Determining The Various Perspectives And Consensus Within A Classroom Using Q Methodology

Susan E. Ramlo

The University of Akron, Department of Engineering & Science Technology, Akron, OH 44325-6104

Abstract. Q methodology was developed by PhD physicist and psychologist William Stevenson 73 years ago as a new way of investigating people's views of any topic. Yet its application has primarily been in the fields of marketing, psychology, and political science. Still, Q offers an opportunity for the physics education research community to determine the perspectives and consensus within a group, such as a classroom, related to topics of interest such as the nature of science and epistemology. This paper presents the basics of using Q methodology with a classroom application as an example and subsequent comparisons of this example's results to similar studies using qualitative and survey methods.

Keywords: Q methodology, epistemology, learning, views, perspectives, consensus

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INTRODUCTION

Q methodology allows researchers to identify, both quantitatively and qualitatively, the various opinions within a group and the number of people within the group who hold these opinions.[1, 2] Thus, Q methodology, or simply Q, is an appropriate choice whenever a researcher wishes to determine the various perspectives and consensus within a group regarding any topic.[1-3] Although many physics education researchers may immediately foresee applications of Q within physics classrooms, Q has most typically been used in the fields of psychology, sociology, conflict management, and marketing.[3] Yet there are additional benefits to Q such as not having to consider validity issues or operational definitions; these are not meaningful in Q because the researcher's view of the sorted items is independent of the determination of the views by the participant.[3] In other words, the sorting process reveals the participants' subjective behavior, or views, based upon their own inner experiences.[2] In addition, Likert-scale surveys are not as powerful as Q methodology for determining the various perspectives and result in a loss of meaning.[4, 5]

THE Q METHODOLOGY PROCESS

In Likert-scale surveys, participants rate each statement on a scale typically of strongly disagree to strongly agree. In Q, participants physically sort items, typically statements on numbered strips of paper, relative to each other into a normalized distribution such as the grid presented in Figure 1. Similar to the Likert survey scale, distribution on the grid typically ranges from least like my view to most like my view. However, Q is unique in that it forces participants to rate each statement relative to the others into this forced distribution based upon that participant's opinion within a particular setting, known as the condition of instruction.[1] The grid presented in Figure 1 was used for an example application discussed here to demonstrate the use of Q in a classroom setting. It is this relational aspect of the sort that removes the need for the researcher to investigate validity or create operational definitions.[3]

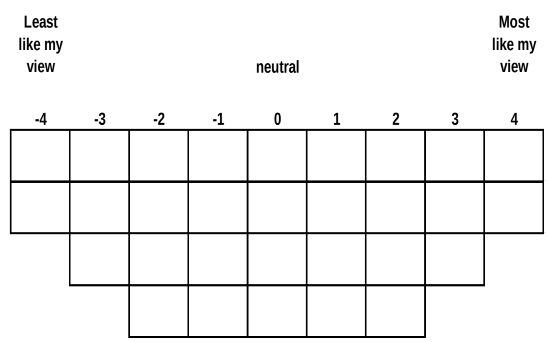

FIGURE 1. One unique statement number is placed in each box during the Q sorting process.

It is important to note here that the sorting process alone does not represent the process of Q methodology. This is a misinterpretation of Q methodology that is not particularly uncommon.[6] Stephenson2 created Q methodology for the study of behavior by implicitly using the combination of the Q sort process and the pattern analysis that utilizes correlation and factor analysis. It is this combination that allows Q to be a measure of subjectivity or individual personal opinion.[2, 6] The sorting process alone or with other types of analyses is not Q methodology but, instead, a misinterpretation of Stephenson's technique.[6]

In the application used to demonstrate the use of Q here, 18 students, from a first semester college physics course for non-majors, sorted 30 statements regarding their views of learning and knowledge of physics within the course, including the laboratory. Because this study is simply used as an example application, the details of the development of the Q sample are not discussed here. However, it should be noted that the Q sample was a hybrid type in that some statements were taken from the popular Likert-scale survey by Schommer,[7] some came from students' communications, and yet others came from the literature on force and motion conceptual understanding.[8, 9] It is also important to note that the p-set, or number of sorters, in Q is not of the same import as "sample size" (number of participants) in other types of studies. In Q, the "sample size" is actually the number of statements, not the number of participants. The reason for this is because in Q it is the people that are correlated, not the items (statements)[1, 3, 6] as would be true in studies that, for example, used a survey such as the Likert-scale Schommer epistemology survey[7] or the contrasting alternatives design Views About Sciences Survey (VASS).[10] In our example, students' were asked to sort the items into the grid shown in Figure 1 based upon their view of their learning and knowledge within the physics course after a preliminary sort of the items into three piles (least like my view, neutral, and like my view) in order to facilitate the final sorting process.

ANALYSES OF THE Q SORTS

Several programs created specifically to handle the type of data collection and analyses in Q exist. PQ Method is one of these and is available for free.[11] PQ Method was used for the analyses in the example application presented here. Regardless of the software used, the analyses of the Q sorts involve correlation, factor analysis, and the calculation of factor scores.[12] Factor scores are simply correlation coefficients. The higher the factor score, the more highly the sorter is correlated with that factor, or view. Thus, those sorters with similar views are more highly correlated with the same factor. In Q, the recommended factoring procedure includes centroid extraction (data reduction) with hand rotation because this allows the researcher to investigate factors based upon theoretical considerations.[1, 2, 11] See Brown[3] for a detailed explanation of hand rotation procedures.

Table 1: Factor matrix displaying correlations with an X indicating a defining sort

	Qsort ID	1	2	3	4
1	CJ24D14	0.0513	0.4537X	-0.1540	-0.2384
2	MJ22C17	0.3081	0.0023	-0.3382	-0.2834
3	EF19C24	0.2897	0.0790	-0.7486X	0.0917
4	SF18A22	0.2227	0.2641	0.5204X	0.1856
5	EF19B31	0.5930X	0.4056	0.0060	0.1540
6	CJ21C28	-0.2355	0.6061X	-0.1339	0.1499
7	MF19C18	0.0497	-0.1362	0.2971X	-0.1178
8	ES20C44	0.5342X	-0.4473	-0.1553	0.1501
9	MS22C38	-0.2782	-0.0847	-0.1098	0.2752
10	CS19A33	0.6917X	-0.2559	0.2710	-0.1576
11	MF22D7	-0.0896	0.6160X	-0.1168	-0.0584
12	CF19A26	0.6298X	0.1464	0.0641	0.0069
13	MS20B24	0.5744X	-0.0521	-0.3998	-0.1098
14	SJ35C15	0.1192	0.0300	0.0527	0.1670
15	MS21D12	0.0249	0.2900	-0.1247	0.4532X
16	SF19B41	0.1349	0.2799	0.2669	0.0103
17	MS27A34	0.7792X	0.0828	0.3071	0.1535
18	CF20C25	0.3218X	-0.0336	-0.1293	-0.0913

Notes: The Qsort ID in this table contains demographic information; the first letter represents the students' major (C = construction, M = mechanical engineering technology, E = Electronic engineering technology, S = Surveying & Mapping), the second letter represents the students' undergraduate level (F = freshman, S =sophomore, J = junior, S = senior), the third letter represents the grade received by the student. The first numerical part of the ID represents self-reported age; the second set of numbers represents the students' score on the FMCE at posttest.

Once the table of factor scores has been generated, those participants represented by a factor must be selected. Typically, researchers use a flagging algorithm that attempts to select only pure cases where the factor explains at least half of the common variance and the correlation with the factor is significant at the .05 level.[11] The flagged entries define the factors and are used to determine representative sorts for each factor. Each factor represents a unique perspective held by those represented by the factor. Additional tables are also produced within the Q analyses including tables of distinguishing statements for each factor (e.g. statements that distinguish one factor's view from another at a statistically significant level) and consensus statements (those statements that do not distinguish, at a statistically significant level, the various factors). These various tables assist in the interpretation of the factors typically in conjunction with sorter's written comments or interviews. Within education, Q has been used in a variety of situations such as promoting organizational change, [13] facilitating a faculty learning community,[14] evaluating a bioinformatics course[15] and evaluating a professional development experience.[16]

RESULTS FROM THE EXAMPLE Q STUDY

Table 1 displays the factor scores with Xs indicating those sorters represented by one of the four factors from the example classroom application. For brevity here, we will only discuss the first two factors and their interpretation. Tables 2 and 3 contain the five most extremely positioned statements for factors 1 and 2, respectively. Interpretation of the factors was based upon these statements, the distinguishing statements for the factors, as well as students' written responses included as part of the sorting process. Because the focus of this article is on the use of Q, more information on the interpretation and additional data / analyses is not included here.

Table 2: Factor 1 top 5 most like / most unlike statements

No.	Statement	Grid Position
12	I like the exactness of math-type subjects.	4
30	I enjoy solving problems.	4
10	I can tell when I understand the material in this class.	3
13	What I learn in this class will help me in other classes.	3
15	When I don't understand something in my physics lab, I ask another student to help me understand.	3
7	Learning something really well takes me a long time in this course.	-3
16	If I am going to understand something in this course, it will make sense to me right away.	-3
5	I have very little control over how much I learn in this course.	-3
23	Sometimes I found the lab results hard to truly believe.	-4
8	In this course, if I don't understand something quickly, it usually means I won't understand it.	-4

The first factor indicated that those represented by this view (seven students) were reflective, help seeking, and enjoyed math / problem solving. These students indicated that they sought a coherent view of force and motion. This view, factor 1, had a high correlation (.46) with the Force and Motion Conceptual Evaluation (FMCE) posttest scores. The remaining three views had negative correlations with the posttest scores. For instance, with a correlation of -.39 with the posttest, the view represented by factor 2 indicated that these students felt like they were struggling to learn in this first semester physics course. The distribution of the statements representing this view also indicated that these students were uninterested in the topics of the course, did not reflect on their learning, and were willing to simply accept answers from peers and the instructor. Two consensus statements were also determined and indicated that students agreed they ask their peers for help in understanding the lab activities and yet disagreed that they tried to combine ideas across the lab activities. Understanding these perspectives may be helpful in improving students' learning of force and motion concepts.

Table 3: Factor 2 top 5 most like / most unlike statements

No.	Statement	Grid Position
28	When I study for this class, I try to get the big ideas instead of focusing in on the details.	4
29	I find it hard to learn from our textbook.	4
24	Sometimes I find I have problems understanding the terms used in physics.	3
4	I like it when my instructor gives me the answer instead of making me figure it out myself.	3
10	I can tell when I understand the material in this class.	3
14	When I don't understand something in my physics lab, I try to figure it out myself.	-3
2	I think of learning as reconstructing and refining my current understanding.	-3
30	I enjoy solving problems.	-3
1	I see the ideas of force and motion as coherent and	-4
19	I am genuinely interested in learning about force and motion.	-4

OTHER MEANS OF DETERMINING STUDENT VIEWS IN THE LITERATURE

Lising and Elby[17] showed, through videotaped class work, student writing, and interviews, that many student learning difficulties in an introductory college physics course were based upon issues related to their personal epistemologies. Generally, qualitative studies of epistemology are dependent upon lengthy interviews[18-20] and other time consuming qualitative ways of determining students' epistemological views such as analyzing student writing.[21, 22]

The use of Likert-scale surveys for a more objective means of assessing epistemological beliefs started in the mid-1980's[23] and has continued to be popular with the development of instruments such as the survey developed by Schommer[7] and the six-dimension VASS with contrasting alternatives design. The contrasting alternative design of the VASS used a continuum of expert to folk responses for each statement. Thus a distribution of responses on one of the ends of the continuum indicated either a folk or expert profile while distributions more centralized along the continuum indicated either high or low transitional profiles.[10] Although, like here, the different profiles of the VASS were directly correlated to a measure of student conceptual understanding, the participants did not experience the same autonomous experience associated with the Q sort.[3, 13] In addition, validity and reliability had to be substantiated for the VASS[10] whereas validity and reliability are not concerns within Q because of the subjectivity of the sorters involved in the process[3] as explained earlier. Finally, Q reveals consensus yet surveys such as the VASS do not necessarily reveal such unifying beliefs of the group. As McKeown[4] stated, Likert-type surveys are not as powerful as Q methodology for determining perspectives and result in a loss of meaning.

CONCLUSIONS & IMPLICATIONS

This paper demonstrates the basics of performing a Q methodology study via a sample application related to student epistemology. Comparisons between Q and other ways of investigating epistemology here establish the benefits of using Q to explore the various perspectives in a group for physics education research. In other words, Q is unique in that it allowed the researcher to determine each of the distinct epistemological views within a physics course along with revealing consensus. It also allowed students to construct their own meaning of the statements and their relative positions on the sorting grid, regardless of any researcher perceived or predetermined dimension. Although not yet common in physics education research, Q offers an exceptional means of investigating views within various physics education settings.

REFERENCES

1. Bruce McKeown and Dan Thomas, *Q methodology*, Sage Publications: Newbury Park, Calif., 1988.
2. William Stephenson, *The study of behavior: Q-technique and Its Methodology*, University of Chicago Press: Chicago, 1955.
3. Steven R. Brown, *Political Subjectivity: Applications of Q Methodology in Political Science*, Yale University Press: New Haven, 1980.
4. Bruce McKeown, *Op. Subj.* **24**, 201-206 (2001).
5. Susan Ramlo, *Op. Subj.* xx (x), xx-xx (in press).
6. Simon Watts and Paul Stenner, *Qual. Res. Psychol.* **2** (1), 67-91 (2005).
7. Marlene Schommer, *J.Educ.Psychol.* **82**, 498-504 (1990).
8. D. I. Dykstra, C. F. Boyle and I. A. Monarch, *Sci. Educ*. **76** (6), 615-652 (1992).
9. Ronald K. Thornton, in *The Changing Role of Physics Departments in Modern Universities, The Proceedings of International Conference on Undergraduate Physics Education*, edited by Edward F. Redish and John S. Rigden, American Institute of Physics: Woodbury, New York, 1997, pp. 241-266.
10. Ibrahim Halloun and David Hestenes, *Sci. Educ.* **7** (6), 553-577 (1998).
11. Peter Schmolck, "PQMethod manual mirror," 2002. Retrieved April 29, 2004 from http://www.rz.unibw-muenchen.de/~p41bsmk/qmethod/.
12. Steven R. Brown, "Q Technique and Method: Principles and Procedures," in *New Tools for Social Scientists: Advances and Applications in Research Methods*, edited by William D. Berry and Michael S. Lewis-Beck, Sage Publications: Beverly Hills, 1986, pp. 57-76.
13. Susan Ramlo, *J. Res. Educ.* **15** (1), 52-69 (2005).
14. Susan Ramlo, Paper presented at the Eastern Educational Research Association, 2008.
15. Susan Ramlo et al., *J. Sci. Educ. Tech.* **17** (3), 219-225 (2008).
16. Susan Ramlo and David McConnell, *J. Faculty Dev.* **22** (1), (2008).
17. Laura Lising and Andrew Elby, *Am. J. Phys.* **73** (4), 372-382 (2005).
18. Orpha K. Duell and Marlene Schommer-Aikins, *Ed. Psychol. Rev.* **13** (4), 419-449 (2001).
19. Andrew Elby and David Hammer, *Sci. Educ.* **85** (5), 554-567 (2001).
20. Gregory Schraw, Lisa D. Bendixen and Michael E. Dunkle, "Development and Validation of the Epistemic Belief Inventory (EBI)," in *Personal Epistemology: The Psychology of Beliefs About Knowledge and Knowing*, edited by Barbara K. Hofer and Paul R. Pintrich, L. Erlbaum Associates: Mahwah, N.J., 2002, pp. 261-277.
21. David Hammer and Andrew Elby, *J. Learning Sci.* **12** (1), 53-90 (2003).
22. David B. May and Eugenia Etkina, *Am. J. Phys.* **70** (12), 1249 (2002).
23. Michael P. Ryan, *J.Educ.Psychol.* **76**(2), 248-258 (1984).