



# Expert-Led Module Improves Non-STEM Undergraduate Perception of and Willingness to Receive COVID-19 Vaccines

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As evidence mounted that existing prevention methods would be insufficient to end the COVID-19 pandemic, it became clear that vaccines would be critical to achieve and maintain reduced rates of infection. However, vaccine-hesitant sentiments have become widespread, particularly in populations with lower scientific literacy. The non-STEM major (called non-major) college students represent one such population who rely on one or more science classes to develop their scientific literacy and thus, become candidates of interest for the success of the COVID-19 vaccine campaign. As these students have fewer opportunities to learn how to identify reputable scientific sources or judge the validity of novel scientific findings, it is particularly important that these skills are included in the science courses offered to non-majors. Two concurrent non-major biology courses ( $N = 98$ ) at the University of Alabama at Birmingham in Spring 2021 completed Likert questionnaires with open-ended questions prior to and after an expert-led Vaccine Awareness educational intervention addressing vaccine-related concerns. In the module, experts gave presentations about COVID-19 related to microbiology, epidemiological factors, and professional experiences relating to COVID-19. Ten students agreed to participate in post-semester one-on-one interviews. Student interviews revealed that students perceived guest lecturers as providing more information and assurance. Questionnaire data showed an increase in student willingness to accept a COVID-19 vaccine as well as increased student perception of the COVID-19 vaccines as both safe and effective (Wilcoxon Rank Sum Test,  $p < 0.05$ ). However, the questionnaire data revealed 10 of 98 students remained vaccine-resistant, and these students expressed insufficient research and side effects as leading vaccination concerns. Overall, we show expert-led modules can be effective in increasing non-majors willingness to accept COVID-19 vaccines. Future research should explore the experiences of non-majors and guest lectures, particularly as they relate to vaccination and vaccine concerns.

**Keywords:** COVID-19, COVID-19 vaccine, guest lectures, vaccine awareness, non-STEM majors, non-majors, biology

## INTRODUCTION

The higher education shutdown in Spring of 2020 due to COVID-19 permanently changed the landscape of education (1), placing a considerable burden on nearly all aspects of educational routines (2). According to UNESCO, as of 1st April 2020, schools and higher education institutions were closed in 185 countries, affecting nearly 90% of total enrolled learners (3). Many college students across the world had to adapt to a remote learning mode due to the COVID-19 pandemic (4, 5). While the majority of academic institutions shifted to distance learning, colleges and universities that continued in-person instruction were found to be associated with increased incidence of COVID-19 cases (6). In order to reduce the transmissibility of this virus, most university campus administrations instituted preventive measures such as screening for COVID-19 prior to starting the semester (7) and mandating facial masking (8). While these measures were evidence-based, vaccination became recognized by Spring 2021 as the most effective preventative measure in reducing risk of COVID-19 infection and death (9).

Several COVID-19 vaccinations have been approved by the Food and Drug Administration since the eruption of the pandemic including those produced by Pfizer-BioNTech (10, 11), Moderna (12) and Johnson & Johnson (13). Despite the wide availability of these vaccines to the public, the vaccination rates remain low and have not yet met the herd immunity threshold (14, 15). The second wave of COVID-19 that emerged during 2021 led to a major shift in the public perception about vaccination (16). In fact, it is becoming increasingly accepted among the public that widespread vaccination is the most effective method to control the COVID-19 pandemic (17). However, despite the publicly available vaccines and the shift in the public perception, a large percentage of eligible people remain unvaccinated, with more than 45% of US adults not fully vaccinated (indicating two doses of a 2 sequence vaccine or one dose of a 1 sequence vaccine) as of March 2022 (9). We note that ongoing research shows that natural immunity provides defense for several months amongst people who have previously been infected with COVID-19, however natural immunity from infection as a sequela does not prevent an initial infection (18).

Even still, several factors have been proposed to explain the lower-than-expected vaccination rate.

These factors are related in part to (a) perceived issues of vaccine efficacy and its safety profile and (b) lack of trust in both the scientific community and the location of vaccine development (15, 19, 20). Of particular importance is the rampant vaccine mistrust to be higher among non-white and non-male demographic groups (20–23). Furthermore, both lower education and information levels were found to be correlated with lower willingness to get vaccinated and to abide by preventive measures (24, 25). Such diverse population of individuals include non-STEM majors (henceforth called “non-majors”) college students who may depend on a college science curriculum to enhance their scientific literacy (26). Non-majors differ from STEM majors and these differences make further investigation well-warranted. First, due to their limited exposure to science in general, or to the rigor of scientific methodology, non-major students tend to have a lower trust and confidence

in the scientific community and their recommendations (27) and thus may decide to seek information related to vaccines and other topics of interest from social media (28, 29). This in turn can lead non-majors to be further prone to conspiracy beliefs related to topics like vaccination (30). Second, this group tends to be more diverse demographically and prefers more personalized pedagogies (31, 32). Third, there are up to three times as many articles (accessible via Google Scholar) about STEM majors than non-majors (data not shown), a disparity which highlights the lack of research related to non-majors’ biology curriculum. These characteristics necessitate a better understanding of the internal dynamics of the non-major college students and a targeted approach to overcome the barriers and misconceptions regarding COVID-19 vaccination. There is a clear need to increase evidence-based pedagogy for non-major classrooms, particularly as it relates to decreasing vaccine hesitancy. Based upon this rationale, we invited expert guest lecturers from an array of fields who could speak about COVID-19 vaccines to our non-majors biology students.

A targeted approach should include the dissemination of trusted information of the vaccine development, its side effects, profile, and the rate of potential protection via immunity (19, 20, 33, 34). While the practice of inviting guest lecturers seems fairly ubiquitous in higher education, the recommendation to invite guest lectures is primarily anecdotal (35). The limited research that exists in the use of expert guest lectures to impart this type of key information suggests that the perceived relevant experience of expert guest lecturers increases the impact of the lecture (35–39). We have previously shown in an experimental study that non-major students are receptive to virtual expert-led guest lectures about COVID-19 (40), but have yet to explore how views can change related to the COVID-19 vaccines especially through a pre-post design. Here, we investigated the degree to which non-majors’ attitudes shift after our intervention with attention to the following questions:

1. How did non-major perceptions of the COVID-19 vaccine change pre to post intervention?
2. How did non-major students’ intention to get a COVID-19 vaccine change pre to post intervention?
3. What were non-major students’ perceptions of the COVID-19 guest lectures?
4. What are remaining reasons vaccine-resistant students reject COVID-19 vaccines?

## METHODS

### Study Population

Participants in this population were all students at The University of Alabama at Birmingham (UAB), which serves as the largest research-intensive university in Alabama, a state in the southeastern United States. Participants were non-biology major students taking one of two biology courses: Topics in Contemporary Biology (BY101) or Introduction to Microbiology (BY 261). Courses are 3 credit-hour non-major courses remotely taught by author S.R. during the Spring 2021 semester. Topics in Contemporary Biology is a generic education requirement for science enrolling 97 non-major students in Spring 2021 with no

prerequisite. Grading for the lecture course (300 total points) was as follows: two exams (100 points each), pre-COVID-19 Vaccine Awareness questionnaire (10 points), post-COVID-19 Vaccine Awareness questionnaire (10 points), Service-Learning project (60 points), pre-Service-Learning reflection (10 points), and post-Service-Learning reflection (10 points). Service-Learning was assigned following this module and post-questionnaire and therefore was not expected to influence student responses herein. Forty three students in this course consented to take part in this research (44% participation rate). Introduction to Microbiology is a required prerequisite for nursing majors and enrolled 216 students in Spring 2021 with one required prerequisite, which could include BY101. The course required enrollment in a lab course. Grading for the lecture course (220 total points) was as follows: two exams (100 points each), pre COVID-19 vaccine questionnaire (10 points), and post COVID-19 vaccine questionnaire (10 points). Students were able to increase their grade by an additional 10 points through bonus quizzes. One hundred and twelve students in this course consented to take part in this research (52% participation rate) for a total of 155 UAB students consenting to take part in this research. Demographic information and response rate is available in **Supplementary Table 1**. This research study was approved by the University of Alabama at Birmingham IRB, Protocol number: IRB-300006871.

## Questionnaire

Participants in both courses completed the same pre and post questionnaires, completed as a quiz through the course's online learning management system. The pre and post questionnaires were identical (see **Box 1**). Questions were edited from questions included in the Pew Research Center's 2020 American Trends Panel, Wave 79 survey conducted November 18-29, 2020, which polled 12,648 individuals in the United States of America (41) and/or were developed by C.M., S.A.-J. and S.M. for the purposes of this study. The wording of the questions used in this study were determined as readable and clear by a focus group of 5 UAB students before they were distributed for this study. "Note response choice "NA" was an artifact recommended by the focus group to account for participants who may have been vaccinated. While most participants did not choose "NA", "NA" was taken into account during the analysis." All students enrolled in the courses were instructed to complete the questionnaire as part of the graded assignments for their course grade. Only the responses of students who confirmed they watched the intervention module and consented to be included were analyzed.

Students had the first week of class to complete the pre-questionnaire. One hundred and fifty five consented students completed the pre-questionnaire. After students developed expertise during the 3-week module (described below), students had 1 week to complete the post questionnaire. One hundred and fifty four consented students completed the post questionnaire.

## Development of Expertise—Vaccine Awareness Module

These modules, like previous modules implemented at UAB (40, 42) used the framework of backwards design (43). The course learning objectives relevant to this module were:

"Understand the basic process of science and identify the valid sources of scientific literature" and "Analyze and apply scientific information to make everyday decisions." From these objectives, a Service-Learning assessment was created (this assignment was completed after this module and is beyond the focus of this manuscript), and based on the objectives and assessment, the expert lecturers and Q&A were chosen as the most suitable learning activity. The expert Vaccine Awareness Module included two pre-recorded sessions (which were both required to be watched) and two live sessions (which were required to be watched live or via recording). Additionally, there were two pre-recorded lectures uploaded to the course learning management system related to the basic microbiology of viruses. This module was completed over 3 weeks between the end of January and early February of 2021. The module included:

1. Pre-recorded session: "Basics of Vaccines" (S.R., PhD in Biology, instructor of record)  
In this lecture there was a discussion about microbiology of viruses, disease transmission, epidemiology, and general immunological principles.
2. Pre Recorded session: "COVID-19: The Virus, the Disease and the Vaccines" (C.M., PhD in Microbiology)  
In this lecture, SARS-CoV-2 virology, COVID-19 symptoms, infection rates and mutants were covered. The different COVID-19 vaccines being studied were compared for what they contain, how they work, vaccine dosage and schedule, and, when the data was available, what their efficacy is as well as: how and why masks work, history of medical inequities, and specific COVID-19 vaccine misinformation.
3. Live session: "Demystifying Vaccine Hesitancy" (Bertha Hidalgo, PhD in Public Health, MPH)  
In this live session, basic epidemiology, and effective vs. ineffective pandemic cessation strategies were presented. Student questions were also answered.
4. Live session: "Demystifying Vaccine Hesitancy Q&A" (Ellen Eaton, MD clinician in infectious disease)  
In this session, after introducing her experience as a physician treating COVID-19 patients in the hospital, E.E. answered student questions about the clinical manifestations of COVID-19.

PowerPoint presentations are available upon request.

## One-on-One Interviews

To supplement the information collected in the COVID-19 questionnaires, consented students were invited to participate in one-on-one student interviews via UAB-hosted Zoom meetings. Ten students chose to participate in these interviews: seven from Topics in Contemporary Biology (BY101-2C) and three from Introduction to Microbiology (BY261-1E). The interviews followed a semi-structured format guided by the questionnaire and took roughly 20 minutes per student. The full question script can be found in **Supplementary Box 1**. Interview transcripts were checked for accuracy by OJP before the transcripts were coded.

**BOX 1 | COVID-19 Vaccine Awareness questionnaire.**

Introduction: This assignment aims to address COVID-19 concerns you may have to improve your classroom experience for a targeted intervention on the safety and effectiveness of the COVID-19 vaccines. Before 1/21/21 complete this assignment.

1. Have you received a COVID-19 vaccine, or do you intend to get a COVID-19 vaccine?

Yes, I have received two doses of a COVID-19 vaccine

Yes, I have received the first dose of a COVID-19 vaccine

No, but I will—I DO intend to get the vaccine

No, but I will not—I DO NOT intend to get the vaccine

Prefer not to answer

2. I have enough information to make a decision regarding accepting the COVID-19 vaccine.

5-point Likert with additional “NA—I have already been vaccinated by one or two doses”

3. I will accept the COVID-19 vaccine if my school or employer mandated it.

5-point Likert with additional “NA—I have already been vaccinated by one or two doses”

4. The coronavirus outbreak is/has been a risk to my personal health.

5-point Likert with additional “NA—I have already been vaccinated by one or two doses”

5. If you or someone you know has been affected by COVID-19, how has that impacted your willingness to get a COVID-19 vaccine?

Open ended

6. The approved COVID-19 vaccines are safe.

5-point Likert with additional “NA—I have already been vaccinated by one or two doses”

7. The approved COVID-19 vaccines are effective.

5-point Likert with additional “NA—I have already been vaccinated by one or two doses”

8. What are the 3 major reasons why you will or will not accept a COVID-19 vaccine? Please list them below in the order of priority.

Open ended

## Coding of Interview Responses

The coding approach used a combination of deductive and inductive analyses. This approach was selected as the deductive element allows the research to be guided by the research questions while the inductive element allows for the exploration of the data within the confines of the research questions (42, 44). Three individual coders, S.E.A, V.C., and S.M. separately read the transcript of the 10 interviews. The coders separately devised open coding subthemes (inductive) that broadly applied to the theme of “Guest Lecturers” (deductive). Coders next discussed their respective themes and came to a consensus regarding refined sub themes that were mutually agreed upon by all three coders.

## Coding of Open-Ended Questionnaire Response

The post questionnaire included the open-ended question “What are the three major reasons why you will or will not accept a COVID-19 vaccine? Please list them below in the order of priority.” This question was coded inductively by C.M. and S.A.-J.

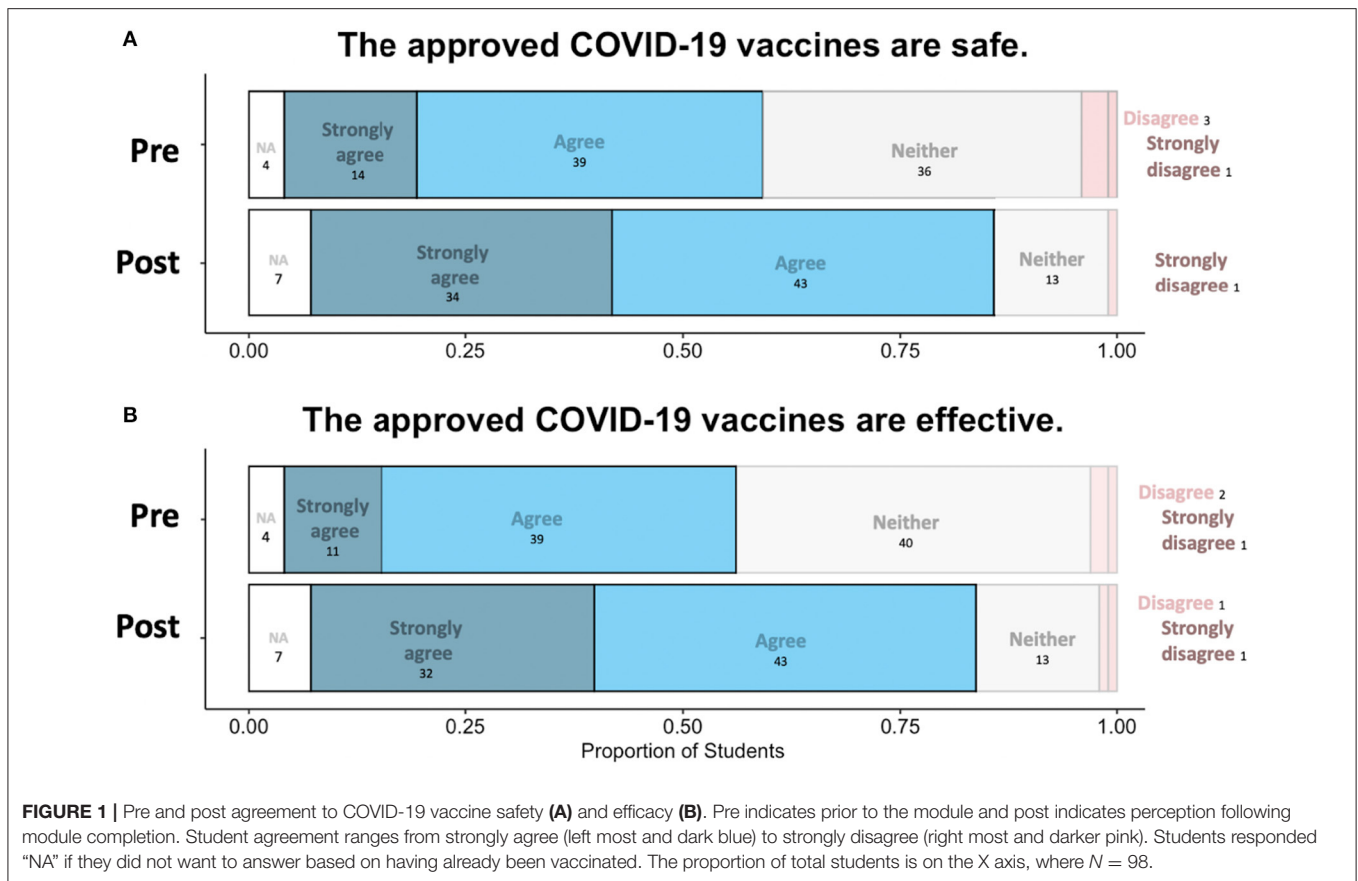
## Quantitative Analysis

Students were asked prior to their post-Vaccine Awareness Module questionnaire if they had completed the module. Students who did not respond to this question or who responded “no” were not included in this analysis, which in the end included 30 students from BY101 and 68 students from BY261

( $N = 98$ ). Differences in changes in perceptions of COVID-19 vaccine perceptions from the questionnaire responses were analyzed using R (45). First, a non-parametric Wilcoxon Rank Sum Test was used to compare pre and post scores for Questions 2 (having enough information), 3 (would take vaccine if employer mandated), 4 (virus is a risk to personal health), 6 (vaccine is safe), and 7 (vaccine is effective). To assess the effect of class, we used linear models with “Class” (BY101 or BY261) as a predictor variable for each of the questions (e.g., “post-score~pre-score + class”). Ordinal regression, often used with ordinal numeric data, was used to confirm the degree which “Class” influenced any of the outcomes (e.g., “post-score~pre-score + class”). The statistical hypotheses were that pre and post values were not equal. Complete RStudio code is available in **Supplementary Files Complete R Code**.

## RESULTS

Analyses indicated an increase in the number of surveyed students who perceived the approved COVID-19 vaccines as both safe (**Figure 1A**) (Wilcoxon Rank Sum Test,  $W = 7435.5$ ,  $p < 0.05$  and LME,  $p < 0.05$ ) and effective (**Figure 1B**) (Wilcoxon Rank Sum Test,  $W = 6998$ ,  $p < 0.05$  and LME,  $p < 0.05$ ) pre to post module. Additionally, surveyed students were more likely to state that they could make an informed decision regarding vaccination after the completion of the module (Wilcoxon Rank Sum Test  $W = 2529.5$ ,  $p < 0.05$ , LME,  $p < 0.05$ ). There was no effect of class enrollment on any Likert question outcome (LME, Ordinal Regression). With regards to the question “Have



you received a COVID-19 vaccine, or do you intend to get a COVID-19 vaccine?” on the questionnaire, 15 students did not intend to prior to the module and 6 did not intend after the end of the module (Figure 2). In other words, 9 surveyed students changed their mind about receiving the COVID-19 vaccine after completing the Vaccine Awareness Module.

All the 10 interviewed students explicitly mentioned they felt either more informed ( $n = 9$ ) or more assured ( $n = 5$ ) about getting the COVID-19 vaccines because of the guest lectures. Four interviewed students explicitly mentioned the guest lectures had a role in their decision to get vaccinated including indications the expert’s provided information as it was the expert’s job to understand things about COVID-19 vaccine science (Table 1). Of the interviewed students who directly compared the guest lectures to being taught exclusively by their professor, more expressed a preference for having guest lectures.

## DISCUSSION

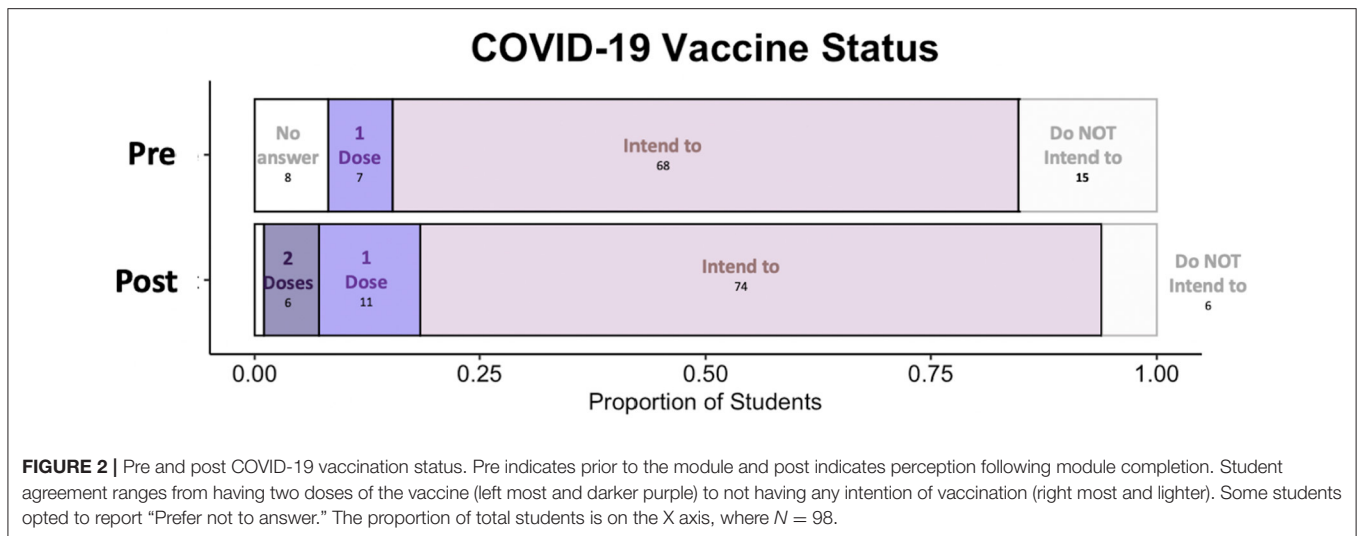
In January 2020, vaccine hesitancy was widely discussed colloquially and with increasingly robust surveys of various national (41, 46) and international populations (47). These surveys have indicated clear gaps in the general population’s understanding of vaccines, virology, and epidemiology (48–50). Moreover, while more research is advancing our understanding of vaccine-hesitancy in some populations (51–53), there remains

little understanding of the vaccine plans of non-STEM majors (54) who make up 79% of all awarded bachelor’s degrees in the year 2018–2019 (55). The non-majors in this population were demographically similar (see Supplementary Table 1) yet represented two types of students: those going into non-STEM healthcare (e.g., students on pre-nursing track) and those going into neither STEM nor healthcare (e.g., students enrolled in humanities programs). While it is possible students had a range of medical engagement and aspirations, our methods revealed no distinguishable differences between outcomes in the two classes taught in the same modality by the same instructor.

First, we explored the question: How did non-major perceptions of the COVID-19 vaccine change pre to post module?

Our results found that our student population was more likely to perceive the COVID-19 vaccines as both safe and effective following the expert guest lectures intervention (Figure 1). Perceptions of safety and efficacy are linked to overall COVID-19 vaccine acceptance (56, 57). Further, students felt like they could make an informed decision regarding vaccination after the completion of the module (Table 1). Given perception of vaccination (15, 19, 20) and information levels (24, 25) are related to vaccine-acceptance, this would suggest that student’s plans to get vaccinated may have shifted due to the module.

Therefore, our second question asked: how did non-majors’ plan to get a COVID-19 vaccine change pre to post for our Vaccine Awareness Module? We found that nine surveyed



students went from not intending to get vaccinated to intending to get vaccinated (Figure 2). While intentions to take the COVID-19 vaccine may not always manifest follow through (57), declaring intention is often the first step toward vaccination (27). Thus, we established that after the Vaccine Awareness Module, students changed their mind toward vaccination. This led us to the third question: What were non-major students’ perceptions of the Vaccine Awareness Module COVID-19 guest lectures? As a field, public health education research seeks to differentiate between effective and ineffective public health educational strategies (58, 59). The strategies employed are often dictated by the population and location of the target audience. Here we evaluated the impact of guest lectures, a common pedagogical tool in higher education (35, 42). While instructors of record are evaluated at the end of the semester at most institutions, evaluation of the impact of guest lectures has been studied only limitedly (35, 39). We had two courses of non-major students at UAB engage with expert guest lectures by a microbiologist, an epidemiologist, and an infectious disease physician. We have previously shown that expert-guest lectures in a non-majors course can impact perceptions of COVID-19 (40). Moreover, it is well-established that the opinions of one’s social sphere has the power to supersede other influences (60–62). However, the efficacy of expert guest lectures related to COVID-19 vaccine in a non-major’s classroom had not been established. All the 10 interviewees explicitly mentioned they either felt more informed or more assured about getting the COVID-19 vaccines because of the guest lectures (Table 1). Our findings are in line with earlier work that indicates that an audience is receptive to speakers’ personal experience (37, 63–65). This implies that even in this period of particularly low scientific trust (33), when given the opportunity to learn from, and pose their questions to scientists, students show trust and acceptance to what scientific experts teach. We note this could have also been influenced by the demographics of the lecturers themselves. The Vaccine Awareness Module was delivered to classes of majority women, many of whom were women of color

and included lectures by four women: two white, one south Asian and one Latina woman. While our study did not specifically address the impact of the race or gender of the guest lecturers, previous research suggests that the diverse students are more significantly impacted by diverse guest lecturers (66). As this area needs more research, in future studies, we recommend investigators evaluate the impact of how race, gender, and other identities play a role in student perception of guest lecturers.

Lastly, we wanted to know: what are the remaining reasons vaccine-resistant students reject COVID-19 vaccine? Given the dramatic underutilization of the available healthcare by college-aged individuals (67), we expected that non-major students at the University of Alabama at Birmingham (UAB) would exhibit similar concerns regarding the acceptance of the novel COVID-19 vaccines. Of the 98 respondents to the post Vaccine Awareness Module questionnaire, ten students answered, “Have you received a COVID-19 vaccine, or do you intend to get a COVID-19 vaccine?” with “I do not plan to” (Figure 2). Analysis of the top three reasons why the surveyed students reported rejecting the vaccines included: a perceived need for more research, unknown vaccine side effects, and a belief that the vaccine is ineffective. These responses were reported by six, five and four of the 10 respondents respectively (Figure 3). The persistent concerns expressed by our participants were like those expressed in other studies (41, 56, 57, 68). Further research suggests a link between vaccine reluctance and thoughts about where SARS-COV-2 originated from (69), governmental distrust (70), and belief in non-evidence based theories (26) particularly through social media (28, 29). While not explored here, these beliefs could be underlying the student reasons against vaccination shown in Figure 3 and could thus warrant future research.

The time sensitivity, urgency, and instructor freedom limited the scope of this work in tangible ways. Validated surveys about COVID-19 were not available to us in January 2021 as the vaccines were not made available to the public until Spring 2021. We could not design an ideal experimental design, which

**TABLE 1** | Interview codes related to guest lectures.

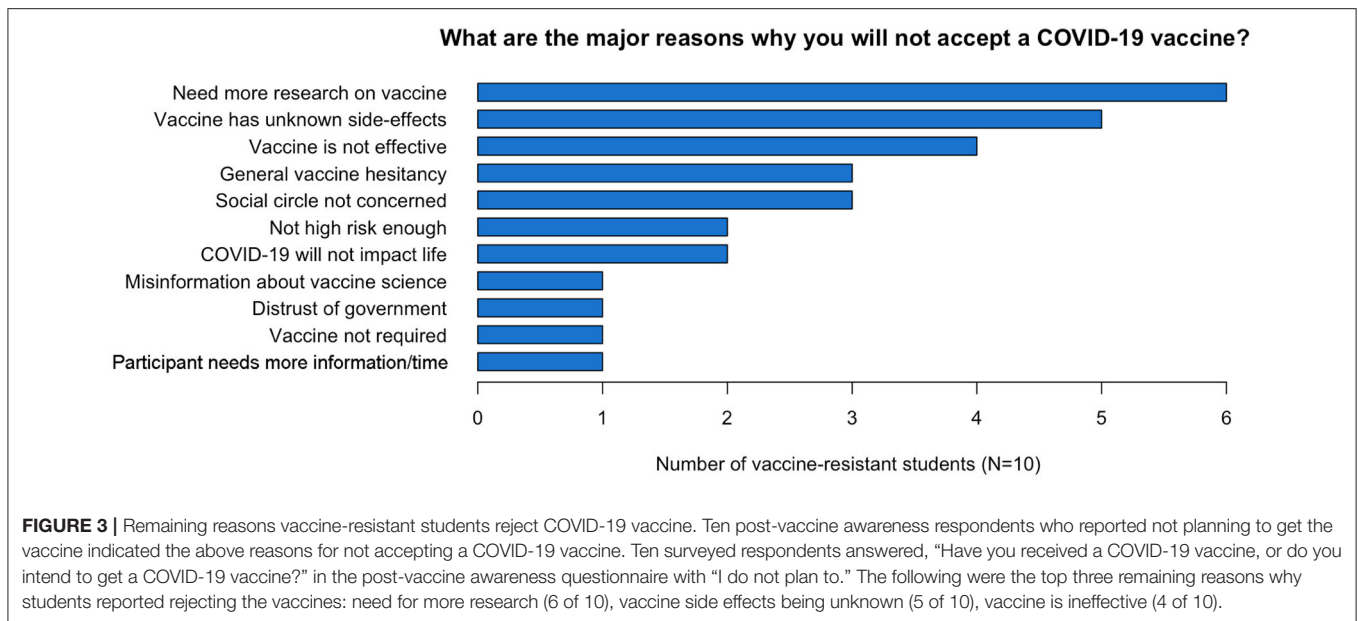
Subtheme	Representative quote	# of interviews
<b>Students felt more well-informed regarding the vaccines after the lectures than before the lectures</b>	<i>"It definitely gave you a more a better understanding of like what the vaccine does and like how it works."</i>	<b>9</b>
<b>The guest lectures increased their assurance of the vaccine</b>	<i>"Saying if you were in a room full of COVID patients that were like positive, that don't mean you can't get COVID, but it just means that you can fight off the symptoms way faster. So that made me feel better, it made me just feel better because like I said like I've seen it all how people were affected by it. So, it's like it made me feel more safer, by them explaining to me that it would just fight off the symptoms more"</i>	<b>5</b>
Guest lectures gave students factual evidence to support their position on COVID-19 vaccination	<i>:"... you could say that kind of affected my opinion because I was able to kind of back up my opinion with like some facts about you know why I thought it was this way and—Why—it kind of just—got a better glance on my opinions."</i>	4
Students were influenced to receive the vaccine after listening to the lecturers	<i>"I was still kind of a little hesitant, but kind of listening to them talking about it and like all what happens with it, it kind of shifts my thinking like okay, you know, this is something that is a necessary thing to get back to normal..."</i>	4
Guest lectures eased their concerns regarding the vaccine	<i>"... they made it kind of less scary, especially since people are always like oh my God this one person got the shot and then they had an allergic reaction, it was the worst thing ever, you should never get it. And then they were just like yeah well that happens with a lot of shots because people are allergic to stuff so definitely help like destigmatize it, I think."</i>	4
Students felt it would not have been any different hearing it from their professor, but they were impacted by the guest lectures and/or thought it was nice to hear from more than one person	<i>"...they impacted my perspective, because they are, I guess, esteemed individuals in our field, and they really understand the topics that they're presenting, and they have studied the topics they were presenting ... I do not at all think it would be any different... She taught very well, and I trusted her judgment a lot."</i>	4
Students preferred and/or were more interested to hear from an expert guest lecturer rather than the professor	<i>"Definitely because they're more specialized in their field, I feel like people will obviously you know, listen to the professor, but when it's coming from you know somebody that it's their job to know about this stuff—they're able to not really trust the information more but definitely pay attention to it and really listen to what they're saying."</i>	3
Students felt indifferent about hearing from an expert guest lecturer rather than the professor	<i>"I don't think I would have responded differently."</i>	1

Ten students participated in interviews. Subcodes that were present in a majority (>50%) of interviewee response are highlighted and bolded.

would have included cross-comparison design with and without guest lectures, due to course limitations. While our data indicate our intervention directly influenced student perceptions, many other factors may have contributed to students' willingness to get vaccinated during the Spring 2021 semester beyond our intervention. We accounted for these limitations by directly asking students how the instruction impacted them and found that some changes were due to the guest lectures (Table 1).

We suspect that the abrupt transition to online education made students less likely to participate as we previously had much higher participation rates in-person classes at UAB (42). While we cannot say the degree to which these students are representative of the non-majors' populations at large, they

mirror demographic composition of the overall UAB student population (71) and nevertheless provide us with insight about non-major's experiences. Much more work is needed to better understand non-major populations, particularly when it comes to COVID-19 vaccine hesitancy. Continued research shows the benefit of connecting everyday issues with non-major students through guest lectures alongside pedagogical interventions like Service-Learning (40, 42, 72). Ongoing work should assess how Service-Learning pedagogies, particularly those using social media (28–30) can impact student perceptions of COVID-19 vaccines. To be able to longitudinally follow the vaccine-resistant students would also uncover meaningful insight that would be useful for better relating and teaching to that population.



Overall, the impact of the expert guest lectures indicates that, as an educational intervention, guest lectures can be impactful in modulating students' vaccination behaviors. Given the increased ubiquity of virtual education, our data suggests that instructors and their students may benefit from expert guest lecturers, especially those pertinent to current affairs and or topics of particular interest to non-major students.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Alabama Institutional Review Board. The participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

CM, SA-J, and SR established the experimental design and research questions. CM coordinated the IRB approval process. CM, SA-J, and SA performed the interviews. OJP validated the interview transcripts. CM, SA-J, and MB contributed to data analysis and figure generation. SA and RF contributed to coding the interview transcripts. CM, SA-J, OJP, BC, DD, MH, and SR contributed to the writing of the first draft of the manuscript

and drawing preliminary conclusions. CM, SA-J, MB, and SR edited the manuscript. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpubh.2022.816692/full#supplementary-material>



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