Chemistry Education Research and Practice

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Journal:	*Chemistry Education Research and Practice*
Manuscript ID:	RP-ART-06-2014-000133.R4
Article Type:	Paper
Date Submitted by the Author:	22-Dec-2014
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A CROSS-AGE STUDY OF SCIENCE STUDENT TEACHERS' CHEMISTRY ATTITUDES

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Abstract

The aim of this study is to investigate the effects of some variables (gender and year of study) on science student teachers' (SSTs) chemistry attitudes. An adapted version of Chemistry Attitudes and Experiences Questionnaire (Dalgety et al., 2003, p. 663) was administered to 983 SSTs drawn from four different universities in Region of Eastern Black Sea, Turkey. Significant differences between genders' mean scores of the CAEQ indicate that the females somewhat develop stronger positive attitudes towards chemistry than do the males. Further, because the first year of the study generally had the highest mean scores of the three subscales of the CAEQ, it can be deduced that tertiary education lacks of improving the SSTs' positive chemistry attitudes to a satisfied level and/or a large effect size. Hence, its attitudinal quality should be intimately inquired.

Key words: Chemistry Attitude, Cross-age, Science Education, Tertiary Education

Introduction

Content (i.e. general chemistry, special topics in chemistry, analytical chemistry) and pedagogical (i.e. Special Teaching Methods, Instructional Technologies and Material Design) courses in science teacher education programme have four principal purposes to: (a) teach content (i.e. fundamental and advanced concepts), (b) acquire scientific inquiry, (c) grasp interrelationships amongst chemistry (science), technology, society and environment and (d) equip with skills of communication, attitude and value (Ültay & Çalık, 2011). Hence, it is intended that tertiary education evolves a positive attitudinal change towards chemistry/science. Because students with an interest in science often have a higher science attitude and are more academically able in science (e.g. Dalgety, Coll & Jones, 2003; Dawson & O'Connor, 1991; Koballa, 1990; Osborne, Simon, & Collins, 2003), it is expected that their traits (e.g. achievement-orientation, convention, and conformation) are different from those with less interest in science (e.g. Stokking, 2000). Because science (as a general scientific discipline) principally covers a combination of physics, chemistry and biology, it is assumed that specialized science disciplines (i.e. chemistry) will give more specialized insights of the students' views of chemistry rather than the general one. For this reason, such students as science student teachers (SSTs) may find a standard science attitude survey (e.g. Geban, Ertepınar, Yılmaz, Altan, & Tahpaz, 1994) simple and/or trivial due to nature of the questions (i.e. I like science/chemistry; I enjoy studying on science/chemistry). Hence, to measure the tertiary students' attitudes towards chemistry, Dalgety, Coll and Jones (2003) provided an instrument called *Chemistry Attitudes and Experiences Questionnaire (CAEQ)* by taking the critics of Scientific Attitudes Inventory II (SAI II) (Moore & Foy, 1997) and Test of Science Related Attitudes (TOSRA) (Fraser, 1978) into account. Overall, the CAEQ integrates the context (chemistry) into the tertiary education by meeting sound theoretical framework and validity concerns.

The related literature reports that the SSTs bring their attitudes to tertiary education by enrolling to a science teacher education programme (e.g. Dalgety, Coll & Salter, 2002; Dalgety et al., 2003; Osborne et al., 2003; Ültay & Çalık, 2011, 2015). Of these studies, Dalgety et al. (2003) and Ültay and Çalık (2011) suggest that the CAEQ with good construct validity is a useful tool for tertiary level educators to measure their attitudes. Further, Çalık, Özsevgeç, Ebenezer, Artun and Küçük (2014) report that significant increases in senior science student teachers' attitudes toward chemistry are attributed to their learning of use of the innovative technologies. However, Ültay and Çalık (2015), who aimed to investigate the effects of different instructional designs (REACT strategy, 5Es model and traditional/existing instruction) relevant to 'acids and bases' subject on the SSTs' conceptions, and attitudes towards chemistry, indicate no statistically significant difference between the groups' CAEQ mean scores. Such discrepant issues call a need for future studies to go over the SSTs' attitudes towards chemistry.

Classroom environment, which is a significant determinant of attitude (i.e. Haladyna, Olsen & Shaughnessy, 1982; Myers and Fouts 1992), is one of the key factors in generating interest in science education (e.g. Piburn, 1993; Osborne et al., 2003). The quality of the science teaching, which embraces a high level of involvement, the use of a variety of teaching strategies and unusual learning activities, appears positive attitudinal changes towards science/chemistry (e.g. Osborne et al., 2003). In other words, the attitudinal change is principally influenced by the kind of science teaching the students experienced. This denotes the significance of the (science/chemistry) teacher that is the most common reason for liking or disliking such subjects as chemistry, physics, science (e.g. Piburn, 1993; Osborne et al., 2003). Phrased differently, the quality of science/chemistry teaching, which is an important determinant of attitude and subject choice, points to the quality of science/chemistry teacher education. That is, Osborne et al. (2003) explain this issue with a strong claim: "the single most important change that could be made to improve the quality of science education would be the recruitment *and retention* of able, bright enthusiastic teachers of science (p.1069)”. However, the calibre of entrants to higher and/or tertiary education in science has been getting poor (e.g. Osborne et al., 2003; Çalık, 2014) in that science/chemistry teacher supply faces a ‘meltdown’. For this reason, the tertiary education should take an extra responsibility to improve the student teachers’ attitudes of chemistry/science. That is, it is hypothesized that if (student) teachers have positive attitudes toward chemistry/science, they may positively develop their students’ attitudes towards chemistry/science (i.e. Bektaşlı, 2013). As a matter of fact, George (2006) and Greenfield (1997) attribute the younger students’ positive feelings towards science to the science classes. Despite the pivotal role of the tertiary education in developing the students’ attitudes towards science/chemistry, how the tertiary education affects and shapes their attitudes over year of study has yet been unexplored. For this reason, the current study not only fills in this gap in the related literature but also sheds more lights on attitudinal quality of science teacher education programme. Furthermore, because Turkish Ministry of National Education has employed a positive discrimination towards females, the current study deploys *gender* as an inclusive variable. Hence, it examines the extent to which the *gender* (as a variable) affects the SSTs’ attitudes towards chemistry (Kurbanoğlu, 2014; Osborne et al., 2003).

The aim of this study is to investigate the effects of some variables (gender and year of study) on SSTs’ chemistry attitudes. The following research questions guide the current study:

1. Is there any significant difference between chemistry attitude mean scores of females and males?
2. Is there any significant difference between chemistry attitude mean scores of the first-year of the study through forth-year of the study (Years 1-4)?

Methodology

Given the research questions, the methodology recruited in the study was quantitative in nature and descriptive in specifics in that data were collected without any intervention or changing of the learning environment (e.g. Çalık, Turan & Coll, 2014). Since the descriptive structure of the study mainly strived to draw out any existing issue(s) in one-time interactions amongst groups of SSTs (cross-age study), the descriptive research design was used in the current study. Further, to track developmental changes (early-later relationship) in students' conceptions, attitudes over year, cross-age and longitudinal studies (as developmental research designs) are generally used (Abraham, Williamson, & Westbrook, 1994; Çalık, 2005; Gökdere & Çalık, 2010). The longitudinal study, which involves the repeated measurement of a sample over a period of time, attempts to find meaningful associations between age (year) changes and specific variables (i.e. chemistry attitude). The cross-age study, which incorporates the measurement of several samples at different ages (i.e. SSTs at different years of the study), discovers age (year) group differences in particular variables (i.e. chemistry attitude) (e.g Schmidt & Teti, 2005). Even though the longitudinal study directly measures intra-individual development over time to investigate individual consistency/change (i.e. Schmidt & Teti, 2005), it contains several pitfalls (i.e. expensive, time consuming, labour-intensive, sample missing, a decrease in sample interest of the data collection instrument). In contrast, the cross-age study is promising to minimize these issues (e.g. inexpensive, time-efficient, one time interaction that reduces sample missing and sample interest of the data collection instrument) (e.g. Abraham et al., 1994; Çalık, 2005; Gökdere & Çalık, 2010; Krnel, Glažar & Watson, 2003). Hence, the cross-age study seems to be more applicable than the longitudinal study. . Overall, the current study employed the cross-age study through the first year of study (freshman) to the fourth year of study (senior). Because SSTs have to complete all specialized science courses (i.e. General Chemistry I-II, General Physics I-II, General

Biology I-II, General Chemistry Laboratory I-II), the current cross-age study identified the STS at different years of the study that faced with the data collection instrument (i.e. CAEQ) at once (as the limited interaction time). For this reason, the current study disregards some uncontrolled issues (i.e. transferred students, missing data). Further, it is believed that any transferred students do not threaten the scope of the study since all science teacher education programmes in Turkey have to apply almost the same syllabus of compulsory courses relevant with the chemistry attitudes.

Sample

A total of the sample was 983 (males: 274, females: 709, aged 17-34 years—Mean Age: 20.95) drawn from Department of Science Teacher Education in four different universities (Artvin Çoruh University, n=193; Giresun University, n=245; Karadeniz Technical University, n=295; and Recep Tayyip Erdoğan University, n=250) located in Region of Eastern Black Sea, Turkey. Distribution of this sample to year of the study was 231 for the first-year of the study (freshman), 239 for the second-year of the study (sophomore), 260 for the third-year of the study (junior) and 253 for the forth-year of the study (senior). The SSTs under investigation virtually possessed the same socio-economical (middle income) background that is a common characteristic for the teacher education programmes. Also, they had almost the same educational background as an output of the centralized education system. Because the authors have been working at these four universities, the current study employs convenient sampling. Of these universities, Karadeniz Technical University is a large-size university. The other universities, which were separated from Karadeniz Technical University, act as independent middle-size universities. Further, because Karadeniz Technical University (with faculties of education in Artvin Çoruh University, Giresun University and Recep Tayyip Erdogan University) has been pioneer at Reconstruction of Faculty of

Education in Turkey, these universities, which involves in different options of undergraduate/post-graduate science education programmes, is of special interest to science/chemistry educators. Also, given the interactive contexts amongst these universities (i.e. similar academic culture, similar educational policies, similar syllabus of learning/teaching context, institutional partnership for educating faculties), their cultural contexts need to be examined across diverse populations.

In Turkey, after a high-staking national-wide examination, the students prepare a preference order form in regard to their scores and then submit a university list (maximally 30) to Assessment, Selection and Placement Center (Ölçme, Seçme ve Yerleştirme Merkezi—ÖSYM). Then, Assessment, Selection and Placement Center places them into the universities in regard to their high-staking national-wide examination scores. In Turkey, the university entrance scores of the science teacher education programmes are generally higher than those of some options (engineering programmes and programmes from faculties of science) The SSTs' orders of preference to these universities were between 1 and 30 (Mean: 8.7). For this reason, such a value (Mean: 8.7) means the sample under investigation seems to have voluntarily preferred these universities and science teacher education programmes given the number of university (109 state universities and 70 private universities) and various programme options.

A-four-year-science teacher education programme, which has an integrated framework of physics, chemistry and biology, embraces a total of 240 European Credit Transfer System (ECTS)—180 ECTS for compulsory courses and 60 ECTS for elective courses. All science teacher education programmes in Turkey have to pursue the same syllabus of any compulsory course suggested by Higher Education Council (Yüksek Öğretim Kurumu). All courses, except for Environmental Chemistry elective course, that might implicitly and/or explicitly influence the SSTs' chemistry attitudes, are compulsory: General Chemistry I-II, General

Chemistry Laboratory I-II (*First-year*), Analytical Chemistry, Analytical Chemistry Laboratory, Organic Chemistry (*Second-year*), Laboratory Applications in Science I-II, Special Topics in Chemistry, Special Teaching Methods-I, Earth Science, Instructional Technologies and Material Design, Scientific Research Methods, Measurement and Assessment, Nature and History of Science (*Third-year*), Special Teaching Methods-II, Field Study, School Experience and Teaching Practicum (*Forth-year*). Moreover, the SSTs, in their future teaching experiences, teach science courses (integrating "physics, chemistry and biology" disciplines into a single class) to lower-secondary school students.

Data Collection

The original version of Chemistry Attitudes and Experiences Questionnaire (CAEQ) (Dalgety et al., 2003, p. 663) consisted of 69 items in the different parts--perceptions about chemistry and related topics (21 items), the confidence in different tasks (17 items) and experiences on most recent chemistry classes (31 items). After a group of experts (three chemistry educators and one science educator) got the suitability of the CAEQ checked for the current study's scope, they ensured that the first part of the CAEQ was suitable for the cross-age study with the SSTs. That is, the subject matter courses (especially, chemistry) are mainly introduced in the first two-years of the tertiary education while the pedagogical content courses of science (as an integrated framework of "physics, chemistry and biology" disciplines) are highly dominant at the last two-years of the science teacher education programme. Phrased differently, the last two-years of the tertiary education are implicitly associated with the second- and third-parts of the CAEQ (the confidence in different tasks and experiences on most recent chemistry classes). Overall, such issues drove the authors to concentrate on the first part of the CAEQ.

The first part of the CAEQ comprised of 21 items in different subscales (8 items for chemists, 4 items for chemistry research, one item for science documentaries, one item for chemistry Web sites, 5 items for chemistry jobs, one item for talking to my friends about chemistry, and one item for science fiction movies). Five science educators, one Turkish lecturer and one English lecturer (who are bilingual) checked and ensured content validity and readability of its Turkish version. Further, five student teachers, apart from the sample, confirmed its readability and understandability. Also, its pilot-test with 290 student teachers was subjected to the confirmatory factor analysis. Three factors loaded: chemists for Items 1–6 and Item 8, chemistry research for Items 9–12, and chemistry jobs for Items 16–19 (see Ültay & Çalık, 2011 for further information). Therefore, the 'science documentaries, chemistry Web sites, talking to my friends about chemistry, and science fiction movies' subscales and Item 15 (from easy to challenging) in the 'chemistry jobs' subscale were removed from the adapted version of the CAEQ (see Appendix for last version of the CAEQ).

For the ethical precaution, the sample was initially informed about contents of the CAEQ and the study. Then, the authors promoted them to answer the CAEQ only if they agreed to take part in the study. Further, the authors emphasized that they might leave the CAEQ blank if they disagreed to participate in the study. Overall, 119 SSTs (9.89%) from the target population (1102 SSTs) in the four-universities located in region of Eastern Black Sea, Turkey were dropped out due to the disagreement issues. Concisely, the response rate to the CAEQ was 90.11%. Because the authors did not suggest any reward (i.e. lottery, giving extra points) for taking the instrument, all participants voluntarily took part in the current study.

Data Analysis

A 7-point CAEQ was scored through a strongly negative response (1 point) and a strongly positive response (7 points). Then, the SSTs' responses to the CAEQ were imported into SPSS 18.0™ to conduct Multivariate analysis of variance (MANOVA) (via post-hoc for multiple comparisons--Tukey), Cronbach's alpha, and descriptive statistics. Hence, the effects of independent variables (gender and year of the study) on dependent ones (subscales of chemists, chemistry research and chemistry jobs) were examined. Because the current study involved several dependent and independent variables, it employed MANOVA for the difference in two or more vectors of means (i.e. French, Macedo, Poulsen, Waterson & Yu, 2014). Also, the effect sizes to present and discuss the significant interaction effects were computed (e.g. Cohen, 1988). Further, for internal consistency, Cronbach's alpha co-efficient values were calculated (i.e. Arjoon, Xu & Lewis, 2013). These values were found to be 0.722 for the 'chemists' subscale, 0.770 for the 'chemistry research' subscale, 0.786 for the 'chemistry jobs' subscale and 0.834 for a total of the CAEQ that are higher than acceptable value suggested by Hair, Black, Babin, Anderson, and Tatham (2006). For descriptive statistics, item mean scores of the CAEQ in regard to year of study were descriptively computed by formula: Related sample's total score for any relevant item / Number of related sample.

Results

The null hypothesis of no overall statistical differences is rejected (Pillai's Trace of 0.02, $F(3.973)= 5.8$, $p<0.05$ for effect of gender; Pillai's Trace of 0.03, $F(9.2925)= 3.5$ $p<0.05$ for effect of year of the study), As can be seen in Table 1, general mean scores of the 'chemists' subscale for the first-year of the study through the forth-year of the study were 35.0, 34.6, 35.8 and 35.0 respectively. This means that their general scores, except for the second-year of the study, were close to each other. Further, the general mean scores of almost items (except for Item 1) in the 'chemists' subscale were higher than the median value. This seems to be very positive when 4 is seen as the neutral attitude. Also, the item mean scores of the females in the ‘chemists’ subscale were slightly higher in Items 1-2 for the first-year of the study, Items 1-5 and Item 7 for the second-year of the study, Items 1-5 for the third-year of the study and Items 1-7 for the forth-year of the study than those of the males. The item mean scores of the males in the ‘chemists’ subscale were slightly greater in Items 3, 5 and 7 for the first-year of the study and Item 6 for the third- and forth years of the study. For the ‘chemists’ subscale, the item mean scores of the males and the females were equal at Items 4 and 6 for the first-year of the study and Item 7 for the third-year of the study. For the ‘chemistry research’ subscale, general mean scores of the first-year of the study through the forth-year of the study were 24.1, 22.5, 22.5 and 22.6 respectively. This reveals a slightly decrease towards the forth-year of the study. Further, the general mean scores of all items in the ‘chemistry research’ subscale were higher than the median value and around 6 out of 7. This indicates a positive chemistry research attitude. Also, the item mean scores of the females in the ‘chemistry research’ subscale were slightly higher in Items 8 and 10 for the first-year of the study, Items 8-11 for the second-year of the study, Items 9 and 11 for the third-year of the study and Item 10 for the forth-year of the study than those of the males. The item mean scores of the males in the ‘chemistry research’ subscale were slightly greater in Items 8-9 for the forth-year of the study. For the ‘chemistry research’ subscale, the item mean scores of the males and the females were equal at Items 9 and 11 for the first-year of the study, Item 10 for the third-year of the study and Item 11 for the forth-year of the study. Also, for the ‘chemistry jobs’ subscale, general mean scores of the first-year of the study through the forth-year of the study were 21.2, 19.7, 20.2 and 20.4 respectively. This depicts that the first-year of the study had the highest mean score of the ‘chemistry jobs’ subscale. Moreover, the males and the females possessed almost the same scores of the CAEQ in the first-year of study, although the males’ mean score of the ‘chemistry jobs’ subscale was slightly higher than that of the females. But general mean scores of the females were higher than those of the males in the other years of the study (see Table 1). Especially, the females' mean scores of the 'chemistry' subscale were higher than those of the males through the second-year of the study to the forth-year of the study. Further, the general mean scores of all items in the 'chemistry jobs' subscale were higher than the median value and around 5 out of 7. This appears a positive chemistry jobs attitude. Also, the item mean scores of the females in the 'chemistry jobs' subscale were slightly higher in Item 14 for the first-year of the study, Items 12, 14-15 for the second-year of the study, Items 12-14 for the forth-year of the study than those of the males. The item mean scores of the males in the 'chemistry jobs' subscale were slightly greater in Items 12-13 and 15 for the first-year of the study, Item 13 for the second-year of the study and Items 12-15 for the third-year of the study. For the 'chemistry research' subscale, the item mean scores of the males and the females were equal at Item 15 for the forth-year of the study.

Insert Table 1 about here

As can be seen in Table 2, statistically significant differences were found in effect of gender (Pillai's Trace of 0.02, $F(3.973)= 5.8$, $p<0.05$) and effect of year of the study (Pillai's Trace of 0.03, $F(9.2925)= 3.5$ $p<0.05$) but no statistical difference appeared at the interaction effect between gender and year of the study (Pillai's Trace of 0.01, $F(9.2925)= 1.0$, $p>0.05$). The multivariate partial eta squared (η^2) values for gender, year of the study, and interaction between gender and year of the study were found to be 0.02, 0.01, and 0.00 respectively (for Pillai's Trace).

Insert Table 2 about here

The closer partial eta squared (i.e., η^2) is to 1, the stronger the relationship between the factor (i.e., gender, year of the study and interaction between them), and dependent variable (i.e. the CAEQ subscales) appears. As seen in Table 3, tests of between-subjects effects show a small effect-size in that values of partial eta squared (η^2) were closer to zero (ranged between zero and 0.02 for Pillai's Trace) (see Table 2). Also, Table 3 indicates that there were statistically significant differences between gender and the 'chemists' subscale, and between year of the study and the 'chemistry research' subscale, ($p<0.05$).

Insert Table 3 about here

As can be seen in Table 4, there were only statistically significant differences between the first-year of the study and others in favour of the first-year of the study in terms of the 'chemistry research' subscale. No statistically significant difference occurred through the first-year of the study to the forth-year of the study for the 'chemists' and 'chemistry jobs' subscales as the dependent variables ($p>0.05$).

Insert Table 4 about here

Discussion

As seen in Table 1, the highest mean score of the 'chemistry research' subscale were pertaining to the first-year of the study. This may result from the framework of the science teacher education programme that explicitly engages the SSTs in chemistry tasks in the first-year of the science teacher education programme (i.e. General Chemistry Laboratory I-II). However, science tasks (as an integrated structure of physics, chemistry and biology) in their last-two years of the programme seem to have decreased their attitudes of the ‘chemistry research’ subscale. Further, the highest mean score of the first-year of the study in the ‘chemistry jobs’ subscale may result from the framework of the high-staking nation-wide examination (administered in the final-year of upper secondary science education) that identifies their future jobs. Thereby, such a procedure may have enhanced their awareness of chemistry jobs. Overall, general values denote that the first year of the study generally had the highest mean scores of the three subscales of the CAEQ. This may result from first-year experience with chemistry and/or chemistry tasks. Further, this may stem from their intensive efforts (e.g. the high-staking nation-wide examination) to be enrolled into the science teacher education programme.

As seen in Tables 2-3, statistically significant differences between genders’ mean scores of the ‘chemists’ subscale (even though a small effect-size occurred) may result from the nature of the teacher training programmes. That is, majority of the sample under investigation was female in that such programmes are generally viewed as the best female profession. Hence, such a common perception may have stimulated their learning enthusiasms and attitudes towards chemistry. In other words, such a social apt (from society, family, teacher and peer) seems to have influenced their attitudes towards chemistry (Ekici & Hevedanlı, 2010; Tekbıyık & İpek, 2007). A significant gender difference towards the chemistry attitudes may be viewed as an outcome of positive female discrimination in National Education or humanistic approach for females (Cheung, 2009). Such a result is in a harmony with related literature depicting that *gender* is the most significant variable influencing attitudes towards science/chemistry (i.e Gardner, 1995; Osborne et al., 2003). However, the results of *gender* in the current study (see Tables 1-3) are inconsistent with Becker’s (1989), Weinburgh’s (1995), and Jones, Howe, and Rua’s (2000) studies indicating that the males had stronger positive science/chemistry attitudes. Overall, it can be concluded that a positive female discrimination in National Education and a large number of inquiry-based interventions/curricula (see Çalık & Ayas, 2008; Çalık, 2014) undertaken in the 2000s seem to have accomplished the targeted goals in the case of Turkish context. On the other hand, their enrolments to the science teacher education programme may be seen as an indicator of their positive attitudes towards chemistry in that the chemists and chemistry educators take active roles in their training continuum.

As seen in Table 1, the mean score of Item 1 (unfit→athletic) in the chemists subscale fell into neutral attitude (around 4). This may result from the authors of the paper that generally teach chemistry and/or chemistry laboratory. Hence, the SSTs may directly relate this item to these chemistry lecturers and prefer to be provisional approach (like neutral). Further, higher means scores of Items 2-3 may come from science-technology-society-environment cycle that can be integrated into chemistry and/or chemistry related classes. Also, a higher mean score of Item 4 than the median value may stem from the SSTs' experiences with the chemists. This may also indicate that the SSTs perceive the chemists as open-minded people (and/or flexible in their ideas) (Çalık & Coll, 2012; Çalık et al., 2014). Similarly, the efforts of the chemists on science-technology-society-environment cycle may have influenced the SSTs' views of Item 5, whose mean score was higher than the median value. Also, higher mean scores in Items 6-7 vis-a-vis the median value may result from some stories of the chemists (i.e. Atomic models and their chemists—Thomson, Rutherford, Bohr, Dalton etc). Further, their engagements with the chemistry laboratory tasks (e.g. General Chemistry Laboratory I-II) that require sometimes much more time may result in developing the idea 'chemists are patient'. For example, they behave like chemists in conducting their laboratory tasks; thereby, such a 'chemist' role may have affected their perspectives and awareness of the chemists (Çalik et al., 2014). That is, the chemistry laboratory tasks may have shaped their attitudes of the chemists. Likewise, Wong and Fraser (1996) depicted a positive correlation between student enjoyment of the chemistry lesson and the chemistry laboratory tasks. Similarly, Dhindsa and Chung (1999), who studied with Form 5 (Year 11) students in Brunei, reported a better female enthusiasm of the chemistry laboratory tasks than the male's one. Such gender differences (even though the small effect size appeared) in the current study (see Tables 1-3) are in a harmony with earlier studies referring to positive attitudinal effects of laboratory tasks (Adesoji & Raimi 2004; Cheung 2009; Parker et al. 1995). To sum up, significant differences between genders' mean scores of the CAEQ (see Table 2) (as an independent effect instead of the interaction effect between gender and year of the study) indicate that the females somewhat develop stronger positive attitudes towards chemistry than do the males, although gender has the small effect-size.

Higher mean scores (around 6 out of 7) of the items in the chemistry research subscale (in comparison to neutral attitude—4 out of 7) (see Table 1) indicate that the SSTs seem to have grasped societal and functional roles of the chemistry researches. However, significant differences between 'chemistry research' scores of the first-year of the study (although the small effect-size arisen) and others in favour of the first-year of the study imply that their interests did not evolve and/or progress over year. This may result from a positive attitudinal transition to tertiary education (i.e. Kıngır & Aydemir, 2012). In a similar vein, this may stem from General Chemistry Laboratory I-II that engage the SSTs in carrying out chemistry research in their small groups of 3-4 (Kılınç Alpat et al., 2011). A lack of positive attitudinal increases (and/or a large effect-size) over year of the study may come from a standardized syllabus suggested by Higher Education Council (i.e. Aytar & Çalık, 2013; Kolomuç & Çalık, 2012). This result is akin to George's (2006) and Greenfield's (1997) studies reporting that science attitudes negatively change over year of the study. As a consequence, it can be deduced that tertiary education lacks of improving the SSTs' positive chemistry attitudes to a satisfied level and/or a large effect size. A lack of another data collection method (i.e.

interview, observation) in the current study to probe the reasons of these issues may be seen as a limitation of the study. In other words, such an issue may result from a pitfall of the tertiary education that does not meet demands and expectations of the SSTs in terms of *'chemists, chemistry research and chemistry jobs'* subscales.

The SSTs' mean scores of the chemistry jobs subscale may be labelled under positive attitude that is a higher value than the neutral one (see Table 1). For example, the SSTs' chemistry classes (i.e. General Chemistry, Analytical Chemistry, Organic Chemistry, Environmental Chemistry) may have improved their awareness of the chemistry jobs and resulted in conceiving the chemistry jobs as varied. Further, the SSTs' preference for the science teacher education programme (as chemistry-related jobs) may have engendered to develop positive attitudes of Items 13-15.

Implications for Practice and Learning

Given the foregoing issues, balancing chemistry courses with practical issues (i.e. General Chemistry I-II intertwined with General Chemistry Laboratory I-II) should be considered and distributed into all years of the science teacher education programme. Because the Higher Education Council centrally decides the capacity of each programme (i.e. teacher education programmes), the current capacity of these universities has been increasing year by year and exposing to crowded classes. For this reason, despite the fact that inquiry-based science teaching is theoretically expected, the overcapacity of the teacher education programmes tends to dampen the lecturers' (i.e. chemists) use of the chemistry laboratory and inquiry-based methods. For this reason, alternative ways (e.g. TESI model suggested by Ebenezer, Kaya, & Ebenezer, 2011) to improve the SSTs' chemistry attitudes should be examined and revisited. Unfortunately, any compulsory science course, which is out of the SSTs' interests, seems to have threatened their motivational processes. Hence, given the idea *"motivational processes facilitate or hinder learning"* the tertiary education should be updated with more elective courses instead of compulsory ones. In a similar vein, taking effect of positive attitudes on academic achievement (Dieck, 1997; Martinez, 2002) into account, the tertiary education should be enriched via inquiry-based learning environments, for example, case studies (e.g. Ayyıldız & Tarhan, 2012; Hugerat & Kortam, 2014; Özdilek, 2015), context-based approach (Ültay & Çalık, 2012; Ültay, Durukan & Ültay, 2015), and technology-embedded scientific inquiry (e.g. Çalik et al., 2014; Çalik, Ebenezer, Özsevgeç, Küçük & Artun, 2014; Ferreira, Baptista & Arroio, 2013; Pietzner, 2014). Finally, how to evolve the first-year SSTs' positive chemistry attitudes should be intimately inquired.

Appendix. Chemistry Attitudes and Experiences Questionnaire (CAEQ)

(Adapted from Dalgety, Coll and Jones, 2003, p.663)

The following information will be only used for demographic purposes. Please write down related information prior to answering the questionnaire.

Age: Gender: ( ) Male ( ) Female

Grade: ( ) Freshman ( ) Sophomore ( ) Junior ( ) Senior

Your order of preference to your current university: ....

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 substances then you would answer the following questions as shown:

Chemistry Natural 1 2 (3) 4 5 6 7 Synthetic Substances

Please indicate what you think about the following			
		Chemists	
1	unfit	1 2 3 4 5 6 7	athletic
2	socially unaware	1 2 3 4 5 6 7	socially aware
3	environmentally unaware	1 2 3 4 5 6 7	environmentally aware
4	fixed in their ideas	1 2 3 4 5 6 7	flexible in their ideas
5	only care about their results	1 2 3 4 5 6 7	care about the effects of their results
6	unimaginative	1 2 3 4 5 6 7	imaginative
7	impatient	1 2 3 4 5 6 7	patient
		Chemistry research	
8	harms people	1 2 3 4 5 6 7	helps people
9	decreases quality of life	1 2 3 4 5 6 7	improves quality of life
10	creates problems	1 2 3 4 5 6 7	solves problems
11	causes society to decline	1 2 3 4 5 6 7	advances society
		Chemistry jobs	
12	repetitive	1 2 3 4 5 6 7	varied
13	boring	1 2 3 4 5 6 7	interesting
14	unsatisfying	1 2 3 4 5 6 7	satisfying
15	tedious	1 2 3 4 5 6 7	exciting

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Table 1. Mean scores of the CAEQ in regard to year of the study

Year of study	Gender	Chemists								Chemistry Research					Chemistry Jobs				
		Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Total	Item 8	Item 9	Item 10	Item 11	Total	Item 12	Item 13	Item 14	Item 15	Total
First-year	Males	3.5	5.2	6.1	4.8	5.3	5.0	5.3	35.0	5.9	6.1	5.8	6.2	24.0	5.6	5.6	5.1	5.3	21.6
	Females	4.1	5.3	6.0	4.8	5.0	5.0	4.9	35.0	6.1	6.1	5.9	6.2	24.2	5.1	5.4	5.2	5.1	20.8
	General Values	3.8	5.3	6.1	4.8	5.2	5.0	5.1	35.0	6.0	6.1	5.9	6.2	24.1	5.4	5.5	5.2	5.2	21.2
Second-year	Males	3.7	5.0	5.6	4.7	4.7	4.8	5.0	33.4	5.3	5.5	5.2	5.7	21.7	4.7	5.2	4.7	4.9	19.5
	Females	4.3	5.2	6.0	5.0	5.2	4.7	5.7	35.8	5.7	5.7	5.8	6.2	23.3	4.9	4.9	5.1	5.0	19.9
	General Values	4.0	5.1	5.8	4.9	5.0	4.8	5.4	34.6	5.5	5.6	5.5	6.0	22.5	4.8	5.1	4.9	5.0	19.7
Third-year	Males	3.9	4.7	5.4	4.6	4.7	5.4	5.2	34.6	5.5	5.4	5.5	5.9	22.4	5.0	5.1	5.2	5.1	20.4
	Females	4.3	5.3	5.9	5.1	4.9	5.2	5.2	37.0	5.5	5.7	5.5	6.0	22.6	4.9	5.0	5.0	5.0	20.0
	General Values	4.1	5.0	5.7	4.9	4.8	5.3	5.2	35.8	5.5	5.6	5.5	6.0	22.5	5.0	5.1	5.1	5.1	20.2
Forth-year	Males	3.9	4.7	5.4	4.9	5.0	4.7	5.3	33.6	5.6	5.7	5.3	5.9	22.5	4.9	5.0	4.9	5.1	20.0
	Females	4.5	5.3	5.9	5.2	5.1	5.1	5.4	36.4	5.5	5.6	5.6	5.9	22.6	5.2	5.2	5.3	5.1	20.8
	General Values	4.2	5.0	5.7	5.1	5.1	4.9	5.4	35.0	5.6	5.7	5.5	5.9	22.6	5.1	5.1	5.1	5.1	20.4

Table 2. MANOVA of the SSTs' chemistry attitudes concerning gender, year of the study, and the CAEQ subscales

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Gender	Pillai's Trace	.02	5.8	3	973.0	.00	.02
	Wilks' Lambda	.98	5.8	3	973.0	.00	.02
	Hotelling's Trace	.02	5.8	3	973.0	.00	.02
	Roy's Largest Root	.02	5.8	3	973.0	.00	.02
Year_of_Study	Pillai's Trace	.03	3.5	9	2925.0	.00	.01
	Wilks' Lambda	.97	3.5	9	2368.2	.00	.01
	Hotelling's Trace	.03	3.5	9	2915.0	.00	.01
	Roy's Largest Root	.03	9.4	3	975.0	.00	.03
Gender * Year_of_Study	Pillai's Trace	.01	1.0	9	2925.0	.42	.00
	Wilks' Lambda	.99	1.0	9	2368.2	.42	.00
	Hotelling's Trace	.01	1.0	9	2915.0	.42	.00
	Roy's Largest Root	.01	1.7	3	975.0	.17	.01

Table 3. Results of tests of between-subjects effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Gender	Chemists	759.1	1	759.1	13.5	.00	.01
	Chemistry_research	56.1	1	56.1	3.1	.08	.00
	Chemistry_jobs	.8	1	.8	.0	.88	.00
Year_of_Study	Chemists	133.7	3	44.6	.8	.50	.00
	Chemistry_research	356.8	3	118.9	6.5	.00	.02
	Chemistry_jobs	218.8	3	72.9	2.3	.07	.01
Gender * Year_of_Study	Chemists	195.4	3	65.1	1.2	.32	.00
	Chemistry_research	66.5	3	22.2	1.2	.30	.00
	Chemistry_jobs	62.3	3	20.8	.7	.57	.00

Table 4. Multiple comparisons results for year of the study and the CAEQ

Dependent Variable	Year of the Study		Mean Difference (I-J)	Std. Error	Sig.
Chemists	1	2	-.16	.69	.99
		3	-1.28	.68	.23
		4	-.41	.68	.93
	2	3	-1.12	.67	.34
		4	-,.25	.68	.98
	3	4	.87	.66	.55
Chemistry Research	1	2	1.27	.39	.01
		3	1.59	.39	.00
		4	1.59	.39	.00
	2	3	.32	.38	.84
		4	.32	.38	.84
	3	4	-.00	.38	1.00
Chemistry Jobs	1	2	1.28	.52	.06
		3	1.01	.50	.19
		4	.57	.51	.68
	2	3	-.27	.50	.95
		4	-.71	.50	.49
	3	4	-.44	.49	.81