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EDITED BY

Sheila S. Jaswal,
Amherst College, United States

REVIEWED BY

Desiree Forsythe,
Chapman University, United States
Anupama Seshan,
Emmanuel College, United States

*CORRESPONDENCE

Samiksha A. Raut
✉ sraut@uab.edu

[†]These authors have contributed equally to this work and share first authorship

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Championing awareness of the opioid epidemic through a service-learning module for non-STEM biology majors

Ryleigh Fleming^{1†}, Sarah J. Adkins^{2†}, Marco Esteban³,
Cinnamin Cross¹, Amy Hutson Chatham⁴ and Samiksha A. Raut^{1*}

¹Department of Biology, University of Alabama at Birmingham, Birmingham, AL, United States, ²Alabama College of Osteopathic Medicine, Dothan, AL, United States, ³University of California, Irvine, Irvine, CA, United States, ⁴Department of Environmental Health Sciences, School of Public Health, University of Alabama at Birmingham, Birmingham, AL, United States

Over 50,000 people die annually from opioid overdoses in the United States leading to what has become known as the “opioid epidemic.” This is of heightened concern in states like Alabama that experience higher rates of overall drug use and overdose deaths. Thus, it is increasingly important for college students in Alabama to learn about how the opioid epidemic is affecting their communities. Previous studies have demonstrated that engaging non-majors in innovative active-learning oriented pedagogies like service-learning can enhance their understanding and awareness about contemporary societal issues. Despite its pedagogical potential, the impact of opioid-related service-learning, particularly for non-majors, continues to remain unexplored. In this study, we describe the implementation of a service-learning module centered on opioid addiction. Students in a non-major biology course learned the science behind opioids, had Naloxone training, and engaged in active discussions with an opioid researcher, physician, and former illicit opioid user. Our assessment of the thematic analysis of pre- and post-reflection free-write data from 87 consenting students revealed 10 categories that students reported in the post- but not pre-reflections (essay gain), pre- and post-reflections (neutral), and pre- but not post-reflections (essay loss). We found essay gains in students humanizing addiction and awareness of the cultural context of opioid addiction and essay losses from students indicating that non-major students had a low level of awareness related to these issues. Eight one-on-one, semi-structured interviews revealed that students were personally impacted by the epidemic and valued its curricular inclusion. Our data supports that service-learning can increase non-major biology student’s awareness and contextual understanding about the opioid epidemic, enabling much-needed advocacy to further enhance its awareness among the public.

KEYWORDS

opioid epidemic, service-learning, non-majors biology, active-learning, STEM, pedagogy

Introduction

The opioid epidemic continues to ravage the United States with over 50,000 people dying every year from opioid-related deaths (Wilson et al., 2020). In the southern states like Alabama, it is a cause for a much deeper concern as the opioid epidemic is characterized by higher rates of death related to illicit opioid-related drug use in the southern US (Kertesz, 2017). The opioid

epidemic can be traced to the 1990s for two reasons: (a) The American Pain Society made efforts to include pain as the fifth vital sign, thus endorsing the freedom of a patient's rights to manage their pain and (b) the Food and Drug Administration approved the opiate oxycodone (also known as OxyContin®; Skolnick, 2018). Fast forward nearly 30 years and the public, according to a convergence of seven national polls, reports a call to action for the opioid epidemic is an “extremely important priority” indicating the topic has become a part of the public consciousness (Blendon and Benson, 2018). Part and parcel with that awareness, several evidence-based ways to combat opioid drug use and its effects have emerged, including: reducing inappropriate prescription of opioids by medical professionals (Blendon and Benson, 2018), reducing excess opioids by offering take-back programs (Clark and Schumacher, 2017), as well as training the public to treat narcotic overdoses (Kim et al., 2009). Institutions of higher education are actively involved in addressing this crisis by training students. As an example, the implementation of the long-standing Medication Assisted Recovery Services (MARS) program developed in association with the Albert Einstein College of Medicine now educates patients on addiction and treatments (Woods and Joseph, 2012). Given the fact that students themselves are stakeholders for their communities, their understanding of these programs is paramount. Considerable attention has been paid toward educating future health professionals related to opioids (Woods and Joseph, 2012; Berland et al., 2017; Ratycz et al., 2018; Wallace et al., 2020). In Alabama for instance, medical students working with pharmacists at the Alabama College of Osteopathic Medicine provide education and medication to community members (The Dothan Eagle, 2022; WDH, 2022). Indeed, medical school students attending educational workshops about opioid misuse favored its inclusion in their curricula and reported associated learning gains (Monteiro et al., 2017).

However, students who are not science majors (henceforth called “non-majors”) are often left out of the conversation in terms of opioid pedagogies, despite making up part of the future college-educated citizenry. Non-majors may only complete one science class for their core requirements, and thus their required science course is an ideal environment to discuss how science (i.e., the science of opioids or vaccines) is relevant to their lives and their community, particularly for a topic of interest to the public (Knight and Smith, 2010; Blendon and Benson, 2018; Morra et al., 2022). Ongoing research indicates a pedagogy called active learning is particularly effective in the non-major classroom (Wilke, 2003; Knight and Smith, 2010; Mendoza et al., 2020; Adkins-Jablonsky et al., 2021). Indeed, active learning, a broad term encompassing an array of engaging student-centered learning activities rather juxtaposed to student's passively listening to instructor's lecture, has well documented positive outcomes (Freeman et al., 2014). One increasingly common active-learning pedagogy related to science (i.e., opioid) education is service-learning (SL; Warren, 2012; Hayford et al., 2014; Germain, 2019; Hill et al., 2020).

Though SL made its debut as early as the 1960s, it is quickly growing in terms of its popularity across global institutional contexts to help meet the changing needs of the communities while aligning those goal to course objectives (Seifer et al., 1996). Active learning encourages various pedagogical modalities, but SL stands out in that students apply what they learn in the classroom through design, implementation, and promoting student involvement; and as such, SL relies on reflective practice and active involvement with a community

with an intent to achieve societal change by utilizing course content (Escofet and Rubio, 2019). Pioneers of SL like Robert Sigmon have demonstrated that SL offers a mutually beneficial relationship between the students and the community partners, wherein both the parties become aware and receptive of each other's needs (Santas, 2009). These guiding principles can lay the groundwork for many universities to establish SL-related programs in their schools to establish and nurture strong connections with their respective communities. For example, students involved in a SL activity with a non-profit safari park reported a greater interest in the coursework (Santas, 2009). A meta-analysis of SL demonstrates the positive effect of SL on cultural awareness, social responsibility, and student learning outcomes (Warren, 2012) including STEM literacy (Hayford et al., 2014).

Ongoing research in non-major biology courses is exploring the impact of SL on connecting biology with the community (Santas, 2009; Begley, 2013; Mendoza et al., 2020) particularly with contemporary issues (Morra et al., 2022). While some studies investigate the impacts of training medical and science students with hands-on training including life-saving Naloxone training (Berland et al., 2017), there is little research on these pedagogies in non-major science classrooms. Here, we developed a SL module on the opioid epidemic that included patient and physician perspectives, the biology of opioids, Naloxone training, and a community-based infographic assignment. Given the dearth of opioid pedagogies tailored for non-majors and the need to train more “lay-people” in Naloxone administration (Kim et al., 2009), we sought to address the following specific research questions:

Research Question 1 (RQ 1): How does our SL module change non-major science students' awareness and knowledge about the opioid epidemic?

Research Question 2 (RQ 2): What were the non-major's science students' perceptions about the opioid SL module?

Methods

Course background

There are a variety of life-science-based courses offered at The University of Alabama at Birmingham (UAB), located in central Alabama. One among these courses includes a large enrollment biology course designed for non-majors entitled “Topics in Contemporary Biology.” This 3-credit hour lecture-based course has no prerequisites. Students may concurrently enroll in the corresponding course-based laboratory research course should their major require additional life science electives. The lecture course was taught by S.R. during the Spring 2020 semester and enrolled 112 students. This course was taught in an active-learning format with various engagement strategies including think-pair share and discussion prompts (Tanner, 2013; Cooper et al., 2021; see syllabus in Supplementary materials for more detail on active-learning) where every module and assignment related to a learning objective.

The general learning objectives (LOs) that fell under RQ1 were as follows:

- Develop environmental consciousness and civic responsibility.
- *Understand the biological basis of opioid addiction* *Includes a service-learning component.*

The general LOs that fell under RQ2 were as follows:

- Understand the basic process of science & identify the valid sources of scientific literature.
- Analyze and apply scientific information to make everyday decision.

Student grades were based on three multiple-choice exams throughout the semester (20% each), and a SL module on opioid addiction (40%). The in-person SL module on the “Opioid Epidemic” was followed by a virtual COVID-19 module, after the declaration of shelter-in-place to educate students about the pandemic and raise awareness about official recommendations, and this module was worth 20% of their final grade (Adkins-Jablonsky et al., 2021). Each SL module included pre- and post-written reflections followed by a group activity and a final impact paper (see [Supplementary materials](#) for course syllabus and more instructional materials).

Opioid addiction module

This module included four interactive guest lectures in-person with the introduction of history and biology of opioids for the first two lectures, Naloxone training with a Jefferson County Department of Health physician during the third lecture time, and active discussions related to addiction with a former illicit substance user as the fourth guest lecture. Each interactive guest lecture was 50 min (PowerPoint materials are available upon request). This was then followed by students completing a required infographic group assignment (see [Supplementary materials](#) for course syllabus and assignment instructional materials) to help raise community awareness of opioids and opioid related addiction. To maximize students from different identities working together and avoid the formation of pre-class friend group bias, all enrolled students were randomly divided into teams of 3–4 students to complete the infographic assignment (Shah et al., 2020). Each group was further assisted by an upperclassman who volunteered their time to serve as a Peer Leader. The course instructor SR collaborated with the University’s Office of Service-Learning and Undergraduate Research and the Department of Biology to display infographics across campus.

Each student group was asked to present their completed assignment in a poster-style presentation either via a printed pamphlet or a digital presentation on their e-devices. Examples of student infographics are shown in [Figure 1](#). This infographic creation and dissemination assignment was identified as a need-based community project in consultation with the UAB Office of Service-Learning and Undergraduate Research and the Jefferson County Department of Health.

Pre/post-reflections

Students were required to complete in-class reflection assignments at the beginning of this SL module (pre) and afterwards (post) with the following prompt: *The Opioid Epidemic is America’s biggest drug crisis. We are interested in knowing your pre [or post] – reflection thoughts on whatever you can ‘free-write’ on this issue: history, cause, treatment, rehab, patient mind-set, social issues, relapse, and resources for patients, etc. Use this page and the back of this page if it applies.* This prompt mirrored verbiage used in this same course for other graded reflections (Adkins-Jablonsky et al., 2021) but was related to a different topic (the opioid epidemic). Of the 112 students who completed the assignment, 87 consented to participate in the study to have their reflections analyzed.

Student interviews

Along with the pre- and post-reflections, we recruited eight previously consented students to participate in one-on-one interviews to seek their opinions about our SL module after the final semester grades were submitted (Adkins-Jablonsky et al., 2021). Each interview was conducted over Zoom, set to record, and began with an explanation of privacy and confidentiality. The student interviews were semi-structured in that students were read the post-reflection essay prompt (detailed above) and allowed to answer verbally. No other specific questions were asked, and students were prompted to continue to tell us anything they considered related to the topic or course in addition to follow up questions based on student’s previous comments. In this

HOW DO DRUGS WORK



IMPORTANCE OF TOPIC



FIGURE 1

Excerpts from student opioid infographics. Here, sections of infographics include graphics for “How [opioid] drugs work” and “Importance of topic”.

way, students could freely discuss their perspective without being graded, unlike the pre- and post-reflection assignments which were a part of the overall module grade (see syllabus in [Supplementary material](#)). Student interviews were transcribed, and their accompanying personal information was de-identified. This study was approved by The University of Alabama at Birmingham IRB-30004903.

Data analysis

The student responses were analyzed using deductive and inductive methods of investigation and methods of the grounded theory (Strauss and Corbin, 1990; Strauss and Corbin, 1998; Adkins-Jablonsky et al., 2021). Two individual coders who were at similar career stages and experience levels (RF and CC) used pre-set larger categories A–D (deductive) from the 87 student pre- and post-reflection essays. Categories A–D can be found below listed under their respective RQ. Then, coders approached each essay sentence line-by-line where they decided on 10 overall open-coded themes (inductive) discussion style and reached a complete consensus. The coders unanimously agreed on the themes in [Table 1](#). Post-reflection essays were then categorized using the same coding framework. The essay gains and essay losses between pre and post were then recorded. A word count was reported for each reflection using the MS Word tool “Word Count” and a two tailed paired t-Test between pre and post values was performed. The coding of student interviews mimicked the pre-/post-reflection writers under the same A–D categories, but with different coders (author ME and acknowledged researcher Cedric King) to prevent the coding of the student reflections from influencing the interpretation of interview data.

Results

Four set categories encompassed 10 themes overall ([Table 1](#)). Each theme was also categorized into sub-themes during the coding process. The essay gains (themes present in post-reflections but not

pre-reflections) are described below with corresponding quotes in [Table 2](#), thus providing insight about how themes emerged. The average word count for pre- and post-reflections was 82 and 312 words, respectively, which was a significant increase ($p < 0.5$). Essay gains and essay losses, as described below, are visualized in [Figure 2](#).

Essay gains

The essay gains (themes present in post-reflections, but not pre-reflections) are described below.

Category A: The science of opioid addiction

“The science of opioid addiction” covered two themes (below). The largest essay gains in this category were in understanding the biological basis of opioid addiction. “**Biological basis of opioid addiction**” was reported by 23% of students. Students explained how opioids provide opioid users with a sense of pleasure, provided examples of which drugs, like fentanyl, were opioids; knew opioids affect a person’s brain chemically (i.e., what chemicals were released, effects of the chemicals); understood the progression of addiction; and knew more about the biological origin of opioids. **Applying scientific information to make everyday decisions** was reported by 4 students or less, including highlighting the scientific information from the guest lectures changed their day-to-day thinking about the opioid epidemic.

Category B: Humanity of opioid addiction

“Humanity of opioid addiction” covered three themes (below). The most common themes in this category were civic responsibility and humanizing opioid addiction. “**Civic responsibility**” was discussed by 19% of students who reported (i) examples of strategies that could be employed to combat the opioid epidemic systemically

TABLE 1 Categories and respective themes in pre and/or post reflections.

Research Question 1 (RQ 1): How does our SL module change non-major science students’ awareness and knowledge about the opioid epidemic?
<u>Category A: The science of opioid addiction</u>
Theme 1: Biological basis of opioid addiction
Theme 2: Applying scientific information to make everyday decisions
<u>Category B: Humanity of opioid addiction</u>
Theme 3: Civic Responsibility
Theme 4: Opioid Addiction personally relates to students
Theme 5: Humanizing opioid addiction and empathy
<u>Category C: Knowledge of opioid addiction</u>
Theme 6: Lower level Awareness of Opioid Addiction Cause and History (Excluding Biology)
Theme 7: Higher level of Awareness of Opioid Addiction Cause and History (Excluding Biology)
Research Question 2 (RQ 2): What were the non-major’s science students’ perceptions about the opioid SL module?
<u>Category D: Curricular feedback</u>
Theme 8: Response to Module (excluding Service-Learning)
Theme 9: Response to Service Learning
Theme 10: Response to Naloxone and Naloxone Training

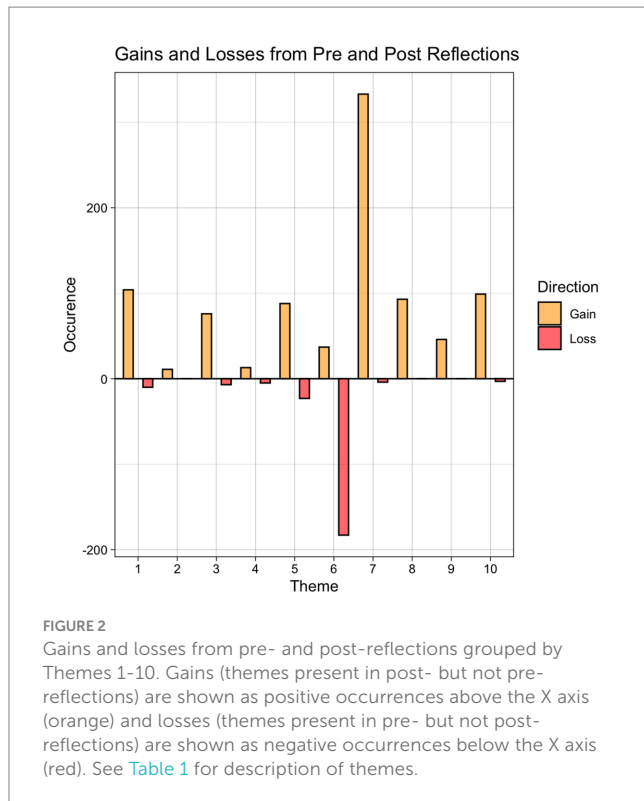
TABLE 2 Major categories, themes, and quotes from post-reflections.

Theme and subthemes	Example of student quote(s)
Category A: The science of opioid addiction	
Theme 1. Biological basis of opioid addiction: <i>Process of how opioids work chemically in the brain</i>	“The main thing that I got to learn was how opioids work within the brain. Opioids attach to receptors in the brain and once they are attached, they send signals to the brain that block pain, slow breathing, and give off a general calming and anti-depressing effect. Opioids target the brain’s reward system by flooding its circuit with dopamine. Dopamine is a natural hormone- a neurotransmitter that regulates emotion, motivation, feelings, and pleasure. Once it is over-stimulated and over produced, the brain produces a euphoric effect.” – Student 20 (Post)
Category B: Humanity of opioid addiction	
Theme 3. Civic responsibility: <i>Strategies that could be employed to combat the opioid epidemic either systemically or directly</i>	“The United States has some states that implement an opioid cap on prescriptions, where a person can only be prescribed a certain dosage for an allotted time and cannot have the prescription refilled for a certain amount of time. This practice is used in states like Iowa, where for dental procedures a patient cannot be prescribed Percocet for third molar extractions where the dose would last more than 3 days. Iowa also has an online database of every single person who has been prescribed an opioid and it states what reason it was given, the dosage and what doctor prescribed it so you can cross reference. By having this system, providers in Iowa are able to verify if a patient is just a drug seeker looking for their next fix, or if they can prescribe them a strong medication.” – Student 70 (Post)
Theme 5. Humanizing opioid addiction and empathy: <i>Anyone can become addicted to opioids</i>	“Opioid addiction is something that can affect everyone. Regardless of your social status, upbringing, or financial status you can still become addicted to opioids. There are some people and locations that are more susceptible to addiction than others, but it is still a universal issue” -Student 70 (Post)
Category C: Knowledge of opioid addiction	
Theme 6. Low level awareness of opioid addiction cause and history: <i>Not aware of opioids/ the opioid epidemic</i>	“Coming into this module, I had little knowledge about what classified as an opioid, what opioids did to people and just the overall knowledge of what an opioid is.” – Student 85 (Post) “Before this module, I knew very little of what opioids are. I did not even know what the effects were of opioids. I did not even know about how much they impact not only the nation, but my state, Alabama.” -Student 63 (Post)
Theme 7. High level awareness of opioid addiction cause and history. <i>Types of treatment options</i>	“For those struggling with opioid addiction, their options for recovery include medication assisted treatments, counseling, IOP, 12 step rehab programs, and partial hospitalization programs.” -Student 51(Post) “I also learned about the treatments in Birmingham such as the Resource Recovery Center, and the UAB Addiction Recovery Program who also has a 12-step program.” -Student 79 (Post)
Theme 7. High level awareness of opioid addiction cause and history. <i>Associating opioid use with overdosing</i>	“Thanks to this project I learned about just how serious this problem actually is. I knew that painkillers could be addicting but I had no idea just how many deaths were caused by overdoses.” -Student 66 (Post)
Theme 7. High level awareness of opioid addiction cause and history. <i>Connection with Alabama</i>	“I wasn’t aware that there were so many prevalent cases in Alabama alone. Not only that, but we were rated number one. I’ve been living in Alabama all 18, going on 19, years of my life with a lack of knowledge towards this topic.” -Student 22 (Post)
Category D: Curricular feedback	
Theme 8: Responses to Module (excluding Service-Learning): <i>Information from the module regarding the opioid epidemic and/or addiction</i>	“Over the course of the past few weeks, I have learned a tremendous amount concerning the opioid epidemic, including why it is so harmful to individuals, why it affects such a large number of people, and what we as a community can do to try and decrease this addiction.” – Student 91 (Post) “Over the course of the module I learned many things that I would not have thought of without this assignment.” -Student 90 (Post)
Theme 10. Responses to Naloxone and Naloxone training: <i>Students cited that the Naloxone/Narcan helps, revives those that have overdosed, or reverse the overdose of opioids</i>	“I learned about Naloxone. Naloxone is an opiate antagonist commonly used in emergency situations to reverse the effects of an opioid overdose. Naloxone only works on opioid overdoses” – Student 20 (Post)

This table represents the essay gains in student’s knowledge from the opioid module and activity by showing the number of times students brought up a theme that fell under one of the major categories when writing their post-reflection. A learning gain qualifies as a student bringing up a piece of information about the opioid module and/or activity they did not mention in their pre-reflection.

or directly, (ii) wanting to spread more awareness about the opioid epidemic, (iii) understanding lack of awareness regarding how much the public knows about the opioid epidemic, (iv) recognizing they could now spread awareness, and (v) a feeling of knowing enough information to help someone in need. **“Humanizing opioid addiction and empathy”** was reflected in 12% of students’ reflections

with the most common subtheme revealing that students understood “anyone” can become addicted to opioids; opioids can cause an opioid users’ mindset to change; addiction is hard to overcome; and opioid addiction is a disease. **“Opioid addiction personally relating to students”** was reported by 5% of students when students explained that the opioid epidemic affects their family.



students. Students learned that Naloxone helps those that have overdosed and that Naloxone does not hurt a person if they are unnecessarily injected. Some students did not know that Naloxone existed before the module, but learned Naloxone can be bought over the counter at a pharmacy. **“Responses to Module (excluding service-learning)”** were shared by 23% of students who cited that they learned a lot of information regarding the opioid epidemic and/or addiction due to the module. Students found the opioid module was eye opening/enlightening, they enjoyed the module, they found the opioid addiction was interesting, it must be helpful and/or comforting to know that resources are available for those suffering from opioid addiction, and that they felt as though they learned accurate and/or valuable information. **“Responses to service-learning”** were shared by 7% of students. Students reported the project helped them to better understand the opioid epidemic, that they enjoyed working with their group go on the project, and they had a good amount of interaction while they shared their project via social media.

Essay losses

The essay losses (themes present in pre-reflections, but not post-reflections) are described below. Essay gains and essay losses are visualized together in [Figure 2](#).

Category C: Knowledge of opioid addiction

“Knowledge of opioid addiction” was split into low level and high level of awareness. The most gains in this section and across all categories were those in higher levels of awareness about opioid addiction cause and history. **“Higher levels of awareness of the opioid addiction cause and history”** was coded in nearly 35% of all student post reflections. The most common sub themes in theme 7 included: associating opioid use with overdosing, understanding that opioids have negative side effects (i.e., death, destruction of families, and etc.); taking opioids makes people feel better because opioids help relieve pain; knowing types of treatment options that could be used to potentially help opioid users; citing a connection between the United States and opioid use; making the connection with Alabama and high amounts of opioid use, citing that the module taught them about what may put people at risk for developing an opioid addiction. **“Low level awareness of opioid addiction cause and history”** was discussed by approximately 16% of students. The most cited subthemes were students discussing that before learning this information they were unaware of opioids/the opioid epidemic; and before learning all this information they understood the general concept of opioids but did not comprehend the broader impact that opioids had on people (i.e., the Opioid Epidemic).

Category D: Curricular feedback

“Curricular feedback” covered three themes (below). The most reported theme was responses to Naloxone training followed by curricular feedback, excluding service-learning. **“Responses to Naloxone and Naloxone training”** were shared by over 33% of all

Category A: The science of opioid addiction

5% of students reported that they understood the progress of addiction and/or withdrawal through their pre-, but not post-, reflections (Theme 1: Biological basis of opioid addiction).

Category B: Humanity of opioid addiction

9% of students reported in their pre-, but not post-reflections, that addiction is hard to overcome, that people may take opioids because they want to control their emotions or mental state, or that there is some stigma attached to being an opioid user (Theme 5: Humanizing opioid addiction and empathy).

Category C: Knowledge of opioid addiction

21% of the students reported only in their pre-reflection, but not their post-reflection that they did not know much about the opioid epidemic. Then 16% of students reported that opioids are highly addictive and/or easy to get addicted to. Additionally, 16% of students also demonstrated that they understood the concept of relapsing. As for Theme 7, 16% of students cited that rehab helps with opioid addiction only in their pre-reflection. 14% of students stated that rehabilitation helps with opioid addiction. Another 14% of students noted that a person’s opioid addiction can begin when they were prescribed opioids while undergoing surgery for an injury or as a medical treatment. Additionally, 12% of students mentioned that the opioid epidemic/ addiction has increased over the years.

Category D: Curricular feedback

Both Themes 8 and 9 had no essay losses with students mentioning a sub-theme in just their pre-reflection, and not in their post-reflection. However, Theme 10 had around 3% of students demonstrate that they generally understood that opioid addicts must receive treatment to help them revive if they overdose.

Student interviews

Table 3 represents the most common themes among the students interviewed. Since the interviews were optional and ungraded, a variety of unique themes emerged from the student interviews. There was a mix of student comments regarding the knowledge gained in the essays on opioid addiction and comments on the students' opinions of the curriculum. One of the most prevalent themes was learning from the creation of the infographic. Not only did students enjoy it (Student 1, 6) they gained experience in design and through the content (Student 2, 3, 6, 8). Many student interviews reflected positive reflections on the curriculum.

Discussion

There exists a lack of research on opioid curricula for non-major undergraduate students yet there is a need for a more general training

in public opioid education including Naloxone training (Kim et al., 2009). In our study, 112 non-major students learned opioid content from guest lectures delivered by an opioid researcher, physician as well as from a former opioid user. Additionally, the invited guest lecture by the physician included training in Naloxone administration. Thereafter, the students were tasked with making infographics (Figure 1) and other digital presentations. Students shared their course products with their UAB peers and emphasized the importance and relevance of opioids in everyday life, which was a unique aspect of our SL module. At UAB, we have previously documented content and affectual gains for non-majors SL projects on topics including climate change (Knight and Smith, 2010) and COVID-19 (Freeman et al., 2014). Meanwhile, as drug overdoses from opioids continue to climb (Rudd et al., 2016), particularly in states like Alabama, which has the highest dispensing rate in the United States (CDC, 2020), it is imperative to educate non-majors students who constitute a significant segment of Alabama's public. Notably, these rates of opioid abuse were further exacerbated during COVID-19 pandemic (Kosten and Petrakis, 2021). Furthermore, based upon author S.A.R.'s experiences serving on UAB's Opioid Taskforce, a campus-wide initiative bringing different stakeholders to brainstorm ideas about tackling Alabama's opioid epidemic, S.A.R. felt passionate about educating and raising awareness about these issues through her course instruction.

Previous studies have shown SL and/or Naloxone training modules promote learning gains among students positioned as

TABLE 3 Major categories, themes, and quotes from student interviews.

Theme	Example student quote	Number of students
Category C: Knowledge of opioid addiction		
Lack of previous knowledge	"I think it was very beneficial just because I do not know how but I had not heard of the opioid epidemic. I did not know that it was a huge problem and I did not really know what opioids were. So, it was definitely informative, and I do think it's something that we all need to know about." - Student 2	4 of 8
Doctor responsibility	"I did not realize doctors were being blamed and causing so much harm, even when it wasn't really their fault because people were telling them they need to give more." - Student 2	4 of 8
Category D: Curricular feedback		
Positive review of TAs	"TAs would hold review sessions for us, which, I think they actually prepared me for the test a little better than the regular lectures, but they were so awesome and they really tried to keep in touch with us and make sure that we got our assignments done." - Student 1	2 of 8
Support for course lectures and guest speakers	"You can look stuff up on the internet, but you do not always know what's true. So, I think it helps to have a person in the research or medical field who is directly involved with it in person telling us these things... my mom actually watched Dr. Singh's lecture with me because she was pretty interested in it." - Student 2 "I feel like even if we had that module but did not have the guest lectures, I do not think it would have been as effective as it was." - Student 5	4 of 8
Learned from making infographics	"There are two things that I learned from this: how to make a flyer firstly, and the second was to get the knowledge of that particular topic, you know, solutions, impacts, history, all sort of stuff that we had to write in flyer. It was a huge help." - Student 3	6 of 8
Gained knowledge through groups	"I really liked having a group component in the class. I felt like we were able to bounce ideas off each other and we were able to do better on our projects." - Student 6	2 of 8

Eight one-on-one interviews were carried out as semi-structured based on the pre- and post-reflection prompt. Categories A–D were used similarly to the reflection coding, but different themes emerged from coding the interviews compared with the reflection data.

future healthcare personnel (Woods and Joseph, 2012; Berland et al., 2017; Ratycz et al., 2018; Wallace et al., 2020; The Dothan Eagle, 2022; WDHN, 2022). Based upon studies exploring the curriculum needs of non-major students (Crossgrove and Curran, 2008; Ballen et al., 2017; Hebert and Cotner, 2019), our research positions non-major students as being representative of current and future cohorts of the public. As such, we view non-majors as potential change agents that could educate others and administer Naloxone in times of need. Our research questions investigated how our newly implemented opioid education SL pedagogy informed student outcomes related to awareness, knowledge, and perceptions.

RQ 1: How does our SL module change non-major students' awareness and knowledge of the opioid epidemic?

We found that students wrote over three times as many words in their post-reflections than their pre-reflections, reflecting an expected yet important intellectual growth throughout the completion of the SL module. Analysis of qualitative data revealed gains in knowledge in the essays about the cause and history of the opioid epidemic and drastic losses in the essays in students' low level of awareness about the opioid epidemic (Figure 2). In other words, following the module, a third of all students reported they had learned about the opioid epidemic and no longer reported they lacked knowledge (Category C, Themes 6 and 7). We note that while these students reporting low-level knowledge seems intuitive in retrospect, collecting pre-information is needed to ascertain what knowledge students have when they enter the classroom (Handelsman et al., 2004, 2007). While the essay loss of general low-knowledge was demonstrated in a third of student essays, it is quite likely that this theme – among others – are low because the data is coming from free-response end of semester post essays, rather than a questionnaire or post exam. We felt as though essays were the truest way to ascertain what students' free thoughts are as they leave the classroom. Next, it was important to ascertain student learning essay gains upon the completion of this module.

Our LOs related to the module was for students to be able to “Understand the biological basis of opioid addiction.” First, they demonstrated increased awareness (Figure 2) in alignment with the instructor's course objectives. Specifically, students reported learning about the biological science of opioid addiction including the neurochemistry of addiction and the chemical derivation of opioids (Category A, Theme 1), and nearly a third of students reported on how opioid and opioid addiction occurs mentally and the psycho-social implications of addiction (Category C, Theme 7). These numbers could be influenced highly by the previous opioid user's testimony but could also be lower than other themes considering students may have felt more inclined to write about biological themes given the essays served as their biology final. Interestingly, more students reflected on psycho-social implications from our opioid module than the same class did on a previous COVID-19 module despite a similarly worded prompt and pedagogy (Adkins-Jablonsky et al., 2021). These differences may be attributable to hosting fewer guest lecturers – in our opioid module, we invited one physician as a guest lecturer who also

demonstrated how to administer Naloxone. In our previous module, there were four physicians or scientist experts who delivered the course content. It may be possible that the quantity and tone of guest lecturers could meaningfully change students' perceptions of the content. On the other hand, students could have been more interested in the biological content of the previous module focused on COVID-19 due to the heightened social discourse and the impact of the pandemic on the world around them.

SL appeared to achieve both aims of promoting civic mindedness as well as improvements in didactic knowledge to create community-oriented students (Seifer et al., 1996; Santas, 2009; Escofet and Rubio, 2019). Indeed, in addition to the aforementioned learning essay gains, a fifth of this class reflected on their civic responsibility, such as being empowered to spread awareness, and/or humanizing opioid addiction through acknowledging the toll that drug addiction takes on the brain as a disease (Category B, Theme 3 and 5). We previously found that guest lectures and a 3-hour community-based assignment were sufficient to demonstrate essay gains in students advocating for environmental civic responsibility (Mendoza et al., 2020). Here, we have shown an extra Naloxone training session and perspective offered by a previous opioid user along with a shorter infographic/digital presentation tabling assignment can change student perspectives on civic responsibility.

RQ 2: What were non-majors students' perceptions of the opioid SL module?

Non-major students tend to benefit from active-learning modules and especially those that help to connect the course content to their day-to-day lives (Wilke, 2003; Knight and Smith, 2010; Freeman et al., 2014; Mendoza et al., 2020; Adkins-Jablonsky et al., 2021). We were interested in student's perceptions of the opioid SL module and therefore, we created “curricular feedback,” a predetermined qualitative category. These data may provide useful information to us and other instructors in future iterations about engaging non-majors in an opioid awareness curriculum. Most of the reflections about the curricula were related to the content included in the module and Naloxone training. A quarter of the students reported that the module was beneficial to their learning, including reference to learning accurate information (Category D, Theme 8). While we could surmise student's perceptions of the module could be tied to their perception of their instructor and guest lecturers relaying accurate information, it is unclear still how students perceived the accuracy of what they were learning.

While all students were required to engage their peers in conversations via their assigned opioid infographics and digital presentation assignment, only six students' reflections or interviews explicitly mentioned this assignment. However, all six reviews in both the reflections and interviews were positive including students saying creating SL infographics helped them to learn more about the epidemic (Category D, Theme 9). The lack of student free writing about this experience may have been due to students not having an actual extramural community partner for this assignment. Our SL activity used the UAB campus as an internal community

partner, but future opioid SL curricula could connect students with extramural medical institutions and organizations to help patients more directly, which was a recommendation of the students in a later course module (Adkins-Jablonsky et al., 2021). Pharmacology students have been shown to demonstrate higher-order thinking and a shift in attitudes following a SL module that included a range of extramural community partners (Surratt and Desselle, 2004). Also, Farley and colleagues demonstrated that educational intervention with post-operative patients who have been prescribed opioids can directly reduce their chance of opioid dependence (Farley et al., 2019). Students could work with such groups to curate or create educational materials based on the community partner's needs. With regards to student outcomes, this study did not specifically tease out students' perceived stigma of opioid users, though it is possible that students' stigma toward opioid users may have changed (Kabli et al., 2013). Continued exploration of ways to reduce the public and non-major population's perception around opioid use would be beneficial for reducing stigma to advance opioid stewardship (Goodyear et al., 2018).

We acknowledge that some higher education instructors or administrators may view SL to "promote civic behaviors" rather than teach course content (Spring et al., 2008), and as such may be less inclined to incorporate SL into their curriculum if they are related to financial barriers and/or time constraints. However, as demonstrated here, SL can provide demonstrative learning gains in addition to civic and social awareness. Notably, the effects of a SL program are largely based on the experience of the implementer and the type of SL experience, such as various kinds of programs that promote socialization (Shek et al., 2020).

Consequently, we recommend that instructors new to SL could review the SL literature, utilize existing SL centers at their institutions, and participate in available SL faculty fellowships and/or initiatives. For those instructors working at institutions without SL centers, it is imperative to identify community partners in alignment with their course objectives. This can be accomplished either through their own institutional contacts or they can explore on their own via the internet. Alternatively, there are a lot of professional development opportunities offered via Science Education for New Civic Engagements and Responsibilities (SENCER) to help implement community-based learning in one's course(s). Regardless, to create a SL oriented course, it is important to identify community partners who can create a project and/or activity for the undergraduate students that is in clear alignment with the course LOs. Thus, it is critical to align the course LOs with community needs to maximize learning gains for students, thus enabling the students to witness the relevance of the course content and their own efforts in addressing community needs and providing them with an opportunity to make a difference in their own communities. When SL partnerships are created with mutual benefit at the forefront and relationships are sustained over time, strong university-community ties will lead to greater and more meaningful collaborations over time.

Conclusion

Our pedagogical exploration is among the first known to document non-major's experiences with the opioid epidemic

including Naloxone training, which was achieved through a novel SL module. This work demonstrated an increase in learning gains around the biology of opioid addiction and contextual understanding of the epidemic while simultaneously teaching students how to administer life-saving medicine. We advocate for the continued inclusion of SL oriented projects, particularly using Naloxone training which can spread knowledge about opioid addiction to community members and help heighten awareness about opioid addiction with the broader community.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the University of Alabama at Birmingham IRB-30004903. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SR and SA devised the study protocol in collaboration with AC. SR instructed the course, assignment materials, and obtained informed consent. RF, CC, and ME performed qualitative coding with oversight from SA. RF, SA, ME, and SR drafted the manuscript. All authors reviewed, contributed to the article, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2023.1155659/full#supplementary-material>

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