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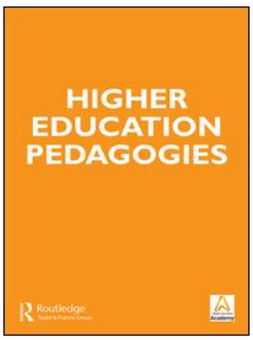

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ARTICLE

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Fostering student engagement through a real-world, collaborative project across disciplines and institutions

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ABSTRACT

Ample research has identified several features of a learning experience likely to enhance student learning, including collaboration, open-ended exploration, and problem-based learning in real-life scenarios. Missing is a model of how instructors might combine these elements into a single project that works flexibly across disciplines and institutions. This article fills this gap by offering such a model and reporting on its effectiveness in fostering student engagement. It describes a project that instructors at four colleges and universities in Flint, Michigan (USA) piloted during the height of the Flint water crisis. The project asked students to apply class content to the real-world problem unfolding around them, and offered students an opportunity to collaborate with peers. We collected qualitative and quantitative data on students' reactions to the project, and found that the project succeeded in engaging students. We offer recommendations for how instructors can create similar projects in their own classrooms.

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Introduction

Few scenarios are as fulfilling to college instructors as a classroom of engaged students eager to participate in the day's lesson. Yet student engagement is often an elusive goal. The existing literature on student engagement allows instructors to identify general principles for modifying their assignments and interactions with students in order to encourage greater engagement with the learning process. To this theoretical body of knowledge, this article contributes a practical model of an assignment that we piloted across four institutions that positively engaged students.

Our pilot study sought to engage students with a dynamic real-world problem in a way that could improve their academic experience. In particular, this study addresses three factors that the literature regards as important:

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(1) Active learning, where students are encouraged to apply their knowledge to new situations (NSEE, 2003).
(2) Collaboration among students in the classroom and across subjects and institutions (Astin, 1993; MacGregor, Cooper, Smith, & Robinson, 2000).
(3) Real-life scenarios (Parsons & Taylor, 2011).

Such a study is especially suited for students entering our classrooms today, who collectively have been characterised as compassionate, concerned for others and interested in making the world a better place (Seemiller & Grace, 2016).

We structured assignments around an urgent, real-world issue affecting the students' community: the Flint water crisis. This article will begin with a brief review of the literature on student engagement. We then describe our motivation for selecting the Flint water crisis as our focal point and the instructors' different approaches to the assignment. Next, we explain our study's methodology based on grounded theory and students' self-reporting on the above-mentioned characteristics of their learning process. The results are described in two sections: the qualitative analysis of students' comments, and the quantitative analysis of our survey's Likert-scale data. The article ends with a discussion of the multiple facets of our research and offers insights and recommendations for instructors wishing to replicate our model at their own institutions.

Literature

Student engagement is the level of effort, interest and attention that students invest in the learning process (Klem & Connell, 2004; Marks, 2000). However, meaningful engagement is deeper than simple participation and involvement (Speight el al., 2018). In general, student engagement has three dimensions: behavioural, cognitive, and emotional (Klem & Connell, 2004; Smith, Sheppard, Johnson, & Johnson, 2005; Tinio, 2009; Trowler, 2010). Behavioural engagement represents learners' contribution as measured by the amount of time, effort and level of concentration they direct toward a specific task (Kuh, 2003, p. 25). Cognitive engagement demonstrates students' understanding of the importance of the assigned activity. Emotional engagement relates to students' impressions, shown by the level of interest, enthusiasm, and optimism toward an activity. Student engagement is a key factor in achieving learning outcomes, and students who are more engaged are more likely to be academically successful and satisfied with their college experience (Astin & Sax, 1998; Kuh, Kinzie, Schuh, & Whitt, 2011; Pascarella & Terenzini, 2005; Tendhar, Culver, & Burge, 2013; Tinto, 1998).

Yet college instructors often find engaging students to be a challenge, no matter the discipline. To address that challenge, a meta-analysis by Parsons and Taylor (2011) identified specific pedagogical practices that enhance student engagement. They found the most influential factors increasing student engagement to be interactive and respectful relationships, assignments that allow open-ended exploration, real-life scenarios, multimedia instruction, an environment that allows students to challenge teachers' claims, and formative assessment of learning.

Specifically, the literature recommends experiential, active-learning approaches that allow students to gain critical thinking skills by extending learning beyond traditional lecture-based classroom instruction (Krain, 2010). These include cooperative learning

and problem-based learning (Krain, 2010; Smith et al., 2005), technology integration (Addi, Alias, Harun, Safri, & Ramli, 2013; Vasquez, Shirazi, & Donner, 2015), and case-study implementation (Davis & Wilcock, 2003; Krain, 2010). Among these, case studies and problem-based learning are known to be effective in improving student engagement as they make the learning process relevant, meaningful and challenging (Krain, 2010).

Recent scholarship continues to affirm the efficacy of engaged learning pedagogies such as undergraduate research, learning communities, and service learning (Kilgo, Pasquesi, Ezell Sheets, & Pascarella, 2014; Kuh, 2008; Lloyd, 2019). In particular, active and collaborative learning have been shown to have positive effects on critical thinking and lifelong learning (Kilgo, Ezell Sheets, & Pascarella, 2015). Carlisle, Gourd, Rajkhan, and Nitta (2017) reported that community-based learning enhances participation and volunteerism, and improves students' ability to work with others and openness to new ideas. Bigg et al. (2018) found that student collaboration across two universities in a large-scale community-based project reinforced students' academic learning through its engaged approach, and also fostered a sense of shared community between students. Reflection has been found to be key in integrating the triad of interdisciplinary teaching, experiential learning, and community engagement (Culhane, Niewolny, Clark, & Misyak, 2018). Finally, Finley and Reason (2016) argue that community-engaged signature assignments should be considered a high-impact pedagogical practice as such learning activities immerse 'students deeply in the real-world implications of complex problems and their solutions', a conclusion echoed by George et al. (2017). As we argue below, this is a central theme in our findings.

With some exceptions (e.g. Bigg et al., 2018), most empirical literature on student engagement focuses on a single aspect of an assignment. Missing is a holistic study of student engagement in a multifaceted, interdisciplinary learning context that incorporates many different best practices that existing studies have identified as ideal for engaging students. To address this, eight faculty members from different disciplines across four institutions of higher learning in Flint, Michigan partnered to construct an interdisciplinary, collaborative, real-world assignment, and then assessed students' engagement with it.

A real-world, collaborative assignment

The process of organising our team was facilitated by an inter-institutional Faculty Learning Community (FLC) initiative sponsored by the Quad-POD Consortium. The Quad-POD Consortium is a joint venture between the centres of teaching and learning at the four colleges and universities in Flint, Michigan, USA: Mott Community College, Baker College, the University of Michigan-Flint, and Kettering University. Its goals are to encourage faculty to 'become more reflective about their teaching practices, familiar with the literature regarding effective teaching and learning practices, and incorporate new methods and technologies into their teaching.' (Quad-POD, 2019). To that end, the Quad-POD invited faculty from all four campuses to take part in a Faculty Learning Community under the umbrella topic of 'Learner-Centred Classrooms.' Four subtopics were suggested, and participants aligned themselves with one of these topics. Our team was assembled by our common interest in student engagement; team members met for the first time at the inaugural FLC meeting and one team member volunteered at that meeting to lead the group. We were subsequently charged with developing a project 'to

improve learning outcomes and increase cooperation among institutions.' The precise nature and scope of the project was to be determined by us.

We began by establishing the scope of our project. Team members from five different disciplines were scheduled to teach during the 2016 Winter/Spring term when we planned to conduct the study. Their classes included a writing class at a public community college; a public speaking class at a private vocational college; a biology class at a satellite campus of a public university; and an applied ethics class and a statistics class at a private STEM university. The interdisciplinary nature of our team thus permitted us to design a project that would allow our students to examine a single topic from multiple disciplinary angles and then share their findings with each other.

Because existing research has shown real-world community-based learning experiences enhance student engagement (NSSE Annual Results, 2019), we chose to design the project around an urgent, real-world local issue that students from all four institutions could relate to. A year and a half prior – in April 2014 – an appointed emergency manager had changed our city (Flint)'s water supply as a cost-saving measure (Michigan Humanities, 2019, p. 10). Unbeknownst to residents, the new water was not adequately treated, causing many people to become ill and some to die. Between July and September 2015 a series of whistleblower reports and scientific findings revealed a cover-up of dangerous levels of heavy metals and bacteria in the city's drinking water, triggering a state of emergency to be declared and the water supply to be switched back to the original source (ibid.). By the time our research team formed in late 2015 our city was reeling from the crisis; the gravity of the situation was apparent to us and our students. The Flint water crisis thus seemed an appropriate current, real-world, local issue to be the focal point for the assignment.

Once we selected our focal point, each instructor developed an assignment for his or her own class addressing a disciplinarily-appropriate aspect of the crisis. These assignments are summarised in Table 1.

In each of these classes, the instructor replaced the content of a pre-existing assignment that they normally used in the class with content from the Flint water crisis. For example, in the statistics class at the private STEM university, instead of analysing a fictitious data-set, students analysed how the levels of lead in Flint homes' drinking water and in children's blood were distributed geographically in Flint during the crisis. Because this pilot project sought to implement a locally-themed, real-world, collaborative project in diverse disciplinary and institutional contexts, we decided that, beyond our agreed-upon set of criteria, instructors should have flexibility to decide how to fit the assignment into their course. Most instructors made the Flint water crisis-themed assignment mandatory for all students, while two allowed students to choose between the normal, pre-existing assignment and the modified version of the assignment focusing on the Flint water crisis. In the latter two classes, choosing the water-crisis-themed version of the assignment required more work on the students' part (in the form of additional research or data analysis). These instructors therefore offered participating students extra credit proportional to the additional work the assignment required.

Because the research has shown that interactive experiences and participation in learning communities foster engagement (NSSE Annual Results, 2019), we designed the project to include two kinds of collaborative elements. The first was within-classroom collaboration. In some of the participating classes, the Flint-water-crisis-

Table 1. Assignments in the pilot project.

Course subject	Institution type	Assignment	Topic & assignment optional?	Extra credit?	Completed assignment in groups?	Total enrollment*	Pre-survey #*	Post-survey #*
Professional Speaking	Private vocational college	Students prepared a problem/solution presentation, identifying a smaller component of the water crisis and proposing a solution.	No	No	No	17	12	2
Applied ethics	Private STEM university	Students researched state government's responses to the water crisis and determined what an ethically sound approach would be.	Topic yes;					
	assignment no	Yes	No	30	18	9		
Statistics	Private STEM university	Students analysed water lead contamination and lead blood content by ZIP codes and compared the results to city, county, and state levels.	Yes	Yes	Yes	98	70	55
Writing	Public community college	Students wrote letters to the editor regarding their concerns about the water crisis.	No	No	No	70	2	2
Biology	Satellite campus of a public university	Students reviewed literature to identify dietary modifications that could reduce the effects of lead.	No	No	No	19	15	15

themed assignment was collaborative (i.e., required students to work in groups), and others it was not (i.e., required students to work independently). 71% of the students in this study collaborated in this way, completing their assignment in teams.

The second collaborative dimension was a large-group discussion session open to all students; it took place after all students had completed their water-crisis-themed assignment. Whereas the in-class assignments had given students an intra-disciplinary

perspective on the water crisis, the discussion session allowed students an opportunity to share their findings in small groups and think about the larger picture of the water crisis together in an interdisciplinary way. 25% of the students in our study attended this collaborative event. Three weeks before the event we reserved a banquet room at the University of Michigan-Flint and notified students to save the date. At the event itself we set up round tables of eight, asked students to sit with people they did not know, and served them a catered dinner. We then presented a general description of the different assignments that each participating class had completed, and asked the students to share and discuss their findings with the other students at their table. We circulated among the tables to monitor and support the discussion, but intentionally took a background role so that the students at each table could explore the implications of their findings together in an open-ended way. At the end of the evening, each table shared with the entire group their most interesting insights from the experience.

Research methodology

Measuring student engagement can be challenging because engagement is a 'within-person' (first-person) experience. It can only be detected indirectly through externally observable phenomena that researchers interpret as evidence of engagement. Some studies measure engagement quantitatively using grades, retention rates, and attendance rates. These quantitative measures fail, however, to capture qualitative indicators of engagement such as enthusiasm and interest in learning (Parsons & Taylor, 2011). Because students' enthusiasm and interest were important parts of what we hoped to measure as indicators of engagement, we chose to conduct a primarily qualitative study, and to supplement our qualitative findings with quantitative data.

The most common qualitative approach to measuring student engagement is to ask students to self-report on their level of interest and their emotional reactions to various existing and new projects (Chapman, 2003). Self-reports can include open-ended responses, checklists, and summative rating scales. External assessments, on the other hand, include behavioural observation and work sample analyses (*ibid.*). Because we were most interested in students' emotional engagement, particularly their enthusiasm and interest, we opted to capture students' self-reported responses to the project through surveys.

Our survey design revolved around two research questions: (1) Were the students engaged by the project? and: (2) What aspects of the project engaged students the most? We developed a pre-survey to capture students' initial reaction to the prospect of the project, and a post-survey to capture their reactions after they had completed the project.

We designed the surveys primarily around open-ended responses in order to accommodate the holistic structure of the learning experience, and also to allow ourselves to discover unanticipated results. The pre-survey consisted of the instructor reading a scripted description of the project to the class, and then asking students to answer the following question through in-class silent writing: 'What is your initial reaction to participating in the Quad Pod collaboration on the Flint water crisis?' (see Appendix). The post-survey was administered as a paper questionnaire approximately 8 weeks later; the exact dates varied slightly by institution and by student, depending on whether they attended the collaborative event. Students who attended the collaborative event completed their post-surveys during the session; all others completed theirs in class. The post-survey comprised ten questions

broken into five pairs. The first of each pair was a Likert-scale question, and the second was a follow-up essay question. The wording of the questions we applied in the post-survey are listed in the Appendix.

To protect students' anonymity, we asked each student to choose a unique identifier – a word, a phrase, or a 4-digit number – to write at the top of all surveys. We asked them to choose an identifier they could remember easily, and instructed them to avoid including personal details in their responses that would give away their identity. These unique identifiers allowed us to match pairs of pre- and post-surveys without collecting personally-identifiable data.

We analysed our data through the method of grounded theory. In contrast to hypothesis-driven methods, which begins with a given theoretical framework and collects data to determine whether it applies to a certain circumstance, 'a grounded theory of a studied topic starts with concrete data and ends with rendering them in an explanatory theory. . . . The analytic process consists of coding data; developing, checking, and integrating theoretical categories; and writing analytic narratives' (Charmaz & Belgrave, 2015). A grounded-theory approach to qualitative data requires that the data be analysed through coding. (For further information about data coding, see Saldaña, 2009).

We analysed students' open-ended responses using NVivo. NVivo is a computer-assisted qualitative data analysis software that allows researchers to code qualitative data under custom-created codes. We coded the data by creating coding-categories ad hoc as the investigators present went along. In every case, all investigators present began by reading students' qualitative responses together, sometimes with as many as seven of us around the computer discussing a student's response, and never fewer than two. All investigators present discussed each student's response in order to identify all of the themes and inflections of meaning evident in it. When considering a student's response, the investigators present prioritised precision, selecting codes that captured the particular themes observed in the response. Oftentimes an aspect of a student's response would resonate with existing codes. If no adequate code existed to capture a particular aspect of a student's response, all investigators present created new codes as needed. Students' word-choice (such as 'real world', 'collaboration', 'excited', etc.) often provided us with clear guidance for how to code a particular passage. Sometimes, however, a student's phrasing left their meaning ambiguous. In such cases we proceeded conservatively, focusing on what the student wrote without attempting to fill in or project meaning onto it. If a proposed interpretation seemed in any way a stretch, those present decided not to code it that way. A decision to code a passage under a particular code required the agreement of all present; if after discussion one person dissented, it was not coded that way. Once all investigators present agreed that our coding had captured all of the relevant facets of a student's response, we moved on to the next passage.

NVivo software allows researchers to arrange codes in a multi-level, tree-like hierarchy. We organised our 'code tree' organically, grouping together codes that shared a common theme under a broader code representing that theme.

General findings

140 students participated in at least one aspect of the project, at very least completing a pre-survey and informed-consent paperwork. 83 students completed a post-survey that

evaluates whether participating in the project impacted their learning. Of these, 63 students chose to participate in their class-specific project about the water crisis and completed a post-survey. For the purpose of this article, except where otherwise specified, when we mention the study's 'participants' we are referring to this group of 63 for whom we had a matching set of pre- and post-survey data. Some of the respondents did not answer all of the post-survey questions, and we discounted their unanswered questions from our data-set for analytical purposes.

As we analysed students' responses to the open-ended questions in the pre- and post-surveys, our team agreed that the most important indicator of engagement that we wished to measure was enthusiasm for the task at hand, which we called 'spark'. We considered evidence of 'spark' to include several things. One was the use of intensifiers to support positive statements about the project – as in, *'much* more interested', 'added a *lot* of value', *'extremely* helpful', *'really* excited', *'very* beneficial', and 'enhanced my learning *tremendously*' (italics added). Other evidence of 'spark' included phrasing that, even in the absence of intensifiers, communicated enthusiasm. This included phrasing such as 'I *loved* this project', and 'applying [class material] to a local issue makes it feel like a *powerful* tool that I now know how to use in future situations' (italics added).

After qualitatively coding the data for 'spark', we compared the pre- and post-survey data for each of the 63 participants to assess the extent to which 'sparked' students' enthusiasm was affected by actually doing the project. These results are summarised in Table 3, which classifies each participant into one of four quadrants, depending on whether their written responses expressed enthusiasm before and/or and after the assignment. More than half (52%, n = 33) of the students were of the same opinion before starting the project as after its completion. These students were rather evenly divided between those who exhibited 'spark' in both the pre- and post-surveys (25%, n = 16) and those who showed 'no spark' in both (27%, n = 17). Among students whose degree of enthusiasm about the project did change after completing the assignment, a small number (5%, n = 3) demonstrated 'spark' in the pre-survey but not in the post-survey. This could indicate that for these few students, the project did not live up to their expectations. The largest quadrant, however, comprised the 43% (n = 27) of participants whose written responses shifted from reflecting 'no spark' in the pre-survey, to 'spark' in the post-survey. All told, 68% of participants (n = 43) clearly expressed enthusiasm for the project after having completed it. The McNemar test for this data confirms that the percentage of 'sparked' students (the engagement factor) improved among the post-survey participants (p-value < 0.05). These findings suggest that the project succeeded in engaging students.

Qualitative analysis

As we coded the data from the pre-surveys and the open-ended (even-numbered) questions from the post-survey, we took note of the specific aspects of the project that students were reacting to when they expressed enthusiasm for the project. We found that the particular aspects that sparked their interest were: the prospect of helping others; the fact that the project dealt with an issue that affected them personally; the fact that it allowed them an opportunity to apply concepts they were learning about in class; and the opportunity to collaborate with students from other universities.

Fully a third (n = 21) of the project's participants were enthusiastic about the prospect of helping, and the same number (n = 21) were enthusiastic about the fact that the project dealt with an issue that affected their lives. 19 were enthusiastic about the fact that the project allowed them an opportunity to apply concepts they were learning about in class, while 13 were enthusiastic about the project's opportunity to collaborate with students from other universities. (These numbers do not total 63 because some students expressed enthusiasm for more than one aspect of the project.) Let us examine each of these areas in turn.

Making it personal: students helping with an issue that affects them

In the post-survey, 21 participants expressed enthusiasm about the fact that the project dealt with an issue that affected them or their community. The following is an example of such a response:

> It made me feel more engaged because I have kids growing up in Flint that can possible (sic) be affected by this in the long term.

Students offered several reasons why working on a personally- or locally-relevant issue made them more engaged with the learning process: 'because this was a real world problem close to us'; 'because it pertained to my life'; because it was a 'relevant and personally affecting topic'; and 'because I was doing work based on my community and looking at data that affects me'. One student noted that 'because my research could have an impact on the community, I am more diligent in my work'. Other students further explained that '[w]ith it happening in my town it made me more motivated to learn the material and made me want to try to find solutions', and that this aspect of the project 'made it real, and made me want to keep going'.

An equally salient (n = 21) dimension of the project that 'sparked' students' interest, according to their responses, was that their participation in the project gave them a sense of helping or contributing to a possible resolution of the problem in some way. Consider the following example:

> I am eager to help with the Flint water crisis. I would like to be engaged in this project and help in any way that I can. Being a part of the Flint Community, I feel passionate about being a part of the solution.

One student explained why this particular sense of serving the community made them more engaged with the course:

> This has given my learning a sense of value to my learning + work. It gives me a sense of value + empowerment that what I am doing matters.

One reason why the water crisis project was so engaging, then, was because it gave students a 'sense of value … that what [the student is] doing matters'.

Another reason was because of the lesson in humility that emerged from attempting to apply classroom knowledge to a complex real-world problem. One student explained:

> I enjoyed helping out my community, but I didn't have all the necessary skills to do it all by myself. It didn't give me a sense of empowerment, instead a sense of humility that I have a long ways to go in my learning skill sets.

For this student, the realisation that their current skills were inadequate to solve their community's problem made them realise that they needed to develop their skills further.

However, not all students took away such a positive lesson. Some were sceptical of the project's ability to help at all. For example, one student commented that 'No one in power is going to read what I wrote'. This was, in fact, an accurate assessment of the specific assignment that the student was working on. Their assignment had been to write a paper that analysed the ethics of how people in positions of power had handled a particular aspect of the water crisis. It was graded by the professor and returned to the student. Had the assignment instead been (for example) to submit their ethical analysis to the Michigan Civil Rights Commission for consideration in their investigation of the cover-up, it is possible that that may have rightfully given that student a more concrete sense of serving the community.

All told, 38 (60.3%) of the 63 students were enthused by the project's 'helping' and/or 'local' aspects. Interestingly, while both of these real-world elements of the project were equally salient (n = 21 each) in 'sparking' students' interest, only four students were 'sparked' by both. The other 34 were especially drawn to either one or the other. An interesting takeaway is that different students found different elements of the project engaging. This offers a reason to design future projects so that they offer students multifaceted opportunities for finding meaning in the activity. It also suggests that student engagement in the learning process can be optimised by gearing assignments toward resolving a problem faced by the local community, especially in a way that makes the problem's relevance to students' lives clear.

Applying classroom learning to the real world

After the 'helping' and 'local' aspects, the project's next most salient dimension for engaging students in the learning process was the fact that the project required students to apply classroom learning to a real-world problem. For example, one student reflected that during this project, 'I was excited and filled with nerves. Involvement in real issues . . . is what I want from college'. A total of 19 students' (30%) interest was 'sparked' by the real-world aspect of the project.

Students repeatedly described the value of the project's real-world dimension in terms of its having made the course content seem more 'relevant' and 'relatable'. One student, for example, explained that 'the project improved my learning by relating topic to a real world problem. By making the assignment relatable I was more inclined and interested in the topic'.

But what *specifically* about the project's real-world aspect engaged students in the learning process? Our analysis identified the reasons why the real-world aspect made course material seem more relevant and relatable. Some students seemed to enjoy the sense of mastery that came from applying classroom material to the real world. For example:

> This project allowed me to take a class topic and apply a relevant current event which was really interesting and allowed me to see how successfully I could apply my learning.

For other students, the project's real-world aspect allowed them to perceive the larger value of what they were learning in the course:

> The real world application helped me see how this course is necessary in the world we live in.

Presumably, this contrasted with the instrumental reason why a student might perceive a college course to be necessary (i.e., to fulfil a degree requirement). Yet even students who seemed instrumentally focused on their career trajectory found the project's real-world dimension to be good practice for honing their skills:

> I found observing a dataset of actual real life data better equipped me to deal with similar data in the future.

The messy, open-ended nature of a real-life situation contrasted with the tidier hypothetical situations many students were accustomed to in the classroom. Some students found this exciting and intellectually stimulating:

> This was a great chance to do some real world application of some of the material learned. It was much different than example problems where your (sic) given a portion of data and specific instructions.

> This project helped enhance my learning experience, because there were so many possibilities for finding a conclusion. It gave the students the control to design the experiment.

Some students reported that the real-world situation provided a context that helped their classroom material to make sense:

> Some of the examples given throughout the term have been difficult in the sense that they are hard to comprehend [without] context. By having a real life example with widespread coverage helped for me to gain a better understanding of the course work due to this.

As an added benefit, the project helped some students to appreciate the real-world situation itself – that is, the Flint water crisis – in a new way:

> The crisis became real for me. Being an engineer, problem always has to have proof or number attached to them. This paper gave me the proof of the problem.

> I feel much more informed on the topic now that I have seen what the data actually means in relation to the crisis.

Some of the students who were enthusiastic about the project's real-world dimension were also excited by its other aspects. Eight of these students were interested in the fact that the real-world issue was specifically a local one. One student, for example, explained that 'I loved this project and communicating about this because this was a real world problem close to us which is why I wanted to participate in this project'. Similarly, four students, including the one quoted below, were interested both in the real-world aspect and the project's capacity to help:

> This project enhanced my learning tremendously. It was interesting to learn about actual research that has been done on lead and how it is affecting people. Learning about possible solutions and recommendations is a closer step to solving this problem.

For some students, it mattered that the real-world problem at the centre of the project had received significant media coverage, as the following quote illustrates:

> Because the water crisis is a national televised problem for Flint, I feel that the work I was doing had more meaning than one that is not in the news.

Collaboration

The next feature of the project that engaged students the most was the opportunity to collaborate with students from their own classes as well as from other universities and disciplines in the Flint area. This project's interdisciplinary nature resulted in diverse assignments, some of which required students to work collaboratively in groups (71% of the students in this study worked collaboratively as a member of such a group). Students reported that this within-classroom collaboration engaged them, with one, for example, writing that 'I learned more from working on this project with a team than I did in class'.

The second collaborative element was a large-group session at the close of the project open to all participating students. As noted previously, 25% of the project's participants attended this session. Students were asked to sit with people they did not know, and to share and discuss their personal findings from their class assignment. Some students appreciated the way that listening to their fellow collaborators expanded their own thinking about the problem:

> Being able to collaborate with others who all looked at the crisis differently was wonderful. I learned much more than just what I discovered in class, and engaging with other students who are dealing with this problem to (sic), some firsthand, was a great experience.

> The other students brought up answers to questions I hadn't even realized were questions.

Others appreciated how the project's collaborative component prepared them for the type of working arrangements they expected to find in their future careers:

> I think the collaboration is an interesting opportunity because in a 'real world' setting you are usually just a piece of a larger group and this opportunity mimicks (sic) that.

Four elements of the project thus engaged students particularly well: its relevance to students' lives and community; its capacity to help; its real-world application of classroom material; and its collaborative element.

The unengaged student

Although the project succeeded in engaging most students, it did not engage everyone. Seven participants (11%) did not feel that it had enhanced their learning. One student explained why this was true for them: 'I'm interested in getting extra credit, but not very interested in the flint (sic) water crisis'. Another student likewise reported that extra credit was their primary motivation for participating in the project, explaining that 'Extra credit project = good'. These students' responses resonate with existing studies that have found that offering extra credit does not tend to enhance students' intrinsic motivation to learn (Harrison, Meister, & LeFevre, 2011; Padilla-Walker, Zamboanga, Thompson, & Schmersal, 2009).

Even so, some students in our study who stated that they did not believe the assignment had enhanced the quality of their class nevertheless admitted that the project had stimulated their interest along the way:

> I don't think it enhanced the quality of the class. I mainly did the assignment for the extra credit but then became interested in the material as I went.

As noted earlier, we found that different students found different aspects of the project to be engaging. The fact that 11% of our students did not report that the project enhanced their learning indicates to us that we may have missed opportunities to design the assignments in ways that would have resonated with these students. However, this is not the only possible explanation for lack of engagement. Sullivan, Tobias, and McDonough (2006) have suggested that the largest barrier to student engagement can sometimes be the attitude that students themselves take towards their school experience. Sullivan et al. imply that this barrier may be overcome through cultivating a classroom culture that inspires students to embrace (rather than define themselves in opposition to) the learning experience. Classroom culture, however, was beyond the scope of our study. We consider the fact that the project elicited enthusiasm from over two-thirds (68%, n = 43) of the study's participants to be a successful outcome for a project that did not seek to address classroom culture.

Quantitative analysis

We complemented our qualitative analysis with an analysis of Likert scale data, comprising the odd-numbered questions from the post-survey (see Appendix). These Likert scale questions asked students to respond to a statement on a scale of 1 (strongly disagree) to 5 (strongly agree). Figure 1 shows the distribution of responses to these questions, and Table 2 summarises statistics across all four institutions. Table 2 reveals that the general pattern of positive responses to the project that we found among the study's participants also held true within each institution. The median responses differ by at most one across all categories and institutions, with institutions with larger sample sizes exhibiting larger variation.

Our purpose in parsing the Likert-scale data by institution was not to identify differences between institutions *per se*, but rather, to detect whether there was a similar effect on engagement despite differences among student populations, and to infer whether our model was replicable in diverse academic environments. For that reason, we did not attempt to study the differences in student responses between institutions or disciplines, and our research design therefore did not aspire to such an analysis. Toward that end, we will now comment on students' responses to specific questions.

Question number 1 on the post-survey asked students to respond to the proposition that the project enhanced their learning. All participants, as shown in Figure 1, evaluated this question with a score of 3 or above, and a significant majority (89%) responded with a score of 4 or 5, indicating that they either 'agreed' or 'strongly agreed' that the project had enhanced their learning. Questions 3, 7, and 9 assessed the impact of the project on students' sense of engagement with the material, perception of the quality of the class, and sense of empowerment over their learning, respectively. An analysis of the Likert-scale responses confirmed that 82%, 82%, and 75% of respondents, respectively, expressed agreement or strong agreement about the effectiveness of the project in these areas (see Figure 1).

Evaluating the responses for post-survey question 5 (regarding the impact of the project's collaborative element) revealed that only 37% of students provided positive feedback on the collaboration impact on learning. This response was in fact higher than we anticipated, because only 25% of students (21 out of 83) who completed the post-survey attended the collaborative session.

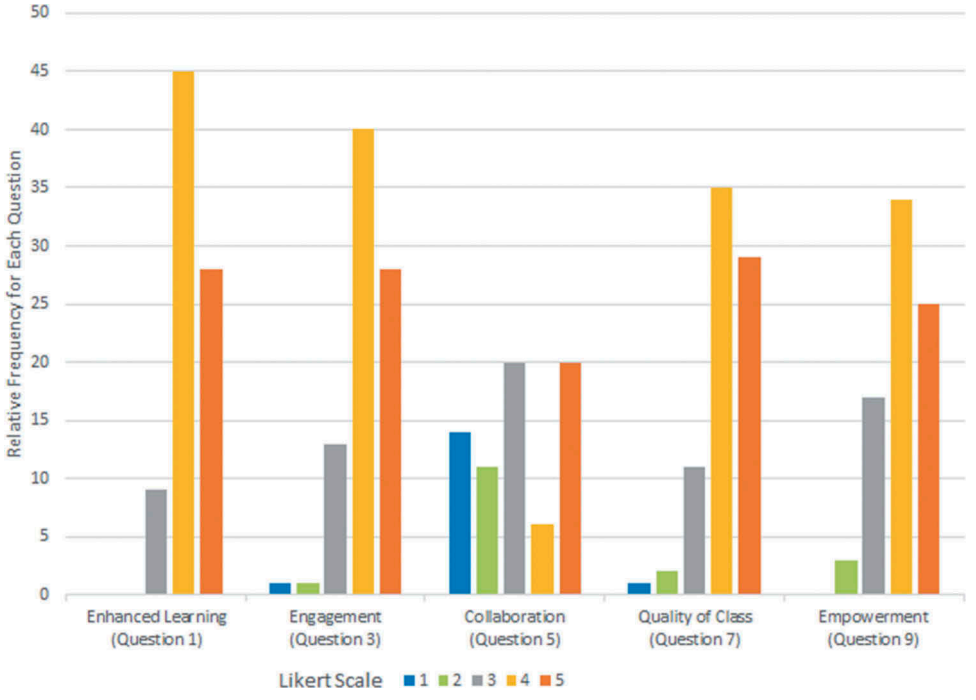

Figure 1. Relative frequency of responses to quantitative post-survey questions. After completing the assignment, participating students completed a post-survey assessing the value of the assignment. This figure indicates students' responses to the general areas surveyed; the specific survey questions may be found in the Appendix. Likert scale: 1 = 'strongly disagree', 5 = 'strongly agree'.

Table 2. Summary statistics of responses to quantitative post-survey questions, (N = sample size, m = median, R = range). Likert scale: 1 = 'strongly disagree', 5 = 'strongly agree'.

	Institution											
	CC			SU			VC			PU		
Category	N	m	R	N	m	R	N	m	R	N	m	R
Enhanced Learning	2	4	2	63	4	2	2	5	0	15	5	1
Engagement	2	3.5	1	64	4	4	2	4.5	1	15	4	2
Collaboration	2	4	2	53	3	4	2	5	0	14	5	2
Quality of Class	2	4	2	60	4	4	2	5	0	14	5	2
Empowerment	2	4	2	61	4	3	2	4.5	1	14	4	3

CC – Community College, SU – Private STEM University, VC – Private Vocational College, PU – Public University.

Table 3. Evidence of enthusiasm in 63 participants' open-ended survey responses. Students' responses to the open-ended questions in the pre- and post-surveys were quantified by the level of enthusiasm they expressed. 'Spark' = students whose responses showed a strong measure of enthusiasm for the task at hand.

		Post-survey	
		Post-survey 'spark'	Post-survey 'no spark'
Pre-survey	Pre-survey 'spark'	16	3
	Pre-survey 'no spark'	27	17

Analysis of quantitative questions 1, 3, 7, and 9 shows that the median Likert-scale score for each question was 4. Students thus showed stronger-than-neutral agreement with the project's objectives to enhance their learning, engagement with the material, course quality, and sense of empowerment over their learning. The question about collaboration (question 5) yielded a median score of 3. Most students did not participate in the collaborative session. If we include in the analysis of question 5 only the students who participated in the collaborative session, the analysis yields a median score of 5 ('strongly agree').

Taken together, this data would support the conclusion that students found this project helpful in enhancing their learning, their engagement with the material, their empowerment over their learning, and their perceptions of the quality of the course.

Distribution of coding-categories in student responses

We also analysed the frequency of coding-categories in responses for both 'sparked' and 'non-sparked' students, and the results are summarised in the graph in Figure 2.

As shown in Figure 2, 'real word', 'pedagogy', 'collaboration', and 'interest' are the most common coding-categories that we observed in the written responses of 'sparked' and 'non-sparked' students alike. 'Workload' was a significant theme in the responses of students who were 'not sparked', which affirms that an increased workload can be a contributing factor that may have caused some students to be hesitant about this project. It is also interesting to observe that 'sparked' students mentioned 'value of assignment' with significant frequency, which may indicate the effectiveness of this project from their perspective.

These conclusions were further supported when we studied the 'attitude' (positivity or negativity/neutrality) expressed in students' responses in different coding categories in pre- and post-surveys, for the 'sparked' and 'non-sparked' groups. The graph in Figure 3 summarises the results of this analysis, where the bars on the right indicate positive attitudes, and

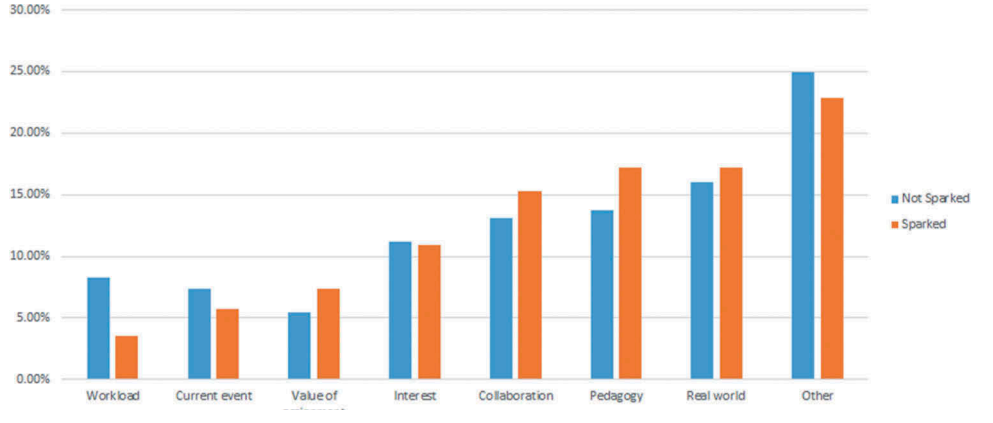

Figure 2. Students' responses to the open-ended questions in the pre- and post-surveys were quantified by the most-common coding categories. This figure shows the relative frequency of coded passages for 'sparked' and 'non-sparked' students. The total number of coded passages was 681.

those on the left indicate neutral or negative attitudes. The data show positive attitudes outweighing negative ones in most instances. From the pre-survey to the post-survey, there is growth of positivity regarding the project's 'pedagogy' and 'real-world' dimensions among 'sparked' students. The negative/neutral attitude in 'collaboration' from pre- to post-surveys reflects the insufficient opportunities for inter-institutional collaboration noted earlier. In addition, the analysis confirms that workload was the main challenge among the 'non-sparked' students in the pre-survey, and it also suggests that students who had a negative attitude about the assignment's workload almost exclusively had this concern prior doing the

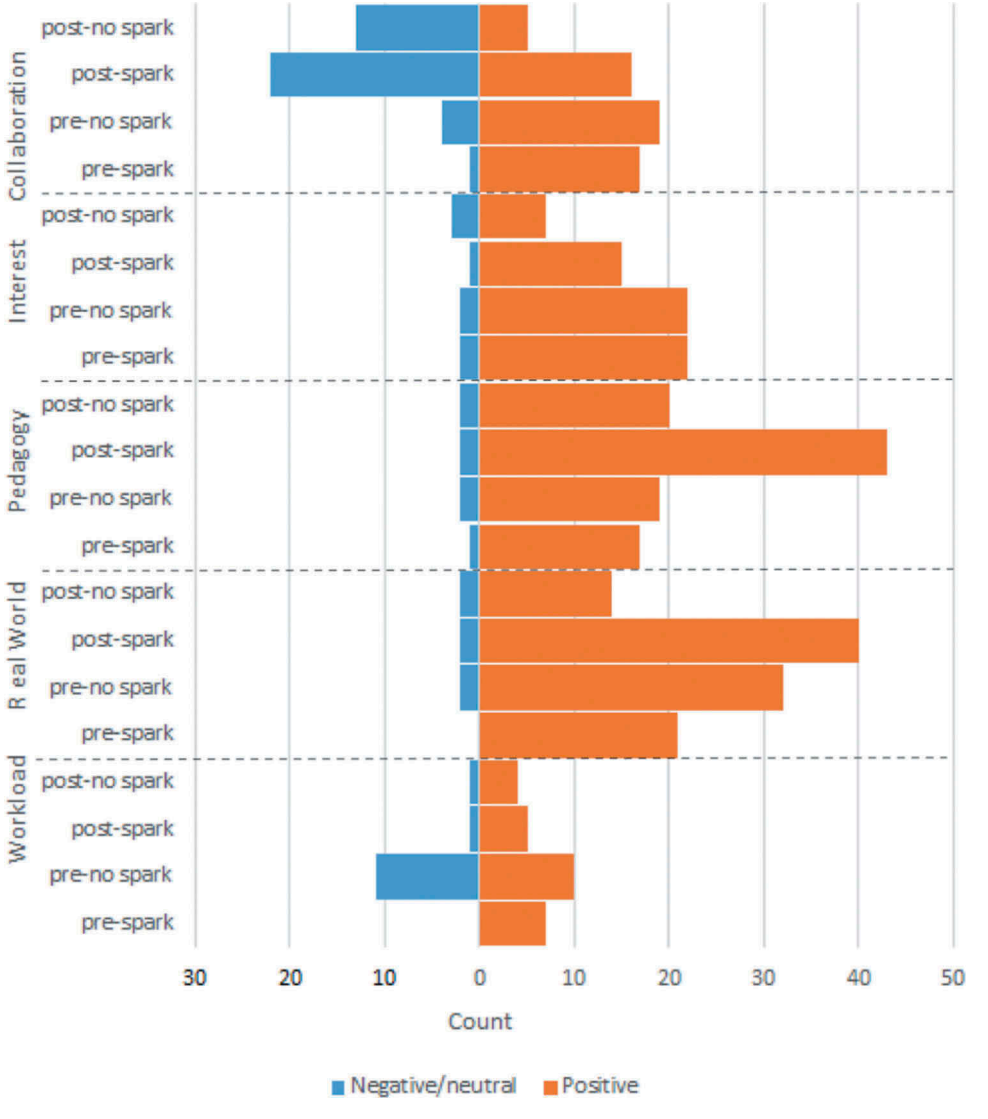

Figure 3. 'Non-sparked' and 'sparked' students' responses in the pre- and post-surveys regarding collaboration, interest, pedagogy, the assignment's real-world element, and workload were analysed in terms of the negative/neutral or positive 'attitude' they expressed.

work. Students who completed post-surveys were generally positive about the project's workload.

In summary, our quantitative analysis concluded that students found this project helpful in improving their learning, enhancing their engagement with the material, providing a sense of empowerment over their learning, and improving their perception of the quality of the course.

Discussion

Our qualitative analyses indicated that the project succeeded in engaging ('sparking' the enthusiasm of) most students. Among the potentially-engaging elements in the assignments that we studied, we found that the best way to optimise student engagement in the learning process is to gear assignments toward addressing a problem faced by the local community, especially in a way that allows students to clearly perceive the problem's relevance to their lives. Other elements that students found particularly engaging were the opportunity to apply classroom knowledge to the real world, and the opportunity to collaborate with classmates and with students from other institutions who brought a different disciplinary perspective to bear on the problem being studied. These findings were supported by our supplemental quantitative analysis of the Likert-scale survey data, which revealed that the broader pattern of positive responses to the project across all institutions taken together also held true within each institution.

The positive response rate was comparable across institutions, which confirms that the differences among student populations did not affect engagement, and supports the notion that our model may be replicable in diverse academic environments. The project that we piloted was complex, and so were the resulting data. Given that complexity, it would be fascinating to be able to draw inferential conclusions by querying the data from multiple angles (for example: does students' level of enthusiasm about a particular aspect of the project vary by institution type? By discipline? If the project is optional rather than compulsory? In response to extra credit?) While our analysis of the Likert-scale data did allow us to engage with some of these layers of complexity in an exploratory way, our study design did not support inferences of this kind.

Our goal in designing the pilot project was to design a potentially replicable learning experience that combined several features, each of which the literature has shown can independently enhance student engagement, and to create a survey instrument that would allow us to draw conclusions about the extent to which students found these different features engaging.

In the real world of our five classrooms, the ethics of conducting research with human subjects required that our students be free to choose whether – and to what extent – to participate in the study. Not all students who completed their class-specific project about the water crisis chose to complete a pre-survey, and some students who completed a pre-survey did not complete a post-survey. Consequently, the numbers of students participating from each institution varied widely. The public community college and private vocational college were underrepresented (each furnishing 2.4% of the post-surveys), while the private STEM university was overrepresented (contributing 77% of the post-surveys; see Table 2). We recommend that future researchers wishing to design a similar study capable of producing

comparisons between different student populations should take steps to ensure large enough samples.

Such researchers should also take care to design the project in other ways that would facilitate robust cross-sectional comparisons. For example, in our implementation of the project, we allowed each instructor the flexibility to decide whether to make the project compulsory or optional, and whether to attach extra credit. Ultimately both instructors at the private STEM university, and no one else, made the project optional, and they also were the only ones who chose to attach extra credit. The confounding variables – institution, instructor, discipline, and type of assignment – make it impossible to interpret the correlation between extra credit (or optionality) and students' enthusiasm for the project. Consequently, even though our data suggest that the group of private STEM university students did respond to the project somewhat differently than the other students – namely, they were more likely to be unenthusiastic at any stage of the project, but also more likely to shift from unenthusiastic to enthusiastic through the experience of doing the project (see Table 4) – our data do not explain the reasons for these differences. Future researchers wishing to draw conclusions about the effects of such factors on students' engagement should control for them in the study design.

In summary, the resulting qualitative data and the supporting quantitative data served our study's primary purpose by offering us insights into what sparked students' enthusiasm about the project, (and why). The study, however, did not permit other types of inferential or cross-sectional conclusions. The open-ended nature of students' written responses to the survey questions allowed us to encounter unexpected findings. In addition to the unexpected findings discussed earlier, we also found that the specific combinations of project elements that 'sparked' different individual students' enthusiasm were remarkably diverse. This diversity suggests that the most broadly-engaging projects may be ones that offer learners many different kinds of opportunities to find meaning in the assignment.

When we first created the project, we had hoped that individual instructors might find a way to arrange for their assignments to have some kind of 'deliverable' manifestation in the community, but we did not require students to make this a part of their assignments. With that intention in mind, we designed questions 9 and 10 in the post-survey to ask students about the prospect of having an 'impact in my broader community'. Considering the small part that the prospect of impacting the community actually played in the assignments, and also the relatively small degree to which the survey acknowledged this possibility, we were surprised by the strong enthusiasm that students showed in their responses for the prospect of helping their community. Returning to the literature, we

Table 4. Evidence of enthusiasm in 63 participants' open-ended survey responses, distinguishing between the 47 students from the private STEM university [SU] (where the extra credit incentive was used) and the 16 students from other institutions (where no extra credit was offered). The percentages compare the cell's value to the column total (e.g., 17% = 8/47).

		Post-survey			
		Post-survey 'spark'		Post-survey 'no spark'	
		SU (N = 47)	Other (N = 16)	SU (N = 47)	Other (N = 16)
Pre-survey	Pre-survey 'spark'	8 (17%)	8 (50%)	2 (4%)	1 (6%)
	Pre-survey 'no spark'	21 (45%)	6 (38%)	16 (34%)	1 (6%)

found no research on student engagement stemming from students' desire to help their community. The closest is Boss's (2006) study reporting on the effectiveness of community service work in furthering students' moral education. We suggest that future studies may wish to explore the nexus between student enthusiasm and students' desire to help solve problems affecting their community.

The collaborative element posed a special logistical challenge. Because our classes met on different days and our institutions used different calendars, it was challenging to find a time for the collaborative session that would work for all students. By the time we had found a workable date, the date itself was not far off, and the short notice meant that many students by then had prior commitments that precluded them from attending. The collaborative session was, nevertheless, one of the most meaningful parts of the project for the students who were able to attend. It was so constructive, in fact, that we believe institutions that are too far away from other schools to collaborate across institutions would still find it worthwhile to collaborate across disciplines by coordinating with other instructors at the same school. We recommend settling upon a time for the collaborative session before the beginning of the semester, and announcing it on the first day of class so that students might save the date.

We recognise that the local issue at the centre of our project was extraordinary. Media coverage brought the Flint water crisis to international attention. Some of our students reported in their responses that the topic's heavy coverage by the media helped to make the project interesting for them. What can instructors do if their towns are not experiencing a high-profile public health crisis? We suggest that all institutions of higher learning are, in fact, located in places that are experiencing at least one urgent problem worthy of students' attention – whether it is air pollution, PFAS contamination, agricultural runoff, industrial waste, microplastic pollution, obesity, diabetes, cancer, addiction, effects of climate change, gentrification, or debt. It may be possible to find both national and local news coverage of the issue, and to show this coverage to students before introducing the project, as a way of communicating the scale of these problems and the risks they pose to students personally. Instructors might also choose to present the class with information about the problem, ask them to reflect privately on the ways it is affecting them and their community, and lead a group discussion before introducing the project.

For example, as the Flint water crisis receded from our students' immediate experience, some of us have since implemented in our classrooms projects similar in nature to the pilot project offering students a real-world assignment affecting their local community that allows them to collaborate with classmates. These later projects were less complex in scope than our pilot project, in the sense that they incorporated within-classroom collaboration but not inter-disciplinary or cross-institutional collaboration. These projects involved topics of PFAS contamination, HIV treatment, malnutrition, and after-school programming for K-12 students affected by neighborhood school closings.

Conclusion

The piloted model for a multi-faceted project was indeed successful in engaging students. Students' responses indicated that the project improved their learning, enhanced their sense of empowerment, and heightened their perception of the quality of the course. Four

aspects of the project enthused students the most: that students were personally affected by the topic; that the project offered them an opportunity to help; that the information they were working with was real (and not from a textbook); and that they had the opportunity to collaborate with peers. We believe this study will help instructors who are seeking to design assignments that engage and enthuse their students.

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Disclosure statement

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Appendix

Pre-Survey Question:

What is your initial reaction to participating in the Quad Pod collaboration on the Flint water crisis?

Post-Survey Questions:

1. Participating in this project enhanced my learning.	(Likert)
2. Please reflect overall on how this project *did* or *did not* enhance your learning. (For example: What aspects of the project did you find most/least interesting or exciting? How did these aspects impact how much you got out of the assignment and course?)	
3. Reflecting on how my course relates to the Flint water crisis made me more engaged with the material.	(Likert)
4. Please share your thoughts on this. (How/why did working on this topic in particular make you feel more/less connected to the course's content?)	
5. Collaborating with other colleges and universities contributed to my learning and engagement.	(Likert)
6. Please explain your answer to number 5. (How/why did it contribute, or not contribute?)	
7. Supplementing my course with the collaborative project on the Flint Water Crisis enhanced the quality of my class.	(Likert)
8. Please explain (how/why?):	
9. Being involved in a project that I have chosen and whose output might have an impact in my broader community has given me a sense of empowerment over my learning.	(Likert)
10. Please explain:	