

*Chapter 6*

**21<sup>ST</sup> CENTURY TEACHER EDUCATION:  
TEACHING, LEARNING AND ASSESSMENT  
OF CRITICAL THINKING SKILLS AT  
SULTAN QABOOS UNIVERSITY\***

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**ABSTRACT**

This study examines the extent to which Sultan Qaboos University students in general and teacher education students in particular have critical thinking skills when they enter the university or develop them after 3 years of study at the university. The findings from CCTST testing indicate that students are not meeting expectations at any level of the educational system. The student test results were then compared to data from a faculty survey about their perceptions of student critical thinking skill attainment. Faculty overestimated students' critical thinking skills.

**Keywords:** CCTST, critical thinking, teacher education, Oman

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## INTRODUCTION

If educational researchers and organizations are correct in their projections about skills needed for student success in the 21<sup>st</sup> century, then teachers will need to focus on critical thinking, problem-solving, creativity, entrepreneurship and global communications along with language arts, mathematics, science and history (Partnership for 21<sup>st</sup> Century Skills, 2014; National Education Association [NEA], 2014; Paul and Elder, 2006; Neisler, 1999; Neisler, 2000). The above proposals either feed into or flow from the UNESCO (2014) vision for education in the post 2015 era that states:

“... The objective of such education must be envisaged ...[to] promote problem solving and creative thinking; understanding and respect for human rights; inclusion and equity; cultural diversity; it must also foster a desire and capacity for lifelong learning and learning to live together, all of which are essential to the betterment of the world and the realization of peace, responsible citizenship and sustainable development.” (p. 4)

To accomplish this type of learning, a priority is the recruitment and training of teachers who can strengthen the “capacities for learners to be innovative and creative and, to assimilate change in their society” (UNESCO, 2014, p. 8). Likewise, Kong (2001) suggests that teachers are the major change-agents for the evolution of a generation of critical thinkers. However, teacher education programs have historically focused on content and content related pedagogical skills. For example, Standard 1 of the National Council for Accreditation of Teacher Education (NCATE, 2008) does not mention of critical analysis for the acceptable level for any of the sub-skills it requires. At the target level however, there is mention of inquiry, critical analysis and synthesis. NCATE is relevant because Zayed University in the United Arab Emirates has received NCATE accreditation and several Middle Eastern teacher education programs including that of Sultan Qaboos University are pursuing this accreditation for their programs.

The Australian Professional Standards for Teachers is also silent about critical thinking, creativity and invention and also focuses on content (Australian Institute for Teaching and School Leadership [AITSL, 2014.]) Despite this lack of emphasis by international teacher education accrediting agencies, teachers themselves consider critical thinking, along with problem solving, communication, creativity and collaboration as the foundation for excellent teaching and learning (NEA, 2014.)

Not only are major educational organizations calling for critical thinking skill development but there are three convergent issues in Oman that justify the urgent need for the development of these skills: Firstly economic, social and workforce goals for Oman; secondly the need for evaluation of the differences in academic performance for General (old system) and Basic Education (phased implementation began in 1998) diploma graduates; and thirdly indicators that suggest lower than expected performance of university and college students as they progress toward degree completion.

The first and most compelling issue is the social and economic context in Oman (Ministry of National Economy [MoNE], 2004; Sultan Qaboos University [SQU], 2009; Education for All [EFA], 2000). The country needs higher education graduates who can provide the human resources to meet the national economic *Vision 2020*'s goals (MoNE, 1995). A recent OECD report (2015) places Omani students 72<sup>nd</sup> out of the 76 countries

analyzed. This report used the student scores on the major international achievement tests, specifically the OECD Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) for the evaluation of basic skills attainment.

The report suggests that if Omani post-basic (secondary) students graduated with the requisite basic skills and functional literacy, the country could anticipate long term economic gains of a 186% increase in GDP. Further, the Association for Career and Technical Education (ACTE, 2015) in a statement about 21<sup>st</sup> century employability skills explains that critical thinking is first among the skills that employees will need.

It is becoming imperative for not only schools, but also higher education institutions to document the extent to which skills such as critical thinking are being developed through the current curriculum. Additionally, these institutions will need to examine the extent to which teachers at all levels not only use these skills but whether they are also able to design classroom instruction that enables students to become critical, creative, innovative, scientific problem solvers.

The second issue is the evaluation of Omani students who are graduating under the Basic Education program that began in 1998. The first students that completed the 12 years of Basic Education began entering Omani universities and colleges in 2009. Of these, 274 entered SQU in fall 2009, and 861 in 2010 which was less than one third of the entering class. By the 2013 cohort over two thirds of the cohort had completed 12 years under the new Basic curriculum; a proportion that is expected to increase each year. While the outcomes of this new curriculum included critical thinking currently no analysis has been implemented to determine whether or not these outcomes have been met.

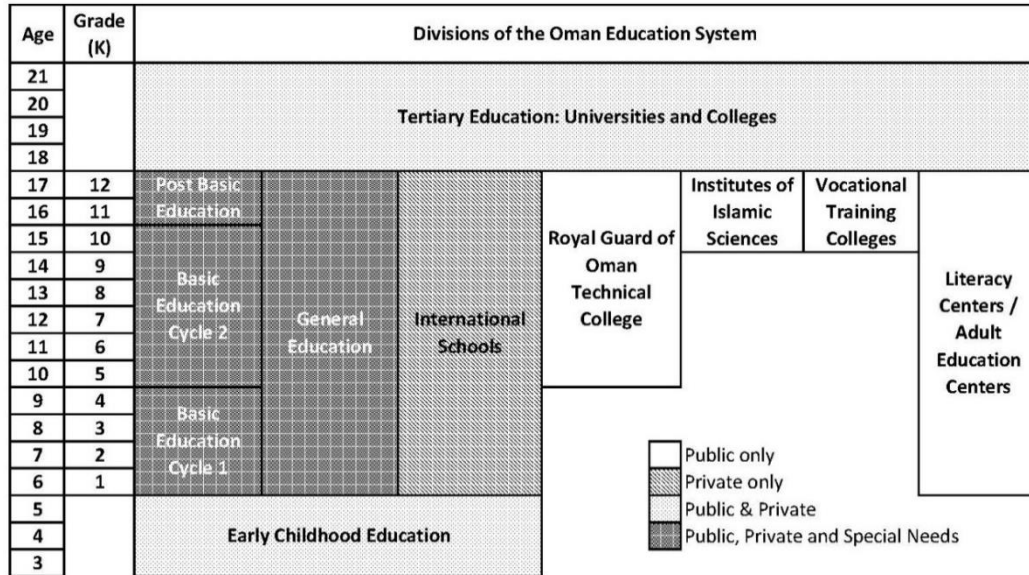
The third convergent issue is the unsatisfactory performance of Omani secondary graduates after they have entered higher education institutions. This has led to the implementation of new foundation placement tests at all higher education institutions in the Sultanate starting in the fall 2009 (Oman Accreditation Commission & MoHE, 2009). At SQU, over half of the 2737 students entering the university in 2010 failed either the mathematics or the computer technology examination and fewer than 10% passed the exit examination for English. Not only do students not have the expected knowledge on admission, but they also perform poorly even after completing remedial courses.

In this chapter, we reflect on the findings about critical thinking skill attainment that was part of a larger three-year case-study of the knowledge, skills and attitudes of all student cohorts entering SQU from 2010 through 2013. From within the context of the performance of students across all nine SQU colleges, this chapter examines the critical thinking skills of teacher education candidates. Further, the study compares faculty perceptions of student skills to the actual critical thinking scores.

## **BACKGROUND TO THE OMANI EDUCATION SYSTEM**

Since 1970 the development of the Omani education infrastructure has been a priority. Table 1 presents a graphic representation of the types of primary, secondary and tertiary education institutions available for Omani students. By April 2014, the total population of Oman reached 4,000,345 of which 2,232,949 were Omani citizens; up from 600,000 in 1970.

A little over 600,000 Omani children are enrolled in grades 1-12 in government and private schools. Further, of the 40-50,000 students who graduate from grade 12 each year, 20,000 enter the labor market without obtaining any additional education or vocational training (Ministry of Education (MoE) and the World Bank, 2012; Times News Service, 2014). In the fall of 2008, nearly 26,000 students enrolled in the first year of Omani and international higher education institutions.



\*MoE and World Bank, 2012, p. 34.

Figure 1. Structure of the Oman Education System.\*

Tertiary institutions include both government and private universities and colleges and currently SQU is the major government research university. There are 27 other colleges and technical colleges in Oman several of which have partnerships with European, Australian, Asian, American, and Canadian universities. Education is free in the government institutions with some government scholarships are provided for study in the private ones.

## THE UNDERGRADUATE YEARS: CRITICAL THINKING AND BRAIN DEVELOPMENT

The undergraduate years are a good period in brain development to examine the attainment and acquisition of critical thinking skills. Cole (2015) summarizes the current research about the development of abstract reasoning. While brain development is on-going through the late 20's, the years between 18 and 22 are particularly important to critical thinking, planning and organization. Further, frontal lobe maturation occurs during the undergraduate years. An increase in white matter relative to grey matter during the freshman year of higher education together with an increase in myelination increases the speed and strength of brain processing (Bennet & Baird, 2006). Cole suggests that these undergraduate

years might be a good time to teach and reinforce the cognitive skill components of critical thinking.

## **RESEARCH ON THE CALIFORNIA CRITICAL THINKING SKILLS TEST (CCTST)**

In 1990, the cognitive elements of critical thinking were defined in the Delphi Report developed under the auspices of the American Psychological Association (APA) (Facione, 1991). Critical thinking was categorized as the cognitive process that drives purposeful self-regulated problem-solving and decision-making. Analysis, evaluation and inference and both inductive and deductive reasoning are components of this critical thinking definition. Each of the 34 multiple choice questions on the California Critical Thinking Skills Test (CCTST) (Facione, 2000) was subjected to 2 years (1989 – 1990) of reliability and validity testing which followed 2 decades of conceptual and experimental research (Facione, 1991). Over the last 20 years Insight Assessment has established CCTST 2000 normative data for 2 and 4-year American college and university students. (Insight Assessment, 2006a). The test is being used by universities as an assessment tool for testing effectiveness of an intervention with a pre and post-test (Giddens & Gloeckner, 2005), as a requisite for placement or graduation (Middle Tennessee State University, 2010) and, for evaluation of effectiveness of a program (Facione, 1991).

The test has been validated in several languages including Arabic by Arabic scholars working with Insight Assessment (2006a).

## **RESEARCH USING CCTST IN TEACHER EDUCATION PROGRAMS**

Several studies report the use of the CCTST with undergraduate teacher education students. Lane-Patrice summarizes the challenge that educators and teacher educators face regarding “outcome accountability in improving students’ overall critical thinking skills.” (Lane-Patrice, 2013, p. 47). She reports the findings from a research study with pre and in-service teacher participants that utilized the CCTST as one of five instruments to document growth in both critical thinking skills and mindset. The CCTST was used both as a pre and post-test. The study was able to document the critical thinking skill improvement that resulted from an 8-week seminar.

Booher (2003) also used the CCTST as one of three measures for documenting growth in critical thinking skills over a semester long educational psychology course at the undergraduate level. The researcher reported that when used as a pre and post-test, the CCTST was as effective as the *Watson-Glaser Critical Thinking Appraisal Forms* (Watson & Glaser, 1964) and the subject specific test, the *Psychological Critical Thinking* instrument (Lawson, 1999).

The CCTST has been used internationally to measure the development of critical thinking skills. For example, Angeli and Valanides (2009) examined the critical thinking skill development of teacher education students at the University of Cyprus by first using the

CCTST score as a comparison against a researcher designed critical thinking rubric score. Students with higher CCTST scores also earned higher rubric scores for their written critical thinking arguments.

Accordingly, the CCTST was selected to collect data about the critical thinking skill attainment of entering students and about the development of these same skills while at SQU.

## RESEARCH QUESTIONS

This study was guided by the following research questions:

1. What are the critical thinking skill capabilities of students entering SQU?
2. How does the critical thinking skill improvement of SQU College of Education students compare to that of students in the other colleges?
3. How does critical thinking skill attainment correlate to cumulative college GPA?
4. Is the faculty assessment of students' critical thinking skills aligned with the CCTST scores?

## METHODOLOGY

The study was designed to collect and analyze longitudinal and cross-sectional quantitative and qualitative data from three instruments administered across all nine colleges of the university: one to students and the second to faculty members

The first instrument was the California Critical Thinking Skills Test (CCTST), used to determine an overall critical thinking score together with 5 sub-scales for analysis, inference, evaluation, induction and deduction (Facione, 1991; Insight Assessment, 2006a, 2006b). The CCTST had already been modified and translated into Arabic. The internal reliability coefficients for CCTST sub-scale scores ranged from 0.78 to 0.84 as computed using the Kuder Richardson (KR-20) method.

Secondly, 52 SQU students from cohort 2011 took part in a 90-minute structured interview in which they were asked to explain their reasoning as they solved two questions from the CCTST.

The CCTST is an intellectually challenging standardized 34 multiple choice-item instrument administered over a 45-minute period to test cognitive skills. The items are based on common topics intended to be of short, discipline-neutral content; problem statements; and scenarios. Scoring provides a total critical thinking score (0-34) and sub-scale scores as follows: Analysis (0 to 9); Evaluation (0 to 14); Inference (0 to 11); Deductive reasoning (0 to 16); and Inductive reasoning (0 to 14) (Facione, 2000). Table 1 shows the interpretation of the individual CCTST scores from "Not Manifested" through "Superior" for the total score and for the sub-scales. Table 2 is useful for the comparison of the SQU data with data from other studies reporting results using the 100-point version of the test.

The third instrument was a written survey developed to collect data from faculty members who taught the foundation and first year students. With minor modifications, this

survey was derived from an earlier one for SQU faculty asking for their perceptions about undergraduate students (Ibrahim, Yahya, and Al Barwani, 1992).

In addition to the data collected from the research instruments, secondary diploma and demographic data were provided by the Higher Education Admissions Centre (HEAC). SQU provided university entrance (Foundation) placement scores and university GPA. To provide the necessary analysis of this multifaceted data set, both descriptive and inferential statistics were used.

**Table 1. Categorical Interpretation of the CCTST Scores**

ALL 34-point Form 2000 versions	CCTST Overall Score – Categorical Interpretation				
	Not Manifested	Weak	Moderate	Strong	Superior
CCTST OVERALL Score	0-7	8-12	13-18	19-23	24 or higher

CCTST SUB-Scale Scores	CCTST Scale Scores Categorical Interpretation		
	Not Manifested	Moderate	Strong
Analysis	0 – 2	3 – 4	5 or more
Inference	0 – 5	6 – 11	12 or more
Evaluation	0 – 3	4 – 7	8 or more
Induction	0 – 5	6 – 11	12 or more
Deduction	0 – 5	6 – 11	12 or more

**Table 2. Comparison of the CCTST Scores on the 34 point and 100 point Versions**

RECOMMENDED PERFORMANCE ASSESSMENTS	CCTST Overall Score – Recommended Performance Assessment				
	Not Manifested	Weak	Moderate	Strong	Superior
Overall Scores					
CCTST Overall Score 34-point Form 2000 versions	0-7	8-12	13-18	19-23	24 or higher
CCTST and CCTST-N Overall Score 100-point versions	50-62	63-69	70-78	79-85	86 or higher
CCTST- G-835 100-point versions	50-65	NA	66-74	75-84	85 or higher

### Population and Sample

The population for this study is all students at SQU in Oman. Students apply for government university and college admission and for scholarships to private higher education

institutions through the HEAC. Students indicate their preferences for institutions and for majors. They are allocated to places as determined by diploma test scores and secondary percentages on a competitive basis with SQU being the institution that many aspire to join. Accordingly, most of the top students from each graduating class are offered seats at SQU, though some prefer to attend universities outside the country for which many receive scholarships from the government. Those attending SQU do not pay tuition or room and board and also receive a monthly living expense stipend. The population of all students at SQU is indeed a population representative of the top students in Oman from both government and private secondary schools.

Each Fall approximately 3,000 students are accepted into the annual SQU academic cohort with 200 -300 enrolling in the College of Education. All students must be fluent in Arabic and must obtain specific levels of English fluency as determined by their academic programs. Therefore, characteristics of this population represent the highest achievement of each school's graduating cohort. It is highly unlikely that the students at any other institution in Oman, governmental or private would have higher levels of achievement. Hence, findings about this group of students will be indicative of the best of each graduating class.

There were four samples used for this study. Different criteria were used for the selection of each sample of students and faculty from the university population. First, as part of a larger study, funded by His Majesty's Strategic Grant (Al Barwani, et. al., 2009) all first year students entering SQU were selected for 4 years. This sample included 1725 students in Cohort 2010, 2903 in Cohort 2011, 3036 in Cohort 2012, and 2896 in Cohort 2013). The CCTST was administered to all students present at orientation. Second, in 2014, a convenience sample of 693 students from Cohorts 2010-2012 was selected for retesting.

Third, in 2013 a stratified purposeful sample of 52 students from the 2011 cohort was selected to be interviewed. The those who had a complete data set that included CCTS test and foundation data. The sample was stratified across the following Foundation Score (FS) categories: Low achievers (FS = 3.5- 5), Medium achievers (FS = 8), or High Achievers (FS = 10.5 - 12). During the interview students were asked to explain their thought processes as they solved two of the CCTST questions. These were part one and part two of a typical question about moving people from places A and B with a vehicle that holds X number of people.

Fourth, in 2013, all faculty members teaching classes throughout the university that had foundation and first year students in them were identified and asked to complete the faculty student perception survey.

To answer the four research questions, the main focus was an in-depth description of the critical thinking skill attainment of students when they entered SQU, their actual thinking process, and the development of their critical thinking skills while at SQU.

## DATA ANALYSIS AND FINDINGS

### *“What are the critical thinking skills capabilities of students entering SQU?”*

To answer the first question, an analysis of the CCTST scores for each entering cohort (2010-2013) was conducted. Table 3 shows the comparison of SQU cohorts to three samples



of USA students. Not only are SQU students 4-8 points below the USA samples but the entering cohort scores are all in the weak range while the USA scores range from moderate to strong.

**Table 3. Comparison of SQU and USA University Students CCTST Overall Critical Thinking Scores**

United States					Oman			
(Notgarnie, 2011)		(Insight Assessment, 2010)		(Ingle, 2007)	SQU Intake 2010	SQU Intake 2011	SQU Intake 2012	SQU Intake 2013
2 year college students	4 year college students	2 year college students	4 year college students	University students at different levels	First year students at SQU 2010	First year students at SQU 2011	First year students at SQU 2012	First year students at SQU 2013
19.27	17.59	14.7	16.8	14.88	11.34	10.97	11.17	11.43

The subscale scores for the SQU cohorts 2010-2013 are shown in Table 4 and, in contrast to the fact that the mean of the overall critical thinking score is weak, all but one of the subscale scores are in the “Not Manifested” range. Only the “Induction” scores across all four cohorts moves upwards into the weak range. These scores indicate that despite goals in the basic education curriculum for teaching and learning critical thinking, Oman’s best performing secondary school graduates have not developed these skills.

**Table 4. CCTST Mean Sub-Scale Scores for All SQU Students by Cohort (2010-2013)**

CCTST	2010	2011	2012	2013
CCTST Total	11.34	10.96	11.18	11.43
Analysis	3.34	3.26	3.39	3.37
Inference	5.04	4.69	4.83	4.93
Evaluation and Explanation	2.82	3.01	2.96	3.12
Induction	6.03	6.05	6.16	6.41
Deduction	5.16	4.92	5.02	5.02

Table 5 shows the critical thinking achievement for the students accepted into the College of Education. However, there were no significant differences in the means for the nine colleges (Agriculture and Marine Science, Arts and Social Sciences, Economics and Political Science, Education, Engineering, Law, Medicine and Health Sciences, Nursing and Science).

**Table 5. CCTST Mean Scores for College of Education Students by Cohort (2011-2013)**

Score	2011 (n = 233)	2012 (n = 2012)	2013 (n = 270)
CCTST total	10.88	10.95	11.03
Analysis	3.24	3.39	3.30
Inference	4.51	4.67	4.70
Evaluation	3.13	2.89	3.03
Induction	6.05	6.03	6.17
Deduction	4.83	4.92	4.86

***“How does the critical thinking skill improvement of SQU College of Education students compare to that of students in the other colleges?”***

In order to answer this question 693 students were re-tested in 2014. Classes taught in all nine colleges where there were a significant number of students from the 2011 cohort were targeted. However, as well as 2011 cohort students (n = 346) the classes contained students from cohorts 2012 (n = 84) and 2010 (n = 263).

As shown in Table 6, there were significant gains in critical thinking skills for the 2014 post-test sample when compared with their original scores (Tables 3 and 4). Gains of 1.67 points on average were demonstrated by the sample of 693 students. When considering the current norm percentiles for comparative samples, this represents a gain of 12 percentile points. Students made gains in critical thinking in every cohort year and in every college. Average gains differ, however, by Cohort. Table 7 breaks out the retest gains by cohort.

**Table 6. Critical Thinking Subscale Score Means on Retesting in 2014**

Critical Thinking Score	3 Year Growth in Critical Thinking (2014 Re-test Sample)	
	2010-12	2014
Scale		
CCTST Total out of 34	11.44	13.17
Analyses	3.40	3.74
Inference	5.07	5.95
Evaluation	3.15	3.60
Induction	6.43	7.58
Deduction	5.19	5.72

Table 7 shows the mean values for the pre and post test scores of these retest students. There were no statistically significant differences in either the pre-test or post-test scores by Cohort. This suggests that all cohorts are improving equally well on average despite the fact that the 2010 cohort has been at the university 2 years longer than cohort 2012. Even though differences in the cohort means were not statistically significant, it should be noted that the mean gain score for the 2012 group (0.75) is not educationally equivalent to the mean gains for the other two cohorts (1.89 and 1.73 for the 2010 and 2011 cohorts respectively).

In actuality, there was a higher than expected proportion of students (110, 16%) in this sample who dropped their scores by three or more points at post-test leading to the lower mean values. Consideration should be given to why so many students demonstrated uncharacteristically poor scores at post-test. When the drop in scores is extreme (>-3), it is likely that many of these students were not providing a true effort at post-test.

**Table 7. 2014 Retest Sample Critical Thinking Skill Growth by Cohort**

CCTST Overall score	2010 (n = 263)	2011 (n = 346)	2012 (n = 84)
Pre-test	11.65 ± 4.6	11.44 ± 3.7	12.31 ± 4.1
Post-test	13.54 ± 3.5	13.17 ± 3.5	13.06 ± 4.1
Mean difference	1.89 ± 4.6	1.73 ± 3.7	0.75 ± 4.1

Figure 2 shows the change in pre- and post- test scores for each student and demonstrates a mean difference score of 1.67 with a range of -11 to +16 with a standard deviation of 4.12. This is a very large range for this variable. Therefore, another approach to the question is to view the increase in CCTST total scores of those students who seem to have given serious effort to the test. There are many students who demonstrated very significant personal gains in critical thinking skills.

Increases in scores of 2 or more points (grey bars: Figure 2) are evidence of effective training programs. Gains of 4 or more points (cross-hatched bars) are exceptional. These differences in scores are the most informative data for analyzing the College program impact on individual student critical thinking skills. White bars represent the scores of individuals who did not show gains at post-test. Black bars represent the scores of individuals who have an unexplained drop in scores at post-test. These are not likely to be true scores. Although it is theoretically possible for a curriculum to result in poorer reasoning ability, this is ruled out by the majority of scores where educationally significant gains are made. Many SQU students have made truly significant gains in the development of critical thinking skills.

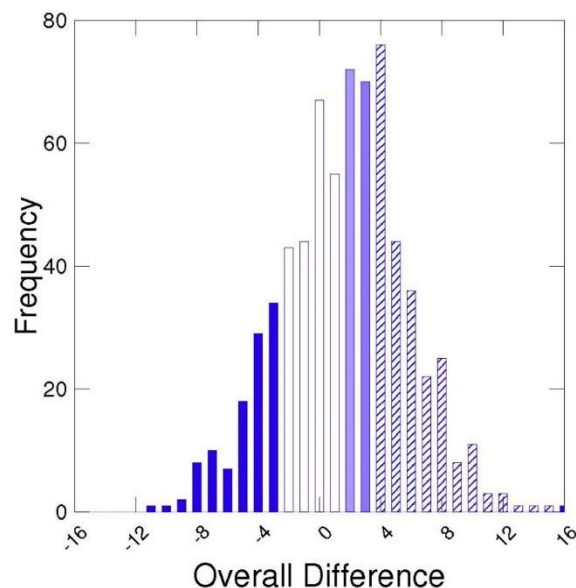


Figure 2. Individual Gains in CCTST Total Score.

Now that we have seen the overall changes in critical thinking of students during their first 1-3 years at SQU and gains made by individual students, we address improvement across the nine SQU colleges. There were significant differences in CCTST overall scores at post-test by College as seen in Table 8. The top three colleges at pre-test were Medicine and Health Sciences, Nursing, and Education. At Post-test, the top three were Medicine and Health Sciences, Engineering, and Education with Nursing dropping to fourth place.

One possible interpretation of the analysis above is that, on average, students in Medicine and Health Sciences, Engineering, Education, and Nursing have significantly stronger critical thinking skills at post-test than those in other colleges. In some ways these differences resemble those seen at pre-test. Given that there were (non-significant) differences at pre-test by college, an examination of individual difference scores is more informative of the effects

of the SQU curriculum. The data in Table 8 also demonstrate the difference in individual scores by college.

**Table 8. CCTST Overall Score by College: Pre- and Post-test**

	N	Pre-test		Post-test		Differences Between Pre and Post-tests	
		Mean	StDev	Mean	StDev	Difference	StDev
Agricultural & Marine Sciences	69	11.29	3.0	12.81	3.4	1.52	4.1
Arts & Social Sciences	23	11.52	3.0	12.13	4.0	0.61	4.9
Economics and Political Science	27	11.63	3.2	11.44	3.9	-0.19	5.6
Education	97	11.66	3.9	13.76	3.3	2.10	3.8
Engineering	83	11.49	3.0	14.37	3.4	2.88	4.1
Law	93	11.09	3.1	11.80	3.0	0.71	3.6
Medicine & Health Sciences	69	13.04	3.4	15.26	3.4	2.22	4.3
Nursing	73	12.00	3.1	13.47	3.7	1.47	4.6
Science	157	11.34	2.8	13.16	3.3	1.82	3.7
Missing	2	11.50	2.1	7.00	1.4	-4.50	3.5

There are significant differences by college in the average individual critical thinking gains made by students. Students in Engineering, Medicine and Health Science and Education demonstrated the highest mean gains. Those in Economics and Political Science, Arts and Social Sciences and Law, demonstrated the lowest. The maximum scores (referring back to Figure 2) documents that there are students in all colleges who made very impressive gains in critical thinking skills. An examination of the minimum scores demonstrated that the problem of dropped scores at post-test was not related to College. Further, these dropped scores obscure the true magnitude of gains for this pretest post-test sample.

Supplementing the CCTST results, the interviews revealed details of how the students solved the problems on the test. Only eight (8) students provided correct answers by drawing a chart. The remaining forty-four (44) did not know the logic for solving what essentially is a logistical transportation problem that required no mathematics more difficult than addition and subtraction of double-digit numbers. Some incorrectly used a mathematical equation because there were numbers in the problem, but most guessed, stating that they did not know how to solve the problem. Even when hints were given about using a chart or table, students could not solve the problem.

In summary, critical thinking skill improvement of Education students is comparable to that of students in the other colleges. Students across all cohorts and all colleges are making gains in critical thinking skills. There is evidence that the first 2 years of study lead to the largest part of the gains and that some students in Engineering, Medicine and Health Sciences, and Education are making the highest mean gains.

***“How does critical thinking skill attainment correlate to cumulative college GPA?”***

To answer question 3, we examined the correlation between CCTST overall scores and SQU cumulative GPA at the end of January 2015. There were small but positive correlations observed between cumulative GPA and CCTST overall post-test scores and individual difference scores. These data indicate that while many students are making gains in critical thinking, perhaps critical thinking is not a major criterion for grading in SQU courses.

***“Is the faculty assessment of students’ critical thinking skills aligned with the CCTST scores?”***

Through question 4 we sought to examine the importance faculty placed on critical thinking skills along with faculty assessment of students’ critical thinking abilities. Surveys were sent to all colleges and Table 9 shows the distribution across colleges of the 36% return.

When asked to rate the students’ critical thinking skills overall, faculty rated student’s ability to think deductively as 2.81 out of 5. This would be a moderate rating compared to the “not manifested” student mean on the CCTST deductive reasoning scale. Even for the 2014 retest results the mean is 5.72 which, while higher than the entering mean, is still only at the top of the “not manifested” range. The faculty rating may be an overestimation of the students’ critical thinking abilities or their rating may be based on evidence from course assignments. It is also possible that faculty members have different definitions of critical thinking from those used as the foundation for the CCTST.

**Table 9. Completion of Faculty Survey by Colleges and Language Center**

College/Centre	Sent	Received
Agriculture & Marine Science	10	5
Arts & Social Science	132	14
Economics & Political Science	12	17
Education	51	29
Engineering	10	9
Language Centre	73	13
Law	3	1
Medicine & Health Sciences	30	13
Nursing	15	12
Science	40	23
Total	376	136

## DISCUSSION

In general, SQU students have a low level of critical thinking skills when compared to students in the USA. Alfaro-Gramajo, Perez-Pineda, Quintanilla, and Sanz (2013) found similar results with students in Central America even for a graduate MBA program. Importantly, critical thinking skills do improve during the students’ first 3 years of study at SQU. However, the levels are still below that of the entry level scores of most of their international peers.

At the same time however, SQU College of Education students improve more than students at six of the other SQU colleges. There are few studies using the CCTST specifically with students in teacher education program. One example is the pilot study of the performance of students enrolled in teacher education programs at a four-year private university in the United States (Lane-Patrice, 2013). Twenty students between the ages of 18-65 showed a marked improvement in their mean overall scores between pre-service (69.5: weak) and in-service (73.7: moderate) for the 100-point version of the CCTST.

The gains of these students from weak to moderate scores parallels what we found with the SQU Education participants who had pre-test values of 11.66 increasing to 13.76 at post-test. However, when 68 freshmen and junior teacher education students were tested at Islamic Azad University, Kermanshah Branch in Iran (Rezaee, Farahian and Ahmadi, 2012), there was no significant difference for the CCTST scores of the two groups. The mean for the 32 freshmen was  $8.00 \pm 2.794$  SD and for the juniors (3rd year students) the mean was 8.39 of  $\pm 2.309$  SD.

None of the teacher candidates at these three institutions is performing at the expected levels of critical thinking. These findings might be considered alarming from within the context of the UNESCO directives for education in the post-2015 era (UNESCO, 2014) which emphasizes cognitive skills, problem solving and creative thinking in addition to basic knowledge. Not only do we have students graduating from grade 12 without these skills but we also may not be bringing our undergraduate teacher education students up to the required 21<sup>st</sup> century critical thinking requirements.

The findings also generate other observations, questions and conclusions. The very weak yet significant correlation between critical thinking scores and cumulative GPA indicates that critical thinking is not strongly rewarded in course marks at SQU; nor did it seem to be rewarded previously in secondary school courses. Overall, the data indicate that while critical thinking is low overall at secondary school completion, the skill development acquired by a few students is not reflected in their grades. It should be investigated further, just how the critical thinking learning goals in the secondary lessons are evaluated. Are there any critical thinking test questions included in the final examinations? Further, at SQU students are acquiring critical thinking skills but the mastery of these skills is again only very weakly reflected in the grading. This may emanate from two causes. First, there is survey evidence suggesting that faculty may not know the specific components of critical thinking and are not constructing appropriate assessments for grading; or second, only a few faculty members are teaching and evaluating critical thinking and those grades are insufficient to raise the mean cumulative GPA. One of the reasons for surveying the faculty was to provide another data source about the students' critical thinking skills demonstrated in their courses. The faculty report higher levels of critical thinking ability than was evident from the CCTST scores.

This last hypothesis is supported by the data which show that there is no significant difference in the retest mean of the 2010, 2011, and 2012 retest sample. One interpretation of these findings is that the major improvement in critical thinking skills is in the first two years of the SQU programs – in the foundation and language center courses – and in the entry level college courses. These programs may be focusing on introductory thinking skill components while higher level courses are focusing on content. We do know that only minimal and insignificant CT gains accrue from years 3 and 4 of SQU study. However, the CCTST scores may not document all aspects of critical thinking skill attainment. While, at SQU there is an increase in the students' critical thinking scores after 3 years of university study, that increase

may not document the full scope of change in critical thinking skills of the participants. Alfaro-Gramajo, Perez-Pineda, Quintanilla, and Sanz (2013) found that the CCTST data did not agree with critical thinking skill development data collected from multiple instruments used in pre and post-tests with MBA students. Analyses of the participant written responses to a course-based case study and the team capstone problem presentation provided different results relative to the critical thinking capabilities of the students. Strengths and weakness, improvements and degradations were more clearly illuminated. In some areas, students' critical thinking was more in-depth than demonstrated in the CCTST.

In summary, students are performing below expectation for critical thinking skills relative to the CCTST scores. The faculty over-estimate student critical thinking skill attainment. Faculty may not understand the sub-components of critical thinking. And lastly, students are unfamiliar with problem-solving strategies. Further, there is only a small correlation between CCTST scores and university SQU GPA which indicates that critical thinking is not being used for course grading.

## RECOMMENDATIONS

Despite the priority for the development of critical thinking skills in K-12 education, there are few references to critical skill attainment in teacher education standards. This would seem to be a serious disconnect for teacher education programs not only at SQU but globally. Teacher education standards should address the attributes of teachers and their higher education faculty with regards to critical and creative thinking.

Despite the recommendations of the 1994 UNESCO report, it appears that little has been done internationally to address their recommendations. That report included desirable attributes for university graduates and faculty alike. These attributes included "the ability to identify a problem, then to develop and evaluate alternative solutions... [using] computers for communication, analysis and design" (p. 98). The report further clarifies the attributes of the higher education teacher as follows:

- Open-minded and receptive to arguments or ideas
- Reasoning skills such as deductive reasoning in order to integrate diverse concepts into a coherent whole
- Logic: well-reasoned thinking

It is clear, from the findings at SQU, that our teacher candidates neither have these reasoning skills when they enter the university nor at the end of their third year of study. There is some evidence from the faculty survey, that the faculty do not understand all of these skills. There is no doubt that they are not teaching them.

Changes in higher education teaching in general but more importantly in teacher education might include: Curriculum innovation that includes critical thinking and creativity as subjects with opportunities for students to solve problems, make decisions, analyze alternatives and evaluate their logical reasoning; sophisticated knowledge management skills; divergent and creative thinking; student-centered collaborative teaching and learning; active learning focused on the higher levels of Bloom's taxonomy; well defined learning objectives;

assessment of learning (UNESCO, 1994; Abu Dhabi Education Council, 2009; Duron, Limbach & Waugh, 2006).

As universities move forward in the integration of critical thinking in programs and courses, revisions to the reported research model might be considered. Further research is needed with large groups of faculty across all disciplines to determine the extent to which they understand the components of critical thinking; the extent to which they model and/or transfer such thinking in their classes; their ability to teach critical thinking skills in their teacher education courses and lastly, their ability to mentor teacher candidates in the integration and teaching of these skills in K-12 classrooms (Yang, 2012). Continued research that monitors the attainment of critical thinking skills at every stage of the educational system is necessary if the socioeconomic goals of the Sultanate of Oman are to be achieved.

Continuing research might also provide a richer analysis of the benefits of the use of various tests to document the critical thinking skill development of pre and in-service teachers. Various researchers have used different tests, some stand-alone or in combinations. The Ennis-Weir Test was used as a pre and post-test by Szabo and Schwartz (2011) and by Sekar and Komur (2008) as a benchmark for analyzing student responses during a critical thinking structured interview. The Watson Glaser has also been used internationally. Sacli and Demirhan (2011) used it in Turkey with pre-service physical education teachers. Additionally, it might prove useful to use a classroom based action research model to understand perspectives of both teachers and students (Baildon & Sim, 2009).

Even as the recommended research is being conducted, policies can be implemented to: provide workshops and materials to improve the critical thinking skills of the higher education faculty; and, include and reward critical thinking in grades 1-12 and in higher education.

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