



# The influence of critical thinking skills on performance and progression in a pre-registration nursing program



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## SUMMARY

**Background:** The importance of developing critical thinking skills in preregistration nursing students is recognized worldwide. Yet, there has been limited exploration of how students' critical thinking skill scores on *entry* to pre-registration nursing education influence their academic and clinical performance and progression.

**Aim:** The aim of this study was to: i) describe *entry* and *exit* critical thinking scores of nursing students enrolled in a three year bachelor of nursing program in Australia in comparison to norm scores; ii) explore *entry* critical thinking scores in relation to demographic characteristics, students' performance and progression.

**Method:** This longitudinal correlational study used the Health Sciences Reasoning Test (HSRT) to measure critical thinking skills in a sample ( $n = 134$ ) of students, at *entry* and *exit* (three years later). A one sample t-test was used to determine if differences existed between matched student critical thinking scores between *entry* and *exit* points. Academic performance, clinical performance and progression data were collected and correlations with *entry* critical thinking scores were examined.

**Results:** There was a significant relationship between critical thinking scores, academic performance and students' risk of failing, especially in the first semester of study. Critical thinking scores were predictive of program completion within three years. The increase in critical thinking scores from *entry* to *exit* was significant for the 28 students measured. In comparison to norm scores, *entry* level critical thinking scores were significantly lower, but *exit* scores were comparable. Critical thinking scores had no significant relationship to clinical performance.

**Conclusion:** *Entry* critical thinking scores significantly correlate to academic performance and predict students risk of course failure and ability to complete a nursing degree in three years. Students' critical thinking scores are an important determinant of their success and as such can inform curriculum development and selection strategies.

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## Introduction

Many factors contribute to students' academic performance, retention and success in pre-registration nursing programs (Jeffreys, 2012). Some of these include age (van Rooyen et al., 2006), gender (Ali and Naylor, 2010), English as a second language (Salamonson et al., 2008), preadmission exams results (Murray et al., 2008) and secondary school performance (Ali and Naylor, 2010). However, a factor that has attracted less attention in relation to performance and success in nursing programs is critical thinking skill. Critical thinking skills are crucial to a nurse's ability to process information, problem solve and make judgements (Fesler-Birch, 2005; Levett-Jones et al., 2010). Yet nursing graduates with less than one year experience are consistently unable to do this (del Bueno, 2005). This lack of critical thinking ability in new graduates has been suggested to be a result of nursing curriculum focusing on the accumulation of knowledge rather than the application of knowledge

to real situations (del Bueno, 2005). Current nursing research has focused on pre-post evaluations of nursing student critical thinking development in association with specific teaching and learning strategies (Morey, 2012; Thompson and Stapley, 2011); and the measurement of graduates' critical thinking skills (del Bueno, 2005; Wangenstein et al., 2011) rather than relationships between *entry* critical thinking skills and students' academic performance, clinical performance and progression.

## Background

The increasing complexity of healthcare requires registered nurses to possess high-level critical thinking skills (Chang et al., 2011). A nurse's critical thinking skill can make a difference to patient safety as this enables a nurse to identify a patient's primary problem and to practice the 'right action for the right reason' (del Bueno, 2005, p. 280; Levett-Jones et al., 2010). With this in mind pre-registration nursing programs have attempted to not only teach critical thinking but also make certain that graduates complete their nursing programs with well-developed critical thinking skills (Berger, 1984; Thompson and

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Stapley, 2011). Although critical thinking is suggested to be a learned process that requires repetitive practice (Andrea Sullivan, 2012; Van Gelder, 2005), there is mixed evidence of the effectiveness of nursing education programs in developing critical thinking skills in nursing students (Daly, 2001; Hoffman, 2006; Lee et al., 2013). These mixed results highlight the need for further research to determine if critical thinking abilities change over time and if critical thinking skill influences students' progress and success. This information is vital for informing decisions related to student selection and curriculum design (Ross et al., 2013).

### Definition of Critical Thinking

Critical thinking has its roots in philosophy, psychology and education; each discipline has a distinct definition of critical thinking (Sternberg, 1986). Although there are differences in disciplinary views of critical thinking there is overriding agreement that critical thinking is crucial to the process by which students make judgements in both their studies and in everyday life (Facione, 1990). A frequently cited definition of critical thinking was developed as a result of a Delphi study that included 46 critical thinking experts from the United States of America (US) in the fields of philosophy, education, social science and physical science (Facione, 1990; Turner, 2005). The definition that emerged from this Delphi study was that critical thinking is a "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (Facione, 1990, p. 3). It is this definition of critical thinking that has been used to inform the current study.

### Critical Thinking Tools

A wide range of tools have been used to measure critical thinking skills in nursing students (Romeo, 2010). Some have been used repetitively in

research and have clear validity and reliability data however many are lesser known with limited application and no reported validity or reliability information (see Table 1). One of the most commonly used tools in nursing is the California Critical Thinking Skills Test (CCTST; [www.insightassessment.com](http://www.insightassessment.com)). This test provides a measure of total critical thinking score and the five sub-scales of analysis, inference, evaluation, deductive reasoning and inductive reasoning. The CCTST is not nursing specific; to combat this Facione et al. (2011) developed the Health Sciences Reasoning Test (HSRT) from Facione's (1990) early definition of critical thinking to measure critical thinking in undergraduate health students (Facione et al., 2011). The HSRT has been used in extensively in nursing research (Hunter et al., 2014; Paans et al., 2010; Shinnick and Woo, 2013; Sullivan-Mann et al., 2009), and has reported content, construct and criterion validity through extensive independent research (Facione et al., 2011) and internal consistency (Kuder Richardson-20) of 0.81. Accordingly it is the critical thinking tool used in this study.

### Academic Performance

A number of studies have measured pre-registration nursing students' critical thinking in relation to academic performance (Morey, 2012; Thompson and Stapley, 2011). However, only eight studies have been found that explored entry critical thinking scores and their relationship to academic performance, none of which included Australian nursing students. Three of these reported a significant relationship (Behrens, 1996; Bowles, 2000; Giddens and Gloeckner, 2005). An early study exploring entry critical thinking skills in US diploma students ( $n = 109$ ) identified a positive correlation ( $p < 0.01$ ) between entry critical thinking (Watson-Glaser Critical Thinking Appraisal (WGCTA)) and Grade Point Average (GPA) (Behrens, 1996). A similar result ( $p < 0.001$ ) was found in a smaller sample ( $n = 65$ ) of baccalaureate US nursing students using the CCTST (Bowles, 2000). Giddens and Gloeckner (2005) also found that students' who passed the National Council Licensure Examination for Registered Nurses (NCLEX-RN) had higher entry critical thinking scores (CCTST) than those who did not

**Table 1**  
Critical thinking measurement tools.

Instrument	Description	Context	Reliability and validity	Publications related to instrument
Health Services Reasoning Test (HSRT; <a href="http://www.insightassessment.com">www.insightassessment.com</a> )	Total critical thinking score and five subscales	Undergraduate health professionals	Internal consistency (Kuder Richardson-20) = 0.81 Validity reported	Sullivan-Mann et al. (2009), Shinnick and Woo (2012), and Paans et al. (2010)
Californian Critical Thinking Skills Test (CCTST; <a href="http://www.insightassessment.com">www.insightassessment.com</a> )	Total critical thinking score and five subscales	Discipline neutral	Internal consistency (Kuder Richardson-20) range 0.77–0.83 Validity reported	Bowles (2000), Giddens and Gloeckner (2005), May et al. (1999), Wheeler and Collins (2003), and Ravert (2008)
Watson-Glaser Critical Thinking Appraisal (WGCTA) developed by Watson and Glaser	Total critical thinking and five subsets	Discipline neutral	Internal consistency (Kuder Richardson-20) 0.6–0.85 Validity reported	Behrens (1996), Berger (1984), Chang et al. (2011), and Forneris (2012)
Critical Thinking Process Test (CTPT) developed by Educational Resources Inc.	Total scores and subscale scores – for critical thinking process and critical process skills	Nursing student specific	Reliability coefficient 0.93 Validity reported	Hoffman (2006) and Morey (2012)
Critical Thinking Assessment (CTA) published by Assessment Technology Institute.	Total score and six subscales	Nursing student specific	Internal consistency Cronbach alpha 0.69 Validity reported	Jones and Morris (2007)
Collegiate Assessment of Academic Proficiency (CAAP)	One critical thinking score	Not stated	Reliability and validity not reported	Shirrell, 2008
Halpern Critical Thinking Assessment using Everyday Situations	One critical thinking score	Not stated	Reliability coefficient Cronbach alpha >0.80 Validity discussed	Ku and Ho (2010)
Health Education Systems Incorporated (HESI) exam – Critical thinking subscore	One critical thinking score	Individual HESI exam created for this study of nursing students	Internal consistency (Kuder Richardson-20) range 0.94 Validity reported	Howard (2007)
Nurse Entrance Test (NET) developed by Educational Resources Inc.	Provides a diagnostic score for critical thinking appraisal	Nursing students	Reliability and validity not reported	Ellis (2006)
Competency Inventory of Nursing Students (CINS)	Six factors – one of which is critical thinking and reasoning.	Nursing students	Internal consistency Cronbach alpha = 0.91–0.98 Validity reported	Hsieh and Hsu (in press)
Subscale Critical thinking & reasoning				

pass. However, others have reported no relationship between critical thinking and academic performance as measured by GPA (Berger, 1984; Jones and Morris, 2007; Ku and Ho, 2010) or NCLEX-RN (Hoffman, 2006).

### Clinical Performance

In the exploration of critical thinking and clinical competence, much of the research has focused on registered nurses (Chang et al., 2011; Forneris, 2012). To date there has been no research conducted on entry level critical thinking scores and measures of clinical competence. However, exit critical thinking scores have been explored in relation to clinical competence. An early study found no relationship between exit critical thinking (CCTST) and clinical competence in 143 US senior nursing students (May et al., 1999). It is thought that this lack of relationship between critical thinking and clinical competence may be more related to the way clinical competence is assessed and the pedagogy that underpins the assessment of competence, that is the assessment of a process or procedure, rather than the assessment of a clinical judgment (May et al., 1999; Tedesco-Schneck, 2013).

### Progression

A direct link has been identified between entry critical thinking and progression in two studies (Ellis, 2006; Jones and Morris, 2007). Progression to the second year of enrolment was noted to be more likely in US diploma students with higher critical thinking scores as measured by the critical thinking section of the Nurse Entrance Test (NET) (Ellis, 2006). Similar results were noted in US associate degree nursing students ( $n = 104$ ) (Jones and Morris, 2007). Those students with higher entry critical thinking scores (Critical Thinking Assessment) were more likely to complete in two years than those with lower scores.

### Aims of the Study

The aims of this longitudinal descriptive correlational study were to:

1. Describe entry and exit critical thinking scores of nursing students enrolled in a three year bachelor of nursing program in Australia in comparison to norm scores;
2. Explore entry critical thinking scores relationship to students' demographic characteristics, academic and clinical performance and progression.

### Method

Following ethics approval a convenience sample of nursing students were recruited from a semi-metropolitan multi-campus Australian university. All students enrolling in the first year of a three year Bachelor of Nursing program in 2009 ( $N = 517$ ) were invited to participate through notifications in enrolment packs, orientation lectures and tutorial classes. Demographic data were collected at the commencement of the study including age, gender, first language, place of residence, being first in the family to attend university; entry qualifications (completed secondary education in 2008/other), previous nursing-related experience and motivation to be a nurse.

### Critical Thinking Skill

Critical thinking skills were measured using the Health Sciences Reasoning Test (HSRT; [www.insightassessment.com](http://www.insightassessment.com)). Students' HSRT scores were measured on entry to and exit (three years later) from the nursing program. The HSRT provides a measure of students' total critical thinking skills (total CT), as well as scores for the sub-scales analysis, evaluation, inference, deductive reasoning and inductive reasoning (see Table 2).

**Academic performance** measures included grade point average (GPA), course aggregate marks and academic failure. GPA is calculated using the total grade points (high distinction = 7, distinction = 6, credit = 5, pass = 4, ungraded pass = 4 and fail = 0) awarded for a semester divided by the total number of course units taken, providing a result on a scale of 0–7. The GPA is calculated at the end of semester 1 year 1 and each subsequent year. Course aggregate marks were calculated using the final mark provided for courses. Course aggregate marks were created by grouping together courses that focused on nursing theory, clinical, elective and bioscience. Additionally they were sorted depending on the year taken first year, second year and third year. Unlike the GPA the course aggregate mark is calculated using students' course marks rather than an average grade such as Pass or Credit providing further exploration of academic performance. Academic failure was reported as a dichotomous variable that identified whether or not a student failed a course each semester.

**Clinical performance** was a dichotomous measure of competent/not competent based on students' final clinical performance appraisal. This appraisal was conducted in a clinical context by a university employed assessor as part of a third year course using a process termed the Structured Observation and Assessment of Practice (SOAP) (Levett-Jones et al., 2011). The SOAP includes a three hour observation period of the student's engagement in patient care, followed by an interview of their "knowledge, values and attitudes" that informed their practice. An outcome of competent or not competent requiring reassessment or remediation is provided. The SOAP has reported face and content validity and internal consistency (Chronbach's alpha 0.98–0.90) and has been adapted by both industry partners and Australian nurse regulatory authorities; evaluation of its effectiveness continues (Levett-Jones et al., 2011).

**Progress** was reported as a three group variable identifying if students completed the program in the 3 years, withdrew or continued enrolment in the program after 3 years. Those who remained enrolled had either changed to part-time enrolment, taken a leave of absence, or needed to repeat a course they had previously failed.

Data were assessed for normal distribution and further analyses were performed using IBM SPSS version 20 (SPSS, Inc., Chicago, IL, USA). Paired sample t-test compared entry and exit HSRT scores. Correlational analysis (Pearson's and Spearman) was performed between HSRT and age, academic performance, and attendance. Both parametric (t-test) and non-parametric tests (Mann–Whitney U-test) were used to explore the relationships between the HSRT scores and students' demographic data. Logistic regression was conducted on HSRT and clinical performance and risk of failure. Multinomial regression was performed on HSRT and program completion. The alpha was set at 0.05 for all statistical analysis.

**Table 2**  
Description of HSRT.

Measures	Definition	Scores
Total CT	Overall critical thinking skill	0–33 <sup>a</sup>
Analysis	Ability to examine meaning and interpret information	0–6 <sup>b</sup>
Inference	Ability to reason or infer meaning using evidence – may not always be right conclusion if it is the wrong evidence.	0–6 <sup>b</sup>
Evaluation	Ability to assess strength of evidence that supports inference.	0–6 <sup>b</sup>
Deductive reasoning	Ability to see draw conclusion based on rules and laws e.g. mathematical calculation that $1 + 1 = 2$ .	0–10 <sup>c</sup>
Inductive reasoning	Ability to draw conclusion based on probability e.g. weather forecast prediction.	0–10 <sup>c</sup>

(Facione et al., 2011).

<sup>a</sup> 0–14 weak; 15–23 midrange; 24–33 strong.

<sup>b</sup> 0–2 weak; 3–4 midrange; 5–6 strong.

<sup>c</sup> 0–5 weak; 6–8 midrange; 9–10 strong.

**Table 3**  
Demographic details of participants.

Demographic variable	(n=) Frequency (%)
Age in years	Median = 24; mean = 27 (range 18–53)
Gender (females)	120 (86%)
First language spoken – English language	124 (89%)
Living with parents	52 (37%)
First in family to attend university	70 (50%)
Completed secondary school in 2008	25 (17%)
Nursing-related experience prior to entry	48 (35%)
Motivation to nurse	86 (62%)

## Results

Of the 517 students enrolled in first year (2009) 139 students participated; a response rate of 26.8%. The majority of the participants were female (86%) with a mean age of 27 years (see Table 3). Of the 139 participants, 134 completed the HSRT.

### HSRT Scores at Entry

Scores for *total CT* ranged from 1 to 29, mean of 16.72 (see Table 4, columns 1–4). Thirteen students obtained a *total CT* score of  $\leq 10$ , indicating critical thinking abilities that are “extremely weak and not consistent with a minimum college (university) entry level” (Facione et al., 2011, p. 23).

### Changes in HSRT Scores Over 3 Years

In 2009 134 students completed the HSRT. At the completion of 3 years, students who had completed or were continuing on in the BN were asked to complete the HSRT. Of the 89 possible students only 28 (31.5%) completed the HSRT (see Table 5). These 28 students' had significantly higher ( $p < 0.05$ ) *entry* HSRT scores in comparison to the complete sample's ( $n = 134$ ) with exception of the sub-score of analysis which although higher was not significant. A paired sample t-test provided a comparison between the 28 matched *entry* and *exit* HSRT scores. For these 28 students *total CT* scores significantly ( $t = 2.102$ ,  $p = 0.045$ ) increased between entry and exit. Although sub-scale scores also increased over time these results were not significant.

### Comparison to other Health Professionals

Norm HSRT scores for undergraduate health science students ( $n = 3800$ ) were based on fourth year undergraduate students (Facione et al., 2011). A significant difference ( $p < 0.001$ ) was noted between *entry* critical thinking and the norm HSRT scores (see Table 4, columns 7–8). However, no significant difference was noted between *exit* HSRT scores in comparison to HSRT norms (see Table 4, columns 11–12).

HSRT scores and demographics of nursing students

There were statistically significant correlations between the HSRT and two demographic variables – age and previous nursing-related experience. Older students had significantly higher scores for the sub-scale of *evaluation* ( $r_s = 0.205$ ,  $p = 0.017$ ). Nursing-related experience included Assistant in Nursing (AIN) certificate ( $n = 24$ ), AIN but no certificate ( $n = 10$ ) and Enrolled Nurse ( $n = 8$ ). Students' with nursing-related experience had lower HSRT scores overall (except *evaluation*), but only three scores (*total CT*, *analysis* and *deductive reasoning*) were found to be significantly lower (see Table 6).

### HSRT Scores and Academic Performance

Significant positive correlations were found between students' HSRT scores and all academic performance scores. The strongest correlation was noted between performance in clinical courses and sub-scale *analysis* and *deductive reasoning* scores (see Table 7). Using logistic regression students' HSRT scores were found to significantly impact their risk of course failure across the three years of the study (see Table 8). The strongest predictor of course failure was students' *entry* sub scale *evaluation* score. As the *evaluation* scores increased by 1 risk of course failure in the first semester, year 1 of study decreased by 50%.

### HSRT Scores and Clinical Performance

Final clinical competence assessment (SOAP) was undertaken by 51 final year students in 2011. Of these, 41 (80%) students were assessed as competent and 10 (20%) were not competent and required a reassessment. No significant difference was noted between HSRT scores for any of these groups.

### HSRT Scores and Progression

At the completion of three years over one third of the original sample ( $n = 46$ ; 33%) had completed the program; one third ( $n = 49$ ; 35%) had withdrawn and nearly one third ( $n = 43$ ; 31%) remained enrolled. Those who remained enrolled had either changed to part-time enrolment, taken a leave of absence, or needed to repeat a course they had previously failed. Using multinomial regression and with the reference category of ‘completed’, *entry* scores for *total CT*, *analysis* and *deductive reasoning* predicted program completion in 3 years. The strongest predictor of completion was students' *analysis* score as this increased by 1 their chance of completing in three years increased by 42% ( $p = 0.001$ , *Odds ratio* = 0.582); as *deductive reasoning* scores increased by 1 the chance of completion increased by 27% ( $p = 0.003$ , *Odds ratio* = 0.726); as *entry total CT* scores increased by 1 students likelihood of completion in 3 years increased by 11% ( $p = 0.011$ , *Odds ratio* = 0.888). No significant relationship was identified between HSRT scores and likelihood of withdrawal.

**Table 4**  
Mean and standard deviations for entry & exit HSRT scores; comparisons the HSRT norms.

Score	Entry HSRT $n = 134$			HSRT Norms <sup>a</sup>		t-test (norm: entry)		Exit HSRT $n = 28$		t-test (norm: exit)	
	Mean	SD	Rge	Mean	SD	t	p	Mean	SD	t	p
Total CT	16.72	4.91	1–29	19.39	4.85	–6.306	0.001 <sup>b</sup>	19.46	4.772	0.082	0.935
Analysis	3.27	1.44	0–6	3.84	1.34	–4.605	0.001 <sup>b</sup>	3.79	1.197	–0.240	0.812
Inference	2.53	1.22	0–6	3.165	1.18	–6.005	0.001 <sup>b</sup>	3.07	1.331	–0.372	0.713
Evaluation	3.39	1.34	0–6	4.38	1.395	–3.940	0.001 <sup>b</sup>	4.71	1.243	1.423	0.166
Inductive reasoning	6.06	1.84	0–9	6.928	1.77	–5.443	0.001 <sup>b</sup>	7.21	1.707	0.887	0.383
Deductive reasoning	4.40	2.16	0–10	5.733	2.31	–7.129	0.001 <sup>b</sup>	5.57	2.516	–0.340	0.737

<sup>a</sup> HSRT Norms are based on fourth year undergraduate students (Facione et al., 2011).

<sup>b</sup> Significant at the 0.01 level.



**Table 5**  
Paired sample t-test results for matched entry & exit HSRT scores.

Score	Entry HSRT n = 28		Exit HSRT n = 28		t-test (entry:exit)	
	Mean	SD	Mean	SD	t	p
Total CT	17.79	5.15	19.46	4.772	−2.102	0.045
Analysis	3.43	1.62	3.79	1.197	−1.205	0.239
Inference	2.82	1.30	3.07	1.331	−0.908	0.372
Evaluation	4.18	1.54	4.71	1.243	−1.856	0.074
Inductive reasoning	6.57	1.83	7.21	1.707	−1.638	0.113
Deductive reasoning	4.82	2.45	5.57	2.516	−1.760	0.090

## Discussion

This study found significant relationships between nursing students' entry critical thinking scores, academic performance and progression. On entry to the pre-registration program older students were found to have significantly higher sub-scale *evaluation* scores. Although the relationship between age and critical thinking has been supported in other studies (Martin, 2002; Shinnick and Woo, 2012), this is not a consistent finding across nursing research (Gross et al., 1987; Hoffman, 2006; Hunter et al., 2014) and is not supported by the HSRT criterion validity studies (Facione et al., 2011).

The finding that students with prior nursing-related experience had significantly lower critical thinking scores may be explained by the suggestion that critical thinking is dependent on context and therefore is not transferable to other situations (Brookfield, 1997). But it is also likely that the nursing assistant or helper roles students were employed in did not provide the opportunity for them to develop higher level critical thinking skills (Algozo and Peters, 2012).

Entry critical thinking scores were found to be positively related to academic performance across all three years of the study. Others have noted a similar relationship between critical thinking and GPA (Behrens, 1996; Bowles, 2000) and NCLEX-RN (Giddens and Gloeckner, 2005). No other studies were located that explored entry critical thinking and academic performance measures throughout a pre-registration program. This study also found that students' entry critical thinking scores predicted a student's risk of course failure during the three years of study, however, the strongest predictor of students' chance of failing was reported in the first semester of study. These findings support the early assessment of students' critical thinking skills, and the need for targeted support or remedial strategies based on the needs of a specific cohort (Martyn et al., 2014). While most pre-registration programs focus on developing individual teaching strategies to improve students' critical thinking (Mangena and Chabeli, 2005; Shinnick and Woo, 2012) these results demonstrate that the assessment of entry critical thinking scores may be a valuable way of selecting students who are best able to progress through a nursing program.

The relationship between critical thinking measures and clinical competence measures has attracted limited attention in nursing. This study found no relationship between entry critical thinking and clinical competence. This finding is supported by May et al. (1999) who found no relationship between exit critical thinking scores and a faculty

designed clinical competency measure. An explanation for the lack of relationship in this study sample may relate to the measures used or the small number of students who completed the final SOAP assessment. Further research on a larger sample is therefore warranted.

Students' ability to complete their nursing education within the expected 3 years of full time enrolment was significantly impacted by their entry critical thinking scores (*total CT*, *analysis* and *deductive reasoning*). Jones and Morris (2007) also found that critical thinking skill influenced a student's ability to complete a two year associate degree on time. This finding supports the need to provide targeted support or remediation for at risk students to ensure progression and success (Harding, 2012).

That student entry critical thinking skills were lower than fourth year undergraduates (HSRT norm) scores was not a surprise. The significant increase in critical thinking scores after three years to become comparative to HSRT norms implies that the program students were enrolled in is likely to be effective in developing critical thinking skills. However it is acknowledged that a number of variables could have contributed to this outcome (Hunter et al., 2014), including the retention in the program of those with higher entry critical thinking who subsequently completed the exit survey. Few longitudinal studies have measured pre-registration program entry and exit critical thinking scores to determine the extent of critical thinking development over a program. Those studies that have been conducted have produced mixed results. The improvement in critical thinking scores over time in this study has been supported by other studies conducted in the US (Baker, 2002; Giddens and Gloeckner, 2005; Gross et al., 1987; Hoffman, 2006). Yet there have been others in the US (Jones and Morris, 2007), United Kingdom ( $n = 43$ ) (Daly, 2001) and Taiwan ( $n = 95$ ) (Lee et al., 2013) which reported no significant change in critical thinking over time. Further longitudinal studies are required to consolidate these results.

## Limitations

A limitation of this study was the use of a convenience sample which may have produced a sampling bias. Although this sample reflects the gender (87.6%) and age (mean = 27.8; median = 24) distribution of the 2009 population; fewer students entered on the basis of completing secondary school in 2008 (17%) than the population (27%). A further limitation was the low response rate in the exit HSRT. Both of these limitations detract from the generalizability of the results. Further research using large samples is required.

## Conclusion

This study found a significant relationship between student's entry critical thinking scores and their academic performance and ability to complete the program in three years. Although students entered the program with lower critical thinking scores than the HSRT norms their scores significantly increased after progressing through the 3 year program to be comparable to published norms. Nursing pre-registration nursing programs remain committed to ensuring that graduates have well developed critical thinking skills as a prerequisite for safe and effective clinical practice. This study identified the importance of considering

**Table 6**  
Prior nursing-related experience and entry HSRT.

	Difference in scores (n = 133)	Experience mean (n = 46)	No experience mean (n = 87)
Total CT	$t = -2.096, p = 0.038$	15.48	17.33
Analysis	$U = 1470, p = 0.010$	2.78	3.52
Inference	$U = 1681, p = 0.118$	2.30	2.66
Evaluation	$U = 1945, p = 0.786$	3.96	3.91
Inductive reasoning	$U = 1979, p = 0.916$	6.04	6.07
Deductive reasoning	$U = 1513.5, p = 0.020$	3.78	4.72

U = Mann–Whitney U; t = t-test.

**Table 7**  
Significant correlations between HSRT and academic variables.

Entry HSRT		Academic performance									BioSc	
		GPA				Theory			Clinical			
		Year 1 Sem1	Year 1	Year 2	Year 3	1st yr	2nd yr	3rd yr	1st yr	2nd yr		3rd yr
	<i>n</i>	131	132	119	92	124	96	70	124	90	63	117
Total CT	<i>r</i>	.40 <sup>a</sup>	.38 <sup>a</sup>	.36 <sup>a</sup>	.42 <sup>a</sup>	.32 <sup>a</sup>	.41 <sup>a</sup>	.31 <sup>a</sup>	.35 <sup>a</sup>	.44 <sup>a</sup>	.35 <sup>a</sup>	.38 <sup>a</sup>
Analysis	<i>r</i>	.29 <sup>a</sup>	.25 <sup>a</sup>	.27 <sup>a</sup>	.42 <sup>a</sup>	.15	.29 <sup>a</sup>	.31 <sup>a</sup>	.23 <sup>a</sup>	.40 <sup>a</sup>	.46 <sup>a</sup>	.27 <sup>a</sup>
Inference	<i>r</i>	.20 <sup>b</sup>	.19 <sup>b</sup>	.15	.19	.18 <sup>b</sup>	.24 <sup>b</sup>	.01	.24 <sup>a</sup>	.18	.06	.11
Evaluation	<i>r</i>	.34 <sup>a</sup>	.28 <sup>a</sup>	.26 <sup>a</sup>	.26 <sup>b</sup>	.23 <sup>b</sup>	.19	.19	.19 <sup>b</sup>	.25 <sup>b</sup>	.17	.30 <sup>a</sup>
Inductive	<i>r</i>	.28 <sup>a</sup>	.26 <sup>a</sup>	.24 <sup>b</sup>	.22 <sup>b</sup>	.23 <sup>a</sup>	.22 <sup>b</sup>	.18	.21 <sup>b</sup>	.19	.17	.26 <sup>a</sup>
Deductive	<i>r</i>	.32 <sup>a</sup>	.31 <sup>a</sup>	.28 <sup>a</sup>	.41 <sup>a</sup>	.24 <sup>a</sup>	.41 <sup>a</sup>	.34 <sup>a</sup>	.32 <sup>a</sup>	.46 <sup>a</sup>	.35 <sup>a</sup>	.33 <sup>a</sup>

Inductive = Inductive reasoning; Deductive = Deductive reasoning; BioSc = Bioscience courses.

<sup>a</sup> Correlation is significant at the 0.01 level (2-tailed).

<sup>b</sup> Correlation is significant at the 0.05 level (2 tailed).

**Table 8**  
Logistic regression of entry HSRT and risk of failure.

HSRT	Semester 1, year 1		Semester 2, year 1		Semester 1, year 2		Semester 2, year 3	
	Wald (df = 1)	Exp (B)	Wald (df = 1)	Exp (B)	Wald (df = 1)	Exp (B)	Wald (df = 1)	Exp (B)
Total CT	10.49	.841 <sup>a</sup>	3.306	.914	8.793	.854 <sup>b</sup>	6.133	.792 <sup>b</sup>
Analysis	7.05	.639 <sup>b</sup>	5.592	.662 <sup>b</sup>	4.254	.707 <sup>b</sup>	4.463	.512 <sup>b</sup>
Inference	0.754	.850	0.001	.995	7.372	.558 <sup>b</sup>	1.976	.595
Evaluation	13.10	.497 <sup>a</sup>	0.118	.926	4.480	.689 <sup>b</sup>	1.217	.718
Inductive reasoning	8.66	.680 <sup>b</sup>	0.301	.932	6.147	.724 <sup>b</sup>	2.678	.706
Deductive reasoning	5.376	.768 <sup>b</sup>	4.463	.778 <sup>b</sup>	2.884	.824	4.450	.612 <sup>b</sup>

<sup>a</sup> Correlation is significant at the 0.01 level (2-tailed).

<sup>b</sup> Correlation is significant at the 0.05 level (2 tailed).

entry critical thinking skills as potential selection criteria as well as an opportunity to provide remediation to reduce the risk of failure.

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