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Richard K. COLL,[1] Jacinta DALGETY,[1] and David SALTER[2]
[1] *University of Waikato, Department of Chemistry (New Zealand)*
[2] *University of Auckland, Department of Chemistry (New Zealand)*

THE DEVELOPMENT OF THE CHEMISTRY ATTITUDES AND EXPERIENCES QUESTIONNAIRE (*CAEQ*)

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ABSTRACT: In this paper we describe the Chemistry Attitudes and Experiences Questionnaire (CAEQ) developed to measure first year university chemistry students' attitude-towards-chemistry, chemistry self-efficacy, and their learning experiences. The instrument was developed to maximise construct validity, by reference to a sound theoretical framework and evaluation of both predictive and concurrent validity. To examine the usefulness of the CAEQ, the instrument was administered at two tertiary institutions at the beginning of the academic year (n=332) and at the end of the first semester (n=337). Data from the learning experiences component suggests that first year university chemistry students prefer a more structured class style. The findings suggest that the CAEQ will prove a useful tool for tertiary level educators who wish to gain an understanding of factors that influence student choice of chemistry enrolment. [*Chem. Educ. Res. Pract. Eur.*: 2002, *3*, 19-32]

KEY WORDS: *self-efficacy; attitude-toward-chemistry; learning experiences; questionnaire; tertiary chemistry*

INTRODUCTION

Researchers in education and science education have two general choices of methodology; a qualitative or a quantitative approach, and each approach possesses both advantages and disadvantages. Qualitative studies typically use resource intensive data gathering techniques such as interviews. These studies are useful in that they allow researchers to study issues of interest in great depth and, for example, allow investigators to probe for underlying reasons about students' views for abstract scientific concepts (see, e.g., Coll & Treagust, 2001). However, because data collection in qualitative studies is more labour intensive, these studies typically involve small numbers of participants, which in the minds of many researchers and teachers results in a lack of generalisability. In other words it is not always clear what implications the findings hold in other contexts. Quantitative studies, in contrast, typically involve a large number of participants and allow researchers to quantify the issues under study. By the judicious use of statistical analysis, researchers can investigate changes and trends and extrapolate their findings to a target population (we do accept that some authors hold reservations about this, and discuss this issue in more detail below). However, whilst the results from quantitative studies are more generalisable, they are often less detailed. Hence, researchers are confronted with a trade-off situation in which they must chose between the depth of understanding provided from qualitative studies, versus the generalisability of a quantitative approach: because of this dilemma, some researchers employ a mixed-methodology approach (see, e.g., Coll & Chapman, 2000).

In this paper, we describe a quantitative study that complements previous qualitative work (Dalgety Coll, & Jones, 2001b), and report on the development of an instrument that investigates tertiary level learning experiences of chemistry students, along with their attitude-towards-chemistry and chemistry self-efficacy. We first review the literature for studies of student attitude towards science and chemistry, and student self-efficacy towards science and chemistry.

MEASURING STUDENT ATTITUDE-TOWARDS-SCIENCE AND ATTITUDE-TOWARDS-CHEMISTRY

Students' attitudes towards science, as reported in the science education literature, are usually measured using purpose-designed questionnaires (more commonly referred to as instruments). The two most widely used instruments employed to measure attitude-towards-science are the *Scientific Attitudes Inventory II* (SAI II) (Moore & Foy, 1997) and the *Test of Science Related Attitudes* (TOSRA) (Fraser, 1978). The differences between like-sounding terms such as attitude-towards-science and scientific attitude are sometimes very subtle and caution is needed when comparing data findings. For example, SAI II measures scientific attitude, which is a slightly different concept from attitude-towards-science – the differences are best illustrated with examples. According to the literature, scientific attitude is a response to statements such as: "Scientists discover laws that tell us exactly what is going on in nature." In other words scientific attitude is what we think science can do. In contrast, attitude-towards-science is a response to statements such as: "Working in a science job would be fun." In this case, attitude-towards-science is to do with what we think of science (e.g., it is fun, boring, difficult, etc.). The SAI II has been criticised extensively in the literature for its lack of theoretical grounding and lack of validity (i.e., an indication of how effective a method is in answering the questions asked) (Munby, 1983, 1997). The TOSRA instrument is considered to possess better validity than SAI II, but is based on a secondary school context. Hence it is less appropriate for a tertiary environment. For example, statements in TOSRA regarding the enjoyment of science 'lessons' are inappropriate for undergraduate students, because the term lesson could be taken to mean lecture, laboratory, or tutorial in the university environment. Thus for a tertiary level study TOSRA requires major revision (see, e.g., Wong & Fraser, 1996).

There has been much less research into students' science self-efficacy: a student's self-efficacy being his or her perception of their ability to undertake a specific scientific task or tasks. Although there has been some recent interest in the measurement of science self-efficacy (Andrew, 1998; Baldwin, Elbert-May & Burns, 1999), much self-efficacy research has been concerned solely with mathematics students (see, e.g., Lent, Larkin & Brown, 1986). Self-efficacy is task specific and so an instrument that measures science self-efficacy of, for example, nursing students, is not appropriate to measure the science self-efficacy of first year chemistry students (Andrew, 1998).

Research into student learning experiences of science, like studies of science self-efficacy, is limited. There is a considerable body of literature on the measurement of students' perceptions of their learning environment (Fraser, 1994), and the relationship between student attitude and self-efficacy, and their learning environment (see, e.g., Lorsbach, 1999). However, research into students' learning experiences is different from learning environment research, in that the former also incorporates experiences and work required outside structured classes. White et al. (1995) developed an instrument to measure first-year tertiary physics students' learning experiences. However, the instrument, ostensibly based upon anecdotal evidence, possesses no theoretical framework and thus is likely to be specific to the educational context in which it was developed.

Instrument design is a complex task, particularly for holistic concepts such as attitude-towards-science or chemistry. Research in this area has been extensively criticised for lack of *construct validity*, which examines the question: Are we really measuring what we think and say we are measuring? (Munby, 1982). For example, consider the question: "Are your chemistry classes presented in an interesting manner?" This may seem like a straightforward question, but put yourself in the position of a first year university chemistry student attempting to answer such a question in a survey instrument: "What do they mean? Are they talking about my lectures, tutorials or maybe my lab classes?" Such ambiguity about the term 'classes' means that the question has low construct validity, in that the researchers may believe they are measuring students' experiences in lecture environments, but the students involved in the study may consider the term 'classes' to mean lectures tutorials, or practical classes, and answer the question accordingly.

There are a number of ways to maximise construct validity – none of these on its own will ensure construct validity, but a combination of tools help researchers and educators to have more confidence in the veracity of the data. First, the instrument structure needs to be based on a well-defined theoretical framework. Second, instruments must be subject to a pilot study using a sample that is similar in demographics to that of the target group. Third, whilst it is inappropriate to rely solely on expert opinion, a panel of experts can also contribute to clarity; ensuring, for example, that scientific terminology is used appropriately (Gardner, 1996; Krynowsky, 1988; Munby, 1997).

DEVELOPMENT OF THE CHEMISTRY ATTITUDES AND EXPERIENCES QUESTIONNAIRE (CAEQ)

An examination of the literature indicated that to understand students' attitude-towards-chemistry, chemistry self-efficacy and perceptions of their learning experiences (in tutorials, lecture and practical classes), it would be necessary to develop a new instrument. Moreover, the instrument needed to be soundly grounded theoretically, and appropriately trialled with a group similar to that of the target population. Because we wished to measure what influence students' learning experiences might have upon their attitude towards chemistry and chemistry self-efficacy, we developed the *Chemistry Attitudes and Experiences Questionnaire* **(**CAEQ). The final version of the CAEQ consists of three scales, each containing a number of subscales (see the Appendix for the scales, subscales and questions). The attitude-toward-chemistry scale contains a total of 21 questions, across five subscales: *attitude toward chemists*, *skills of chemists*, *attitude toward chemistry in society*, *leisure interest in chemistry*, and *career interest in chemistry*. The self-efficacy scale, containing 17 questions, consists of one scale with students not appearing to have different efficacious beliefs for the different tasks in chemistry (see, Dalgety, Coll, & Jones, 2001a). The learning experiences scale, consisting of 31 questions, has four subscales: *demonstrator learning experiences* (relating to graduate assistants who supervise practical classes), *laboratory class learning experiences*, *lecture learning experiences* and *tutorial learning experiences.*

The development of the CAEQ entailed comprehensive statistical analyses. A detailed description of this process has been reported elsewhere (Dalgety et al., 2001a). In this paper, we focus on two aspects of the development of the CAEQ that we believe have been neglected in instrument development in the past: a well-defined theoretical framework, and techniques designed to ensure high construct validity. We conclude with an illustration of the utility of the CAEQ, using data gathered at two different tertiary institutions in New Zealand.

Before going on to describe the instrument development, we wish to clarify the stance we have taken in the handling of the quantitative data. The data obtained in this work is ordinal level in nature; that is to say it can be used to rank or rate participants' views but the values obtained do not represent continuous variables (e.g., age, years of experience, etc.) (Argyrous, 1997). In reporting such research findings, authors have a choice of measures of central tendency (e.g., the mean or median), and measures of dispersion (e.g., standard deviation, interval limits) (Reid, 1987). The measures of central tendency and dispersion used to summarise data are related to the level of data. For ordinal level data, the usual measures would be reporting of the median and range rather than the mean (strictly, means are computed for ratio/interval data like age) (De Vaus, 1995). Examination of the literature reveals that in educational and science education research there are essentially two schools of thought about summarising ordinal level data. One is the strictly correct approach in which one reports medians and intervals, the other is in which authors compute estimated means. This latter approach is the more common in the US and arguably internationally. Because we wished our instrument to be available for comparison with other instruments such as TOSRA and SAI II we have chosen this latter strategy. We do note the importance of not considering that estimated means, as computed here, are one and the same as means computed for ratio/interval level data. So, for example it is not appropriate to infer that an estimated mean for the ranking of importance of a particular laboratory experience that is say twice the value of another laboratory experience, means that participants think this issue is twice as important. Rather all we can say is that they ranked this issue as more important that the one with the lower estimated mean. Hence, as with all data, quantitative and qualitative alike, it is important that authors and readers show due caution in interpretation.

Developing a Theoretical Framework for the CAEQ

The theoretical framework for the development of the CAEQ is based on current thinking in behavioural theory; specifically, it has been adapted from the *Theory of Planned Behaviour* (TPB) (Figure 1). The TBP is an all-encompassing theory that maintains behaviour is determined by many influences including significant individuals in ones life. According to the TBP, an individual's behaviour is influenced by their attitude toward that particular behaviour, their associates' (e.g., peers, family and mentors) attitude toward the behaviour, and the individual's perceived control over the behaviour (Ajzen, 1989). The focus of the CAEQ is on the *antecedents* of attitude towards enrolling in chemistry: namely, their learning experiences, attitude-towards-chemistry and chemistry self-efficacy (in other words, the concepts detailed on the left of Figure 1). The influence of associates attitude and perceived behavioural control also may influence students' attitude towards enrolling in chemistry. This influence is not addressed by the CAEQ, but has been investigated by us previously in a qualitative study (see, Dalgety et al., 2001a; Dalgety et al., 2001b).

As a first step in developing a theoretical framework for the CAEQ, we defined chemistry, attitude-towards-chemistry and chemistry self-efficacy. Chemistry is defined as the learned patterns for thinking, feeling and acting that are transmitted via the acquisition of chemistry theory, skills and values. We used Allport's definition of attitude, namely "a mental and neutral state of readiness, organised through experience, exerting a directive and dynamic influence upon the individuals' response to all objects and situations with which it is related" (Horowitz & Bordens, 1995, p. 228), and Bandura's (1986) definition of self-efficacy, as "people's judgements of their capabilities to organize and execute courses of action required to attain designated types of performance" (p. 391). Learning experiences

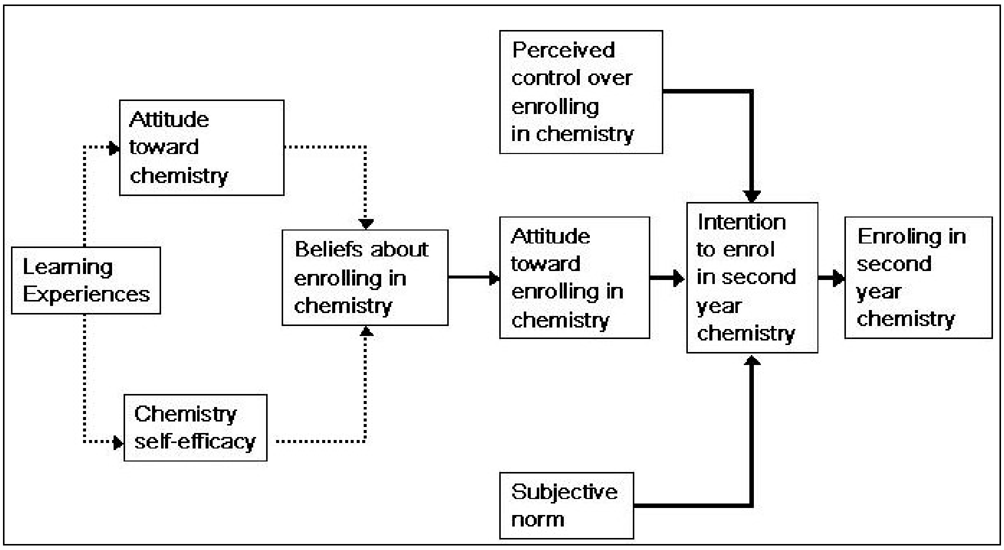

FIGURE 1. *Theoretical framework used in the development of the* Chemistry Attitudes and Experiences Questionnaire (CAEQ). *The focus in instrument development was on antecedents of enrolling in second year chemistry.*

were considered to be any experience resulting in a belief formation about chemistry (where that belief is attitudinal, knowledge, or skill based).

MAXIMISING CONSTRUCT VALIDITY FOR THE CAEQ

As mentioned above, we sought to maximise the construct validity of the CAEQ during its development. First, we employed the "panel of expert's" technique. This involved subjecting the instrument to analysis by experts in the field that the instrument examines; in the case of this study, three chemistry academics (Germann, 1988; Krynowsky, 1988). The experts read the questions and provided detailed feedback about items addressed in the questionnaire. We then checked the readability of the instrument and participant comprehension of the items by asking 19 participants to complete the instrument and subsequently interviewing them. We also employed the skills of an experienced teacher of English as a second language, who examined the items for comprehension by English as a second language speaking students.

Next, the instrument was piloted in a first-year university chemistry course (n=129). The data from the pilot study were subject to statistical analyses that enabled us to assign group questions under specific concepts or constructs, resulting in the formation of subscales (i.e., the subscales in the Appendix). After the pilot, we administered the CAEQ to first year one-semester chemistry courses at two different New Zealand tertiary institutions; at the beginning and at the end of the courses. In the first administration, the participants completed only the attitude-towards-chemistry and chemistry self-efficacy components (n=469). The presumption was that these students had not at this point experienced any tertiary chemistry learning experiences, and hence it was not appropriate to ask them about their learning experiences. At the end of the courses, the participants completed all three scales (n=337); about half completed both versions of the questionnaire (n=177). After statistical analyses (factor analysis, reliability and discriminant validity) two other tests of construct validity were undertaken. The first was predictive validity, which examines whether the instrument predicts something that it is expected to predict. Second was concurrent validity, which examines whether the instrument differentiates between two groups it is expected to differentiate between.

Evaluation of Predictive Validity for the CAEQ

An instrument has predictive validity if it successfully predicts something it is expected to (Trochim, 1999). To determine predictive validity for the CAEQ, the learning experiences subscales were correlated with the attitude and self-efficacy subscales from the data collected at the end of the semester using Pearson's correlation (Table 1).

TABLE 1. *Predictive Validity for Chemistry Attitudes and Experiences Questionnaire (CAEQ) as evaluated from Pearson's Correlation* between learning experiences subscales with attitude-toward-chemistry and chemistry self-efficacy subscales.*

	Lectures	Tutorials	Practicals	Demonstrators
Attitude toward Chemists	0.43	0.30	0.39	0.38
Skills of Chemists	0.43	0.27	0.45	0.38
Attitude toward Chemistry in Society	0.34	0.24	0.39	0.35
Career Interest in Chemistry	0.41	0.25	0.38	0.32
Leisure Interest in Chemistry	0.42	0.24	0.38	0.37
Self-efficacy	0.38	0.29	0.47	0.34

*All correlations are statistically significant ($p<.01$)

The correlations are not particularly strong (the closer the correlation is to 1.0, the closer to linear is the relationship between the variables), but all correlations were statistically significant ($p < .01$), suggesting, for example, that perceptions of practical chemistry classes exert some influence on the participants' ability to recognise the required skills of chemists. It is worthwhile to note at this point that correlation implies association between variables, but the associations might be in either direction or might be due to some underlying causal variable (Moore & McCabe, 1998). Thus it is a necessary, yet not sufficient, condition for causal links for there to be some association in the first place. According to the data obtained from the CAEQ as administered here, as one might expect, students' learning experiences are influenced by both their attitude and self-efficacy (and vice-versa). In other words, the CAEQ predicts a result that it was designed to do so, and hence it possesses predictive validity. If it did not, this would cast doubt on the value of the instrument, as it would not be able to produce a predictable result.

The interrelation between the items in the subscales raises the question as to the value of having subscales at all. The subscales are based on the theoretical framework and whilst there is some correlation as described above, the subscales are independent also as described in more detail elsewhere (see, Dalgety et al., 2001a,b). This is a similar situation to that reported for other generic instruments of this type such as the *Questionnaire on Teacher Interaction* (QTI) and *College and University Classroom Environment Inventory* (CUCEI) (see, Fraser, 1994).

Evaluation of the Concurrent Validity of the CAEQ

An instrument has concurrent validity if it differentiates two groups that it is expected to differentiate between, for example, between subject majors and non-majors (Trochim, 1999). The theoretical framework used here (i.e., the modified TPB) suggests that students intending to enrol in a second chemistry paper after completing their initial chemistry course would likely have a more positive attitude-toward-chemistry, a higher chemistry self-efficacy, and be more positive about their learning experiences, than those who do not intend to take chemistry beyond first year. We examined the data from our administrations of the CAEQ for concurrent validity from the data collected at the beginning of the year. The results show that students intending to enrol in a second chemistry paper chemistry do in fact have a more positive attitude-towards-chemistry, a higher chemistry self-efficacy, and are more positive about their learning experiences than their counterparts. All of the subscale differences were found to be statistically significant (p<.01), suggesting that the CAEQ also possesses concurrent validity (Table 2).

Hence overall the CAEQ possesses high construct validity, as measured by predictive and concurrent validity. This suggests then that the conclusions drawn from the theoretical constructs of the subscales will be valid.

TABLE 2. *Estimated means for subscales for the* Chemistry Attitudes and Experiences Questionnaire (CAEQ).

	Mean*	
Subscale	Planning on enrolling in second year chemistry	Not planning on enrolling in second year chemistry
Attitude toward Chemists	4.5	4.2
Skills of Chemists	5.2	4.9
Attitude toward Chemistry in Society	5.8	5.5
Leisure Interest in Chemistry	4.4	3.9
Career Interest in Chemistry	5.3	4.5
Self-efficacy	4.8	4.3
Lecture Learning Experiences	3.5	3.2
Tutorial Learning Experiences	3.6	3.3
Practical Learning Experiences	3.8	3.6
Demonstrator Learning Experiences	3.7	3.4

*All differences in estimated means are statistically significant (p<.01)

Note: Attitudinal and self-efficacy responses were measured using a seven point semantic differential scale (1=negative, 7=positive), and learning experiences using a five point Likert scale (1=negative, 5=positive).

USING THE CAEQ TO DEVELOP AN UNDERSTANDING OF TERTIARY CHEMISTRY STUDENTS' LEARNING EXPERIENCES

To illustrate the usefulness of the CAEQ, we used data obtained from its administration at two New Zealand universities to investigate student perceptions of their tertiary chemistry learning experiences. This serves to illustrate how tertiary chemistry teachers and researchers might use the CAEQ to gain an understanding of first year tertiary chemistry students' chemistry learning experiences.

It is important to note that the classes from the two institutions involved in the study have significantly different demographic compositions. The first institution, *Riverside University*, had approximately 200 students enrolled in the first year-first semester, chemistry class, of whom the majority were of New Zealand European decent. Over half of these students were enrolled in applied science degrees. The second institution, *Seaside University*, had a larger first year-first semester, chemistry class with over 600 enrolments. In Seaside University's chemistry course a large number of the students were studying medicine or pharmacy and there was also a wide ethnic diversity, with, for example, a large proportion of participants identifying themselves as being of Asian ethnicity.

Each lecturer has a distinct personal style of teaching chemistry and the CAEQ can be used to investigate students' impressions of different teaching styles. The two first year chemistry courses offered at the universities were the participants' first encounter with tertiary chemistry learning. Despite having similar overall objectives and the same three learning experiences (i.e., lectures, practical and tutorial classes), the classes are structured quite differently and cover different content, with *Riverside University* teaching basic chemical concepts, solution chemistry and atomic theory, and *Seaside University* teaching organic chemistry and kinetics. *Riverside University's* practical classes are of three hours duration and are assessed based on the completion of worksheets (first six weeks) handed in at the end of the class and a laboratory book write up (second six weeks) completed outside the practical classes. All the experimental information, and some theory are presented in a separate laboratory manual. At *Seaside University*, the practicals are of two hours duration and are assessed purely on worksheets handed in at the end of the class. These worksheets include details of experimental procedure along with some background theory about the experiment. *Riverside University* provides weekly structured tutorial classes in which all students are formally enrolled, whereas *Seaside University* offers weekly tutorials that are voluntary and based on questions from students.

A comparison of the participants' perceptions of their learning experiences at the end of their courses is given in Figure 2. Participants were generally positive about their learning experiences, with only very few students identifying their learning experiences to be very negative in all four subscales (Appendix). There were, however, statistically significant differences in the participants' perceptions of tutorial and practical classes. More participants attended at least one tutorial class at *Riverside University* (96%) than at *Seaside University* (82%). *Riverside University* participants were more positive about their tutorial classes, suggesting that they found the more structured nature of the tutorial classes beneficial. The participants likewise preferred more structure in their practical classes, as occurred *at Seaside University*. It is interesting to consider why this apparent preference for more structured learning opportunities occurs. As mentioned above, these first year chemistry classes represent the participants' first encounter with tertiary chemistry. Having come to university directly from high school, it seems likely that their school experiences, and the associated modes of assessment, may influence their expectation of appropriate pedagogy.

Hence, as their most recent learning experiences (i.e., their high school learning) were relatively structured it is perhaps not surprising that, as reported elsewhere, these participants are happier in a more directive environment (see, e.g., Coll, Taylor, & Fisher, in press).

CONCLUSIONS

The CAEQ was developed to measure first year chemistry students' attitude-towards-chemistry, chemistry self-efficacy and tertiary level learning experiences. Instrument development, as well as using the conventional statistical evaluation tools such as factor analysis, sought to address the validity issues that have adversely affected other attitudinal survey instruments. Construct validity was addressed by means of predictive and concurrent validity. Predictive validity was established by the development of a sound theoretical framework, derived from modern behavioural theory, specifically the Theory of Plannal Behaviour, along with definitions of chemistry, attitude and self-efficacy. Concurrent validity was evaluated by investigation of the instruments' ability to distinguish between two different cohorts of participants; intending majors and non-majors.

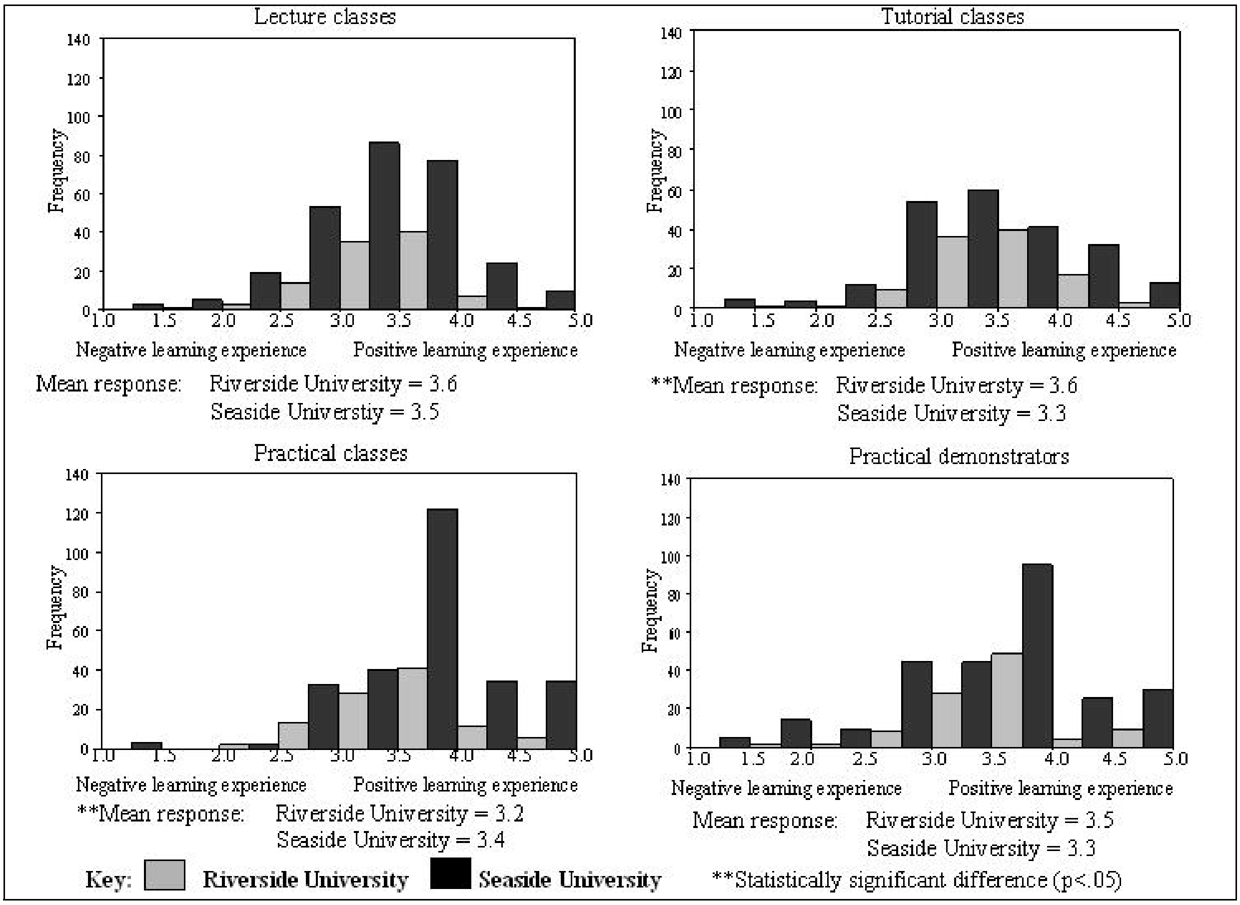

FIGURE 2. *Student perceptions of their first year chemistry learning experiences (n=337) as measured using the* Chemistry Attitudes and Experiences Questionnaire (CAEQ).

These analyses revealed that the CAEQ possesses both high predictive and concurrent validity, and this, along with other statistical analyses (Dalgety et al., 2001a), suggests that the CAEQ will prove to be a useful probe for tertiary chemistry teachers and institutions that wish to investigate first year chemistry students' learning experiences. An investigation of student learning experiences illustrates the utility of the instrument and revealed that students for the institutions investigated here prefer structure in their teaching style that they experience. Given the broad scope of the CAEQ as evidenced by the subscales, there are many aspects of student attitude-towards-chemistry, self-efficacy and learning experiences that are open to investigation. It is up to tertiary education researchers and teachers to decide if this instrument will be useful in gaining an understanding their classroom practice and students' perceptions; the instrument is available from the authors in electronic form upon request.

A final remark is necessary on the use of, and interpretation of data from, questionnaires like the CAEQ. As we mentioned in the introduction, many authors find such tools useful for developing a general understand of the issues of interest to them. Data from questionnaires, by its very nature, is severely reductionist in nature. Such data, we believe is useful in highlighting matters of interest for more detailed study, for example, gaining an idea of what issues are of importance for researchers to investigate. What is increasingly common, and what we have done in our work, is to combine survey data with more detailed data collection tools (albeit on a smaller number of participants), to develop an in-depth understanding of educational issues. Hence, statistical significance between variables may be present – as we have found here. The educational significance of such differences is less easily understood (see Carver, 1978, 1993 for an excellent discussion of this issue). This is why we, and others, utilise a mixed-methodology approach when investigating educational issues. We intend reporting a full details of our research findings, including full data from the CAEQ accompanied by data triangulation in the form of interview and other data.

CORRESPONDENCE: *Richard K. Coll, Department of Chemistry, The University of Waikato, Private Bag 3105, Hamilton, New Zealand; fax: (64) 7 8383 4218; e-mail: r.coll@waikato.ac.nz*

APPENDIX: THE CHEMISTRY ATTITUDES AND EXPERIENCES QUESTIONNAIRE (CAEQ)

(**Note:** Demographic questions in the original instrument are not included here)

This part of the questionnaire investigates the perceptions *YOU HAVE ABOUT CHEMISTRY AND RELATED TOPICS.* For example: If you feel chemistry is mostly about the study of natural substances, and only a little bit about the study of synthetic material then you would answer the following questions as shown:

Chemistry Natural Substances __ _√_ __ __ __ __ __Synthetic Material

	Please indicate what YOU think about the following		
	Chemists		
1	athletic	__ __ __ __ __ __ __	unfit
2	socially aware	__ __ __ __ __ __ __	socially unaware
3	environmentally aware	__ __ __ __ __ __ __	environmentally unaware
4	flexible in their ideas	__ __ __ __ __ __ __	fixed in their ideas
5	care about the effects of their results	__ __ __ __ __ __ __	only care about their results
6	imaginative	__ __ __ __ __ __ __	unimaginative
7	friendly	__ __ __ __ __ __ __	unfriendly
8	inquisitive	__ __ __ __ __ __ __	indifferent
9	patience	__ __ __ __ __ __ __	impatient
	Chemistry research		
10	helps people	__ __ __ __ __ __ __	harms people
11	improves quality of life	__ __ __ __ __ __ __	decreases quality of life
12	solves problems	__ __ __ __ __ __ __	creates problems
13	advances society	__ __ __ __ __ __ __	causes society to decline
	Science documentaries		
14	enjoyable	__ __ __ __ __ __ __	boring
	Chemistry web sites		
15	interesting	__ __ __ __ __ __ __	boring
	Chemistry jobs		
16	challenging	__ __ __ __ __ __ __	easy
17	varied	__ __ __ __ __ __ __	repetitive
18	interesting	__ __ __ __ __ __ __	boring
19	satisfying	__ __ __ __ __ __ __	unsatisfying
20	exciting	__ __ __ __ __ __ __	tedious
	Talking to my friends about chemistry		
21	fascinating	__ __ __ __ __ __ __	dull
	Science fiction movies		
22	exciting	__ __ __ __ __ __ __	tedious

This part of the questionnaire investigates the confidence ***YOU HAVE IN UNDERTAKING DIFFERENT TASKS***.
For example: If you feel very confident about talking to a scientist about chemistry:

a. Please indicate how *CONFIDENT YOU* feel about talking to a scientist about chemistry
Totally confident __ _√_ __ __ __ __ __Not confident

	*Please indicate how **CONFIDENT YOU** feel about*			
2	Achieving a passing grade in a chemical hazards course	Totally confident	__ __ __ __ __	Not confident
3	Reading the procedures for an experiment and conducting the experiment without supervision	Totally confident	__ __ __ __ __	Not confident
4	Designing and conducting a chemistry experiment	Totally confident	__ __ __ __ __	Not confident
5	Tutoring another student in a first year chemistry course	Totally confident	__ __ __ __ __	Not confident
6	Determining what answer is required from a written description of a chemistry problem	Totally confident	__ __ __ __ __	Not confident
7	Ensuring that data obtained from an experiment is accurate	Totally confident	__ __ __ __ __	Not confident
8	Proposing a meaningful question that could be answered experimentally	Totally confident	__ __ __ __ __	Not confident
9	Explaining something that you learnt in this chemistry course to another person	Totally confident	__ __ __ __ __	Not confident
10	Choosing an appropriate formula to solve a chemistry problem	Totally confident	__ __ __ __ __	Not confident
11	Knowing how to convert the data obtained in a chemistry experiment into a result	Totally confident	__ __ __ __ __	Not confident
12	After reading an article about a chemistry experiment, writing a summary of the main points	Totally confident	__ __ __ __ __	Not confident
13	Learning chemistry theory	Totally confident	__ __ __ __ __	Not confident
14	Determining the appropriate units for a result determined using a formula	Totally confident		Not confident
15	Writing up the experimental procedures in a laboratory report	Totally confident	__ __ __ __ __	Not confident
16	After watching a television documentary dealing with some aspect of chemistry, writing a summary of its main points	Totally confident	__ __ __ __ __	Not confident
17	Achieving a passing grade in a Part Two chemistry course	Totally confident	__ __ __ __ __	Not confident
18	Applying theory learnt in a lecture for a laboratory experiment	Totally confident	__ __ __ __ __	Not confident
19	Writing up the results section in a laboratory report	Totally confident	__ __ __ __ __	Not confident
20	After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person	Totally confident	__ __ __ __ __	Not confident

This part of the questionnaire ***LOOKS AT YOUR EXPERIENCES DURING YOUR FIRST YEAR CHEMISTRY CLASSES***.

Please answer these questions considering ALL your experiences during your first-year chemistry classes. For example if you thought that THREE out of FOUR of your lecturers encouraged you to enrol in the chemical hazards course , you would answer the following question:

a. My lecturers encouraged me to enrol in chemical hazards

SA A (N) D SD

		Strongly Agree	Agree	Neither	Disagree	Strongly Disagre e
	Please answer these questions about your LECTURE classes					
1	The lecture material was relevant to the objectives of the course	SA	A	N	D	SD
2	My lecturers were interested in my progress in chemistry	SA	A	N	D	SD
3	The concepts introduced in the lecture material were explained clearly	SA	A	N	D	SD
4	My lecturers encouraged me to take further chemistry papers	SA	A	N	D	SD
5	The lecture notes were interesting	SA	A	N	D	SD
6	The chemistry lecturers have made me feel that I have the ability to continue in science	SA	A	N	D	SD
7	The lecture notes were clearly presented	SA	A	N	D	SD
8	It was easy to find a lecturer to discuss a problem with	SA	A	N	D	SD
9	The lectures were presented in an interesting manner	SA	A	N	D	SD
10	The lecturers explained problems clearly to me	SA	A	N	D	SD
	Please answer these questions about your TUTORIAL classes					
11	The tutorial problems covered all parts of the course	SA	A	N	D	SD
12	My tutors were interested in my progress in chemistry	SA	A	N	D	SD
13	The problems in the tutorial sheets were relevant to the course	SA	A	N	D	SD
14	My tutors encouraged me to take further chemistry papers	SA	A	N	D	SD
15	The tutorial sheets helped me understand the lecture course	SA	A	N	D	SD
16	The chemistry tutors have made me feel I have the ability to continue in science	SA	A	N	D	SD
17	The material presented in tutorials was useful	SA	A	N	D	SD
18	The material covered in tutorials was presented in an interesting manner	SA	A	N	D	SD
19	It was easy to find a tutor to discuss a problem with	SA	A	N	D	SD
20	The tutors explained problems clearly to me	SA	A	N	D	SD
	Please answer these questions about your LABORATORY classes					
21	The laboratory manual contained instructions that were easy to follow	SA	A	N	D	SD
22	When writing-up experiments in my laboratory book, the relationship between the data and the results was clear	SA	A	N	D	SD
23	My demonstrators were interested in my progress in chemistry	SA	A	N	D	SD
24	The practical experiments were related to lectures	SA	A	N	D	SD
25	What is required in the write-up of an experiment is clear	SA	A	N	D	SD
26	My demonstrators encouraged me to take further chemistry papers	SA	A	N	D	SD
27	The theory behind the experiments was clearly presented	SA	A	N	D	SD
28	The purpose of the calculations required for laboratory books write-up was clear	SA	A	N	D	SD
29	The chemistry demonstrators have made me feel I have the ability to continue in science	SA	A	N	D	SD
30	The laboratory manual, experimental techniques and write-up were all interlinked	SA	A	N	D	SD
31	What was required in the questions when writing up the laboratory book was clear	SA	A	N	D	SD
32	It was easy to find a demonstrator to discuss a problem with	SA	A	N	D	SD
33	The experiments were interesting	SA	A	N	D	SD
34	The amount of work required when writing up the laboratory book was appropriate for the amount of the assessment	SA	A	N	D	SD
35	The demonstrators explained problems clearly to me	SA	A	N	D	SD

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