

Designing an open course to highlight the work of underrepresented STEM scholars

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Abstract

Faculty across science, technology, engineering, and math (STEM) disciplines are interested in making their instructional materials more representative of their students' identities. However, they often lack guidance and time for finding these materials. Utilizing our specialized skills in finding resources as librarians, we developed the *Representation in STEM (RIS)* course to provide resources and guidance on finding and using more representative materials across STEM disciplines. The course is comprised of pages that can be adopted as micro-lessons in disciplinary courses, lowering the barrier for faculty to participate in more inclusive instruction. To ensure RIS is as useful as possible for faculty and students, pages from the disciplines and special topics sections of the course were sent to faculty at Colorado School of Mines and STEM librarians across the United States and Canada for review. We sought feedback on organization, breadth of coverage, and content depth that can be incorporated in the ongoing development of the course. This paper describes the development of RIS, initial feedback received, and lessons learned in the design process that could inform similar projects at other institutions.

Introduction

Faculty and scholars, especially in the United States and United Kingdom, are encouraged to diversify their teaching materials, consider more inclusive approaches to content, and incorporate culturally-responsive examples into their courses [1]–[4]. However, little guidance exists on how to go about finding, evaluating, and using research from scholars belonging to underrepresented identities. Barriers persist to the participation of Black, Indigenous, and People of Color (BIPOC), women, differently abled, and members of the LGBTQIA+ community in STEM disciplines [5], [6].

While programs exist to encourage members of these groups to participate in STEM, few resources exist to help faculty find and incorporate underrepresented scholars' work into their teaching and research. Guidance tends to take the form of blog posts or brief guides from the university teaching center or diversity office [7], [8]. Challenges, including the need for scholars to self-identify, problematic and incomplete item metadata, and inherent biases make it difficult for faculty to find appropriate materials, creating barriers both to underrepresented scholars and to those who seek to use their work [9].

The glaring gap in guidance for faculty led us to develop the *Representation in STEM (RIS)* open mini-course. This course was designed to provide faculty with a single page of adaptable content related to representation in a specific discipline or topic area that can be easily used in their disciplinary courses. The full course currently contains five modules with the following content:

1. Introduction – details on course development and guidance for using and adapting the course
2. Disciplines – 16 single page lessons for STEM disciplines with readings, videos, websites to explore, and reflection questions
3. Special Topics – single page lessons for nine topics with readings, videos, websites to explore, and reflection questions
4. Additional Resources – bibliographies of additional resources organized by topic for faculty to draw from in adapting or expanding the lessons in modules 2 and 3
5. Finding and Using Inclusive Resources – guidance on finding inclusive materials for use in teaching and research

RIS introduces faculty to the topics of representation, systemic bias, and inequality in STEM and provides participants with statistics, resources, and opportunities to reflect. This open course fills a critical need in the discussion on representation in STEM as it equips librarians, faculty, and graduate students with the tools to seek out and incorporate perspectives from underrepresented groups in their course materials, teaching, and research. RIS provides a foundation for faculty in STEM and beyond to incorporate more culturally responsive materials in their curriculum.

This paper explores the ongoing development of RIS using a community-focused approach which incorporates feedback from faculty, STEM librarians, and student organizations throughout the development process. We gathered initial feedback via content review in spring and summer 2023. Faculty across disciplines at the Colorado School of Mines (Mines) and STEM librarians across the country have reviewed portions of the content related to academic disciplines and special topics such as research funding, inclusive teaching, and faculty development. As STEM librarians ourselves, it was important to seek feedback on source quality and course design from professional peers. This paper details lessons learned in course design and how reviewer feedback is being incorporated into future iterations of the course.

Course Design

RIS is intended to provide practical guidance to faculty while lowering barriers to their use of more diverse materials in their teaching and research. To achieve these goals, the course has three substantive modules related to 1) specific disciplines, 2) special STEM-related topics, and 3) how to go about seeking out more diverse sources. These modules comprise the bulk of the course materials.

The disciplinary and special topics modules were designed to lower barriers to faculty use of diverse materials. The modules are comprised of a series of pages, each focused on a single discipline or topic. They are intended to be adopted by faculty in those disciplines and incorporated into their courses as micro-lessons. The page can be used in conjunction with an in-

class discussion, homework assignment or quiz; enabling faculty to infuse their curriculum with equity-related discussions and content without having to fully redesign a course module or the entire course [10]. At present, 16 disciplines are covered, with the intention to collaborate beyond our institution to add disciplines we do not offer, such as aerospace engineering and biomedical engineering. The special topics module presently includes nine topics: faculty development, cultural capital and cultural relevance, inclusive teaching, persistence, field work, laboratories, patents, funding and research, gender inclusive standards, and STEM librarianship.

Each page in the disciplinary and special topics modules contains readings, videos, and websites to explore as well as reflection questions. When adopted, the content can be used as is by faculty, or edited to meet their specific learning outcomes and course topics. Content was selected to provoke discussion and introduce students to issues and resources. For example, the Electrical Engineering page contains readings on gendered interests in computer engineering [11], and engineering identity in electrical engineering [12]. The videos include a Ted Talk by a female identifying engineer [13] and a Ted Talk on how computer engineers used robots to give a stroke survivor a telepresence [14]. The web content to explore includes IEEE's diversity guidance [15] and an article about how an associate professor is indigenizing the profession [16].

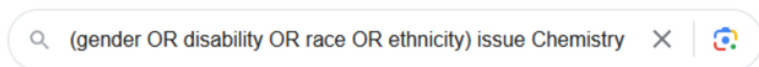
The module on finding and implementing inclusive resources in teaching and research addresses the goal of providing faculty with practical guidance. It begins by helping faculty consider the issues in their specific discipline and/or the topics they would most like to focus on in their course or lesson. For example, disciplines that involve a significant amount of fieldwork can be difficult for students with disabilities to fully participate in. Likewise, a faculty member teaching at a Hispanic serving institution may want to focus on helping students to see Latinx role models in their discipline. The module also contains practical guidance on how to seek out specific sources related to their needs. It provides places to get started, such as collections like the Journal of Stories in Science [17] or the History Makers digital repository [18]. Beyond collections, it contains tips for formulating searches and pitfalls to avoid when searching for content. This module also contains information on ABET's Diversity, Equity, and Inclusion Framework [19]. Finally, the module helps faculty consider how best to incorporate sources into their course. There are sample activities and resources for helping faculty make their courses culturally relevant and authentic for students.

RIS was created in the Canvas learning management system (LMS) and shared in Canvas Commons via a CC BY license [20]. Funding from the Newmont STEM Equity Faculty Fellowship at Mines enabled us to hire a graduate research fellow to help build content. The fellow, completing a Master's in Library and Information Science degree, was able to learn about representation issues in STEM while helping to identify potential content for the disciplines and special topics modules.

Content for the various modules was acquired in several different ways. Some content was found through review of the literature and other existing resources. These sources included blog posts of aspects of representation, conference presentations from professional colleagues, websites, and trainings we've completed. The majority of course content was acquired in the way that most faculty would typically have to acquire resources for their courses, Google. We used a variety of

search techniques including Boolean operators, truncation, and domain limiting to formulate searches that would bring back results on various aspects of representation. Figure 1 contains three examples of searches conducted.

A. Using Boolean operators to search for multiple identities in a single search



B. Using truncation to search for various forms of the word identity



C. Using domain limiting to search for sources from educational sources

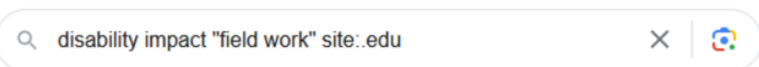


Figure 1. Examples of searches conducted to acquire course materials.

Our own search for sources validated the need for a course like RIS. As information professionals dedicated to the project, we were able to spend the time necessary to locate and evaluate sources, time that most disciplinary faculty do not have in addition to their regular course preparation. In addition to the time-consuming process of seeking out sources, we were able to make connections between found materials and locate collections that could be of interest to multiple disciplines. Prior to beginning the project, we sought to determine if a course like RIS already existed by reaching out to our colleagues via the ASEE Engineering Libraries Division (ELD) listserv. There was interest among professional colleagues, but no existing collections to fill the need. We gained valuable skills in locating and evaluating sources that will aid in our work with faculty at Mines.

Methodology for Seeking Feedback

Feedback from diverse community members and stakeholders is an important part of the iterative design of RIS. Designing the course with community needs and interests as a central focus helps RIS be more representative and useful to the target audience. We are in the ongoing process of seeking feedback from STEM faculty, librarians, and students. Initial feedback was solicited from individual faculty at Mines via email and STEM librarians across the United States and Canada via the ASEE ELD listserv. The course creators are librarians, and STEM librarians are a potential audience for the open course, so their input and evaluation of the resources was important.

Interested librarians were asked to complete an online form in which they identified the disciplines and/or special topics they would be interested in reviewing. They were able to select as many as they wanted. The Mines faculty were solicited via a personal email from us. They

were asked if they would be willing to review course content in their discipline and/or special topics page(s) of their choice.

15 librarians from various academic institutions completed the form expressing interest in reviewing course content. They volunteered for all nine special topics and 15 of the 16 disciplines. Several disciplines were sent to three librarians, including Math, Computer Science, Design Engineering, Civil and Environmental Engineering, and Chemistry. Two pages were only sent to a single librarian reviewer, Geology and Chemical and Biological Engineering. Additionally, nine faculty responded to the email asking for reviewers. None of them volunteered to review their discipline, but all volunteered to review various special topics pages. They reviewed the topics of faculty development, cultural capital and cultural relevance, persistence, inclusive teaching, and laboratories. All the topics were sent to multiple reviewers, except the Patents, Funding, and Research page, which was sent to only one librarian.

All volunteer reviewers were sent their assigned pages as a PDF to ensure that they could access the content without having to use the Canvas LMS. Although the PDF did not contain all the formatting found in Canvas, it gave reviewers a good understanding of the page's content. They were also sent a link to a form on which they could provide their feedback about the assigned pages. The form contained three classifying questions, three Likert-scale questions and 3 open-ended questions. The complete questions on the reviewer form can be found in Appendix A.

No demographic information was collected from reviewers. As representation can be a sensitive topic, we sought to protect their anonymity and refrain from expecting them to self-identify in any way. Because representation can be a very personal topic, reviewers were given the option to include their feedback in the publishable dataset or to just provide feedback for the course creators' use.

Early Course Feedback

26 reviews were received, representing 41% of the pages sent out for review. Six reviews were from reviewers who elected not to have their review included in publishable results. Nine of the remaining 20 reviews covered disciplines including Electrical Engineering, Civil and Environmental Engineering, Physics, Computer Science, Mechanical Engineering, Humanities, Design Engineering, Economics and Business, and Chemistry. The other 11 reviews covered special topics, including persistence, field work, cultural capital, standards, inclusive teaching, faculty development, and STEM librarianship. Persistence was the only page that had two submitted reviews. The reviews represent half of the discipline pages and all the special topics pages except laboratories.

Reviewers were asked three Likert-scale questions to rate 1) the quality of the content on the page, 2) the depth of content coverage on the page, and 3) the organization of the page. On a five-point scale of very poor quality to very good quality, 19 of the 20 reviewers gave a rating of fair, good, or very good quality for the content quality question. One reviewer found the content

of the Standards page to be poor (Figure 2). Half of the ratings noted that resources were good quality. This would equate to a four out of five on the Likert scale.



Figure 2. Reviewer feedback for Likert question about the quality of the content on the page.

Reviewer perspectives on the depth of content question were more varied. On a five-point scale of too superficial to optimal depth, each point on the scale had at least one rating (Figure 3). Reviewers found the Physics and Standards pages to be superficial and too superficial. The majority of reviewers rated the content as fair, sufficient, or optimal depth, with the most ratings indicating sufficient depth. As with the page quality question, this was the equivalent of a four out of five on the Likert scale.

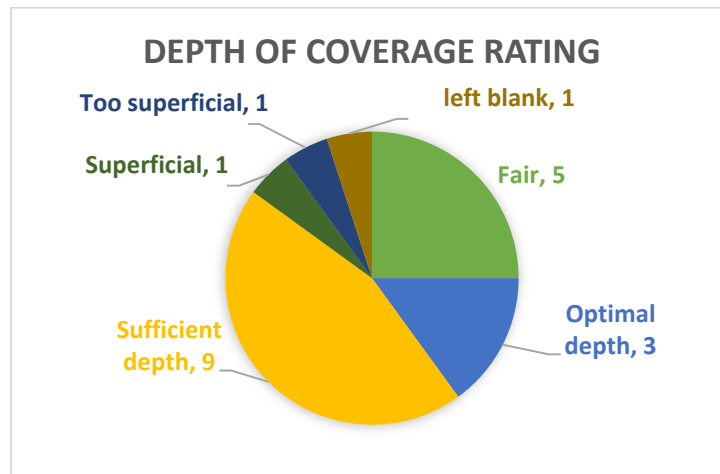


Figure 3. Reviewer feedback for Likert question about the depth of content coverage on the page.

Finally, for the organization question, reviewers found the pages to be fair, organized, or very organized on a five-point scale of very disorganized to very organized (Figure 4). Two reviewers found the organization of the cultural capital and cultural relevance page to be just fair. All other reviewers gave a score of organized or very organized. Most reviewers gave the rating of organized, again an equivalent to a four out of five on the Likert scale.

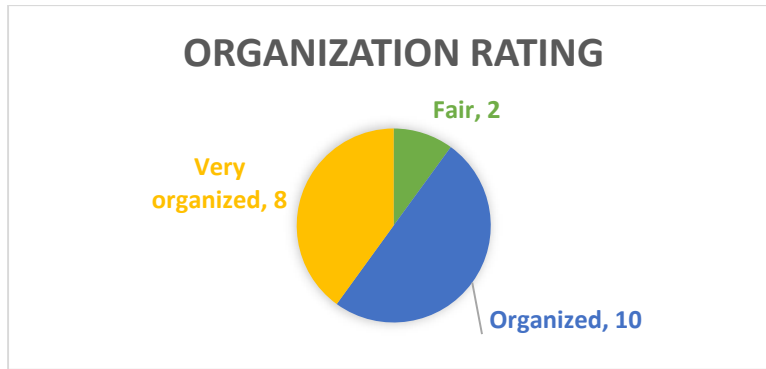


Figure 4. Reviewer feedback Likert question about the organization of the page.

Reviewers were also asked three open-ended questions about 1) their overall impressions of the page, 2) areas for improvement including gaps in coverage, and 3) their final thoughts and considerations. None of the questions were required for reviewers to complete. To analyze the responses to these questions, individual statements were classified as positive, negative, suggestion, or technical. The suggestion category contained statements that either proposed specific items to include or noted areas for expansion or improvement. The technical category was used for statements that identified typos, broken links, or other technical issues with the content.

Overall, reviewers felt the content of their assigned page was good, well organized, and well presented. As one reviewer noted, “the page was well organized with a manageable number of resources presented.” The rest of the comments on this question fell into two general categories. Five reviewers felt the resources were not diverse enough. They noted specific sections of their page, such as the read and watch sections. Several other reviewers asked for more context and clarification about the purpose of their assigned page. They asked what was meant by the Explore section of the page or suggested places on the page to add additional reflection questions and context.

The responses to the question regarding areas for improvement largely aligned with the theme of needing additional context for the page. Multiple reviewers suggested ways to make the page more interactive or to add scaffolding around the materials for students. They also made suggestions for additional content that would be helpful on the topic. Some suggestions included specific websites, articles, and videos. Others identified aspects of identity and representation that could use additional coverage. As one reviewer noted, “it would benefit from a few more articles about the barriers and potential solutions to entry and success that marginalized groups face in [discipline].” These suggestions are actionable and will help to improve the coverage of topics.

Eight reviewers added additional feedback for the final thoughts and considerations question. These comments largely consisted of additional suggestions to provide opportunities for reflection or context for the page content. One reviewer suggested, “add in a discussion question to have participants reflect on how some of these biases appear in their own departments/fields or what the general state of their particular situation is.” The comments on this final question

follow the general theme throughout the other two questions regarding providing additional scaffolding and context to the pages.

Lessons Learned

Feedback from librarians and faculty helped us identify areas for improvement in both the course design and review process. These lessons learned will make the course more useable for faculty and will enable further solicitation of feedback as development continues.

1. Provide more context

Several reviewers asked questions about the intended purpose of the pages or suggested ways to provide additional context and guidance for end users throughout all three open ended questions. Some suggestions would benefit faculty implementing the pages as micro-lessons in their courses. The most common feedback was that we should provide additional structure and context for faculty about how to use the content. This structure could include synopses of the materials as well as details on how students should access or interact with materials. Several reviewers wanted to see more reflection questions throughout the page to better scaffold content and guide the use of the micro-lesson.

Some reviewers provided feedback to help students navigate the materials and interact with the lesson content. One reviewer suggested that “adding information like video title, length, and a short description would help students decided when to open which videos.” Other suggestions included finding ways to make the page more active such as enabling a comments section for the page, interspersing content with reflection questions focused on each item, or providing an opportunity for students to share their own stories related to representation in their field.

Some suggestions in this area will be easy for us to implement, including more details about the videos and brief synopses of the materials used. It will be important to balance the length of the lesson with adding additional context for materials. A few reviewers expressed concern about the length of the pages, so it will be important to find ways to add additional reflection questions and structure without overwhelming faculty or student users of the content.

2. Determine the best way to share content with future reviewers

While analyzing responses to open ended questions, it became clear that sharing the content as PDFs was not the best method. Most statements tagged technical throughout the open-ended question responses were related to long links that broke when they ran onto a second line (Figure 5). These long links were only problematic in the PDF download of the page, and not a problem when clicking on the hyperlink in Canvas. Additionally, sharing the individual pages with reviewers decontextualized them from the entire course, leading to an increase in the number of reviewers asking for context. The introductory module contains information on how to adopt a page for use as a micro-lesson in a disciplinary course. Reviewers did not have access to this information when completing their reviews. They only had a basic description of the course’s purpose provided in the email containing the review instructions.


- [Meet 5 women who are using science to help save the planet](http://www.unep.org/news-and-stories/story/meet-5-women-who-are-using-science-help-save-planet)  (<http://www.unep.org/news-and-stories/story/meet-5-women-who-are-using-science-help-save-planet>)

Figure 5. Example of links that ran onto a second line in the PDF download

It will be important for us to determine a better method of sharing course content for review moving forward. PDFs were used to ease access for reviewers at institutions without the Canvas LMS. Reviews from diverse community members and potential courses users is key to ensuring the course's content is relevant and applicable to their needs. We will need to find the right balance of providing context for reviewers without overwhelming them with information to read prior to conducting the review.

3. Carefully edit all content pages for breadth of coverage

While some reviewers thought the content on their assigned page provided sufficient coverage of the identities and issues associated with that topic, others noticed gaps in coverage on their topics. These reviewers provided concrete suggestions for items to include as well as broad areas they felt could use better coverage. One reviewer noticed that the videos on their page were focused entirely on women, neglecting other identities. Another noticed that their page was highly focused on race to the exclusion of other identities. Several of the reviewers asked good questions about the missing aspects of content that will be important for us to consider. For example, one reviewer asked if there are other types of field work that could be considered on that special topic page. The page is currently largely focused on geology and the earth sciences; other fields, such as mechanical or civil engineering probably also have field work activities that could be barriers to inclusion for some students. Now that an initial review of the course has been conducted by faculty and librarians, we need to carefully review and edit each page for the breadth of coverage to ensure the pages are representative and useful for faculty and students.

Conclusion

Both librarian and faculty reviewers provided valuable feedback on the design and content of RIS course disciplinary and special topics pages. Their insights were valuable in identifying gaps in coverage and places to provide additional support for learners. The reviews will be used to improve content coverage on specific pages as well as the usefulness of the course as a whole. These comments will be incorporated into future iterations of the course.

In November 2023, we made revisions to the course based on reviewer feedback. Brief introductory instructions for faculty were added to each micro-lesson explaining the purpose of the lesson and how to go about adapting the lesson for their disciplinary course. We reduced the number of items in each Read, Watch, and Explore section to make the page more focused and easier to use. The instructions point faculty to the Additional Resources module should they need to exchange any of the pre-selected materials to better fit their specific learning outcomes. Instructions were added to the Explore section on each micro-lesson explaining the purpose of that section. All pages were carefully reviewed to ensure diverse representation of identities and

remove any grammatical or typographical errors. Finally, edits were made to some links to increase accessibility and improve readability.

The process of seeking community feedback was a useful learning experience for us. Seeking reviewers both internal and external to our home institution provided us with a variety of perspectives. Although the distribution of PDF copies was logistically easy, it limited the context reviewers had access to as they completed the review. As course development continues, alternative methods of sharing materials will be necessary to maximize feedback received.

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Appendix A. RIS Reviewer Form Questions

1. After reviewing the informed consent form, would you like your anonymous review to be included in potential publications about this project?
 - a. Yes b. No
2. Is this review for a discipline page or a special topics page?
 - a. Discipline b. Special Topics
3. What were your impressions of the page that you reviewed?
4. How would you rate the quality of the content on this page?
 - a. Very poor quality b. Poor quality c. Fair quality d. Good quality e. Very good quality
5. How would you rate the depth of content on this page?
 - a. Too superficial b. Superficial c. Fair d. Sufficient depth e. Optimal depth
6. How would you rate the organization of this page?
 - a. Very disorganized b. Disorganized c. Fair d. Organized e. Very organized
7. What areas have room for improvement? Any gaps in knowledge? Specific suggestions?
8. Is there anything else we should be considering? Do you have any final thoughts on the content for us?