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All Opinions Matter: Q Pedagogy in an Environmental Health Science Class

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Abstract: This paper describes a study, in the form of multiple field tests, designed to help students in an environmental health science course express and understand the subjective perspectives that they and their classmates hold on important course topics. This study is part of a project using the Q sorting technique found in Q methodology as the basis for a classroom activity, an approach we term Q pedagogy. Q methodology is a research methodology designed to study people's subjectivity and was first formulated by William Stephenson in the 1930s. Results show that the Q pedagogy activity was effective in promoting individual reflection and group discussion among students in the class. Q pedagogy adapts the rich, mixed methods research approach of Q methodology for instruction to advance the Scholarship of Teaching and Learning (SoTL).

Keywords: Environmental Health Science, Q Methodology, Subjectivity, Scholarship of Teaching and Learning

Introduction

A goal of many disciplines in higher education is to engage students in ways that go beyond merely learning the subject matter. The goal is to have students form and defend opinions while also being open to the points of view of others. Creating a classroom environment in which students feel open to share their opinions and are respectful of the opinions of others is not so easy. Many students may be reticent to share their opinions because they fear embarrassment if their views are out of step with the majority. On the other extreme are students who have strong beliefs based on social or political allegiances, but are ill-informed about the facts or evidence supporting their beliefs or are not inclined to listen to other people's views.

Many disciplines in higher education also aspire for students to use what they have learned to make behavioral changes in their daily lives. There are a variety of methods to promote behavioral changes, such as promoting personal investment (Hungerford & Volk, 1990). but few studies exist that measure whether students conceptualize the agenda or goals of the discipline. And, when they do assess this subjectivity-based information, it is usually after the course ends or in anonymous surveys. There is a need to improve instruction in higher education to engage students on a personal level with course content as well as to be able to assess student conceptualization of key course themes.

The discipline of environmental health science, like many disciplines that address the environment and sustainability, is tasked with educating its students on the basics of preservation of the environment for the sake of public health, as well as giving students tools to implement changes in their own lives that lessen their personal environmental impact. Examples include water reduction activities (e.g. shorter showers), eliminating animal products from the diet, conserving electricity, and composting. These changes, once adopted by students, may lead them to influence friends and family to adopt similar sustainable behaviors. Previous work has suggested that empowering students with a sense of responsibility has been an effective way to impart behavioral change (Hungerford & Volk, 1990). Understanding students' impressions about environmental health science after an introduction

course is imperative to assess whether students will use that material to self-adjust to environmental conditions that involve better stewardship behaviors.

The goal of this study was to support and promote student subjectivity in environmental health science education. The study began with several assumptions. The first is that students come to class with subjective points of view on environmental issues. These views are shaped by their exposure to the range of narratives they encounter in the popular media, friends, and family. Views represented in the popular media can range from those based on science, personal experience or bias, as well as political bias, but to name a few. Many topics in environmental health science are controversial and students may be uncomfortable trying to express their views in an open forum. Another assumption is that students would welcome opportunities that would let them express their views in a safe space.

Subjectivity is defined "…as a person's communication of a point of view on any matter of personal or social importance" McKeown and Thomas (2013, p. ix). We reveal our subjectivities in our natural interactions with people, such as casual conversations with friends or co-workers. Likewise, college students will often express their subjectivities about school topics with classmates in the downtime before or after a class meeting, but may be reticent to do so in class. There are many ways to elicit and assess impressions and subjectivities of students in class. One could simply ask them for their opinions in an open-ended survey, or in informal or formal interviews. However, a person may find it difficult to express their opinion on a topic because they might not yet have the necessary domain language required in a new realm of study. Even if they do, they may not feel free to express their opinions in a face-to-face setting for fear of judgement or repercussions from peers or their instructor. It is also difficult to generalize common viewpoints or discriminate distinct points of view among the group with open-ended surveys. Another common approach would be to design a survey using a typical rating scale of 1-5 ranging from agree to disagree. However, this approach has several drawbacks, such as students potentially rating the items with little reflection or thought. Furthermore, each statement is rated independently of the other statements, thus making a holistic interpretation of the survey difficult.

In this article, we present an instructional strategy designed to elicit students' subjective views on even the most controversial of course topics followed by engaging them in productive classroom discussions. We also present the findings of a study conducted as multiple field tests of this approach. A key feature of this instructional strategy is the way the students' views are collected, analyzed, and reported back to them. The strategy is a classroom adaptation of Q methodology (Q), a research methodology first developed by Dr. William Stephenson (1953) in the 1930s to study subjectivity. (A brief overview of Q methodology is below.) The data collection technique used in Q is called a Q sort. In a Q sort, a participant is asked to sort a group of statements representing the full range of views on a topic using a grid that resembles a normal distribution, as shown in Figure 1. There are as many slots on the grid as there are statements, thus forcing the participant to make difficult choices about preferences among the statements.

The purpose of this project in general, and this study in particular, was to explore the use of Q methodology as a viable college classroom activity, an approach we term *Q pedagogy*. This project is framed within the Scholarship of Teaching and Learning (SoTL). Of the four separate scholarships of the professoriate that Ernest Boyer (1990) outlined and described in his seminal work *Scholarship Reconsidered* (i.e. discovery, integration, application, and teaching), this project is firmly placed within the scholarship of teaching, but also supported with the scholarship of application. Q pedagogy embraces Boyer's view that the scholarship of teaching creates "… a common ground of intellectual commitment. [Teachers] stimulate active, not passive, learning and encourage students to be critical, creative thinkers, with the capacity to go on learning after their college days are over" (1990, p. 24). This project is also an example of the scholarship of application in the way that the Q research methodology has been reconceptualized as an integral tool within the instructional design of Q

pedagogy. As Boyer (1990, p. 21) wrote, "…the application of knowledge, moves toward engagement as the scholar asks, 'How can knowledge be responsibly applied to consequential problems?'"

Prompt: Sort the statements into this grid based on your agreement with each statement.

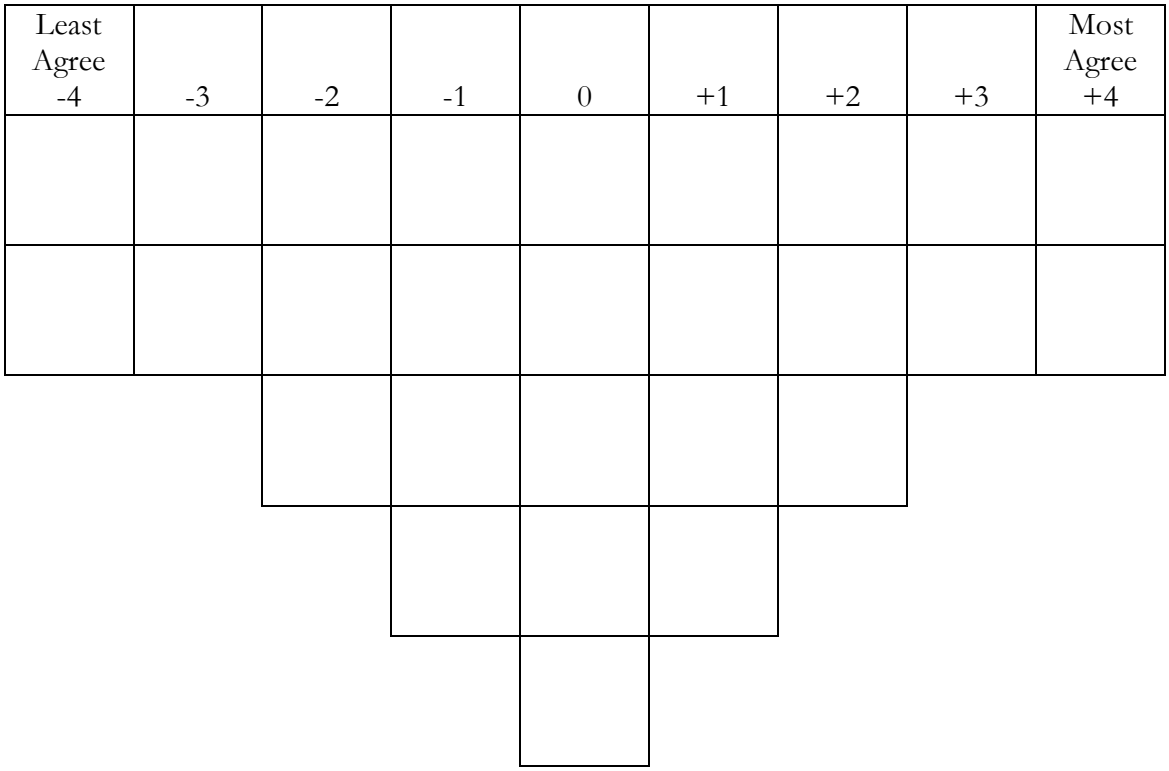

Figure 1. A typical example of a Q sort grid.

To understand the challenge of reconceptualizing Q methodology for instruction, one must understand that Q sorts are typically done on paper by Q researchers and are usually administered to participants individually. To administer a Q sort in a group setting requires preparing as many copies of the materials as there are people in the group. Each Q sort topic requires its own unique set of materials, so the laborious process of constructing the materials must be repeated each time a new Q sort is administered. In contrast, our ambition is for Q pedagogy to become a routine class activity. Like any routine class activity, an instructor should be able to implement a Q sort within the normal demands of classroom preparation. In more practical terms, the instructor should be able to create, administer, and score any number of Q sorts over the course of a college term, perhaps even doing several in a single class period. To make this possible, Q pedagogy makes use of a digital Q sort tool to vastly speed up the time it takes to create a Q sort activity, administer it, and score it. This allows preliminary results of the Q sort activity to be shared with the class immediately and a full Q analysis to be completed in about an hour. Q pedagogy was initially conceived, developed, and tested by the first author (Rieber) in small-scale field tests in his own teaching (Rieber, 2020a). This study represents the first field test of Q pedagogy in a relatively large lecture-based class in a new domain. The initial research question we asked was whether Q pedagogy could enable rich classroom discussions to take place based on the evidence presented by the Q sort results. We also asked a secondary research question during phase 2 of the project about what are the dominant perspectives held by students on

the topic of being an environmentalist. Asking this second research question was possible due to improvements made to the digital tool used in the project.

Overview of Q Methodology

Q methodology was proposed by William Stephenson in 1935 as a systemic method to capture people's subjectivity. Q methodology is based on a holistic view of individuals with the purpose of understanding the complexity of their subjectivity. The uniqueness of Q methodology lies in its data collection and analytical process (Watts & Stenner, 2012).

The first step in Q is the development of the concourse (Stephenson, 1978; Watts & Stenner, 2012). A concourse represents all possible understandings of a certain topic. A concourse, in theory, could consist of hundreds of unique ways to understand the topic. A representative sample is then drawn from the concourse to form the Q-sample, typically a list of anywhere between 25 and 60 statements. The group of participants in a Q study is called the P-set. Next, the participants are asked to sort the statements in some way, such as by preference or by how much they agree or disagree with each statement. As previously mentioned, the Q sort typically uses a pre-formatted grid in the shape of an inverted normal curve, as shown in Figure 1. A key principle in Q is self-reference. Each participant evaluates each statement in relation to other statements based on their feelings and values at that moment in time. Each participant's Q sort is subsequently factor analyzed to reveal clusters of commonality among the participants.

The goal of factor analysis in Q is to detect the patterns of perspectives by grouping individuals who sort the statements in similar ways (Brown, 1980, 1993). It is similar to traditional factor analysis except that the traits and constructs are replaced by Q sorts. Q factors, which are the result of Q analysis, allows the perspective patterns to emerge. Each emerging Q factor is presented in the form of an "idealized" or "composite" Q sort (also called a factor array), which captures or at least approximates a specific type of perspective held by individuals in that group. Since a Q factor is constructed based on people's sorting in a group, it can also be viewed as a "shared form of understanding and orientation" (Stenner et al, 2000). Finally, researchers need to interpret and define the shared perspective of each group based on the factor analysis results along with individual Q sorts and post-sort interviews. However, in Q pedagogy, this step can be made the responsibility of the students that comprise that group.

Q methodology involves quantitative and qualitative methods in unique ways. It not only adopts a qualitative research tradition that enables participants to fully express their subjectivity and allow researchers to interpret meaning, but also takes advantage of the quantitative factor analyzing procedure to reveal perspective patterns. Q methodology is a mixture of constructivism and post-positivism and can be used to both confirm and develop theory (Ramlo & Newman, 2011). Due to its mixed nature in exploring subjectivity, it has been recognized as a mixed methodology by the mixed method research community (Ramlo, 2016).

Q methodology is first and foremost a research methodology used to study subjectivity. The outcome of Q research is the identification of distinct points of view held by people in the group. The knowledge gained from Q research is useful for many purposes. This knowledge can help all people recognize and understand the different perspectives held by members of their group. It could be used to inform policy or make changes to existing practices in a workplace or community setting. Interestingly, the act of actually completing the Q sort can be very instructive to a participant, but these personal benefits are rarely explored during Q research. The Q sort helps the participant to see the full range of ways of thinking about the topic, as represented by all the statements used in the sort. It also helps to reveal to the person what they really value in the topic. Q pedagogy embraces and promotes these reflective aspects of completing a Q sort. These personal outcomes, especially when

coupled with knowledge of the group results, are potentially very beneficial to college students taking courses involving controversial topics.

Q has been used in fields as diverse as medicine (Di Giuseppe, et al., 2020), engineering (Du, Lundberg, Ayari, Naji, & Hawari, 2021), journalism (Peters, Christian Schrøder, Lehaff, & Vulpius, 2021), environmental governance and policy (Davies, Van Alstine, & Lovett, 2016), and marketing (Oliveira, Barbosa, & Sousa, 2020). A good example of the use of Q in an area related to environmental science is its use in conservation research. A review by Zabala, Sandbrook, & Mukherjee (2018) concluded that Q has proven to be a useful approach to understanding people's attitudes, values, and beliefs in a wide range of conservation topics. Their review categorized Q research in conservation into four themes: Conservation management alternatives; critical reflection of values held by conservation professionals; appraisal of conservation policies; and conflict resolution among groups holding opposing views in the management of wildlife territories.

Interestingly, there are few examples of using Q methodology to assist with teaching in higher education. The work of Susan Ramlo is the most prominent. She and her colleagues have explored ways to improve college teaching in several domains, but most notably college physics (2012). For example, in one study Ramlo (2006/2007) examined undergraduate students' perspectives of learning within an introductory physics course. The results provided both evidence and guidance for the need to make changes to how lab and course activities were organized. Ramlo (2015) also used Q methodology as a mid-semester course evaluation approach to understand students' views of the use of a "flipped classroom" in another college physics course. The results led to a redesign of the course curriculum to explicitly train students in how to both access and use the course videos in order to be prepared for the in-class activities. It is important to note that although Ramlo's Q research yielded useful results to help to improve teaching and instruction, the students who participated did so as research participants first, and students enrolled in a course second. That is, the goal of these studies was not to use Q as an instructional approach in their course, but only as a research methodology to improve the course for other, future students. Unlike Q pedagogy, Q was not integrated directly into the instructional practice of the course teaching.

Methods

Q pedagogy was field-tested in an Introduction to Environmental Health Science course in three separate semesters over the period of two years (i.e. fall 2016, spring 2017, and spring 2018). The first two field tests represented Phase 1 of the project consisting of an evaluation of early design iterations of the digital tool and the instructional approach. The results of these early field tests, in combination with small scale evaluations conducted in other settings, were used to identify revisions to the design of the digital tool. Consequently, a much improved version of the digital tool was used in the third field conducted in spring 2018 (see Rieber, 2020b[1]) along with improvements to the instructional approach. This third field test constituted Phase 2 of the study. Each Q sort was based on a simple guiding question, which is described in detail below.

Project Phase 1

The first two field tests were conducted over two sessions occurring on different days. We provided an overview of the Q sorting activity during the first session. This included guiding the students to download and install the Q sorting app onto their laptop computers. Then, a sample Q sort activity was conducted in class on a fun topic that was tangentially related to the course. Students were asked

[1] The digital tool is free and can be downloaded at the following web site: http://nowhereroad.com/qsort/

to rate their preferences for visiting a list of "15 wonders of the world." This list was generated based on a google search of top geographical points of interest in the world. This sort was guided by the following prompt: "Please sort the following natural wonders from those you most to least prefer to visit." The goal of conducting this Q sort activity was simply to acquaint the students with both the Q sort activity and the digital tool. Based on the results generated by the app, a short discussion was held.

The next step was for students to answer two simple, open-ended guiding questions:

1. In about 15-20 words or less, what does environmental health mean to you?
2. In about 15-20 words or less, provide your personal definition of an environmentalist.

The student responses for each question became the basis of the Q sets used in two separate Q sorts, one for each question. Prior to the second class meeting, Rieber and Zimeri collaborated in editing the student responses to both questions. The goal was to reduce redundancy and correct basic grammar while maintaining the student voices in the statements. The students then completed two Q sort activities – one for Question 1 and the other for question 2 - in class on the second day. The digital tool computed the results instantaneously. A whole class discussion of the results was then conducted.

Project Phase 1 Results

After each of the first two field tests concluded, students were asked to complete a survey to give their opinion of the Q sort activity they had just experienced. These results are shown in Table 1. As shown in Table 1, about half of the questions asked for some general impressions of the Q sort activity (e.g. enjoyment) and about half asked more specific questions about the pedagogical approach used (e.g. responding to the one-item survey, completing the Q sort in class, class discussion, and wrap-up comments). As shown in Table 1, students responded very favorably to the activity and to the overall instructional strategy we used.

The results of the first two field tests were encouraging. These results warranted continued development of the digital tool and the pedagogical approach. In the year after the second field test, significant changes to the digital tool were made. Most changes improved the software's overall usability and graphic design. Another update allowed the data collected during a Q sort activity to be exported to a Q statistical analysis software application for a full Q analysis to be conducted using factor analysis.

Project Phase 2

The classroom procedures for the third field test conducted in spring 2018 were changed slightly, but significantly, from those procedures followed during the first two field tests. We again conducted the field test during two class sessions. The most significant change was the decision to run a full Q analysis prior to the second class meeting and use those results as the basis of a whole class discussion. This change was implemented due to the opportunities afforded by improvements made to the digital tool between the end of the second field test and the start of the third field test in phase 2 of the project. By running a full analysis prior to class, more time in class could be devoted to fuller and richer in-class discussions of the Q sort results and the student perspectives. We also decided to omit the Q sort about "what environment health means to me" and focus instead only on the students' personal definition of an environmentalist. The first session was again devoted to an orientation to the Q sort activity and a demonstration of the digital tool again using the natural wonders of the world

activity. The first class session again ended with the task given to students to submit responses to the one-item survey featuring the question "In about 15-20 words or less, provide your personal definition of an environmentalist." However, they were also given the task of completing the Q sort activity for this question before coming to class on the second day. A full Q analysis was run based on the students' Q sort responses. These results were shared with the students during the second class meeting.

Table 1. Summary of student responses to class survey during Phase 1 of the study about the Q sorting experience. *(N=41)*

Survey Question	Mean (SD)
Please rate how much you enjoyed participating in this sorting activity: *(5-High enjoyment; 4-Some enjoyment; 3-Neutral; 2-Little enjoyment; 1-No enjoyment)*	3.93 (0.83)
Please rate your interest in the topic of this sorting activity: *(5-High interest; 4-Some interest; 3-Neutral; 2-Little interest; 1-No interest)*	4.00 (0.95)
Please rate your opinion of this sorting activity as a way to learn about the topic of the activity: *(5-Excellent; 4-Very good; 3-Ok; 2-Not very good; 1-Poor)*	3.93 (0.88)
The sorting activities were part of an overall instructional strategy. Please rate the importance of each of the strategy components separately. *(5-Very important; 4-Important; 3-Neutral; 2-Somewhat important; 1-Not important)*	
Submitting your own response on the topic prior to completing the sorting activity:	4.05 (0.84)
The sorting activity itself. That is, the actual act of using the sorting software tool and sorting the statements provided:	4.10 (0.83)
Participating in a class discussion of the topic after the sorting activity responses were submitted by all class members:	4.17 (0.83)
Any final discussion, wrap-up comments, or review of the sorting activity results provided by the instructor to put closure on the topic of the sorting activity:	4.17 (0.74)

Project Phase 2 Results

A first important result of the second phase of the project is the final list of edited students responses listing their personal definitions of an environmentalist, shown in Table 2. The list reveals much reflection and depth of thought on the part of the students. This was likewise evident in the responses by students during the first two field tests.

The second important result was that the Q analysis revealed three distinct groups of opinions or viewpoints about what is means to be an environmentalist: 1) *Hard Core Environmentalists* – favored strong adherence to formal environmental principles and beliefs with expectations that others do the same; 2) *Being an Environmentalist is a Way of Life* – favored a personal commitment to follow environmental practices; and 3) *Amateur Environmentalists* – general agreement to environmental principles, but not committed to lifestyle changes. The third group was bipolar in that one person significantly loaded onto that factor, but negatively. This means that this person basically held an opposite view of the others who loaded onto that factor. A total of seven students' Q sorts did not significantly load on any of the factors. It is not unusual in a Q analysis for some Q sorts not to significantly load onto any factor. In a traditional Q analysis, respondents would be discarded from the analysis. But, for a classroom discussion, it is important that all students be represented. So, their results were explained as being "on the boundary" between at least two of the factors.

Given the number of students in the course (about 40) and the relatively short amount of time available for the class (about 45 minutes), the decision was made not to reveal which students were in which group. Instead, the entire class was asked to try to understand and discuss the point of view of each of the groups. To facilitate this, an "idealized" Q sort was displayed for each of the three groups. An idealized Q sort can be considered a composite or average Q sort based on all of the responses for that group. A handout was also distributed to each of the students that listed all 32 statements used in the Q sort along with three narrow columns to the left and to the right of the statements where students could take notes about which statements were those that people in that group most preferred and least preferred. The idealized Q sorts also showed the "discriminating" statements for each of the groups. Discriminating statements are simply those statements that, statistically speaking, were rated uniquely by that group. In addition to reviewing the statements at the extremes (i.e. those the group felt most positively or negatively about), discriminating statements can help reveal unique perspectives held by that group. The goal of the class discussion was for the class to try to tease out what they felt were the key differences among the three groups.

Table 2. List of Q Sort Statements on "What Being an Environmentalist Means to Me." (Spring 2018).

1. Someone who is an advocate of the environment and heavily considers the promotion of its present and future health and wellbeing when making lifestyle decisions.
2. Someone who makes certain lifestyle changes in order to make a positive impact on the environment, such as conserving energy, water, eliminating meat, etc.
3. Someone who leads a lifestyle that will have a positive impact on the environment.
4. Someone who is educated on the history and issues facing all aspects of the environment, and who values personally preserving the environment as much as possible.
5. Someone who deeply cares for the environment and seeks to improve its current state.
6. Someone who studies and advocates greener ways to help and maintain our environment.
7. Someone who practices sustainable efforts and advocates for the protection of our environment.
8. Someone who cares about the environment.
9. Someone who promotes the protection of the environment and does as much as possible to lessen his or her negative impact.
10. Someone who educates themselves on environmental issues, takes action to address environmental problems, and shares their knowledge with others.
11. A person focused on improving or sustaining the natural world.

12. Someone who cares about many or all aspects of the environment and shows an interest in protecting it for the future.
13. Someone who is an earthy, crunchy, hippie type person who distorts the truth to make a point about the environment.
14. Someone who is passionate about the treatment of the environment and taking the steps to maintain sustainability of the planet.
15. Someone who is conscious of the decisions they make in terms of how sustainable they are and how they may affect the environment.
16. Someone whose purpose is to be the spokesperson for nature while seeking friendly alternatives for the environment.
17. Someone that is aware of the current state of the environment and tries to provoke positive lifestyle changes to help the environment.
18. Someone who is concerned about the environment's well-being and takes action to protect it.
19. Someone who is concerned about environmental degradation and actively makes choices to protect it.
20. Someone who studies our planet and applies sustainable, safe, and effective measures to address the current issues it faces.
21. Someone who is aware of how their daily activities affect the environment.
22. Someone who values the environment and wishes action to be taken to be beneficial to the environment.
23. Someone whose actions reflect that they care about the longevity of the environment.
24. Someone who puts the environment's needs over their own, living a sustainable lifestyle.
25. Someone who is concerned for the planet Earth.
26. Someone who cares about the environment in which we live and looks at the big picture when making decisions.
27. Someone who takes action to ensure a sustainable future for all species.
28. Someone who is conscience about what they eat and treat the Earth with respect.
29. Someone who values the environment and wishes action to be taken to be beneficial to the environment.
30. Someone who studies human habits that may influence the environment, and then works to combat the habit's impact.
31. Someone who is concerned with and advocates the safety, conservation, and protection of the environment.
32. Someone who strives to promote the longevity and health of the environment by carrying out sustainable lifestyle behaviors and actions.

Discussion

This study is part of larger research agenda to explore ways to use and adapt Q methodology for college classroom teaching, an approach we call Q pedagogy. As such, this project can be framed within SoTL. According to Hutchins and Shulman (1999), faculty pursuing SoTL "…frame and systematically investigate questions related to student learning – the conditions under which it occurs, what it looks like, how to deepen it, and so forth – and to do so with an eye not only to improving their own classroom but to advancing practice beyond it" (p. 13). Although our investigations into Q pedagogy have just begun, we too hope to improve teaching – our own and beyond – with this innovative approach. The study reported here is a first step in that direction.

The purpose of the study reported here was to explore the subjective understandings of undergraduate students enrolled in an introductory college course on environmental health science through multiple field tests of Q pedagogy. Results of this study yielded insights to both the initial research question of whether the Q sort activity could improve classroom discussion and the subsequent research question about what are student subjectivities on the topic of being an environmentalist. Each of these results will be discussed next.

It can be difficult for instructors to inspire and assess a fruitful class discussion. Discussion value is often assessed based on student participation. But, what are the criteria for judging the quality of the discussion? One is the degree to which each member of the class contributed to the discussion. Another is whether all students felt comfortable voicing their point of view, especially if it seems to be counter to those views already expressed most vocally by a few students. The Q sort activity used in this study addressed both of these criteria. First, all students contributed their own personal definition of key environmental health topics, such as what it means to be an environmentalist. The statements were compiled and presented in the Q sort activity. Students immediately saw that their voice was represented in this group of statements. Next, the sorting task itself forced all students to consider of the points of view in the class. There is no taking sides when doing a Q sort. Instead, the Q sort captures the nuance of a student's point of view. It's important to note that unlike a typical Likert-type survey where class scores can be calculated for individual questions or statements, the entire Q sort completed by the student is the single data point. That is, one cannot interpret a student's opinion about one statement without considering their opinion about all of the statements.

Using factor analysis, Q reduces the number of personal perspectives from the number of students in the course to usually 2-5 profiles (i.e. factors). This provides students with data to show how their opinion matches those of the entire class. Of course, factor analysis does not guarantee that the Q sorts of all students will significantly load on a single factor. It is common for some of the participants to find themselves dispersed among two or more factors. However, this result is just as interesting and meaningful to students if explained to them in the right way. Providing students with this information and the idealized Q sorts produced by the analysis software have the potential to impact discussions in many important ways. First, rightly or wrongly, the mystique of results produced by statistical calculations provides a sense of authority and objectiveness. In a way, these results validate the fact that not everyone in the class does agree and relieves an individual students from any feelings of having to conform to a master class narrative. Second, the class discussion can start with the goal of first having everyone understand what each of the factors represent. Interpreting the factors results from factor analysis is not easy. In this study we, the researchers, provided an interpretation of the three factors as reported above in the results. Our interpretation was generally accepted by students during the whole class discussion and also seemed to help move the discussion along.

An additional value to using Q sort methodology in the domain of environmental health science is that it allows the assessment and comparison of students who are already savvy and onboard with good environmental stewardship (e.g. environmental health science majors or students who enrolled in the class based on interest) with students who may be introduced to the material for the first time or are enrolled to fulfill a requirement and may not have an intrinsic interest in the material. Traditional discussions can be dominated by the former group, who are already excited and knowledgeable about the material. Q sort procedures force the inclusion in discussion of all students, regardless of interest or major and places value on their perspective of the key concepts and major theme of the course. Q sort has the additional value of presenting class subjectivity in a data-based, statistical manner that may be more readily accepted by students trained in evidence-based critical thinking. It includes all of the students' input in a no risk environment that mediates the manner in which to reveal their points of view with regard to the central dogma of the course. Because of this

inclusion, students can better evaluate the continuum of student subjectivity in the class and view where they fall on the continuum. This can aid them in better understanding their own point of view so that they can reflect on their perspective.

A fair question to ask is whether Q pedagogy can achieve its goal of becoming a routine classroom activity by interested college instructors. Undoubtedly, readers at this point may feel that learning the technical details of Q pedagogy seems quite daunting. This is particularly true given it is likely most college instructors have never heard of Q methodology. In addition, a full Q analysis requires an understanding of factor analysis. Like any new instructional technique, learning Q pedagogy would require professional development. However, Q pedagogy also builds on and aims to improve one of the cornerstones of college teaching with which instructors are already familiar, namely the class discussion. Any instructor who values class discussions but also feels they need to improve their practice of it should find the potential of Q pedagogy intriguing. Certainly, learning factor analysis takes time, but the principles are straightforward and the fundamentals can be mastered sufficiently in a workshop. The difficult part of factor analysis for most people is the mathematics, but this is handled entirely by current statistical packages, one of which, *Ken-Q*, specializes in Q analysis and is available at no cost (Banasick, 2019). The Ken-Q software produces the "idealized" Q sorts described earlier. Also, it is important to remember that Phase 1 of this project did not include a full Q analysis, but instead relied solely on the summary report that is generated by the digital Q sort tool. This summary report included the most fundamental of statistics, namely frequencies, sums, averages, standard deviations, and correlations. The results from this limited summary report was sufficient to generate a productive class discussion.

Another reasonable question is whether our initial success using Q pedagogy in environmental health science can be repeated in other domains. Answering that question is an important goal of this ongoing research agenda. The first author (Rieber) has implemented Q pedagogy in graduate courses focused on topics such as design thinking, instructional design, and research methods (Rieber, 2017). He has also collaborated with another faculty to implement Q pedagogy in social studies education. That research is still underway, but preliminary results have been very encouraging (Rieber & Dinkelman, 2020). Our assertion is that Q pedagogy is relevant to any college teaching context in which class discussions involving student subjectivity are involved.

In conclusion, an important assumption of Q pedagogy is that students have opinions and want to share them. However, they also are likely to weigh the risks in doing with people with whom they are not sure they can trust. College classrooms bring people together, often for the very first time. It takes time to know whether a particular classroom environment can be trusted for sharing one's opinions. Of course, the instructor has much influence over this. An advantage of Q pedagogy for students is that it gives a relatively safe space for a person to express their point of view. Results from Q factor analysis reveal clusters of people who, by definition, share a common set of viewpoints. The cluster therefore acts as a type of affinity group and provides each member with a "home" for their own point of view that they know other people share. The implications of Q pedagogy need more study across different instructors and content areas, a need aligned with the mission of SoTL. As Divan, et al. (2017) point out, "although contested and complicated, the aim of SoTL is to enhance instructors' teaching practices and students' learning experiences" (p. 17). Fortunately, SoTL is multidisciplinary and embraces a diverse collection of approaches, perspectives, and research methodologies (Huber & Hutchins, 2005; Divan, et al., 2017). Q pedagogy adds to that collection.

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