



## **Work in Progress: Using a Second Intervention to Continue Improving Information Literacy Outcomes in a First Year Design Class**

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## **Abstract**

Does a reinforcement lesson on scholarly and authoritative sources positively affect the quality of students' sources in the completion of an engineering design project? In the spring of 2017, the Design I information literacy team at Colorado School of Mines piloted a flipped lesson on evaluating sources in the first-year engineering design course. Research results demonstrated that the flipped lesson improved the quality of students' sources on mid-semester design proposal and less so on their final report. The lesson was fully implemented for fall semester 2017. Based on data from the team's first research project, and feedback from course faculty, the team piloted a mid-semester reinforcement lesson in fall 2019. This second phase of the research project seeks to specifically reinforce students' retention of concepts related to both the use of proper citation formatting and incorporation of more scholarly and authoritative sources in their team's final project report. This work in progress paper discusses preliminary results from the fall 2019 pilot, specifically faculty perceptions of the lesson and its placement within the course structure.

The 2019 reinforcement lesson provided a mid-semester opportunity for teams to revisit the scholarly and authoritative sources module from early in the semester. A short group writing assignment asked students to reflect on sources they had found and used thus far. It also provided an opportunity for faculty to remind students about related help materials in the course's library research guide. The new mid-semester lesson was piloted in 6 course sections; deployed and graded via Canvas, the university's learning management system (LMS).

A sampling of course faculty, both those who piloted the lesson and those who did not, were interviewed about their perceptions of the success of the pilot and the role of the information literacy lessons in the course. They were asked for their perspective on two primary topics; the content of the piloted reinforcement lesson and how valuable it is to the course as a whole. They provided input on the types of activities that should be part of an information literacy reinforcement lesson and the best time in the semester to place the lesson. This paper will discuss the design of the reinforcement lesson, results of the faculty interviews and future work needed to improve the lesson before it can be implemented course-wide.

## **Introduction**

Design I is the required first year engineering design course at Colorado School of Mines (Mines). Each semester, roughly 600 students, in teams of 4-5, tackle a large scale project on topics such as food deserts, urban infrastructure, upcycling or bicycle and pedestrian safety. Throughout the 16-week semester they complete significant assignments including problem validation (week 5), design proposal (week 8), subsystems report (week 12) and final report (week 16). At the end of the semester, each team presents their final solution in a trade fair setting and demonstrates a working prototype. Their final report describes and validates their concept solution. All the major assignments in the course assess students on how well they've made use of scholarly and/or authoritative sources in their work. For the final report, 5% of the

team grade is based on how well student claims are supported by testing, stakeholder interviews, and research that is scholarly and/or authoritative (typically 20-30+ citations).

In 2017, the team successfully piloted a flipped information literacy lesson in which students completed a module in Canvas then participated in a required design team meeting with a librarian. The module helped students explore source evaluation via text, videos and practice examples. It provided instructions on identifying scholarly and authoritative sources. The lesson also included an overview of the IEEE citation style used in the course. Finally, students completed an auto-graded quiz to check their understanding of the content. A few weeks into the semester, as they are beginning to validate the problem, each team meets with a librarian to discuss the module and sources appropriate for their team's approach to the course problem.

Success of the initial lesson pilot was determined by evaluating team bibliographies from their mid-semester design proposal and final report assignments. A sampling of bibliographies from pre-flip fall 2016 semester were used for comparison. The bibliographies from the student teams' final project were quantitatively evaluated on both the lower order concerns of citation correctness and the higher order concerns of effective source selection. The team found that students successfully used higher quality sources on both assignments following the implementation of the flipped lesson. However, the results for the final report demonstrated less improvement, written 10-12 weeks after the lesson [1].

To improve the impact for the final deliverable, the research team sought to find a way to reinforce the early semester information literacy lesson. In week nine of the fall 2019 semester, a brief lesson was piloted in six of the 26 course sections. It replaced one of several brief check-in assignments already scaffolded throughout the course. In the assignment, students were asked to revisit the information literacy lesson in Canvas and then answer a series of reflective questions. The research team then interviewed four professors, split between those who had and had not piloted the lesson, to learn more about their perspectives of the lesson. This stage of the research will lead to another pilot of the reinforcement lesson and more comprehensive analysis of student team final report bibliographies.

This paper describes the results of the first implementation of the reinforcement lesson. It seeks to answer two questions, in the perceptions of interviewed course faculty:

1. Does a well-designed mid-semester reinforcement activity help skills retention later in the semester?
2. Does the additional lesson provide enough added value to the curriculum to justify the time expended on it?

## **Literature Review**

This project lies at the crossroads between information literacy instruction and designing curriculum for engineering design courses. More specifically, it examines the role of reflective learning and assignment scaffolding in enhancing student retention of concepts and skills. Iterating, or learning through experimentation and research, and then reflecting critically on what drove those changes, are foundational tenets of open-ended problem solving. Without explicitly

using the term “information literacy” in their work on informed design teaching, Crismond and Adams argue that design students need instructor support when learning to conduct research related to their design project. They found, “Beginning designers skip doing research in favor of generating solutions immediately. Informed designers instead do research...to build understandings of the problem and potential solutions” [2]. This habit is also found in Design I, where teams often try to skip problem definition to find a comfortable solution, which can then be used to retroactively define their problem. In the process, they do not explore the offhand assumptions and biases they bring to that hasty solution.

This second iteration of the Design I information literacy lesson builds on the design literature by slowing down students’ impulsive solution-making and incorporating reflective practices into their work. Students reflect on the sources they find and revisit prior course content to further practice developing their source evaluation skills. In her research on reducing biases towards better problem solving, Jeanne Leidtke describes the process of design thinking, “Conducting and then reflecting on experimental results simulates a kind of “after-event review” (AER), which researchers have proven improves future performance” [3]. Planned repetition of experiences, information, testing, and material in a design course supports the learner as they expand their understanding of how best to solve the problem at hand.

The literature contains significant discussion of the role of scaffolded assignments in engineering and engineering design courses [4], [5], and [6]. As described by Tom Eppes et al., scaffolding organizes learning into progressively challenging modules in which assistance is gradually removed as students develop and practice new skills [7]. Each time students revisit a particular skill or concept, they become more confident in their ability to use it in their coursework. At Purdue University, Lisa Bosman combined the concept of connected, scaffolded assignments with reflective learning in a Transdisciplinary Studies in Technology course. Students were introduced to four design-focused frameworks through a series of scaffolded modules. Content was paired with reflective assignments to help students engage more deeply with each framework. She found, “after completing the semester-long scaffold assignments, students generally reported to primarily assess the ability to complete tasks from a strengths perspective with a particular focus on learning and growing from past experiences” [8]. Through scaffolded lessons, students reflected on their own learning and how they approach problems or tasks. Scaffolding the information literacy lesson within the Mines Design I course enables students to revisit source evaluation skills in connection with progressively difficult course assignments.

The teaching community has also begun discussion of the role of reflective learning in conjunction with experiential learning like the Design I semester-long project. According to Thea Morgan, of the University of Bristol, reflection is an essential part of experiential learning, but most engineering students treat work in their design courses as rational problems to be solved [9]. Reflection about the design and approach to the overarching problem has to be enabled through coursework. In the case of her second year design course, Morgan enabled this reflection via a series of reflective learning journal assignments [9]. This research project builds on this body of literature by using a reflective mid-semester assignment to reinforce information literacy concepts introduced earlier in the semester. In a pilot study, Patel and Dasgupta examined the role of reflective practices in engineering design. They found that there are several triggers throughout the design process that provide the opportunity for reflection, including testing and

information relevant to the design context. They also suggest interventions that can assist students in practicing reflection when they face one of the triggers. For example, maintaining a design diary can help students return to testing they've already completed [10].

There is a large body of literature on the role of information literacy in design education [11], [12], [13], [14] and [15]. In the literature, discussion of scaffolding content and assignments in a single course is most typically discussed within the context of embedded librarianship [16], [17], [18] and [19]. According to the National Network of Libraries of Medicine, embedded librarianship includes “an academic librarian who participates in an academic course on an ongoing basis, teaching information literacy skills” [20]. In this model, the same librarian or team of librarians work with the same course at multiple points; providing more time to reinforce concepts and revisit areas of confusion than a single one-shot lesson can. As Pati and Majhi describe, the activities of embedded librarianship can be quite varied, and do not necessarily require multiple trips to the classroom [21]. At Canisus College in New York, Bordonaro and Richardson collaborated to embed a librarian in an undergraduate education course. They found that through the embedded information literacy assignments, several types of scaffolding occurred including: peer to peer, librarian and professor to student, library and professor to each other and external education professionals to student [22]. As students worked through the assignments, they gained experience using information literacy skills in the discipline.

## Methodology

Following full implementation of the flipped information literacy lesson in fall 2017, the research team began to discuss methods to improve the quality of student bibliographies on the final report assignment. In the initial research project, quality of the bibliographies improved 5.8% for the design proposals, but only 2% for the final reports (Figure 1). A mid-semester reinforcement of the information literacy content was needed to remind students about using high quality sources prior to beginning work on their final report.

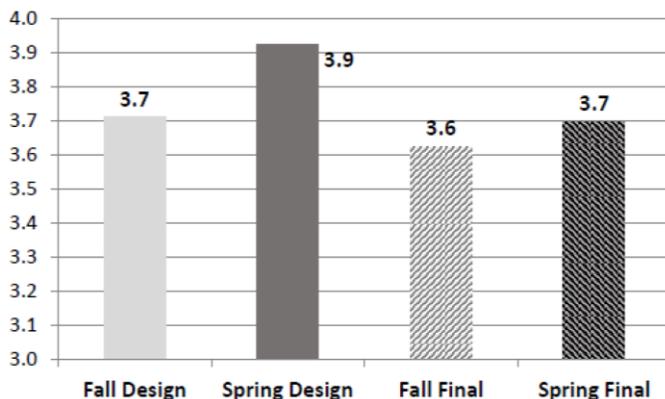


Figure 1: Weighted average citation scores for both deliverables, pre- and post- intervention

The course structure already includes seven brief check-in assignments in which student teams send answers to a series of questions to their course instructor. The check-in assignments are designed to ensure teams are on task and working towards completion of their project. The research team replaced check-in assignment #2, approximately halfway through the course with

a research version of the assignment, in six course sections. The original assignment, utilized in the other 20 sections asked students to update their project plan and project research log. They were also asked to inform their professor of any struggles they are encountering in the project or with team members and what their next steps in the project will be. In addition to these routine updates, the research version of check-in #2 asked students to revisit the information literacy lesson in Canvas and address the following topics:

- Design concepts/aspects changed based on research you've conducted so far
- One relevant scholarly source found and used
- One solid authoritative source found and used
- One aspect of the research that your team has struggled with

Anecdotal discussions with faculty involved in the pilot raised the question of how much added value the expanded check-in lesson really provides for students. Due to the large workload in the course, most teams delegate the check-in assignment to one or two team members. Therefore, all team members may not be benefitting from revisiting information literacy content. To assess the role the lesson played in pilot sections the team conducted interviews with a sample of course faculty after the conclusion of the fall semester. The research team spent approximately thirty minutes with each faculty member. They were asked a series of questions about the role of information literacy in the course, whether or not they utilized the pilot reinforcement lesson in their sections and their perceptions of any added value a second information literacy lesson would bring to the course (Appendix A). The research project received approval for institutional review board exemption from the Mines Human Subjects Review Team.

## Results and Discussion

Notes from the interviews were compiled and overarching themes were identified. First, all sample faculty agreed that the early semester information literacy lesson is helpful and a valuable addition to the course. They also agreed that some form of intervention would be helpful later in the semester to reinforce early content. However, they acknowledge that the course schedule is very full and timing the reinforcement lesson for maximum impact could be difficult.

Four faculty interviews were conducted from among the 22 course faculty for this preliminary research project. Two interviewees taught sections utilizing the pilot reinforcement lesson and two did not. Combined, the four faculty taught seven course sections in fall 2019, four pilot and three control (Figure 2).

<b>Interview Number</b>	<b>Pilot or Control</b>	<b>Years Taught this Course</b>	<b>Sections Taught Fall 2019</b>
1	Pilot	4-6	2
2	Pilot	4-6	2
3	Control	2-3	2
4	Control	4-6	1

**Figure 2: Breakdown of Faculty Interviewees**

### *Value of the Flipped Lesson and Reinforcement Lesson*

To address research question one about faculty perceptions of a well-placed reinforcement lesson within the course, the team asked the two pilot faculty why they chose to participate in the pilot, their perceptions of the costs and benefits of the lesson, the placement of the reinforcement lesson within the course structure and suggestions for other ways to revisit the information literacy content. Based on these questions, the team found both faculty agreed the use of the reinforcement lesson was useful in their course sections. One faculty interviewee described how students are informed early in the semester about scholarly and authoritative research, but the reinforcement "...raised awareness that it is important. It works as long as teams are willing to see it as an iterative project." In their observation, if teams take the time to work on milestone assignments and revisit content, they are more likely to have a successful final product.

From the pilot faculty perspective, there are several benefits to utilizing the reinforcement lesson. These include another touch point for content that faculty view as important and an opportunity for students to practice new skills. However, there are also costs to adding an additional lesson to the already busy course schedule. As one interviewee noted, "There was a lot going on with that check-in and it diffused their focus as compared to other check-ins. We should try to keep the check-ins to three things maximum." The most significant issue the research team will have to contend with is the already full nature of the course schedule and how to meaningfully include reinforcement of important early semester lessons.

To balance the perspectives of the two pilot section faculty, the team interviewed two faculty who chose not to utilize the pilot check-in #2 lesson. These faculty were asked why they chose not to implement the pilot, what else they do to help students reinforce early lessons later in the Design I course, and if they revisit the use of scholarly sources in later courses. Most importantly, they are asked if they think students need a mid-semester reinforcement and what that might look like. For both faculty, it was not a conscious decision to not participate in the pilot. Neither remembered hearing much about the opportunity prior to implementation. Both faculty utilize a variety of means to reinforce the information literacy lesson later in the course. They take advantage of course-supplied slides and faculty lecture notes that remind students about validation via stakeholder engagement, testing and scholarly/authoritative research (Figure 3). They also verbally engage with teams throughout the semester by checking the course research log and providing feedback on milestone assignments. Both faculty agreed that some sort of mid-semester reinforcement would be helpful in the course. According to one interviewee, "In Design I, we are moving so fast that they don't do an organized job of exploring options for project solutions." Teams get into a mid-semester rush and latch onto a solution without fully exploring existing solutions and competing ideas.

## FINAL PROPOSAL (REPORT) HIGHLIGHTS

### Validation

**Just like in the subsystems report\* you will justify your decisions using:**

- Research (... S \_\_\_\_\_ and/or A \_\_\_\_\_)
- User and stakeholder input
- Analysis
- Testing and experimentation, and iteration

**Cite all these sources in your bibliography**

*\* and all technical writing...*

Figure 3: Sample reminder slide for all Design I sections

### *Challenges in Scheduling the Reinforcement Lesson*

The most difficult point of consideration, both for interviewed faculty and the research team, is the placement of the reinforcement lesson within the course schedule. The assignment needs to be properly placed to help students get maximum benefit. All of the interviewees had an opinion on the timing of the reinforcement lesson. Both control faculty would like to see the lesson placed approximately halfway through the course, a week or two prior to the subsystems report. This is where the fall 2019 reinforcement pilot was located. According to one interviewee, “they need a nudge before the subsystems report, because validating their subsystem is often the weakest part of the report, maybe 2 weeks [before].” One pilot faculty interviewee suggested placing the reinforcement lesson closer to the design proposal assignment, which is due not long after the teams initially meet with librarians. The other pilot faculty suggested moving the reinforcement lesson back two weeks because, “they aren’t really starting to write the final report until the last 10-14 days” and a later date would be timelier if the ultimate goal is to improve results on that project. The team also has to account for discrepancies between fall and spring semesters, such as how the timing of spring break or Thanksgiving break affects the due date of mid-semester projects like the subsystems report. Through further research, the team will have to determine which assignment is best suited to pair with the information literacy reinforcement lesson and when to place that lesson within the course.

To address research question two about faculty perceptions of the added value of a reinforcement lesson, the team asked all four faculty the same set of questions. They were asked if they would include something similar to the reinforcement lesson in future semesters, if they are already doing something that is duplicated by the lesson, what the lesson should look like and when they would place it within the course schedule.

All four faculty agreed that yes, it would be helpful to reinforce the earlier information literacy content as long as the product was not too time or resource intensive. The 16-week course is already quite full of milestone assignments, either graded or for participation points, interspersed between the due dates of major assignments. According to one interviewed faculty, “It is a very

busy course, there are so many pieces they have to manage, both individually and as a team, and it can be overwhelming.” It would be difficult to get faculty buy-in for an additional assignment that involved a lot of student time to complete or faculty time to grade.

The faculty all made suggestions for how the information literacy lesson can be reinforced later in the semester. One suggested something similar to a citation management account, such as Mendeley, that faculty can check on periodically. Another suggested a worksheet that helps them to directly apply the skills to an assignment like the subsystems report. Along those lines, the third instructor suggested a checklist or survey attached to the subsystems report that would remind students without asking them to actually complete a separate assignment. And the fourth suggested a quiz that could be auto-graded by Canvas.

## **Conclusions and Future Work**

Based on the results of the faculty interviews, the team will pilot another version of reinforcement activity in either summer or fall 2020. Instead of replicating the check-in #2 lesson pilot that was tested in fall 2019, the lesson will be completed individually by students and placed immediately following the subsystems report. The individually completed subsystems report is due approximately three quarters of the way through the semester. Faculty return grades on the assignment the next week so that students can account for that feedback in their final report due three weeks later.

The new pilot will be twofold. First, students will review a page in Canvas with information literacy content. Then they will revisit their subsystems report bibliography and choose one citation they can improve either by selecting a higher quality source or by following that citation to a more suitable source to cite. The improved citation can then be incorporated into their team’s final report. This lesson incorporates concepts of reflective learning by asking students to self-evaluate their citations. While this new pilot assignment is a bit more time intensive for students, it is a tangible way to directly contribute to the quality of the sources used in their final team report. It will not require any additional grading by faculty. Also, unlike the check-in assignments, the subsystems report and reinforcement lesson will be individual assignments, ensuring that all students have the opportunity to revisit their source evaluation skills.

The bibliographies from the student teams’ final project in pilot sections will be quantitatively evaluated on both the lower order concerns of citation correctness and the higher order concerns of effective source selection. Results from analysis of the pilot bibliographies will be compared to results from both the spring 2017 research project as well as with a control group from the same semester to determine if the reinforcement lesson was successful in increasing the quality of final report bibliographies. The team will also briefly re-interview the faculty who participated in this preliminary study to gather their perspective on the design and placement of the new reinforcement lesson pilot.

As the research team develops the new pilot lesson and continues evaluation of the role of information literacy in the course, two concerns raised in the interviews will need further consideration. First, if the student teams divide up work on team assignments, how can faculty ensure that all students are practicing the skills they should be learning? Through the interviews,

the research team learned that in most sections, the team will assign one to two team members to complete smaller assignments, like check-in #2 but will collaborate more on larger assignments like the problem validation or final report. The research team will need to determine if assigning the information literacy lesson as an individual assignment better helps students practice learned skills than a team assignment such as check-in #2.

Second, as part of larger discussions about the structure of the course, the team will have to evaluate how much content is too much for a single course to cover. All the faculty interviewees acknowledged that the course is already quite full with the four major assignments and several iterative milestone assignments. Some course topics that are built upon in later courses, such as Design II and Capstone Design, are only briefly discussed in the class. It can be difficult to devote time to provide enough depth for students on essential course topics. All four faculty agreed that an information literacy reinforcement lesson would be an added value to the course. But, they want to ensure that whatever form it takes will be manageable for both students to complete and faculty to grade.

These preliminary interviews were particularly helpful for the Teaching & Learning Librarian because they provided insights into faculty perceptions of information literacy in foundational courses, as well as areas for further exploration within the Mines design curriculum. Three of the four interviewees teach other courses within the design curriculum, and provided information about how they revisit Design I information literacy lesson content in their work with upper class students. One faculty member discussed how the first paper in Capstone Design is often poorer quality than the final report in Design I because most students have had very little technical writing practice between the two courses. These interviews and continued collaboration with the Design I faculty will provide opportunities to further scaffold information literacy instruction throughout the design curriculum.

## **Appendix A – Faculty Interview Questions**

### **Introductory Questions**

1. How many years have you been involved in teaching Design I?
2. What is the role of scholarly and authoritative research in Design I?
3. How effective is the course in helping students learn research skills?
4. How do your students divide the work in the course, specifically with the check-in assignments? Do they do it all together or assign it to one person?

### **The Reinforcement lesson – Utilized the Pilot**

1. Why did you choose to pilot the lesson?
2. Based on your experience with the research version of Check-in #2, what were the benefits of including this reinforcement lesson in the course curriculum?
3. What were the costs (time, sacrificing something else, etc.)?
4. Based on your perspective as the instructor, overall, do you think the students benefited from the lesson? Can you provide any examples?
5. Do you like the lesson's placement within the course? Would you move it to another time?
6. Do you like the lesson's content, or would you suggest another means of reinforcing?

7. What else do you do in your classes (including non-Design I) to help students revisit research concepts through the semester?

#### The Reinforcement lesson - Did not Utilize the Pilot

1. Why did you choose not to pilot the lesson?
2. What do you do in your section(s) of Design I to help students revisit research concepts throughout the semester?
3. Do you reinforce these lessons in other courses? If so, how?
4. Based on your perspective, do you think students need a research reinforcement lesson mid semester? Why or why not? Can you provide any examples?

#### Perceived Value of a Reinforcement Lesson

1. (Based on what you've heard from the other faculty or seen in your own sections,) would you include this lesson or a similar one in the course moving forward?
2. Are you already doing anything in class that is duplicated by this lesson?
3. What do you think could be done instead to help students reinforce early semester research lessons?

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