, not only in the curriculum (Gay, 2002), but also in the form of teacher expectations, stereotypes, and microaggressions (Pollock, 2001).

To ensure the course's cultural relevance to the target audience, we designed course content on two curricular levels: the official curriculum and the symbolic curriculum (Gay, 2002). The core content provided to students were taken from textbooks, articles, and electronic media. Text materials or textbooks that provide core content in a course are typically viewed by students as the official, accurate, complete, and incontestable truth (Child & Schwab, 2005). As Bowling (2018) indicated, there is a need for students of color to see more people of color in positions of expertise and authority. Thus, as a part of the text materials, we included images and videos of people of color engaged in important and significant forensics work (Benitez, James, Joshua, Perefetti, & Vick, 2017; Gay, 2002). By doing so, students were inclined to accept the involvement of people of color as central to the core content of forensics. Beyond the core text, we also showed people of color in peripheral roles outside of the core text. The symbolic presence of people of color as part of the overall learning environment was a means of conveying the relevance of the content to the target audience.

In determining the content for the course, the graphic nature of the information, along with the prior exposure to the crime scene material that students would have, was a consideration. Forensic television dramas such as *CSI* and their spin-offs (*NY, Miami, Cyber*), *NCIS*, and *Bones* have made the list of the highest watched shows around the world for more than ten years (Andreeva, 2018; Collins, 2015). The Nielsen ratings found similarly high viewership among teenagers (Slater & Jain, 2011). Despite its popularity among youth, forensic science television shows deal with many adult themes, issues, and often the worst actions of human behavior. These adult issues were a key design consideration in determining what and how the course content and experiences were to be presented to the audience of minors. Since today's youth are exposed to more information about criminal activity than past generations (via news, social media, TV shows and movies), we did not assume complete naiveté on the part of the audience. Their experience made the use of portions of prime-time forensic television shows a familiar entry-point for the audience.

Subject matter expert as instructional designer

Early in the process, we decided to utilize a forensic practitioner to determine the course topics, activities, and readings. The SME had 28 years of experience as a forensic scientist, including case experience in drug/toxicology, DNA/serology, trace evidence, computer forensics, and crime scene processing, and had served as an expert witness in local, state, and federal court. The SME also was experienced in instructional design for higher education, in face-to-face and online courses, and in professional training. The benefit to course design of the dual capacity of the SME/instructional designer was that course content and materials were vetted for authenticity and fidelity in light of instructional methods decisions. That is, the instructional designer possessed the needed technological, pedagogical, and content knowledge (Mishra & Khoeler, 2006).

Instructor role

The SME possessed an acute awareness of the lack of access to forensic content in typical high school curriculum and the limited expertise in the subject matter among high school science teachers. Thus, the decision was made by the SME/instructional designer and the G-STEM program director to design the course in such a way that students could work through the course materials and learn the content independently and with little need for a SME instructor. Thus, the instructor for future iterations of the course did not have to be knowledgeable or experienced in forensic science. Instead, the instructor role would be that of a facilitator who needed only to be familiar with the course objectives and materials and focus their efforts on supporting students as they progressed through the course.

Design Decisions: Creating Availability via Online Learning, Aligning to National Educational Standards, and Selecting Course Topics

This section will introduce our design decisions on choosing the online learning format, aligning to national standards, and selecting course topics.

Creating availability via online learning

Online instruction was chosen to provide the students with access to forensics expertise and content that otherwise would not be available to them. Additionally, the online instruction would accommodate students' scheduling needs. The course was designed to enable G-STEM students to complete their required 40 hours of summer educational activity. Placing the course online alleviated the challenge of identifying a set time and a physical location that both the forensic expert and students could easily access and commit to attending 40 hours during the summer.

Aligning to national educational standards

The Next Generation Science Standards (NGSS) were used to guide the selection of forensic content and ensure the content was age-appropriate for the audience and that the learning experiences complemented the students' formal education. The standards for high school students addressed learning in the fields of physical sciences, applied sciences, life sciences, and earth sciences (NGSS Lead States, 2013).

Table 1
Examples of NGSS High School Standards Associated with Course Development

Module	Standard	Implementation
Drugs/ Toxicology	HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.	Question 6 under "Drug & Toxicology Quiz"
DNA/ Serology	HS-LS3-1: Ask questions to clarify relationships about the role of DNA and chromosomes in coding instructions for characteristic traits passed from parent to offspring.	Question 3 under "DNA & Serology Quiz"
Questioned Documents	HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations	Questioned document comparison exercise under "Questions Document Activities"
Firearms/ Tool Marks	HS-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.	Tool marks exercise under "Firearm & Tool marks Activities"

We selected forensic topics based on biological and physical science principles to align the course with the standards. Table 1 shows examples of how the standards were applied in the course development. Similarly, the evaluation quizzes and activities were developed to measure student achievement of the standards.

Selecting course topics

Determining the main topics to include in the course was a major design decision. In selecting topics, it was important to remain cognizant of the purpose of G-STEM and the course development goal: to provide students an opportunity to experience the common forensic disciplines conducted in criminalistics laboratories around the world. Forensic science incorporates many different STEM disciplines (e.g., biology, chemistry, physiology, computer science, etc.). Exposing students to many science fields via the course could potentially cultivate their broader interest in pursuing one of these disciplines as a career, which was consistent with the G-STEM program mission.

Forensics, by definition, means relating to judicial matters; thus, forensic science can be considered the application of scientific knowledge to judicial matters (Saferstein, 2011). Therefore, any scientific discipline can have a forensic nature to it. To narrow the potential course topics, we began by considering areas routinely examined at state criminal investigative laboratories. In reviewing potential topics, we focused on pedagogical concerns and determined that to effectively foster meaningful student learning of forensic science in an online environment, it was necessary to incorporate hands-on laboratory activities as part of the course.

The incorporation of hands-on laboratory activities influenced the selection of course topics because it was essential to identify suitable hands-on activities for each topic that could be completed at home with no adult supervision. The six topics selected to comprise the course modules were DNA/serology, drug/toxicology, fingerprints/footwear, questioned documents, firearms/tool marks, and trace evidence. As stated previously, these fields are routinely a part of law enforcement crime laboratories and are commonly depicted in reality TV shows, such as *Forensic Files.* The original course design included eight topics. The two topics left out were computer crimes and arson/explosives. Both of these topics presented unique issues when it came to laboratory activities to be conducted at home. The issues related to computer crime had to do with system compatibilities and the need to have everyone use a specific computer type with the same operating system (i.e., Windows or Macintosh). At-home, hands-on laboratory activities regarding arson/explosives obviously could have disastrous consequences with the unsupervised use of fire or incendiaries.

To determine the length of time students would need to complete each module, the SME/instructional designer timed how long it took him to complete the modules. Given the students' limited prior knowledge of forensics and the independent nature of the online learning experience with hands-on activities, it was estimated that six and half hours per topic would be a sufficient amount of time for students to complete the learning activities for each module. The forensic course contained six modules which required approximately 40 hours for students to complete.

Designing the Lesson Structure

Once the topics were identified, we focused our design and development efforts on how the lessons and modules would be structured. Bonk and Zhang's (2006) Reading, Reflecting, Displaying, and Doing (R2D2) model was specially developed for online learning environments. Utilizing the R2D2 model, we developed a structure for presenting the content. Our structure included the organization of course components within each module, techniques of gamification, integrating hands-on laboratory activities with the online instruction, and choosing a Learning Management System (LMS) to host the online course (Kilcoyne & Habig, 2016).

R2D2 model

Our design process was informed and guided by the R2D2 model which has been effective in addressing the diverse preferences of online learners of various generations. Based on Kolb's (1984) experiential learning and Flem and Mills's (1992a, 1992b) four types of learners and learning preferences. Bonk and Zhang (2006) proposed the R2D2 model to address different online learning preferences to help online instructors integrate various learning activities with appropriate technology. According to the R2D2 model, reading and listening focuses on knowledge acquisition for learners who prefer verbal or auditory formats; reflecting works for reflective or observational learners; displaying learning for visual learners; and hands-on activities for kinesthetic learners (Bonk & Zhang, 2006). While it is clear that students can and do learn in a variety of ways, providing assignments that more closely cater to their preferences can aid in motivating student learning (Hong, Milgram & Rowell, 2004).

Due to the students' lack of prior knowledge of forensic science, we chose to incorporate the R2D2 multiple methods of learning with each module to provide a scaffolding effect that reinforces the learning objectives through various instructional methods. For example, in the DNA/serology module, students were expected to complete the reading assignments, watch videos, conduct hands-on activities, utilize computer simulators, and write reflections on their work. Although students were expected to participate in all of the instructional activities, the R2D2 model recognizes that some students may prefer to learn the material better from one particular methodology than the other methodologies. At the same time, another student prefers to learn the materials using different instructional activities.

Course components

In our application of the R2D2 model, we organized the materials and activities of each module into four components: reading, reflecting, displaying, and doing (Table 2).

Table 2

List of Components by Course Module in Online Forensic Science Course

Module	Reading	Reflecting	Displaying	Doing
Drugs/ Toxicology	Drug-Paraphernalia	Toxicology Simulator Reflection	FTIR and GC/MS Video	Cocaine/Meth Spectrum Analysis
DNA/ Serology	Blood Typing-DNA	DNA Simulator Reflection	Forensic Files Video OJ Simpson Case Video	Blood Spatter Activity ABO Blood Typing
Fingerprints	Boy Scout Fingerprinting Guide Casting Footwear Impressions	Casting Your Own Footwear Reporting	Myth Busters Video Forensic Files Video Comparing Fingerprints	Fingerprint Classifying Lifting Latent Prints
Questioned Documents	Handwriting and Counterfeiting Analysis	Writing Comparison Simulation Reflection	Counterfeiting Video Forensic Files Video	Ink Chromatography Handwriting Comparison
Firearms/ Tool Marks	Firearms, Ammunition, and Tool Marks	Firearms Simulator Reflection	Firearms and NIBIN Tool Marks Analysis Video	Tool Impression Comparison Activity
Trace Evidence	Glass & Soil Analysis Hair & Fiber Analysis	Collect Evidence and Locard's Principle Reflection	Forensic Files Video Collecting Trace Evidence Video	Duct Tape Matching Trace Evidence Collection and Review

The *Reading* component consisted of the presentation of information through readings or videos (e.g., e-readings from books, journals, articles, or videos of recorded lectures and real-time presentations). The *Reflecting* component was where students presented their views and perspectives on the forensic concepts they were learning. Their reflection was to go beyond repeating factual information to include critical thoughts about the implications of the forensic concept and in what contexts it may be applied. Students expressed their reflection in writing or verbal presentations. The *Displaying* component allowed students to organize and represent the forensic module information in a creative manner, such as the use of graphs, photographs, diagrams, audio depictions or a combination thereof. Students with artistic and inventive strengths may have a greater appreciation for assignments that let them creatively display information. The fourth component, *Doing*, was particularly motivating for students who preferred hands-on experiences. This component, via hands-on laboratory activities, digital simulations, and individual endeavors, allowed students to apply the knowledge obtained through action. After completing the exercises, students often used their phones to take photos of their work and submitted the images as evidence of their completion of the hands-on laboratory activities.

Culturally relevant pedagogy

Throughout the course modules, stories, and scenarios within the context of casework were used to teach core forensics concepts. The use of stories and storytelling is an essential means of communication within communal and collectivist cultures, such as African American culture and Latino culture (Gay, 2002). Utilizing stories was a means of culturally relevant pedagogy that was consistent with the cultures of G-STEM students.

Gamification

To support student engagement and enhance motivation, gamification strategies were incorporated into the course design. Gamification is the use of game elements and game mechanics in the implementation of non-gaming interactions (Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011). Elements associated with gamification include assessment, immersion, challenge, rules, and fantasy (Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012). For this course a point system, a leaderboard, and badges were incorporated as motivational incentives, which are subcategories of assessment (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2015).

Point system. A point system was incorporated into the design of the course to provide students with a mechanism to calibrate their engagement and performance. Students were informed that there were 2,000 points they could earn by completing the course, and they could earn an additional 300 points by completing advanced or additional activities available in various modules. Each homework assignment and quiz were worth 100 points. Earning 2,000 points was considered to be 100% achievement. Students who wanted to go beyond 100% could do so by completing advanced and additional activities. Students were also given the opportunity to make up missed points by completing the additional activities. The class average at the completion of the course was 1972 points (99% achievement), with a range of 1853 to 2084 (93-105% achievement).

Leaderboard. As a motivator, a leaderboard was published in the LMS and emailed to students on a weekly basis (Figure 1). The use of a leaderboard was to encourage the students in completing assignments (Hamari, Koivisto, & Sarsa, 2014). Total points (without student names) were published on a bar graph. With access to their own points, students were encouraged to review the leaderboard to determine their class standing among peers. Based on student submissions and responses after the publishing of the weekly leaderboard, the leaderboard reminded students who were getting behind to complete and submit their work. It was not clear whether any competitiveness based upon point total comparisons played a motivating role.

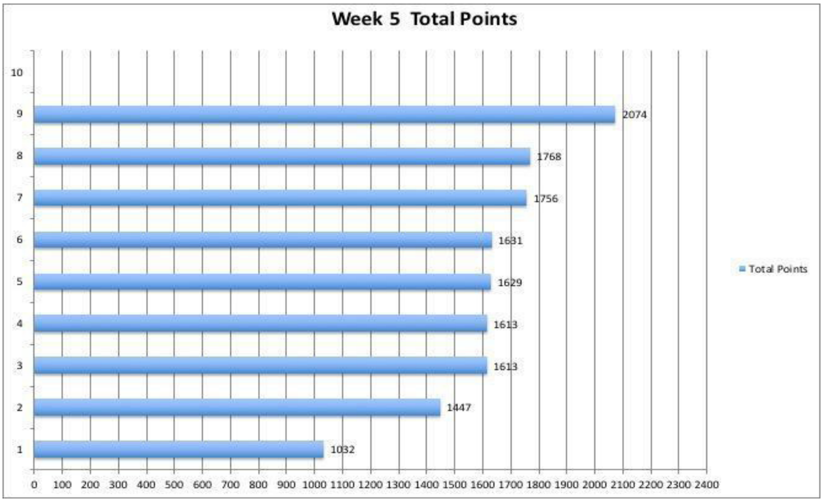

Figure 1. Screenshot of Week 5 Leaderboard in Online Forensic Science Course.

Badges. The use of badges, as a method of recognition and motivation, seemed appropriate for a criminal justice-related course (Figure 2). Badges were awarded as students reached specific point totals. The adaptive release feature (i.e., establishment of rules to result in specific actions based upon specific criteria) of the LMS was used to award badges. That is, as defined point totals were reached, badges were automatically awarded to students who reached the point total. There did not, however, appear to be any observable motivation provided by the badges. It is possible that a public awarding of badges (posting on course site or via email) may have had a more significant impact on motivation, rather than the private awarding that was applied.

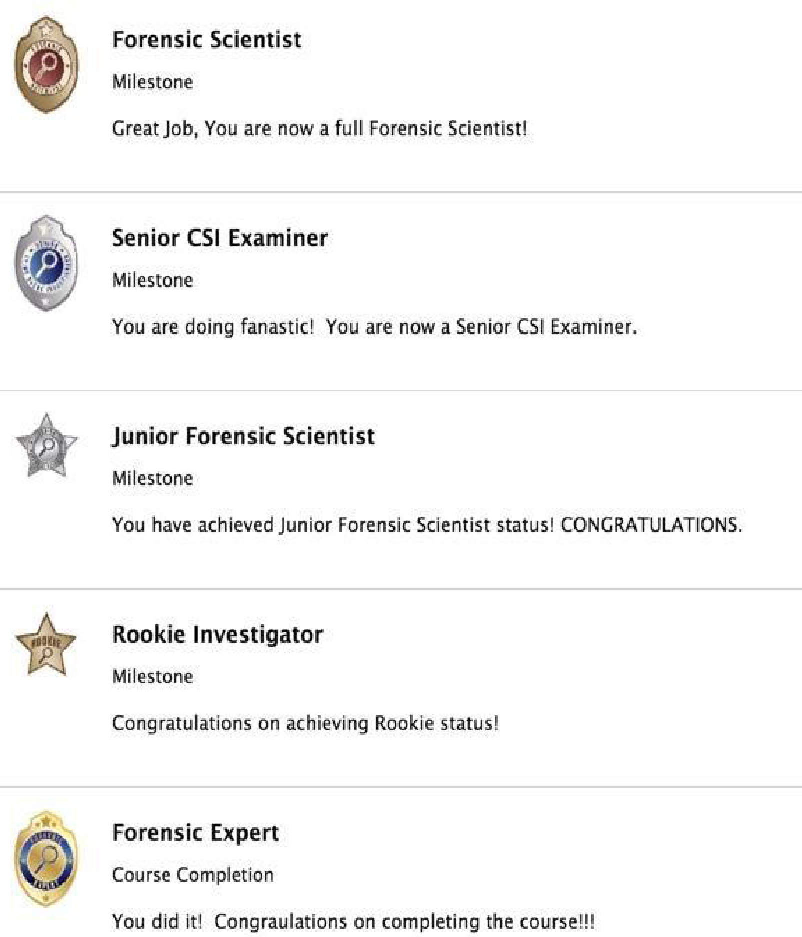

Figure 2. Screenshot of Badges in Online Forensic Science Course.

Integrating Online with Hands-on Laboratory Activities

A significant design emphasis that differentiated this course from other forensic courses was the combination of online instructional materials with hands-on laboratory activities conducted independently by students at home. The integration of common online course requirements, along with activities that are typically conducted in a face-to-face course, sets this design apart from other forensic courses available for high school students.

Blended learning is a recent development in education that has experienced significant growth during the past 20 years (Graham, 2006; Napier, Dekhane & Smith, 2011). The most widely accepted definition of blended learning is the thoughtful integration of traditional classroom face-to-face learning experiences with online learning experiences (Garrison & Kanuka, 2004; Graham, 2006; Macdonald, 2008). Previous studies have highlighted the benefits of blended learning compared to traditional face-to-face classes, such as flexible scheduling, reduced costs, self-paced learning materials, and face-to-face interaction with instructors (Driscoll, 2002; Graham, 2006; Napier, Dekhane & Smith, 2011). Given the benefits of blended learning, we decided to integrate hands-on laboratory activities with online instruction in this design case without direct teacher supervision. Based upon students' developmental levels, prior forensic experience, and the learning context, it was determined that this approach would best facilitate student learning of forensic concepts. In addition, this method would cultivate students' personal interests in forensic science and prepare them for future online learning in college.

Hands-on laboratory activities

The hands-on laboratory activities, a core component of each module of the course, were selected because they could be safely conducted by students of varying ages without adult supervision. Many of the hands-on activities were identified via forensic science publications or face-to-face workshops; however, significant modifications had to be made to these activities to fit the online learning context of this course. In the online learning environment, students would not have access to scientific equipment to conduct the exercises. Instead, for each activity, all of the needed items had to be provided to each student. To provide each student with a kit containing all the necessary materials for each laboratory activity, cost factors were taken into consideration. For example, many attempts were made to find an inexpensive yet realistic substitute for fingerprint powder. One method considered for students to collect the powder was to have them do what early forensic scientists did: hold an aluminum pie plate over a candle and allow the soot (lamp black) to amass. However, this process is very time consuming and is not safe for students. Other powders, such as cocoa powder and finely ground graphite from mechanical pencils, were tested as well. In the end, it was determined that the most educationally viable and cost-effective resource was to purchase real black fingerprint powder and proper brushes. This was the best way to give the students an authentic experience. Some items, like a blood substitute, had to be developed because blood has a fairly unique consistency which is difficult to replicate. A number of recipes were found on Halloween-related websites. Through trial and error, a workable concoction was developed from edible, nonperishable items such as corn syrup, cocoa powder, and food coloring.

Table 3
Items Included in Hands-on Laboratory Kit in Online Forensic Science Course

Item	Module	Item	Module
Modeling clay	Tool Marks	3 pens, markers	Questioned Documents
Casting material	Footwear	Coffee Filters	Questioned Documents
Talcum powder	Latent Print lifting	Acetone	Questioned Documents
FP Brush	Latent Print lifting	Rubbing alcohol	Questioned Documents
Clear tape	Latent Print lifting/ Trace Evidence	Plastic dropper bottles	Questioned Documents DNA
Fingerprint card	Latent Print lifting	Duct tape	Trace Evidence
Magnifying glass	Latent Print lifting	Blood typing kit	DNA
Black powder	Latent Print lifting	Fake blood	DNA
Fingerprint Pad	Latent Print lifting	Measuring tape	DNA

The majority of the kit items were found in online big-box stores, and many items could be purchased in bulk and then divided into individual items for students (Table 3). The hands-on laboratory kit cost approximately $85 per student; however, the fees were covered by the G-STEM program and provided at no cost to the students.

Online simulation activities

For exercises when hands-on activities were not practical or safe for students to complete independently (such as firearms analysis), online simulations were used to provide equally-engaging experiences for students. Many forensic science websites offering simulation activities (e.g., DNA, toxicology, firearms, handwriting, etc.) were reviewed. We sought simulations that gave learners a realistic idea and appreciation of the types of analyses that forensic scientists conduct. After careful review, we selected Rice University's simulation. Based on the television program CSI, students work through and learn forensic techniques while solving fictitious crimes (Figure 3). After completing the computerized exercises, students were directed to write reflections about the concepts and techniques learned.

Figure 3. Screenshots of Online Forensics Simulation Website (Source: http://forensics.rice.edu/).

Choice of LMS

To meet the course goal of fostering independent learning among high school students and accommodating their schedules, the course was offered asynchronously through CourseSites by Blackboard. This LMS was selected after evaluating several systems to determine which system could best meet our six requirements. The LMS should be able to (a) provide easy, intuitive navigation for students through the course modules; (b) offer the ability for students to upload assignments as well as provide an exam/testing feature; (c) provide adequate storage capacity for files, photos, videos; (d) require no cost to the students; (e) require no installation or maintenance to be done by the instructor or G-STEM staff; and (f) offer a discussion area – this was of value but was not a critical necessity.

While several tools were initially reviewed, a comparative analysis was conducted between CourseSites and Edmodo. CourseSites was finally selected because the G-STEM staff, designers, and some students were familiar with this platform. Figure 4 shows a screenshot of one module designed in the LMS.

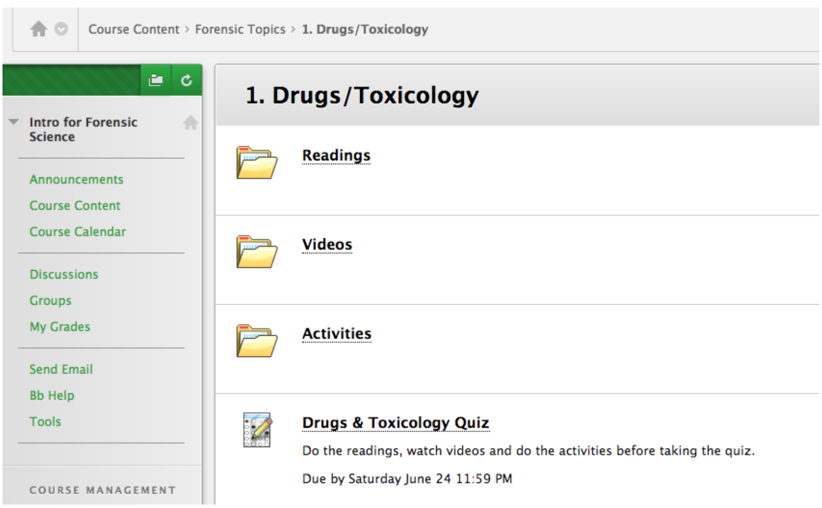

Figure 4. Screenshot of Drugs/Toxicology Module in the LMS.

IMPLEMENTATION

This course was implemented in Summer 2017 for six weeks. The following section will provide more details about the instructional operations of the course including the overview and debriefing session and how the instructor communicated with students and taught the class during the offering period.

Overview Session with Students and Parents

Prior to the start of the course, an in-person meeting was held with the students who chose to participate in the online class. The opportunity to enroll in the course was offered to G-STEM junior and seniors who, by March 1, were not yet committed to a summer learning experience. Eleven high school students initially chose to take the online forensics course and attended the meeting along with several parents. At this meeting, the students met the instructor, received an overview of the course layout and expectations, and had their questions answered. The parental consent was received from all G-STEM parents for the utilization of data generated by student engagement in the course. The Institutional Review Board determined that this project was exempt from review.

As an introduction to forensics and the course, all the attendees were given a practical activity in handwriting comparisons. This activity was used to demonstrate some forensic principles, such as identity detection through patterns. This was an interactive activity designed to motivate students to get started and help parents understand what their child would be learning. The hands-on laboratory kits also were distributed to students at the meeting. So that students were aware of what they would be doing, the instructor displayed and discussed each item in the kit. The students were informed that the course was to be completed over a six-week period.

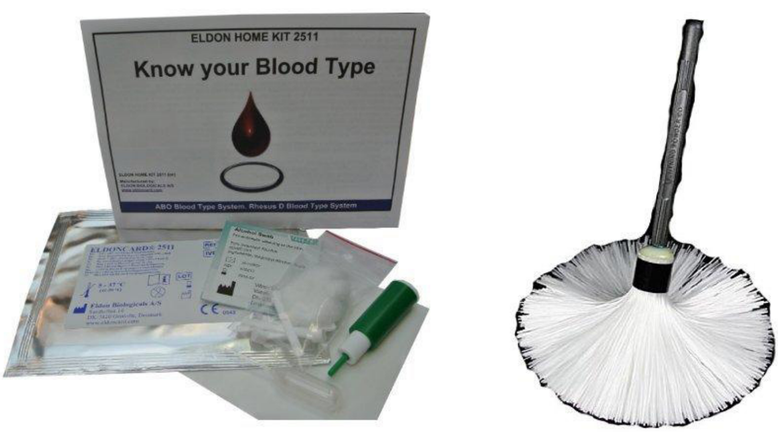

Figure 5. Image of Selected Items Contained in the Hands-on Laboratory Kit.

Texting App and Communicating with the Instructor

Based on information from G-STEM staff as well as information about the communication habits of youth, students were more likely to read and respond to text messages than email messages (Marshall & Wiseman, 2017). To support students' engagement in the course, at least once per week a text message was sent out to students with due dates, hints and tips for assignments, or changes to the course or assignments. A free educational app, Remind (www.remind.com), was used for the weekly messages, and students could also communicate with the instructor via the text messaging app. This provided an easy way for students to ask questions of or interact with the instructor and did not require anyone to log in to the LMS. In addition to text, students could access the instructor via email or telephone.

Teaching the Course

As soon as the course was released for students, they began and progressed through the course at their own pace. The asynchronous course format allowed students to determine for themselves when was the best time to engage in the course activities. Through the Remind app, the instructor encouraged the students to complete one module per week, although this was not a requirement. Each of the six modules of the course featured an online quiz, which was automatically graded by the LMS and provided immediate feedback to the students. As previously mentioned, additional opportunities were provided for students who wanted to delve more into a particular topic. The additional activities consisted of quiz questions and hands-on activities, and students could earn up to 300 additional points.

The majority of hands-on laboratory activities could be conducted inside, and a few, such as footprint casting, required the students to be outside. There were some testing activities that utilized household chemicals such as rubbing alcohol and fingernail polish remover where care and precautions for the surroundings were necessary to ensure nothing was damaged and no one was injured. Over the six weeks, students progressed through the course and at times asked the instructor questions about the content or how to complete a hands-on laboratory activity. As students worked through the modules, the instructor provided positive feedback and commentary to encourage their expressed interest in a particular module. Overall, the instructor received a few questions, and no issues arose that required a face-to-face meeting.

Debriefing Meeting with Students

Within days after the conclusion of the course, a debriefing meeting was held to discuss how the students perceived their learning experience, what feedback they had regarding the course design, and what suggestions they would provide for course improvement in the future. The debriefing meeting was conducted in a format of semi-structured focus group interview with a list of critical questions to elicit student perspectives. The results of the focus group are included in the evaluation section below.

EVALUATION

The purpose of the course was to enable students to learn forensic science content through their independent engagement in an online course. The effectiveness of the forensic course was determined based on student performance data, course evaluations, and client (G-STEM program) feedback.

Student Learning: Pre-Test and Post-Test

Ten of the original eleven students completed the 40-hour forensic course over a six-week period. Since students had some exposure to forensic science through TV and movies, a pre-test was given to ascertain students' forensic knowledge before they took the course. Overall, the students scored a mean of 55.56 out of 120 points on the pre-test (Table 4). The range was 10 to 110, and the median was 50. Among the ten students, only one student scored above 60. The results indicated that the students had little previous factual knowledge of forensics.

A matching post-test was given at the end of the course. Students scored a mean of 103.89 out of 120 (N = 10) on the post-test (Table 4), with a median score of 100 and a range of 85 to 120. Since N was 10, and a normal distribution could not be assumed, a Wilcoxon signed-rank test (W) was computed instead of a paired t-test to determine the level of statistical significance in the mean comparison (Kasuya, 2010). The Wilcoxon signed-rank test indicated that the post-test mean was statistically significantly higher than the pre-test mean ($Z = -2.701$, $p = .007$). Therefore, the result is significant at $p \leq .05$. Almost all the students increased their knowledge of forensics as a result of completing the online forensic science course.

Table 4
Pre- and Post-Test Results

Item	Pre-Test	Post-Test	Difference
Student 1	40	120	80
Student 2	60	100	40
Student 3	50	100	50
Student 4	50	85	35
Student 5	50	120	70
Student 6	110	100	-10
Student 7	10	120	110
Student 8	50	85	35
Student 9	60	95	35
Student 10	60	130	70
Mean	55.56	103.89	51.50

Student Feedback on Course Design

Pre-questionnaire

In addition to the forensic knowledge pre-test, students were asked to complete a questionnaire before they began the course, which consisted of four background questions (age, school, whether feel committed to this course, and whether took online course before), three Likert-scale questions (Table 5) regarding their online learning perceptions, and one open-ended question about why they decided to take the course.

The questionnaire was designed to gather information on prior online education experiences, reasons for and commitment to taking the course, and understanding of the course organization and expectations. Ten students completed that questionnaire, and the analysis showed that most students had no or limited experience with online learning but felt determined to complete this course.

Table 5
Likert-Scale Questions and Results in the Pre-Questionnaire

Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I feel comfortable with taking this online, self-paced course during the summer break.	40%	50%	10%	0%	0%
2. I have a clear vision on what I need to do online to complete this course.	20%	60%	20%	0%	0%
3. I may need to seek help from the instructor or peers if I encounter some difficulties.	10%	60%	30%	0%	0%

In the last open-ended question about why they decided to take this course, most students expressed their interests in forensic science and the desire to experience an online course in preparation for college. As one respondent said,

> This opportunity is giving me a chance to get a feel for college and to try something I've never done before. I've never taken an online course before and I thought it would also help me a lot in managing my time and relying a lot on myself to complete the work. I also decided to take this course because I've always been interested in forensic science and I really want to learn more about it.

Post-questionnaire

After completing the course, students were asked to complete a questionnaire about their experiences in the course, which contained nine Likert-scale questions (Table 6) and four open-ended questions collecting students' feedback. Eight students completed that questionnaire and the analysis showed that the vast majority of students were satisfied (i.e., either chose "Strongly Agree" or "Agree") with the quality of this course.

Table 6
Likert-Scale Questions and Results in the Post-Questionnaire

Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The instructor provided timely feed-back or assistance for me.	62.5%	25%	12.5%	0%	0%
2. The instructor was helpful in explaining exercises or other course requirements.	25%	50%	25%	0%	0%
3. The Blackboard page (via CourseSites) was easy to navigate, locate information, and ease my learning process.	62.5%	12.5%	12.5%	12.5%	0%
4. All the learning materials were organized in a clear structure and sequence that is easy to navigate and learn.	37.5%	50%	12.5%	0%	0%
5. The assigned readings or other resources helped me to understand each topic in this course.	37.5%	50%	12.5%	0%	0%
6. I have sufficient time each week to complete the required assignments.	25%	50%	12.5%	12.5%	0%
7. I found this course is interesting and would like to recommend to other Science Bound students.	75%	25%	0%	0%	0%
8. Overall, the course content was useful in giving me an overview on forensic science.	75%	25%	0%	0%	0%
9. Overall, I am satisfied with the overall quality of this online, self-paced course during the summer break.	62.5%	25%	12.5%	0%	0%

In open-ended questions, seven out of eight respondents indicated that certain activities and written assignments were challenging to complete, such as footwear casting, ink chromatography, and blood splatter. One respondent said, “I think the footwear casting was the most difficult because it took longer than I thought it would complete it, but I still enjoyed doing it.”

Focus group interview

The focus group interview was conducted in a high school two weeks after the completion of the class. A total of four students agreed to participate in the interview after receiving a recruitment email from the instructor. Three major themes about the online forensic course were identified from the interview: readings, assignments (hands-on activities and online simulation), and online learning format.

In general, the students did not like the amount of readings required in the course. Because individual reading of materials was the primary way students gained content knowledge, a few participants pointed out that for a summer class, the length and amount of readings were overwhelming. Yet, when asked to compare this class with a class during the school year, they reported that they spent less time reading for the summer online forensic course than they did for courses during the school year.

Similarly, some hands-on activities (e.g., blood spatter, footwear casting) were identified to be challenging and time-consuming, although students reported they highly valued all the hands-on activities and highlighted the importance of doing the activities on their own. For the online simulation activities, most participants enjoyed the opportunity of conducting online simulations on toxicology and firearms. The comments from the focus group interview were consistent with what student reported in their reflective assignments, as one participant wrote in the reflective paper:

> I received my pipette as an award for completing the case then I took the personality test that would show my strengths needed to be a toxicologist. My results came back scoring high for being conventional, realistic and investigative. This module was a good way to show the toxicology lab in action and it helped me understand the complex readings and videos. I can see everything starting to make sense and tie together.

Regarding the online learning format, all participants indicated that they enjoyed taking this summer class which afforded them the flexibility of self-paced learning. Three students commented on being independent learners. They said it was important for them to take ownership of their learning by having to manage their online course activities while figuring out how to do the hands-on activities. They emphasized that it was their job, as independent learners, to seek out the instructor when they had questions. Even though this was the first time most of the students were enrolled in an online course, they appreciated the opportunity to complete the course and obtain a basic overview of forensic science.

Client feedback

G-STEM staff was pleased with the overall design and implementation of the forensic science course. Staff members were enrolled in to the course through the LMS system along with the students and could participate in any of the activities. As one G-STEM staff member said in a post-course conversation,

> The course met our needs in two major ways. First, the course gave our students the opportunity to explore and learn forensic science concepts in a way that was meaningful to them. The course allowed [students] to study core content and do related hands-on activities so they come to understand what forensic science is and the type of thinking and reasoning required to do this kind of work. Second, the online format allowed our students to have access to forensic content. Since it was online, students were able to learn when it worked for their day-to-day schedules, and they got experience managing and being responsible for their own learning.

Recommendations for Course Modifications

Based on the feedback from students and data gleaned from the instructor's experience leading the course, two significant modifications to the design of the hands-on laboratory activities are warranted. In addition, the low level of student-initiated communication with the instructor indicated modifications in the course design and implementation may be beneficial to encouraging student engagement. In the focus group interview, students expressed a desire for more communication. Several students indicated that they had questions during various segments of the course but did not take the initiative to ask the instructor or a peer. Creating contexts for student-to-student and student-to-instructor interactions may better support deep student engagement and learning.

During the course and in the focus group interview, students indicated that the methods for conducting the hands-on activities were not always clear. Although the students understood what they were supposed to do, they did not understand the written instructions explaining how to perform the activity. To help them know how to complete the activity, several students suggested the inclusion of a video of an expert conducting the hands-on activities. A video demonstration of forensic experts conducting the laboratory activities could be added. The addition of video demonstration would allow students to better understand how to complete the tasks. Such a video would allow students to focus their attention on the techniques for completing the laboratory activity and not merely interpreting the written directions describing how to do the task. Video demonstrations of forensic experts were a part of the original course design, but resources for video production were limited, and thus not included. For the next iteration of the course, video demonstrations of forensic experts completing the step-by-step laboratory activities will be included for each module.

Two of the hands-on activities did not function as intended, and thus, failed to provide the requisite learning experience that was a part of the objective. The blood spatter exercises had students using fake blood to produce droplets from different heights and different angles. Unfortunately, the fake blood did not produce enough differentiation in the droplets to be observable by the students and thus provide meaningful learning. A complete redesign of this exercise will be needed for future classes. Similar results were noted with the paper chromatography exercise that was a part of the "Questioned Documents" module.

While the Remind app was very useful for weekly announcements, few students individually sent messages to the instructor. This was problematic in part because students, as reported in the focus group, did not always fully understand the course material but did not always ask the instructor questions. In the future, to build rapport, it may be helpful if the instructor initiates discussions with individual students about concepts with which they appear to struggle and excel. This may encourage students to ask more questions and initiate content-related dialog with the instructor.

When the students did ask questions, the instructor often noted similar questions were asked by different students. Because the course did not use a discussion feature, students only received answers to their individual questions. Adding a frequently asked questions (FAQ) page for each module may be an effective way for students to gain additional knowledge and have their questions answered, both the questions they verbalize and the ones they do not. This would be a scaffolding feature, as students may not only find needed answers to their questions, but they would also see that they were not the only ones with a question. This page could be easily maintained and built upon during each administration of the course.

DISCUSSION

The online forensics course was designed to address the learning needs of high school students of color engaged in an informal STEM educational development program. This design case was situated in a unique context to support high school student learning in an out-of-school venue, specifically, students of color learning in an asynchronous, independent summer learning environment. Our discussion of the results center on the significance of the findings, designing for students of color, and the implications of coupling online and hands-on activities for informal learning.

Significance of the Findings

Ten of the eleven students completed the six-week online course, and nine out of the ten students who completed the course performed better on the post-test than on the pre-test. It is worth noting that the student whose performance on the post-test was lower than the pre-test had the highest pre-test score (110 out of 120). The quality of student work submitted throughout the course was high, which supports the significant increase in the post-test scores.

G-STEM students must maintain a minimum grade point average of 3.0. Several studies have shown that college students who were better performers in traditional face-to-face courses, also were better performers in online courses (Atchley, Wingenbach & Akers, 2013; Cavanaugh & Jacquemin, 2015; Driscoll, Jicha, Hunt, Tichavsky, & Thompson, 2012). This appeared to be the case among the high school students who participated in the forensics course; each had a grade point average above 3.0 in their traditional face-to-face high school courses, and a group average of 87% in the online course.

Each of the students elected to take the forensics course to fulfill the 40 hours of summer learning required by G-STEM. They were not required to complete the course and could have opted out (only one student did not complete the course). The ability to choose to participate in the course as well as the popularity of forensics (Andreeva, 2018; Collins, 2015; Slater & Jain, 2011) may have contributed to student motivation and engagement. Our evaluation data suggested that the ability to engage in course activities independently was a motivator for the high school students. Students reported that completing the course activities on their own timeframe and having to manage their learning were reasons they chose to enroll in the course. They viewed the opportunity to take the online class as a way to prepare for learning in college. Instruction designed to support and empower students to take responsibility for their learning and develops their sense of learning independence warrants further research.

The minimal instructor presence in the online environment did not appear to negatively impact student learning. This course was designed in such a manner that a SME is not needed to facilitate future offerings of the course, rather the instructor can serve in a facilitation role providing sufficient guidance to allow for self-directed learning.

Designing for Students of Color

A key factor for this design case was the development of instruction for high school students of color enrolled in an informal STEM educational program. Lee and Buxton (2008) noted the lack of science curricula designed for students of color. Access to high-quality STEM instructional materials is an essential component of providing equitable learning opportunities (Lee & Buxton, 2008). This course provided high school students of color with forensic science content, otherwise not available to them, that complemented their formal school curriculum. In addition, the online format gave students flexibility in scheduling course activities in order to accommodate their personal schedules, and they developed independence in managing their learning.

This course offered informal STEM learning experiences designed to be culturally relevant to students of color. The intentional incorporation of people of color in the core course content as well as in the peripheral curriculum helped make the course culturally relevant to the target audience (Gay, 2002; 2010). The use of stories and scenarios to convey forensics content is consistent with communal cultures and thus a culturally-relevant teaching approach for the target audience (Gay, 2002). Although we used gamification features, such as badges and a leaderboard, to engage students and keep them progressing through the course, our use of these features was not aligned with the cultures of the students. Incorporating ways for students to cooperatively, not competitively, interact with each other would further extend the cultural-relevance of the pedagogy and better meet the needs of students from communal cultures such as Latino culture and African American culture (Gay, 2010).

Although students expressed frustration with the amount of reading required to complete the course, based upon the post-test performances they read the text materials that carried the majority of the forensic content. Quinn and Polikoff (2017) noted that loss in reading skills was of particular concern for students of color. Completing the course may have decreased the students' summer learning loss. Because students were interested in learning about forensics, their willingness and motivation to read the course materials may have been heightened.

Implications of Coupling Online and Hands-on Activities for Informal Learning

The incorporation of hands-on laboratory activities was an important pedagogical component of the forensics course. Consistent with Bonk and Zhang's R2D2 model (2006), the use of hands-on laboratory activities accommodated and supported kinesthetic learners who preferred experiencing and practicing concepts beyond reading and writing about them. Evaluation data indicated the students enjoyed the hands-on activities and conducting the activities help students grasp course content.

The findings suggest there are benefits in using self-directed, hands-on activities as part of an asynchronous online course for informal STEM learning. This study did not include a thorough examination of students' implementation of the hands-on activities. Student feedback indicated the need for video demonstrations of how to complete each laboratory activity. However, additional information about the hands-on laboratory component, such as the amount of time and attempts taken to complete each exercise, levels of student understanding of the processes, and specific learning outcomes based on the hands-on laboratory exercises, was not investigated.

The effectiveness of coupling hands-on learning exercises and online instruction needs further investigation. Studies examining learning outcomes from the hands-on laboratory activities compared to other reading/watching/written assignments might further inform educators on the use of different types of student assessment in similar learning contexts.

The forensic course online design case described the major design and development decisions that resulted in the production of an online learning course for students of color enrolled in an informal STEM learning program. The course was effective in meeting the client's needs for a STEM content-rich, asynchronous summer learning experience. Students made significant gains in their knowledge of forensic science and enjoyed the learning experience. This design could also be utilized in other STEM courses where students may benefit from hands-on activities. Popular topics in disciplines such as chemistry, biology, and physics could potentially be offered in a similar fashion and become more engaging for students.

References

Andreeva, N. (2018). *'CSI' Lives On, Wins Most Watched Drama Series Award at Monte Carlo TV Festival.* Deadline. Retrieved from https://deadline.com/2016/06/csi-big-bang-theory-better-call-saul-monte-carlo-tv-festival-awards-1201774233/

Atchley, W., Wingenbach, G., & Akers, C. (2013). Comparison of course completion and student performances through online and traditional courses international. *Review of Research in Open and Distance Learning, 14*(4), 104–116.

Bedwell, W. L., Pavlas, D., Heyne, K., Lazzara, E. H., & Salas, E. (2012). Toward a taxonomy linking game attributes to learning: An empirical study. *Simulation & Gaming, 43*(6), 729–760.

Benitez, M., James, M., Joshua, K., Perefetti, L., & Vick, S. B. (2017). "Someone Who Looks Like Me": Promoting the Success of Students of Color by Promoting the Success of Faculty of Color. *Liberal Education, 103*(2), 50–55.

Bettinger, E. & Loeb, S. (2017). Promises and pitfalls of online education. *Brookings*. Retrieved from https://www.brookings.edu/research/promises-and-pitfalls-of-online-education.

Bonk, C. J., & Zhang, K. (2006). Introducing the R2D2 model: Online learning for the diverse learners of this world. *Distance Education, 27*(2), 249–264.

Bowling, N. (2018, March). *Students of color need to see more people of color. That shouldn't be controversial.* Retrieved from http://educationpost.org/students-of-color-need-to-see-more-people-of-color-that-shouldnt-be-controversial/

Cavanaugh, J., & Jacquemin, S. (2015). A large sample comparison of grade-based student learning outcomes in online vs. face-to-face courses. *Online Learning, 19(*2), 1–8

Cilliers, E. (2017). The challenge of teaching generation Z. *International Journal of Social Sciences, 3*(1), 188–198.

Collins, S. (2015). 'CSI's 'Immortality' finale draws highest ratings in nearly 4 years. *Los Angeles Times*. Retrieved from http://www.latimes.com/entertainment/tv/showtracker/la-et-st-csi-finale-immortality-ratings-nielsen-20150928-story.html

Darling-Hammond, L. (2007). Race, inequality and educational accountability: The irony of 'No Child Left Behind'. *Race Ethnicity and Education, 10*(3), 245–260.

Deterding, S., Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011, May). Gamification: Using game-design elements in non-gaming contexts. In *CHI'11 extended abstracts on human factors in computing systems* (pp. 2425-2428). ACM.

Driscoll, M. (2002). *Blended Learning: Let's Get Beyond the Hype.* Retrieved from http://www-07.ibm.com/services/pdf/blended_learning.pdf

Driscoll, A., Jicha, K., Hunt, A. N., Tichavsky, L., & Thompson, G. (2012). Can online courses deliver in-class results? A comparison of student performance and satisfaction in an online versus a face-to-face introductory sociology course. *Teaching Sociology, 40*(4), 312–331.

Dudley-Marling, C. (2015). The resilience of deficit thinking. *Journal of Teaching and Learning, 10*(1), 1–11. DOI: https://doi.org/10.22329/jtl.v1011.4147

Fleming, N. D., & Mills, C. (1992a). Not another inventory, rather a catalyst for reflection. *To Improve the Academy, 11*(1), 137–155.

Fleming, N. D., & Mills, C. (1992b). *VARK a guide to learning styles*. Retrieved from http://www.vark-learn.com/English/index.asp

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education, 7*(2), 95–105.

Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education, 53*(2), 106–116.
Gay, G. (2010). *Culturally Responsive Teaching: Theory, Research, and Practice.* New York, NY: Teachers College Press.
Gibson, D., Ostashewski, N., Flintoff, K., Grant, S., & Knight, E. (2015). Digital badges in education. *Education and Information Technologies, 20*(2), 403–410.
Graham, C. R. (2006). Blended learning systems: definition, current trends and future directions. In C. J. Bonk, & C. R. Graham (Eds.), *Handbook of blended learning: Global perspectives, local designs.* San Francisco, CA: Pfeiffer.
Hamari, J., Koivisto, J., & Sarsa, H. (2014, January). Does gamification work? – A literature review of empirical studies on gamification. In *2014 47th Hawaii international conference on system sciences (HICSS)* (pp. 3025–3034). IEEE.
Hargrave, C. P. (2015). Counter space: Analysis of educational structures of an after-school program that fosters Black academic success narratives. *Journal of Negro Education, 84*(3) p. 348–361.
Hong, E., Milgram, R. M. & Rowell, L. L. (2004). Homework Motivation and Preference: A Learner-Centered Homework Approach. *Theory into Practice, 43*(3), 197–204.
Kasuya, E. (2010). Wilcoxon signed-ranks test: symmetry should be confirmed before the test. *Animal Behaviour, 3*(79), 765–767.
Kilcoyne, M., & Habig, W. (2016). Online Learning - Learning Styles in a Virtual World Addressing student learning styles in a virtual class focusing on the ability to enhance the learning experience for students in the online learning environment. *International Journal for Innovation Education and Research, 4*(12), 143–152. Retrieved from http://www.ijier.net/ijier/article/view/63
Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development.* Englewood Cliffs, NJ: Prentice Hall.
Larson, C. L. (2010). Responsibility and accountability in educational leadership: Keeping democracy and social justice central to reform. *Scholar-Practitioner Quarterly, 4*(4), 323–327.
Lee, O. & Buxton, C. (2008). Science curriculum and student diversity: A framework for equitable learning opportunities. *The Elementary School Journal, 109*(2), 123–137.
Macdonald, J. (2008). *Blended learning and online tutoring* (2nd ed.). Hampshire, UK: Gower.
Marshall, D. & Wiseman, J. (2017, January). Improving student communication with texting: strategies for more effective outreach. *University Business, 20*(1), 20–21.
Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.
Molenda, M. (2003). In search of the elusive ADDIE model. *Performance improvement, 42*(5), 34–37.
Napier, N. P., Dekhane, S., & Smith, S. (2011). Transitioning to blended learning: Understanding student and faculty perceptions. *Journal of Asynchronous Learning Networks, 15*(1), 20–32.
National Center for Educational Statistics. (2014). *Racial/Ethnic Enrollment in Public Schools.* Retrieved from https://nces.ed.gov/programs/coe/indicator_cge.asp
National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits.* National Academies Press.
NGSS Lead States. (2013). *Next Generation Science Standards*. Retrieved from http://www.nextgenscience.org/

Outschool. (2018). Outschool: Small Online Classes for K-12 Learners. Retrieved from https://outschool.com/classes/forensic-science-high-school-nsN4kIAu#abjj6fskf6

Pollock, M. (2001). How the question we ask most about race in education is the very question we most suppress. *Educational Researcher, 30*(9), 2–12.

Quinn, D. A., & Polikoff, M. (2017, September 14). *Summer Learning Loss: What is it, and what can we do about it?* Retrieved from https://www.brookings.edu/research/summer-learning-loss-what-is-it-and-what-can-we-do-about-it/

Riley, T., Foster, A., & Serpell, Z. (2015). Race-based Stereotypes, Expectations, and Exclusion in American Education. In L.D. Drakeford (Ed.), *The Race Controversy in American Education* (pp. 169-190). Santa Barbara, CA: Praeger.

Rollins, A. D., Hargrave, C. P., & Romero-Hernandez, D. E. (2018). Culturally Responsive Home/School Partnerships: The Cultural Assets of High School Parents of Color. In K. Norris, & S. Collier (Eds.), *Social Justice and Parent Partnerships in Multicultural Education Contexts* (pp. 255-273). Hershey, PA: IGI Global.

Sackey, D., Nguyen, M., & Grabill, J. (2015). Constructing learning spaces: What we can learn from studies of informal learning online. *Computers and Composition, 35*(2015), 112–124.

Saferstein, R. (2011). *Criminalistics* (10th ed., pp. 4-5). Upper Saddle River, NJ: Prentice Hall.

Slater, M. D., & Jain, P. (2011). Teens' attention to crime and emergency programs on television as a predictor and mediator of increased risk perceptions regarding alcohol-related injuries. *Health Communication, 26*(1), 94–103.

STEM Education Coalition. (2016). T*he Case for Investing in Out-of-School Learning as a Core Strategy in Improving Science, Technology, Engineering, and Mathematics (STEM) Education.* Retrieved from http://www.stemedcoalition.org/2016/04/27/the-case-for-investing-in-out-of-school-learning-as-a-core-strategyinimproving-stem-education/.

U.S. Department of Education, Office of Civil Rights. (2016). *2013-2014 Civil Rights Data Collection A First Look: New Release for 2016.* Retrieved from http://i2.cdn.turner.com/cnn/2016/images/06/07/crdc.data.highlights.pdf

U.S. Department of Education, Office of Innovation and Improvement. (2016). *STEM 2026: A vision for innovation in STEM education.* Washington, DC: U.S. Department of Education, Office of Innovation and Improvement.

Vantassel-Baska, J., Landau, M., & Olszewski, P. (1984). The benefits of summer programming for gifted adolescents. *Journal for the Education of the Gifted, 8*(1), 73–82.

Wang, S., & Hsu, H. (2009). Using the ADDIE Model to design Second Life activities for online learners. *TechTrends, 53*(6), 76-81.