A Project-Based Collaboration between Software Engineering and Criminology Students

Building Applications to Understand Racial Injustice in the Criminal Justice System

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ABSTRACT

Undergraduate software engineering courses typically require students to work on team-based projects that reinforce disciplinary content and soft skills. At the same time, these students, particularly those at liberal arts institutions, are required to take courses that focus on civic issues, including on racial and ethnic inequality. Often, students perceive these courses to be outside their disciplinary areas, and may not comprehend how these topics are applicable to computer science and software engineering. This paper reports on the experience of Pulimood and Leigey as they and their students grappled with issues of racial injustice in the criminal justice system, and drew upon their own disciplinary backgrounds to apply computational thinking and software engineering principles to help the community better understand these issues and advocate for reform. The paper also describes the experience of teaching courses from different disciplines in a collaborative model, working closely with a local community partner to support its work on an identified social issue, and the learning outcomes, as well as the benefits and challenges of this approach. Recommendations and future directions are also discussed.

ICSE-SEET '22, May 21–29, 2022, Pittsburgh, PA, USA

ACM ISBN 978-1-4503-9225-9/22/05 $15.00
https://doi.org/10.1145/3510456.3514158

CCS CONCEPTS

•Software and its engineering→Software creation and management→Collaboration in software development •Social and professional topics→Professional topics→Computing education→Computational thinking •Social and professional topics→Professional topics→Computing education→Computing education programs→Software engineering education

KEYWORDS

Interdisciplinary collaboration, undergraduate software engineering, software design and implementation, racial justice, community engaged learning, project-based learning

ACM Reference format:

S. Monisha Pulimood, Margaret E. Leigey, Diane C. Bates, Kim Pearson and Supriya Mishra. 2022. A Project-Based Collaboration between Software Engineering and Criminology Students: Building Applications to Understand Racial Injustice in the Criminal Justice System. In *Proc. of the ACM/IEEE 44th International Conference on Software Engineering: Software Engineering Education and Training (ICSE-SEET '22). ACM, New York, NY, USA.* https://doi.org/10.1145/3510456.3514158.

1 Introduction

At The College of New Jersey (TCNJ), a primarily undergraduate liberal arts institution, all students are required to take courses that focus on civic issues, including on racial and ethnic inequality. Often, these courses are perceived by software engineering students to be outside their disciplinary areas, and they do not always comprehend how these topics are applicable to their major. Pulimood teaches Software Engineering, a course that is required for computer science majors and minors, and computer engineering majors, while Leigey teaches Penology, a course that is required for criminology majors. Both had been individually pondering approaches to help students in their respective courses

more deeply engage in their disciplinary content, and envision how their disciplinary knowledge can be applied to help address issues related to racial injustice. The murder of George Floyd and the racial reckoning that followed in Summer 2020 deepened each one's commitment to making racial justice a focal point of her respective class in the Fall 2020 semester. Pulimood wanted her students to specifically delve into racial injustice and mass incarceration. TCNJ's Center for Community Engagement (CCE) recommended that she contact Leigey. During their discussions it emerged that both authors shared a deep interest in incorporating community-engaged learning (CEL) and social issues into their courses. Embracing the benefits of interdisciplinary, project-based learning, they designed a collaboration between their classes and the local chapter of The Campaign to End the New Jim Crow (EndNJC), a community organization dedicated to ending racial injustice in the criminal justice system, recommended by CCE. Additionally, Leigey had previously worked on a CEL project with Ms. Yumiko Mishima, who would represent the organization for this collaboration.

This paper reports on the experience of Pulimood and Leigey as they and their students grappled with issues of racial injustice in the criminal justice system, and drew upon their own disciplinary backgrounds to apply computational thinking and software engineering principles to help the community better understand these issues and advocate for reform. The paper describes the experience of teaching courses that emphasize interdisciplinary collaboration, with a local community partner, during the COVID-related pandemic, the learning outcomes for students and faculty, as well as the benefits and challenges of this approach. The paper additionally recommends practices for successful implementation of this collaborative model, based on the experiences reported here. Ultimately, as articulated by one student, both classes *"learned that the fields of computer science and criminology can be utilized together to form solutions to important nationwide problems."*

1.1 Background

This experiential report details the specific collaboration of Pulimood and Leigey in Fall 2020, which is part of a larger Collaborating Across Boundaries (CAB) project funded through Award #1914869 from the National Science Foundation (NSF), for which Pulimood, Bates and Pearson are principal investigators. This larger project is designed to evaluate the CAB model, where students in two courses, from two disciplines, collaborate with each other and a community partner, on a STEM-focused project to address a community-identified issue. The intent of this curricular model is that students from both courses, with diverse perspectives and disciplinary backgrounds, will not only learn the STEM (Science, Technology, Engineering and Mathematics) concepts more deeply but will also learn how to collaborate and integrate concepts from their respective fields to develop scientific solutions for complex real-world problems. See tardis.hpc.tcnj.edu/cabportal/ for more details on the CAB project.

The CAB model draws from three areas, interdisciplinary collaboration, project-based learning, and community-engaged learning, that have each been shown to improve student learning outcomes and improve retention, particularly among students from marginalized groups. Interdisciplinary collaboration emphasizes problem-solving in a gender-neutral, culturally and ethnically diverse community, and provides an engaging learning environment in which students solve real problems in collaboration with their peers from other disciplines. It has been shown to improve content knowledge and communication skills among undergraduate learners [31]. A balanced collaboration is an effective approach to engage participants more deeply since students can learn how concepts are applied in other contexts rather than being presented a traditional perspective on those concepts [8]. Such learning communities have been shown to be successful in helping students develop scholar identities as scientists and collaborators in the scientific process. [11, 43].

Inquiry- or project-based learning (PBL) involving peer-led teams has been shown to enhance process-oriented learning [36, 37, 42, 44, 49]. Research shows that the active teaching methods of PBL are more effective in helping students absorb and retain course content [32]. PBL is based on a constructivist learning theory that assumes that "learners form or construct their own understandings of knowledge and skill" [42], and that this is strengthened through requiring student teams to devise solutions to problems.

Community-engaged learning (CEL) is a high-impact practice that has been empirically linked to greater student engagement, efficacy and learning [9, 24, 25, 26, 27, 29, 48, 51]. Unlike traditional service learning (sometimes referred to as community-based learning), CEL requires students and faculty to treat their community partner as an intellectual equal who helps to define problems and refine solutions in a real-world context [19, 38, 39]. It is designed to reduce the tendency for students to view community work as charity, but rather as a mutually beneficial collaboration [10, 20]. CEL has been linked to higher rates of retention [6, 52], particularly among women and members of marginalized groups [29, 41]. Qualitative studies of low-income, first-generation students found that CEL enhanced their skills, and helped them develop resilience and a sense of efficacy in academic settings [12, 50]. CEL's impact varies dramatically by the quality of the experience; direct service [13, 46], sustained community partnerships [10], and effective integration of service with the course material [21, 26] produce better learning outcomes. Students are more motivated by activities they perceive to be useful and socially relevant [3, 17, 18, 42].

The CAB model is aligned with ABET's criteria [1] for computing programs where students should be able to "analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions," "apply computer science theory and software development fundamentals to produce computing-based solutions," and "recognize professional responsibilities and make informed judgments in computing practice."

1.2 The Collaboration

The collaboration discussed in this paper is between Software Engineering (SE) housed in the Department of Computer Science (CS), Penology (PEN) housed in the Department of Criminology (CRI), and the local chapter of The Campaign to End the New Jim Crow (EndNJC). SE, taught by Pulimood, follows the ACM/IEEE [22] curriculum guidelines, and is required for computer science majors and minors, and computer engineering majors; in Fall 2020, two sections were offered, with a total of 40 students. CS majors in this course are typically juniors, while the non-majors are typically seniors. PEN, taught by Leigey, is required for criminology majors. Penology, a subfield of criminology, focuses on the study of punishment. The overarching goals of Leigey's course are to critically examine how punishment in its various forms is constructed and applied, how justice-involved individuals experience punishment, and how to reform the criminal justice system to make it more just and effective. In Fall 2020, two sections of PEN were offered, with a total of 35 students. One criminology major enrolled in PEN was simultaneously enrolled in SE as a CS minor. Criminology majors in this course are typically juniors or seniors.

The course descriptions for both courses on TCNJ's enrollment management system included additional notes to inform students about the collaboration before they registered for the courses. Prior to the start of the semester, Pulimood and Leigey each sent "welcome" emails to students in their respective courses and included more information about the collaboration and project. During the add/drop enrollment period at the start of the semester, students in both courses were once again reminded of the collaboration and project. An alternate course offering would have been made to fulfill the major requirement if needed; however, no student in either class expressed concern with the collaborative project. TCNJ's Center for Community Engagement (CCE) facilitated the collaboration with the local chapter of EndNJC, represented by Ms. Yumiko Mishima. The stated mission of this organization (www.endnewjimcrownj.org/) is "to expose the injustice of mass incarceration as a form of racialized social control, and to advocate for the end of institutional racism in our criminal justice system that decimates communities of color and perpetuates a permanent undercaste." To ensure that the collaboration was mutually beneficial to both the students and the community organization alike, in a pre-semester planning meeting, Pulimood and Leigey asked Mishima to share ideas for possible student projects that would be most helpful to EndNJC.

2 The Collaborative Project and Logistics

2.1 Goals of the Collaboration

Through the activities and assignments in Software Engineering, students are expected to:

- Build a strong foundation in software engineering, including analysis, design and development;
- Become proficient in working collaboratively with people from different backgrounds, and integrating concepts from computer science and other disciplines to solve complex problems;
- Learn to contribute disciplinary knowledge to enhance local and global communities;
- Learn about emerging trends in the field, and how to adapt quickly and efficiently to change.

The intent is that students will become proficient in:

- Computer science foundations (use of abstraction, concept of a system, human factors, code reuse, implementation and run-time issues, defensive programming);
- Software modeling and analysis (requirements gathering and analysis, decomposition, generalization, behavioral modeling, and the use of UML);
- Software design (fundamental design issues and trade-offs, design principles such as information hiding, cohesion, and coupling, user experience and interface design);
- Use of construction tools (development environments, versioning systems, and project management tools);
- Group dynamics and communication skills (dynamics of working in groups, dealing with uncertainty or ambiguity, technical writing and documentation, group communication, and presentation skills);
- Community-engaged learning (significance of social issues, analyzing and addressing social issues using computational thinking).

SE requires students to work in teams on a semester-long project following a software development life cycle. Through this experience students can meet many of the course learning outcomes. In addition to the collaborative project, students are required to complete assignments that are not directly related to the collaboration. They implement individual programming projects and write a technical report. They also complete class exercises that provide scaffolding for the larger individual and collaborative projects.

In Fall 2020, the goal for Pulimood and Leigey was to empower students to delve more deeply into the issues around the pervasive racial injustice in the criminal justice system, including mass incarceration, and better understand how their disciplinary knowledge can be applied to help address a real-world problem. To this end students in both classes were required to collaborate with each other and EndNJC to propose, design and develop a web-based application that would further the mission of the organization. Computing technologies have been implicated in reinforcing "rational discrimination," i.e., the encoding of invidious categorical distinctions between people [15]. It has also been argued [4] that database design can be an 'exercise in world-building' and reproduce the 'technology of race.' Criminology / criminal justice scholars [28, 33] have demonstrated that the ontologies and taxonomies of seemingly race-neutral data sets, such as local arrest records and the Uniform Crime Reports, reflect the race and class biases of the times in which they were constructed. Collaborating with PEN students would compel SE students to thoughtfully examine the social impacts of the

applications they build, that inscribe and reinforce rational discrimination. This is well-aligned with the principles outlined in ACM's Code of Ethics (www.acm.org/code-of-ethics). In turn, collaborating with SE students would provide PEN students with the opportunity to explore how computational thinking can be employed to address criminal justice reform.

2.2 Implementing the Collaboration

Due to the protocols necessitated by the COVID-19 pandemic, all classes at TCNJ were offered remotely in Fall 2020. As a result, all class sessions, including the collaborative meetings, occurred on Zoom. Both courses were taught separately, in their own virtual classrooms and time slots, enabling the instructors to cover disciplinary content. Serendipitously, the sections of both classes were scheduled to meet at the same times, 9:30 - 10:50 a.m. for one section in each course, and 11:00 a.m. - 12:20 p.m. for the other section in each course. This enabled the collaborative meetings to occur during class time when the professors and all students were available. Over the course of the 15-week semester, the two classes and the community partner came together on six occasions, roughly every two weeks, to work with each other on the project during class time. The instructors formed teams composed of six or seven students from both classes, taking care to balance them out by gender, class (e.g., junior or senior), and major. This helped to promote equity and learning among students of different disciplines.

2.2.1 Defining the Project Requirements. PBL is most effective for students learning process-oriented "general skills" like science literacy, but it must be supplemented with domain-specific skills, e.g., disciplinary content [42]. Moreover, experiential learning should be structured as a cyclical process consisting of concrete experience, opportunities for reflection, abstract conceptualization, and active experimentation [23]. The authors' experience is consistent with the findings of previous researchers about the importance of clearly defining projects, tasks, and roles so that expectations are clear to all participants, and that project deliverables and milestones should be realistic and achievable within allotted timeframes.

At the start of the semester, a detailed document was provided to students from both classes to clarify the collaborative project's purpose, deliverable deadlines and details, and expectations. All students in a team were expected to understand the domain, and contribute to brainstorming ideas and designing the modules. In general, the SE students were expected to focus on the technical aspects of application design and development, while the PEN students were responsible for the content, and ensuring that the modules were appropriate and relevant to the community partner. The team was collectively responsible for each deliverable, with the expectation that every team member would contribute significantly. To promote accountability the document specified the tasks for which the PEN or SE team members would take the lead. Over the semester, there were seven iterations of the project with deadlines every other week. Both classes met together six times during class time; Mishima came to four of these collaborative meetings. To ensure that students from both classes devoted similar degrees of effort, the project was worth the same amount, 30% of the final grade, in both classes. The remaining 70% of the final grade was devoted to course-specific assignments and exams.

2.2.2 Project Goals. The project goals drew from both courses equally, and were aligned with the learning outcomes stated on the individual course syllabi:

- Apply criminological and computer science concepts and skills to propose and develop a software application that will deliver value to a community partner.
- Gain experience with, and a clear understanding of, punishment-related issues and the system development process.
- Apply concepts learned in the respective courses to understand the domain, analyze requirements, and design and implement an innovative software solution that addresses a community-identified need.
- Strengthen problem solving and critical thinking abilities, integrating knowledge gained in these and other courses, through the innovation and software development process.
- Develop and strengthen communication abilities, project management skills, and teamwork by working collaboratively with students from different disciplinary backgrounds.
- Develop a deeper understanding of the significance of social issues, such as incarceration, and the ability to analyze and address social issues using computational thinking.

2.2.2 Project Activities. To ensure that students from both disciplines had a common foundation from which to approach their collaborative projects, in Week 2 of the semester, Leigey facilitated a lecture-discussion on the history of racism in the United States prison system. In preparation for the class, students were required to complete two common readings [2, 14] and reflection questions. They were also pointed to additional resources [5, 35, 40, 45, 47] for further exploration. During the virtual collaborative class meeting, the students would break out into small groups to reflect on and collectively answer questions. In addition to providing students with context to approach their collaborative projects, the lecture-discussion had several other benefits. First, it reinforced that the collaborative project was a major focus of the class. Second, as the instructors had already assigned students to teams, this allowed for interaction across classes early in the semester and for team members to become acquainted with each other. Third, the students were able to delve more deeply into the issues and social impacts of various approaches to address them. The following week, in Week 3, Mishima participated in the collaborative meetings. In addition to building rapport with the students and sharing more about her organization, she provided a summary of the major areas of criminal justice reform in New Jersey. Several of the issues that she highlighted (e.g., bail reform and felony disenfranchisement) became the topics of team projects. Additionally, Mishima answered questions related to specific content areas or applications that would be especially useful to EndNJC. The SE

students had prepared for this meeting as part of a class exercise related to the inception and requirements gathering (elicitation) process during a prior class session. In Week 4, the teams pitched their ideas in class to Pulimood, Leigey, Mishima, CCE staff, and the other teams, and received preliminary feedback. Mishima was especially helpful here as she provided encouragement and detailed constructive feedback on the pitches. While all projects needed to revolve around the central theme of racial injustice in the criminal justice system, there was significant variation in the projects proposed, and most built on the team members' interests and expertise. Table 1 lists the themes on which the students focused, and the resulting projects.

Table 1: Applications Developed by the Collaborating Teams

Project Themes	Applications Developed
Racial Disparities and COVID-19 in New Jersey Prisons	Interactive map that shows racial disparities in COVID infection among the prison population.
Racial Injustice in Risk Assessment Instruments	Interactive quiz to help users gain insights into their own understanding and biases related to racial injustice, and the efficacy of risk assessment tools.
Racial Bias in Incarceration Rates in New Jersey	Interactive map showing the number of incarcerated persons in different demographics.
Collateral Consequences of Felony Conviction	Enables blog posts on lived experiences that show the effects and collateral consequences of felony convictions (e.g., unemployment, lack of housing opportunities, and disenfranchisement).
Post-Release Educational and Vocational Services	Resources for those released from prison; includes sign-up for mailing list and posts on lived experiences.
Increasing Employment Opportunities	Employment site for individuals with an incarceration history with a focus on employers who are open to hiring justice-involved individuals.
Bail Reform	Repository of bail information, pending related bills and policies (searchable by various criteria); includes functionality to email legislators indicating support or opposition.
Legal Aid for Indigent Defendants	Site to connect individuals needing legal representation with legal aid volunteers.
Social Effects of Incarceration	Functionality to contact legislators to share information about the social effects of incarceration
Felony Disenfranchisement	Discussion boards for this topic; includes functionality to email legislators to advocate for change.
Injustice in the Criminal Justice System	Interactive quiz to help users gain insights into their own understanding about racial injustice in the criminal justice system.

The instructors adapted some of the class exercises and discussion time to make 'theory-to-practice' more apparent, by connecting concepts taught in class to the project. For example, in SE when learning about designing effective system sequence diagrams (SSD), in past semesters there was a related exercise from the textbook for students to gain some practice in drawing these diagrams. In Fall 2020, the exercise was modified so that instead of using a textbook example, students worked with their SE teammates to develop the SSD for one use case, during class time. Pulimood met with each team and provided detailed feedback that students could then apply to the remaining SSDs during their team meetings outside class. In PEN, in order to develop their research skills so that they could identify and describe content to be used in their projects, students wrote an individual research paper for their project topic. The instructors used group discussion times to check in with each team to ensure that they were on track, and to provide guidance and clarifications as appropriate. In Week 9, the collaborative meetings were dedicated to teamwork, to facilitate design and development. It was also another opportunity for Pulimood and Leigey to check in with each team, especially members from the other class, to answer questions and offer feedback. Some teams who had implemented early prototypes were able to get feedback on these as well. The teams continued to design and develop their projects, meeting outside of class time to make progress.

In Week 11, SE students conducted technical reviews on each other's projects. During a collaborative class meeting, Pulimood, Leigey, Mishima, and CCE staff reviewed prototypes and provided feedback to the teams, in preparation for the final presentations which occurred in Week 13. At this time the teams demonstrated their final products to Mishima and their classmates. The presentations showcased how the collaboration improved computational thinking, technical skills, and understanding of how their disciplinary knowledge can be applied to address real-world problems.

The following comment from a SE student underscores this point: *"Personally, it took a while to understand how the social issue and computational thinking would play out. I was confused because prior to this class, I had mostly used my computational skills for logical problems rather than real world issues. Yet, then I realized that computational thinking and the needs of people are everywhere around me. I never grasped that idea until I started to build the app. While building the app, we never really had to solve [any] mathematical problems, rather address those of the users. I realized that the app had to become something accessible, usable, available, and reliable to the users. This was also a problem, but just a different kind and different languages and methods were used to solve it. Similarly, when analyzing and addressing another social issue, I would have to look at the intended purpose of my app, its functions, and how the user can use it."* PEN students also came to understand the benefits of applying computational thinking to address social issues, as evidenced in the following statement: *"As a criminology major and a computer science minor, I hope to utilize my knowledge of technology and*

knowledge of issues with the current criminal justice system to help fix these issues in the future. This project was the [perfect] example of that because I was able to build an easily [accessible] web application that discusses the issues with the system and allows people to get involved."

During the last week of the semester (Week 15), students submitted their final project report and individual reflections. The latter consisted of open-ended questions that asked students to:

- Identify and assess their own and their team members' primary responsibilities and contributions to the project.
- Reflect on the experience of utilizing disciplinary expertise to help the community, and working with teammates from different disciplinary backgrounds.
- Consider how the concepts learned in their discipline-specific course were applied in the project, and what they learned about the other discipline.

The student comments contained in this report were taken from these individual reflections. Benefits to student learning were assessed systematically and are discussed in section 3.3.

3 Lessons Learned

3.1 What Worked Well: Recommended Practices

3.1.1 Teamwork and Collaboration. The project was a successful collaboration for all involved. A common theme in the individual reflections was how well the teams worked together, despite the obstacles posed by the remote learning environment. Students felt that they were able to leverage their individual strengths in the creation of a meaningful, collaborative project, as reflected in this comment: *"By working in a team setting, we were able to learn about each of our strengths and weaknesses and to use them to our advantage. By assigning each of [us] to our strongest skill [areas], we were able to give our all in each of our tasks."* Another student commented that the final product *"is an excellent display of [everyone's] commitment to the project and hard work. We had a great group and we made time to work things [out] and help one another when in need."*

Pulimood and Leigey were in regular communication prior to the semester to develop the project details and timeline. To ensure that students had sufficient knowledge to complete each iterative task of the project, the overall schedule of topic coverage in both classes was aligned with the project timeline. Pulimood and Leigey met regularly throughout the semester to discuss progress on the collaborative projects, issues that emerged, and strategies to address them. They graded the deliverables together, making the process more efficient and equitable across teams.

3.1.2 Engaged Community Partner. The project benefited immensely from having a knowledgeable and engaged community partner who encouraged and inspired the students, and provided them with valuable feedback as they developed their projects. Mishima was an ideal partner for various reasons. First, she was well-informed about racial injustice in the criminal justice system, particularly in the state. Second, she was a former educator, and as such, brought experience in, and passion for, working with students. She provided feedback in a very gentle and constructive manner, providing clear rationale for her comments. This resonated well with the students, as demonstrated by this student's remark: *"[Mishima's] feedback was very helpful as well as she suggested some ways or methods we can use to make sure our topic gets the attention it needs."* Third, she had professional work experience in both disciplines, and this came across clearly in her interactions with the students, as she prompted them to examine the issues more deeply and from a variety of perspectives as reflected in this student's comment: *"Also meeting with Mishima and other stakeholders encouraged students to actively think about implications of criminal justice issues [for justice-involved individuals]."*

3.1.3 Structure and Creativity. The project was a good blend of structure and creativity. All teams needed to iteratively produce a final project that contained the required elements. They were free to explore an issue of interest to them, as long as it pertained to racial injustice in the criminal justice system. They also had license to be more creative in how content and analyses were presented to the users. Agendas for the non-collaborative sessions (i.e., when the classes met separately) and collaborative sessions (i.e., when the classes met together), and exercises were planned in advance. Pulimood and Leigey provided significant scaffolding and support to the students throughout the project. For example, the two classes were given a shared module on Canvas, the learning management system, and all materials relevant to the project were posted here. Students responded positively to this approach; in the words of one student, *"This project was laid out very thoroughly on [C]anvas and the things that might have been slightly confusing, [the professors] and my team members were able to clarify for me."* Each team was assigned a virtual machine (VM) pre-loaded with the environment needed for development. SE students were given technical tutorials and detailed instructions on using the VM and tools. Version control with git was explained to SE students, while GitHub's collaboration features were explained to both classes during a combined class session. The GitHub tutorial empowered PEN students to contribute significantly to managing the repositories, including creating milestones and submitting issues, as evidenced by the comment, *"The explanation of GitHub by [Pulimood] greatly helped me as it guided me through the workings of the site and encouraged me to use it more."*

3.1.4 Understanding the Domain. The common readings and lectures provided early in the semester were helpful in providing context and foundational information for the projects. Two related themes that emerged from the student reflections were that students were not fully aware of the profound racial injustice in the criminal justice system, and why it is important for everyone to become involved in addressing the issue. For example, one student commented, *"It was really interesting to get a better understanding of risk assessment tools and why they are such a problem."* Other students commented, *"[This] is a major issue that we are experiencing as a nation that I had not as much information about prior to this class,"* and *"I understand bias better, I understand that the cards are really stacked against people of color from the very beginning of entering the criminal*

justice system and that this has prevailed and will continue to prevail until there's intervention."

3.1.5 Grade Distribution and Grading Strategy. To encourage students in both courses to devote a similar amount of effort on the collaborative project, the final project grade was the same in both classes. Blum [7] argues that grading students undermines learning. To emphasize collaboration over competitiveness, and deep learning, creativity and risk-taking over following instructions, grades were not attached to interim deliverables. Instead, detailed feedback was provided throughout the semester in multiple ways, including written feedback from both Pulimood and Leigey, and verbal feedback offered by each individual instructor to all members of the team during a collaborative session or to the students in her own discipline-specific course in a non-collaborative session. Each team was expected to reflect on the feedback and revise the project for the next iteration. The final grade for the team was based on criteria such as the value the project provided to the community partner, the collaboration within the team, and effort put into revising the project based on feedback. To avoid the "free-rider" problem, expectations for individual effort were clearly outlined in the original project document. Any student who did not contribute significantly to the project, incurred a reduction in the final project grade. Pulimood and Leigey also relied on their own observations, student self-assessment, and team members' feedback when determining final individual grades.

In the final reflection, students were asked the following questions to gauge individual contributions:

- What were your primary responsibilities?
- Did you meet all your responsibilities?
- What were the primary responsibilities of each teammate?
- Did each teammate meet all their responsibilities?
- Who was the project team leader for each iteration (i.e., who kept the team on track, scheduled meetings, etc.)? If different students filled this role in different stages, specify.
- Who was the project's primary GitHub repository manager?
- How much did each person contribute to the overall project (as a percentage of the whole)? [self and each teammate].

Another set of questions required students to reflect on the experience of working on a socially relevant project, to apply disciplinary knowledge and as part of a collaborative team. They were asked to explain how they better understood each of the items in the list below, as a result of working on the project.

- Significance of social issues.
- How you can analyze and address social issues using computational thinking.
- How you can contribute your disciplinary expertise to help the community.
- How to work with teammates from different disciplinary backgrounds.
- How to apply conceptual understanding in a practical setting.
- Other (add anything not listed above).

Students were also asked to identify course-specific concepts they learned and understood better, as well as what they learned about the other discipline through the experience of working on the collaborative project. These questions were aligned with the learning outcomes for the two courses.

Ultimately, the teams were successful in fulfilling the project requirements and most teams received an 'A' on their projects. More importantly, given the goal of a mutually beneficial partnership in CEL, Mishima was very impressed with the effort put in by the students and expressed interest in including some teams' applications on the organization's website.

3.2 Challenges Faced

3.2.1 Remote Learning. As a result of the COVID-19 pandemic, all classes at TCNJ were online in Fall 2020. The resulting remote modality of instruction posed challenges for collaboration and the projects. One student described the challenges that their team faced, *"Being online made it much harder to meet … and keep each other accountable."* Some students did not initially have the technology required to be successful in an online class, and they had not yet requested this from TCNJ's loaner program that had been set up to provide technical resources during the pandemic. While the physical and mental health of students was the top concern, the disruption brought about by the pandemic had implications for student focus and engagement, and negatively impacted the ability of some students to fully participate and keep up with the project assignments. Some students contracted COVID-19 and needed time to recover. Others worked full-time to support their families or had to care for their younger siblings to enable their parents to work. The teams never met in-person, meaning that all group work was completed virtually. Rapport, both in terms of the classes and teams, may have been more difficult to establish in a virtual setting [16]. The instructors also faced logistical challenges. A simple but salient one was that professors, CCE staff, and Mishima needed to move from one Zoom breakout room to the next in order to provide feedback to each team. However, before the Zoom update, meeting participants did not have the autonomy to move themselves. As a result, Pulimood had to act as a dispatcher and move individuals from room to room, limiting her own ability to join breakout rooms and provide feedback to the teams.

3.2.2 Communication and Division of Labor Between Disciplines. As evidenced by student feedback and the overall quality of the projects, the collaborations were largely successful. Given their proficiencies, PEN students took the lead in supplying the written content of the computer applications, and SE students took the lead in the design and development of the application. Overall, this arrangement worked well, as reflected in the following statement from a PEN student that encapsulates the value of a cross-disciplinary collaboration: *"You are rewarded with teammates who have experience in areas that others [or you] do not."* However, Leigey reflects that this collaboration may have benefitted further if the role of the PEN students had been

articulated more thoroughly, especially in the early iterations during analysis and design. A clearer expression of the division of labor could have ameliorated the perception (from both sets of students) that SE students had greater project responsibilities and the PEN students lacked knowledge of how to accomplish the tasks of each iteration. One PEN student commented, *"The biggest issues we faced were really working as a group, I feel like we did not communicate much as a group at the beginning especially. We really only worked together when we had to in class … I could have taken the initiative to reach out and ask questions and be more involved earlier."*

Building on the above PEN student's comment, effective communication is an important component of any group's success but especially with interdisciplinary teamwork, as noted in the following SE student's remark, *"Communication is the most important factor to work with teammates from different backgrounds."* A PEN student agreed and suggested mutual respect and clarification were also critical: *"Communication is key, having mutual respect and asking questions is conducive to being able to work interdisciplinarity."* Groups reported that they needed to spend time talking through ideas or tasks as terminology that may be assumed to be commonly understood in one discipline may be unfamiliar or have a different connotation in another. Additionally, discipline-based expectations of how to collect or display data were also reported by groups as an initial challenge that they worked through with improved communication, as reflected in the following comment from a SE student: *"I learned how there could be miscommunications due to [different] backgrounds because [of] a lack of specificity. When we [SE students] asked for data for the graph, we expected a csv that could be easily imported to code. As CS students, this seemed expected, but instead we received 60 page PDFs of unparsed data. It opened my eyes to how to communicate with a multidisciplinary group."*

3.2.3 Time Commitment. A few students expressed dissatisfaction regarding the amount of time that they needed to devote to the project. The following is a representative comment: *"My other coursework would often suffer due to my over-compensation required to meet the [bare] minimum requirements in most aspects of this project."* At TCNJ, a full course unit is worth four credit hours, with the expectation that the fourth hour will be utilized for educational activities that extend beyond the scheduled class time, including collaborative meetings and out-of-class assignments. Perhaps, a clear statement by the instructors at the first collaborative session, with reminders throughout the semester, in which they reiterated expectations for the fourth hour, acknowledged the amount of work that is reflected in the weight of the project toward the final grade, and the value to the community partner and to the student's own learning may have allayed some of the dissatisfaction.

3.3 Results and Analysis

As noted earlier, this collaboration is part of a larger study on the efficacy of the CAB model where students in two courses, from two disciplines, collaborate with each other and a community partner, on a STEM-focused project to address a community-identified issue. The analysis of student self-assessment presented below should be considered preliminary. A more rigorous research study is underway, and results will be published in the future.

In order to assess the impact that the collaboration had on student learning and civic engagement, a paired-samples t-test was used to compare student self-assessments of their scientific skills, computational thinking, civic responsibility, and civic efficacy before and after the collaboration. Measurement of skills and computational thinking self-assessment are modified from indexes developed and validated through a prior project [39], while civic responsibility and efficacy indexes are adapted from another source [34].

Four separate indexes were used to measure our key learning outcomes: self-assessment of scientific skills, computational thinking, civic responsibility, and civic efficacy. Reliability statistics measure how consistently individuals answer items within an index; higher reliability statistics indicate more consistency, and thus more valid measures of the concept being measured. Alpha is computed by determining how consistently a respondent answers questions within the index. Indexes of at least three items with alpha statistics over .70 are generally considered to be reliable.

Index reliability statistics are summarized in Table 2.

Table 2: Index Reliability – Scientific Skills (SS), Computational Thinking (CT), Civic Responsibility (CR), and Civic Engagement (CE)

Index	Valid Cases, Pre/Post	Pre-test Alpha	Post-test Alpha
SS	76/70	.854	.885
CT	76/69	.823	.714
CR	77/70	.762	.828
CE	77/70	.629	.747

3.3.1 Scientific Skills (SS) self-assessment was measured with six-item index using a 4-point scale of agreement: (1) I can apply knowledge of science appropriate to my major; (2) I can analyze a problem, and then identify and define the scientific requirements appropriate to its solution; (3) I understand the impact of science on society; (4) I can use current scientific techniques, skills, and tools necessary in careers for which my major prepares me; (5) I can collaborate with others to design and develop science-based tools and technologies appropriate to careers for which my major prepares me; (6) I can conduct research and evaluate information by methods appropriate to my major.

3.3.2 Computational Thinking (CT) self-assessment was measured with a four-item index using a 4-point scale of agreement: When solving problems, designing systems, and understanding human behaviors, I am able to… (1) use abstractions; (2) use logical thinking; (3) use algorithms; (4) use revision.

3.3.3 Civic Responsibility (CR) self-assessment was measured with a five-item index using a 5-point scale of agreement: (1) Adults should give some time for the good of their community or country; (2) People, regardless of whether they've been successful or not, ought to help others; (3) I feel that I can make a difference in the world; (4) Individuals have a responsibility to help solve our social problems; (5) It is important to help others even if you don't get paid for it.

3.3.4 Civic Efficacy (CE) self-assessment was measured with a seven-item index using a 5 point scale of agreement: (1) It's not really my problem if my neighbors are in trouble and need help (reverse coded); (2) I believe I can make a difference in my community; (3) When I see someone being taken advantage of, I want to help them; (4) I often think about doing things so that people in the future can have things better; (5) When I see someone being treated unfairly, I don't feel sorry for them. (reverse coded); (6) I feel sorry for other people who don't have what I have; (7) It is important for me to contribute to my community and society.

All data collection activities in this project, i.e., pre- and post-tests, grade record reviews, and de-identified qualitative reflections, were approved by TCNJ's Institutional Review Board, Protocol #2019-0236.

Since pre- and post-tests could not be administered in person as originally planned, they were administered electronically through a Qualtrics survey. Despite being an all-remote semester, student participation rates in the two classes were high; pre- and post-tests were received from 85.33% of students based on official enrollment (87.67% when excluding students who withdrew from the classes after the official add/drop period but are still included in the official enrollment records).

A paired-sample t-test found that the total sample reported higher scores in all areas with significant positive change noted in scientific skills, computational thinking, and civic efficacy (see Table 3).

Table 3: Comparison of Pre- and Post-test Scores in Scientific Skills (SS), Computational Thinking (CT), Civic Responsibility (CR), and Civic Engagement (CE)

	SS	CT	CR	CE
Pre-test Mean	19.45	12.67	16.81	24.05
Pre-test sd†	2.77	2.23	2.41	2.61
Post-test Mean	20.91	13.69	17.25	24.91
Post-test sd†	2.57	1.81	2.43	2.83
Change	+1.46	+1.02	+0.44	+0.82
T Statistic	-3.99***	-4.35***	-1.508	-2.951**
N	56	55	57	57

† sd = standard deviation, *** $p \leq .001$ and ** $p \leq .01$

On average, students' evaluations of their scientific skills and computational thinking increased 1.46 points and 1.02 points, respectively. While these gains are modest, they are statistically significant, and the positive change suggests increased student confidence in their overall scientific skills and computational thinking abilities. The results demonstrate some growth in civic measures over the course of the semester. Analysis of students in both classes found a slight increase in the civic responsibility score (mean 0.44 point increase), though the difference was not statistically significant, and a modest but significant increase of 0.82 point on average in civic efficacy. A related inquiry examined change in self-assessment in these four areas for SE and PEN students separately. Further analysis (not shown) suggested that SE students assessed themselves as having higher capacities on both the pre- and post-tests of scientific skills and computational thinking than the PEN students. However, on both post-tests, but in particular computational thinking, the PEN students' scores increased more, narrowing the gaps. With regard to civic responsibility and civic efficacy, there was growth in both classes, albeit in different areas. While SE students did not report significant change with regard to civic responsibility, they reported a significantly higher sense of civic efficacy, with an average increase of 1.0 point from pre-test to post-test. In contrast, while no statistically significant growth occurred for PEN students in civic efficacy, their reported sense of civic responsibility increased on average by 1.0 point from pre-test to post-test. These preliminary observations require additional research to determine the robustness of these patterns.

During the Fall 2021 semester, Pulimood led two sections of the same Software Engineering class that included a project with a community partner, but without collaboration with another class (like Penology). In forthcoming (non-equivalent control group) analysis, we hope to isolate the effect of the interdisciplinary collaboration to account for change unrelated to the collaborative experience, in order to address potential threats to internal validity (i.e., endogenous change, selection bias, and/or a history effect).

In summary, the total sample of SE and PEN students reported significant increases in their learning in the areas of scientific skills and computational thinking, as well as an increase in civic efficacy. Participation in the project was additionally associated with an improvement in the scientific literacy of non-STEM majors, and correlated with an increase in perceived responsibility to help others for PEN students and an increase in perceived capacity to address social problems among their SE counterparts.

4 Conclusion and Future Directions

The purpose of this paper was to describe the experience of an interdisciplinary collaboration between two courses and a community partner to empower students to more deeply engage in their disciplinary content, and use this knowledge to better understand and address a social issue, specifically racial injustice in the criminal justice system. Consistent with previous literature on the benefits of PBL and CEL, students in both courses regarded the project as a successful learning experience since they learned more about another discipline and worked together to address the most pressing issue in the United States' criminal justice system. Participation in the project was associated with significant increases in scientific skills and computational

thinking in both classes. It was also associated with significant growth in civic efficacy for SE students, and with significant growth in civic responsibility for PEN students. This is a critical finding with wider implications beyond a particular project or course. PEN students, some of whom will be future criminal justice practitioners, grew in their perceptions of responsibility to address social issues, and SE students grew in their confidence that their education has imbued them with the software engineering skills and knowledge to effect change. Responsibility and efficacy are necessary building blocks to address societal problems, such as systemic bias. While they encountered challenges, this experience reinforced to Pulimood and Leigey students, and their students, the value of interdisciplinary teamwork and collaboration with a community partner.

In Spring 2022, Pulimood and Leigey will facilitate a second CAB collaboration in their SE and PEN courses. They look forward to implementing the lessons learned from this first collaboration in an in-person course with the same goals of increasing scientific literacy among STEM and non-STEM students, supporting a local community organization, deepening student understanding of disciplinary content, and awareness of how to take action to address racial injustice in the United States' criminal justice system. Special attention will be paid to student learning outcomes, in particular, whether similar benefits exist for both groups in the areas of scientific skills, computational thinking, and civic efficacy, as well as the discipline-specific benefits noted above, increased scientific literacy and perceived responsibility for PEN students and an increase in perceived capacity to address social problems among SE students.

More broadly, the partnership between Pulimood and Leigey is one of five CAB collaborations planned for spring 2022 that continue to promote the development of scientific thinking vis-a-vis interdisciplinary collaboration and community engagement.

ACKNOWLEDGMENTS

This work is supported by the National Science Foundation (NSF). Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of NSF. Additional support was provided by TCNJ's Barbara Meyers Pelson Chair in Faculty-Student Engagement award.

REFERENCES

[1] ABET Computing Accreditation Commission (CAC), *Criteria for Accrediting Computing Programs*. Retrd. Aug. 9, 2021 from https://www.abet.org/wp-content/uploads/2021/01/C001-21-22-CAC-Criteria.pdf.

[2] Julia Angwin, Jeff Larson, Surya Mattu and Lauren Kirchner. 2016. *Machine Bias*. Retrd. Aug. 10, 2021 from https://www.propublica.org/article/machine - bias-risk-assessments-in-criminal-sentencing

[3] Lecia J. Barker, Eric Snow, Kathy Garvin-Doxas, and Tim Weston. 2006. *Recruiting middle school girls into IT: Data on girls' perceptions and experiences from a mixed-demographic group*. In Women and Information Technology: Research on Underrepresentation. Cohoon & Aspray (eds). 113-136. The MIT Press, Cambridge MA.

[4] Ruha Benjamin. 2019. *Race After Technology*. Polity Press, Boston, MA.

[5] Ruha Benjamin. 2020. Race After Technology. Video. (12 May 2020). Retrd. Aug. 9, 2021 from https://www.youtube.com/watch?v=rY8RkET3KC0.

[6] Robert G. Bringle, Julie A. Hatcher, and Richard N. Muthiah. 2010. The Role of Service-Learning on the Retention of First-Year Students to Second Year. *Mich. Jour. of Comm. Svc. Lrng.,* 16 (2), 38-49. DOI: http://hdl.handle.net/2027/spo.3239521.0016.203

[7] Susan Blum and Alfie Kohn. 2020. *Ungrading: Why Rating Students Undermines Learning (and What to Do Instead)*. (1st ed.), Morgantown: West Virginia University Press.

[8] Lillian N. Cassel, Thomas Way, and Sridhara Potluri. 2009. CPATH: distributed expertise - collaborating with other disciplines. *In Proceedings of the 14th annual ACM SIGCSE conference on Innovation and technology in CS education (ITiCSE '09)*. ACM, New York, NY, USA, 382. DOI: https://doi.org/10.1145/1562877.1563024

[9] Christine I. Celio, Joseph Durlak, and Allison Dymnicki. 2011. A Meta-Analysis of the Impact of Svc. Learning on Students. *Jour. of Experiential Educ.* 34, 2, 164-181. DOI: https://doi.org/10.1177/105382591103400205

[10] He Len Chung, Michael Nordquist, Diane C. Bates, and Patrick Donohue. 2016. Partnerships in Civic Engagement: Cultivating Transformational Campus-Comm. Relationships Built to Last. *Soc. Behavior Rsch. and Practice*, 1 (1), 22-33. DOI: http://dx.doi.org/10.17140/SBRPOJ-1-105

[11] Kristina Henry Collins. 2018. Confronting Color-Blind STEM Talent Development: Toward a Contextual Model for Black Student STEM Identity. *Jour. of Adv Acad*, 29 (2), 143–168. DOI: doi.org/10.1177/1932202X18757958

[12] Paige Conley and Maria Hamlin. 2009. Justice-learning: Exploring the efficacy with low-income, first-generation college students. *Mich. Jour. of Comm. Svc. Lrng.*, 16 (1), 47-58. DOI: http://hdl.handle.net/2027/spo.3239521.0016.104

[13] Jerusha Conner and Joseph Erickson. 2017. When Does Service-Learning Work? Contact Theory and Service-Learning Courses in Higher Education. *Mich. Jour. of Comm. Svc. Lrng.,* 23 (2), 53-65.

[14] Ruth Delaney, Ram Subramanian, Alison Shames, and Nicholas Turner. 2018. *Reimaging prisons*. Vera Inst. of Justice. Retrd. Aug. 10, 2021 from www.vera.org/downloads/publications/Reimagining-Prison_FINAL3_digital.pdf

[15] Oscar H. Gandy, Jr. 2008. Engaging Rational Discrimination: Exploring Reasons for Placing Regulatory Constraints on Decision Support Systems. *Ethics and Info. Tech.*, 12, 29-42. DOI: 10.1007/s10676-009-9198-6.

[16] Rebecca A. Glazier. 2016. Building Rapport to Improve Retention and Success in Online Classes. *Jour. of Pol. Sci. Educ*., 12 (4), 437-456. DOI: 10.1080/15512169.2016.115599

[17] Michael Goldweber, John Barr, Tony Clear, Renzo Davoli, Samuel Mann, Elizabeth Patitsas, and Scott Portnoff. 2012. A framework for enhancing the social good in computing education: a values approach. *In Proc. of the final reports on Innovation and technology in CS education 2012 working groups (ITiCSE-WGR 39;12)*. ACM, New York, NY, USA, 16-38.

[18] Joanne Goode, Rachel Estrella, and Jane Margolis. 2006. *Lost in Translation: Gender and High School CS*. In Women and Information Technology: Research on Underrepresentation. 89-113. Cohoon & Aspray (eds). The MIT Press.

[19] Karen Hacker. 2013. *Comm.-Based Participatory Research*. Thous. Oaks. Sage.

[20] Dave Harker. 2016. Political Consciousness but not Political Engagement: Results from a Service-Learning Study. *Mich. Jour. of Comm. Svc. Lrng.*, 22 (2). 31-47. DOI: http://hdl.handle.net/2027/spo.3239521.0022.203

[21] Gregory W. Hislop, Heidi J.C. Ellis, S. Monisha Pulimood, Becka Morgan, Suzanne Mello-Stark, Ben Coleman, and Cam Macdonell. 2015. A Multi-Institutional Study of Learning via Student Involvement in Humanitarian Free and Open Source Software Projects. *In Proceedings of the 11th Annual Intl. Conf. on Intl. Computing Educ. Rsch. (ICER '15)*. ACM, New York, NY, USA, 199–206.

[22] The Joint CC2020 Task Force. 2020. ACM and IEEE Computer Society. Comp. *Curricula 2020: Paradigms for Global Computing Educ*. ACM, New York, NY, USA. Retrd. Aug. 10, 2021 from https://www.acm.org/binaries/content/assets/education/curricula-recommendations/cc2020.pdf.

[23] David A. Kolb. 2014. *Experiential learning: Experience as the source of learning and development*. Pearson Education. United States.

[24] George D. Kuh. 2008. *High-impact educational practices: What they are, who has access to them, and why they matter*." AAC&U. Wash., D.C. 34 pages.

[25] Beverly E. Moely and Vincent Ilustry. 2013. Stability and Change in the Development of College Students' Civic Attitudes, Knowledge, and Skills. *Mich. Jour. of Comm. Svc. Lrng*., 19 (2), 21-35.

[26] Beverly E. Moely and Vincent Ilustry. 2014. The Impact of Service-learning Course Characteristics on Univ Students' Learning Outcomes. *Mich. Jour. of Comm. Svc. Lrng.*, 21 (1), 5-16.

[27] Beverly E. Moely and Vincent Ilustry. 2016. Outcomes for Students Completing a University Public Service Graduation Requirement: Phase 3 of a Longitudinal Study. *Mich. Jour. of Comm. Svc. Lrng.*, 22 (2), 16-30.

[28] Khalil Gibran Muhammad. 2019. *The condemnation of Blackness: Race, crime, and the making of modern urban America*. Harvard University Press.

[29] Monita Hollis Mungo. 2017. Closing the Gap: Can Service-Learning Enhance Retention, Graduation, and GPAs of Students of Color? *Mich. Jour. of Comm. Svc. Lrng.*, 23 (2), 42-52.

[30] Yolanda Nelson. 2015. *Exploring the factors of persistence for African American senior nursing students*. Ph.D. Dissertation. Rowan University, New Jersey. ProQuest LLC.

[31] Sue Noy, Rebecca Patrick, Teresa Capetola, Janine McBurnie. 2017. Inspiration from the Classroom: A Mixed Method Case Study of Interdisciplinary Sustainability Learning in Higher Educ. *Australian Jour. of Environmental Educ.*, 33 (2), 97-118. DOI: https://doi.org/10.1017/aee.2017.22

[32] Jeffrey A Nunn and Janie Braud. 2013. A Service-Learning Project on Volcanoes to Promote Critical Thinking and the Earth Science Literacy Initiative. *Jour. of Geoscience Educ.*, 61(1), 28–36.

[33] Cathy O'Neil. 2016. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. Crown Publishers.

[34] Rachel Parker-Gwin and J. Beth Mabry. 1998. Service Learning as Pedagogy and Civic Educ.: Comparing Outcomes for Three Models. *Teaching Sociology*, 26 (4), 276-291.

[35] Pew Rsch. Center. *Criminal Justice*. Retrd. Aug. 10, 2021 from www.pewresearch.org/topic/politics-policy/political-issues/criminal-justice/police-1/

[36] *Process Oriented Guided Inquiry Learning in CS*. Retrd. Aug. 10, 2021 from https://cspogil.org/.

[37] *Process Oriented Guided Inquiry Learning*. Retrd. Aug. 10, 2021 from https://pogil.org/

[38] S. Monisha Pulimood, Donna Shaw, and Emilie Lounsberry. 2011. Gumshoe: a model for undergraduate computational journalism education. *In Proceedings of the 42nd ACM Tech. Symp. on CS education (SIGCSE '11)*. ACM, New York, NY, USA, 529–534.

[39] S. Monisha Pulimood, Kim Pearson, and Diane C. Bates. 2016. A Study on the Impact of Multidisciplinary Collaboration on Computational Thinking. *In Proceedings of the 47th ACM Tech. Symp. on CS Educ. (SIGCSE '16)*. ACM, New York, NY, USA, 30–35.

[40] RAND Corporation. *Racial Equity*. Retrd. Aug. 10, 2021 from https://www.rand.org/topics/racial-equity.html.

[41] Susan C. Reed, Helen Rosenberg, Anne Statham, and Howard Rosing. 2015. The Effect of Comm. Service Learning on Undergraduate Persistence in Three Institutional Contexts. *Mich. Jour. of Comm. Svc. Lrng*., 21 (2), 22-36.

[42] Dale H. Schunk. 2012. *Learning Theories: An Educational Perspective*, 6th Ed. Pearson. New York, NY.

[43] Mary L. Smith. 2017. *Reported Ideal Traits of a Mentor as Viewed by African American Students in Science, Technology, Engineering, and Mathematics*. Ph.D. Dissertation, The University of Southern Mississippi. ProQuest LLC.

[44] Smithsonian Science Educ. Center. 2015. *The LASER Model: A Systematic and Sustainable Approach for Achieving High Standards in Science Educ. Exec. Summary*. Wash., DC: Smithsonian Inst.. Retrd. Aug. 10, 2021 from https://ssec.si.edu/sites/default/files/SSEC%20Summative%20Report%20Section%201%20Executive%20Summary.pdf

[45] Bryan Stevenson. 2012. We need to talk about justice. Video. (5 March 2012). Retrd. Aug. 7, 2021 from https://www.youtube.com/watch?v=c2tOp7OxyQ8

[46] Julia D. Thompson and Brent.K. Jesiek. 2017. Transactional, Cooperative, and Communal: Relating the Structure of Engineering Engagement Programs with the Nature of Partnerships. *Mich. Jour. of Comm. Svc. Lrng*., 23 (2), 83-99.

[47] The Urban Institute. *Crime and Justice*. Retrd. Aug. 10, 2021 from https://www.urban.org/research-area/crime-and-justice.

[48] Lori Vogelgesang and Alexander Astin. 2000. Comparing the Effects of Comm. Svc. and Service-Learning. *Mich. Jour. of Comm. Svc. Lrng*., 7 (1), 25-34.

[49] Grant Wiggins and Jay McTighe. 2005. *Understanding by Design* (2nd. ed.). Pearson, London, UK.

[50] Theresa Ling Yeh. 2010. Service-Learning and Persistence of Low-Income, First-Generation College Students: An Exploratory Study. *Mich. Jour. of Comm. Svc. Lrng.* 16 (2), 50-65.

[51] Patrick L. Yorio and Feifei. Ye. 2012. A Meta-Analysis on the Effects of Service-Learning on the Social, Personal, and Cognitive Outcomes of Learning. *Academy of Management Lrng. and Educ.,* 11 (1), 9-27.

[52] Hongtao Yue and Steven M. Hart. 2017. Service-Learning and Graduation: Evidence from Event History Analysis. *Mich. Jour. of Comm. Svc. Lrng.,* 23 (2), 24-41.