The assessment of learning skills in nursing student selection: A scoping review

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Abstract

Higher education student selection has significant societal, institutional and individual impacts. Thousands of applicants apply only for nursing, one of the major higher education disciplines.

As the nursing profession is characterised by cognitive requirements, higher education institutions assess the learning skills of nursing applicants. However, there has been no comprehensive analysis of learning skills assessment for nursing student selection. The purpose of this scoping review was to describe the assessment of learning skills in undergraduate nursing student selection. Five databases were systematically searched, and 24 studies published between 2006 and 2016 were included. Learning skills were most commonly assessed using standardised tests in the areas of language and communication, reasoning, mathematics and natural sciences. Overall scores of onsite selection methods were found to best predict future academic performance. The results indicate that higher education institutions may benefit from comprehensive assessment of learning skills in their selection processes. This assessment should focus on a wider range of cognitive aptitudes, including reasoning skills. This review focused on nursing education, but the results may benefit other higher education disciplines due to the generic nature of learning skills and similar cognitive requirements of higher education studies. The results support the development of more comprehensive and valid methods for assessing learning skills.

Keywords: *higher education, learning skills, literature review, nursing student selection*

Introduction

Student selection affects a large number of higher education institutions and their applicants internationally. For example, there are hundreds of thousands of higher education applicants in the United States of America (USA) each year (NACAC 2018). Nursing is among the major higher education disciplines, with 123,000 nursing professionals graduating in the European Union alone in 2016 (Eurostat 2018). As the estimated 35 million nurses and midwives worldwide represent a significant proportion of the global healthcare workforce (WHO 2007), nursing student selection has significant societal and institutional as well as individual impacts. Many countries face substantial shortages of nursing staff in the next decade, and newly qualified professionals are badly needed (Buchan et al. 2014; WHO 2016). Thousands of applicants apply for a study place in nursing education each year (Talman et al. 2018), and recent concerns about quality of care, fewer resources, higher student attrition, academic failure and the lack of evidence-based selection practices have led to greater scrutiny of selection methods. As a result, nursing schools face the challenge of developing their student selection processes internationally (Schmidt and MacWilliams 2011; Pitt et al. 2012; Taylor, MacDuff and Stephen 2014; MacDuff, Stephen and Taylor 2016). Higher education institutions aim to select students for their nursing programmes who are most likely to succeed (WHO 2009; Schmidt and MacWilliams 2011; Talman et al. 2018) and to graduate on time (Hinderer, DiBartolo and Walsh 2014; Finnish Ministry of Education and Culture 2016) while also delivering safe and appropriate care to service users (Francis 2013). Higher education institutions should also have transparent admission policies that specify the process of student selection and minimum acceptance criteria (WHO 2009).

Cognitive skills are crucial in higher education studies and one of the most expected generic skills of all graduating students (Ghanizadeh 2017; Klegeris et al. 2017). As the nursing discipline is characterised by increasing cognitive requirements (FIOH 2018), cognitive ability is one of the central competences in nursing education (Kajander-Unkuri et al. 2013). Cognitive skills are crucial

in complex work environments (Ghanizadeh 2017; Klegeris et al. 2017), and nursing studies also demand extensive reading, which is likely to overwhelm students' attempts to compensate for low learning skills (Harner 2014). Undergraduate bachelor-level nursing students are required to become proficient in specified competence areas within a relatively short timeframe of 3–4 years of formal education (ANA 2010; EFN 2015; Eriksson et al. 2015). As nursing students must also demonstrate their ability as independent learners (WHO 2009), higher education institutions need to assess the learning skills of nursing applicants as part of the selection process. Learning skills can be understood as generic skills and abilities related to cognitive readiness and academic intelligence (WHO 2009; Herrera 2012). For the purposes of this study, learning skills are understood as the cognitive skills, abilities, readiness and aptitudes required to gain entry to a nursing programme while constructs such as personality, attitude and motivation are considered non-learning-related (Megginson 2009).

Traditionally, learning skills have been assessed using theoretical parameters that include previous academic achievement as measured by high school grade point average (GPA) and prerequisite course achievement (Herrera 2012; Crouch 2015). However, there is accumulating evidence of the effectiveness of standardised tests and other onsite selection methods to select students (Stuenkel 2006; Hernandez 2011). These methods commonly assess learning skills in the areas of basic science, mathematics, reading comprehension, communication and language as required in higher education (WHO 2009; Herrera 2012). Additionally, recent research has identified the role of other cognitive attributes such as reasoning skills in the student selection process. For example, the United Kingdom Clinical Aptitude Test (UKCAT) is used in medical schools to measure clinical aptitude in terms of reasoning, decision-making and situational judgment (Lievens et al. 2016; UKCAT 2018).

Higher education institutions also have a responsibility to employ valid and reliable tools when selecting students on the basis of attributes that predict future academic success (Perkins et al. 2013;

van Ooijen-van der Linden et al. 2017). However, there is a lack of evidence-based information in relation to nursing student selection practices and the questions of what to assess, and how (Taylor, MacDuff and Stephen 2014). In light of this knowledge gap, this scoping review addresses the need for a comprehensive analysis of learning skills assessment in student selection for undergraduate (bachelor-level) nursing programmes. To that end, the following research questions were formulated.

1. What learning skills are assessed in undergraduate nursing student selection?
2. What methods are used to assess learning skills in undergraduate nursing student selection?
3. What methods of assessing learning skills in undergraduate nursing student selection are known to relate to academic performance?

Materials and methods

Scoping review

A scoping review is a process of mapping the existing literature, evidence base (Arksey and O'Malley 2005) and extent of research evidence (Grant and Booth 2009). Although this does not usually include assessment of the quality of selected studies, scoping reviews can be of value in guiding future research (Armstrong et al. 2011). The present review focuses on the scope of definitions and the implications rather than on the quality of the reviewed studies. Like systematic reviews, scoping reviews involve different stages. This review follows Armstrong et al.'s (2011) five steps: 1) identify the research questions; 2) identify relevant studies; 3) select the studies; 4) chart the data and 5) collate, summarise and report the results.

Identifying relevant studies

Having identified the research questions, a systematic search of five electronic databases (Figure 1 near here) was conducted in July 2018 by two researchers (JV, KT). The preliminary data search

utilised Medline Subject Headings (MeSH), CINAHL headings and various dictionary terms describing learning skills (e.g. academic, scholarly, cognitive) and nursing student admission and selection. In the final search, the concept of reasoning (and its synonyms) was included to ensure a wide range of studies addressing the assessment of learning skills. Search terms were combined with Boolean operators (Figure 1). To capture the most recent literature, the search was confined to English or Finnish language publications with abstracts during the years 2006–2018. Additionally, the reference lists of the retrieved articles were manually searched.

Study selection

As part of the search strategy, inclusion and exclusion criteria were developed to identify relevant publications and to maintain the focus of the review (Aveyard 2007). Empirical studies, literature reviews and doctoral dissertations reporting assessments of the learning (cognitive/academic) skills of applicants to undergraduate bachelor-level nursing programmes were included in the review. Two of the authors (JV, KT) used these criteria to select studies based on their title, abstract and full text. The study selection process was summarised as a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Moher et al. 2009) (Figure 1).

Charting, summarising and reporting the results

Charting enabled the authors to map the extent of the research evidence and to identify gaps, commonalities and differences in the review results (Armstrong et al. 2011). Two spreadsheets were created to chart relevant data from the studies. The first spreadsheet (Supplemental online material: Table 1) included data about the studies: author(s), year, country of publication, article type, purpose, participants, design, methods, main results and reliability or validity of the instruments used (Armstrong et al. 2011).

The second spreadsheet included data about learning skills items assessed in undergraduate nursing student selection. The results from this spreadsheet were further synthesised (Grant and Booth 2009;

Armstrong et al. 2011) to answer the first research question. Using inductive content analysis, similar meanings were compiled in a table and further classified into categories (Table 2 near here) (Aveyard 2007). To answer research questions 2 and 3, the summarised results (Table 3 near here) were further investigated, and the review results were reported using narratives (see Results section of this paper) (Grant and Booth 2009; Armstrong et al. 2011).

Results

General description of the studies

In total, 24 studies met the inclusion criteria and were chosen for review (Figure 1). Five of the chosen studies were doctoral dissertations, and 19 were empirical research articles. The studies were published between 2006 and 2016 and originated from four countries: Australia (n = 1), Italy (n = 2), the United Kingdom (n = 3) and the United States (n = 18).

Learning skills assessed

The review identified four categories of learning skills assessed in undergraduate nursing student selection (Table 2): language and communication skills, reasoning skills, mathematical skills and natural sciences skills. The most frequently assessed learning skills were language and communication (24 studies) and mathematical skills (21 studies). The least assessed learning skills were reasoning (7 studies) and natural sciences skills (6 studies). All categories included several items used as objects of assessment; most of these were in the language and communication skills category (n = 12) while natural sciences skills were least frequent (n = 4) (Table 2).

Methods used to assess learning skills

The methods used to assess learning skills include onsite selection (test or exam before or during the selection process) and previous academic achievement. The two main onsite selection methods were standardised tests and other methods (Table 3); standardised tests were most often used (9 tests

out of 13), mainly to assess language and communication skills (7 tests) and mathematical skills (6 tests). Natural sciences skills were assessed in only two of the standardised tests (Health Education Systems Inc. [HESI], National League for Nursing [NLN]), and two (Health Sciences Reasoning Test [HSRT], Watson-Glaser Critical Thinking Appraisal [WGCTA]) focused exclusively on reasoning skills (Table 3). In addition, four other methods of onsite selection were identified, of which two were interviews and two were non-standardised tests. None of the onsite selection methods identified in this review assessed all four categories of learning skills (Table 3).

Test reliability was confirmed in only one of the selected studies (Nelson-Denny Reading Test [NDRT]) (Lajoie 2013); predictive validity was confirmed for three instruments: Test of Essential Academic Skills [TEAS] (Bremner et al. 2014), American College Test (ACT) and Scholastic Aptitude Test [SAT] (Grossbach and Kuncel 2011). Six of the studies reported previous assessments of reliability or validity by the instrument developers (Supplemental online material: Table 1). Overall, TEAS was the most tested instrument (Table 3).

In some of the selected studies, previous academic achievement was used as an admission criterion. Assessment of learning skills was based on indicators such as GPA in secondary school (Lancia et al. 2013) and prenursing studies (Stuenkel 2006; Newton et al. 2007; Newton and Moore 2009; McGahee, Gramling and Reid 2010; Grossbach and Kuncel 2011; Hernandez 2011; Herrera 2012; Jarmulowicz 2012; Cunningham et al. 2014; Harner 2014; Hinderer, DiBartolo and Walsh 2014; Crouch 2015; Elkins 2015). However, these studies reported previous academic achievement at a very general level, including only titles of preliminary courses or use of final course grades. For that reason, it was not possible to perform any more specific analysis of learning skills assessed by previous academic achievement.

Methods of assessing learning skills and relationship to academic performance

Relationships between onsite selection methods and academic performance were examined in 19 of 24 studies (Table 3). Most studies reported the use of total entry scores and their association with academic performance. Overall, onsite selection methods were positively related to academic performance in 15 studies, principally in the areas of first semester/year success (6 studies) and National Council Licensure Examination-Registered Nurse (NCLEX-RN) success (4 studies). Five studies found no correlation between entry scores and attrition, graduation or clinical competence. The relationship between standardised tests and academic performance was studied more often than for other onsite selection methods (Table 3).

Of all standardised tests, TEAS (measuring language, communication and mathematical skills) was the most studied (7 studies). In particular, TEAS entry scores predicted first semester/year success (Newton et al. 2007; Wolkowitz and Kelley 2010; Bremner et al. 2014; Harner 2014). Entry scores for standardised tests measuring reasoning skills (HSRT, WGCTA) were positively related to academic success at the beginning or during nursing studies. HSRT was the only standardised test that was positive related to entry scores and graduation (Pitt et al. 2015). Besides standardised tests, two of four other selection methods were reported to relate to academic performance. Overall Multiple Mini Interview (MMI) and MMI numeracy scores were significantly related to academic success during studies, but MMI literacy scores were only weakly related (Gale et al. 2016). The Nationwide Entry Exam ranking (Dante et al. 2011; Lancia et al. 2013) returned contradictory results; one study (Dante et al. 2011) identified a positive relationship with graduation and academic success, but another (Lancia et al. 2013) reported no statistically significant relationship between the exam and academic success/graduation (Table 3).

The relationship between previous academic achievement and academic performance was found to be positive in 11 of the selected studies (Stuenkel 2006; Newton et al. 2007; Newton and Moore 2009; McGahee, Gramling and Reid 2010; Grossbach and Kuncel 2011; Hernandez 2011; Herrera 2012; Lancia et al. 2013; Cunningham et al. 2014; Crouch 2015; Elkins 2015) (Supplemental online

material: Table 1). GPA was widely used in combination with onsite selection scores to predict academic performance. However, it was not possible to perform any more specific analysis because of the general nature of indicators of previous academic achievement (Supplemental online material: Table 1).

Discussion

Main findings

It is important to assess the learning skills of nursing applicants, because the nursing profession is characterised by certain cognitive requirements. According to the results of this review, undergraduate nursing student selection processes assess learning skills in four main areas: language and communication, reasoning, mathematics, and natural sciences. These results confirm previous reports that language, communication and mathematical learning skills are traditionally assessed. Assessment of basic science skills has previously been suggested, but there is no detailed description of these skills (WHO 2009; Herrera 2012). The present review identifies key natural sciences skills. Assessment of language, communication, mathematical and basic science skills is globally recommended for nursing student selection (WHO 2009). As indicators of academic aptitude, these may be regarded as core learning skills for nursing applicants. However, the review indicates that assessment of learning skills should encompass a wider range of cognitive aptitudes, including reasoning skills. Although reasoning skills are among the key competencies in nursing education, they are less often assessed when selecting student nurses (EFN 2015). Additionally, the selected studies reported that reasoning skills in the selection phase were a promising predictor of future academic performance. This finding supports the assessment of reasoning skills when selecting undergraduate nursing students. Developing reasoning skills is a core objective of all higher education students (Ghanizadeh 2017), but these skills are especially important in nursing as nurses worldwide become increasingly autonomous and responsible for patient care (Simmons 2010). All

the four categories of learning skills identified in this review, can be regarded as generic skills being applicable for all higher education applicants.

According to the results of this review, learning skills have mainly been assessed using standardised tests, but no existing test assesses all four identified categories of learning skills. However, more comprehensive assessment of learning skills may help higher education institutions to select those students most likely to succeed in their studies. This view is supported by the finding that overall scores in onsite assessments of learning skills are the best predictor of future academic performance (Stuenkel 2006; Newton et al. 2007; Wolkowitz and Kelley 2010; Dante et al. 2011; Grossbach and Kuncel 2011; Hernandez 2011; Underwood et al. 2013; Bremner et al. 2014; Cunningham et al. 2014; Hinderer, DiBartolo and Walsh 2014; Crouch 2015; Elkins 2015; Pitt et al. 2015; Gale et al. 2016). The most effective predictors of academic performance may be the primary focus for admission decisions to detect applicants with possible academic success or failure (Grossbach and Kuncel 2011). This finding is important concerning all higher education applicants. The comprehensive assessment of learning skills may benefit not only nursing schools, but most likely, also other disciplines due to the generic nature of the assessed skills.

Based on the review results, standardised tests may prove more valid and reliable as tools for selecting students with the required attributes (Perkins et al. 2013; van Ooijen-van der Linden et al. 2017) and may be better predictors of future academic success than the prenursing GPA alone (Stuenkel 2006; Hernandez 2011). Other onsite selection methods identified in this review are rarely studied. Overall, more research is needed to assess the validity and reliability of methods and follow-up settings for detecting key measurable skills and aptitudes that best predict performance in both educational and clinical settings. Additionally, concepts related to reasoning (e.g. decision-making, critical thinking) are used interchangeably in existing instruments; future studies should clarify and operationalise these concepts to ensure comprehensive assessment of reasoning skills.

Ethics, validity and limitations of this review

Guidelines for responsible conduct of research (TENK 2012) were followed to ensure honest reporting of the results of this review. As the included studies are publicly available, no permissions were needed. A review's validity is evaluated in phases (Whittemore and Knafl 2005). The research questions were clearly identified by the four authors before the search for relevant studies. Search terms were thoroughly modified by using several synonyms and by performing preliminary searches, concluding with the final search. The search parameters (articles published in Finnish or English during the period 2006–2018) may have excluded some relevant studies. Data charting by two of the authors (JV, KT) helped to ensure information accuracy. To enhance trustworthiness, special attention was paid in the reporting stage to critical examination of the results and conclusions of the scoping review (Whittemore and Knafl 2005). The implications of the results for further research and practice were also considered, making the results more meaningful and further enhancing trustworthiness (Armstrong et al. 2011). Reliability and validity issues were poorly reported, and this should be taken into account when interpreting the review results. Although most of the studies originated in the USA, the authors consider the review results to be generalisable because of the more or less universal requirements of nursing competencies and higher education studies.

Conclusions

The results of this review have implications for future higher education, research and for policy makers. Higher education institutions assess learning skills as part of their selection practices with various methods. The findings of the review suggest that higher education institutions can benefit from a comprehensive assessment of learning skills when selecting undergraduate nursing students. This assessment should focus on a wide range of cognitive aptitudes, including reasoning skills. The objective of the particular review was nursing education, but the review results may benefit other

higher education disciplines due to the generic nature of learning skills and similar cognitive requirements of higher education studies. The results support the development of more comprehensive instruments and methods for assessing learning skills to ensure the validity, equality and cost-effectiveness of selection processes. All higher education institution are encouraged to critically appraise their current selection practices.

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Declaration of interest statement

No potential conflict of interests was reported by the authors.

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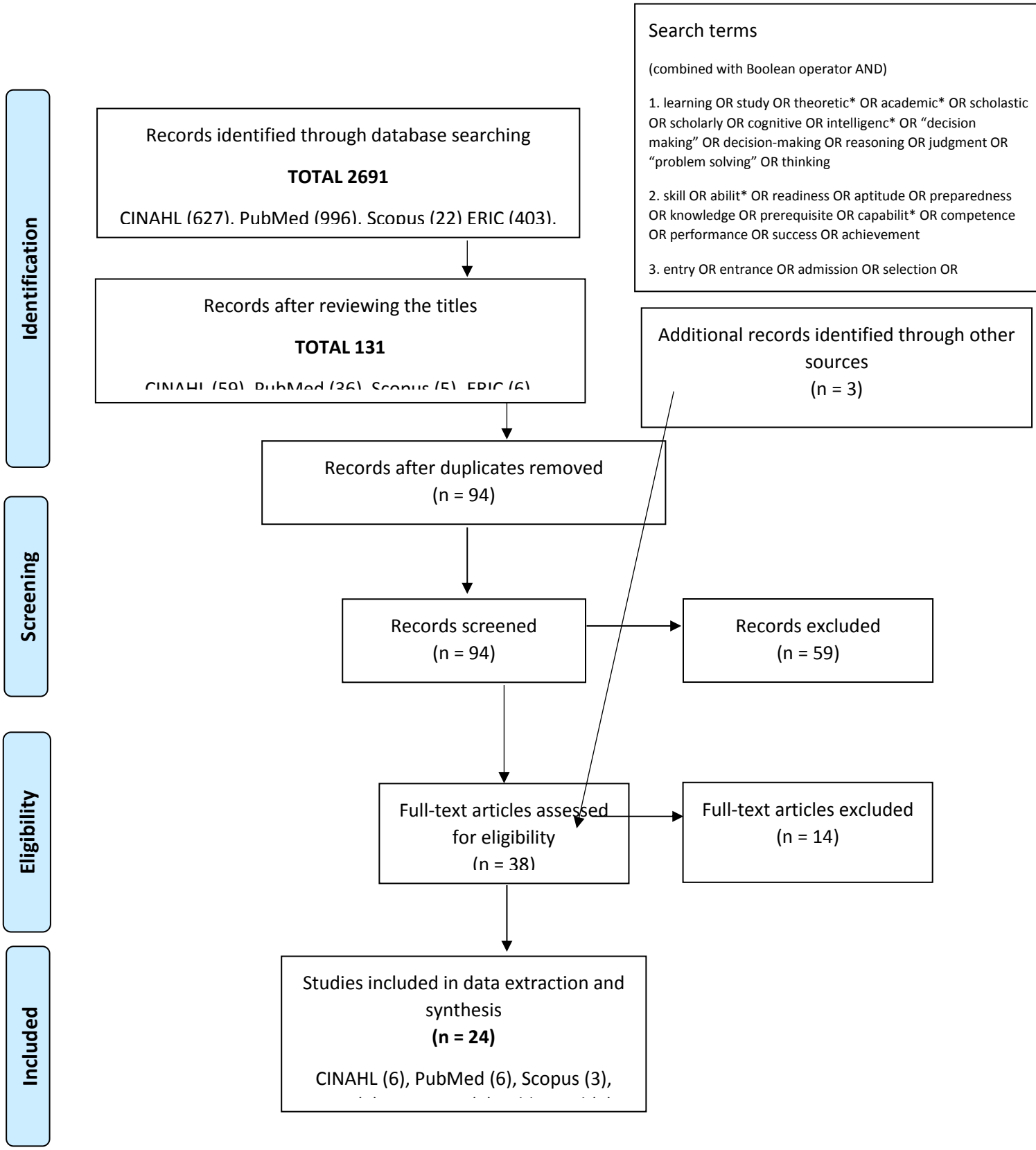

Figure 1. Flow diagram for the data search (Moher et al. 2009).

Supplemental online material

Table 1. Articles that met the inclusion criteria (n=24).

Author, year, location, article type	Purpose of the study	Participants, design, methods	Main results
Bremner et al. 2014, USA. Research article.	To identify students most likely to succeed in nursing studies using TEAS (V).	511 first semester students enrolled from fall 2011 to fall 2013. A cross-sectional, descriptive study.	Test of Essential Academi semester ATI proficiency
Crouch 2015, USA. Research article.	To assess Watson-Glaser Critical Thinking Appraisal (WGCTA), prerequisite GPA and the National League of Nursing (NLN) preadmission test as a pre-admission criterion.	192 first-year nursing students. Design not stated. Independent variables: WGCTA, prerequisite GPA, NLN. Dependent variable: nursing GPA.	WGCTA, prerequisite GP significant relationship wi relationship between prere (r=376, p<0.01).
Cunningham et al. 2014, USA. Research article.	To compare the predictive validity of rational versus empirically derived admission formula score.	283 students enrolled between fall 2005 and spring 2013. Design not stated. Predictor variables: overall GPA at entry, science GPA, and number of completed prerequisites and TEAS exam scores. Outcome variables: Nine ATI-specialty test scores, ATI fundamental score, second semester GPA, overall average GPA.	Four predictors explained of the variance in all four at entry and ATI-TEAS sc the outcomes. Results sup scores generated from reg
Dante et al. 2011, Italy. Research article.	To define the factors associated with academic success or failure.	117 nursing students enrolled in years 2004–05 on two different bachelor's courses. Retrospective multicenter design. Predictor variables: ranking in the entry exam, high school vs. professional or technical diploma. Outcome variables: academic success (graduation).	Having good entry exam s success (OR 4.217, IC95% exam mean a four-fold im graduating within three ye
Elkins 2015, USA. Research article.	To investigate the possible predictors of success in completing the baccalaureate nursing program and passing the NCLEX-RN licensure exam.	187 BSN nursing students from two courses admitted during fall 2007 and 2008.Correlational archival study (student records). Independent variables: preprogram GPA, American College Testing (ACT) scores, anatomy and physiology course grades, HESI exit exam scores. Dependent variables: graduation status in the BSN program, NCLEX-RN exam status.	A statistically significant r the preprogram GPA, ACT HESI Exit Exam scores w program and passing the N
Gale et al. 2016, UK. Research article.	To ascertain evidence of bias in Multiple Mini Interviews (MMI), and to determine the predictive value of the MMI of academic success.	204 students (one cohort of students from adult, child, mental health and learning disability programmes) who commenced studies in September 2011. A longitudinal retrospective analysis of student demographics, MMI data and the assessment marks for years 1, 2 and 3 modules.	MMI and MMI numeracy predict academic success (results predicted weakly a or no evidence of bias (ge secondary education).
Grossbach and Kuncel 2011, USA. Research article.	To examine the power of key admission and nursing school variables for predicting NCLEX-RN.	7,159 participants yielded correlation estimates for 13 different predictors. A meta-analysis of 31 independent samples across from year 1983 to 2008. Predictor variables observed: SAT, ACT, prenursing GPA.	SAT and ACT predicted p (GPA) was also predictive
Harner 2014, USA. Doctoral dissertation.	To examine the relationship between TEAS scores and early academic success in a BSN program.	218 nursing students. A correlational study. Predictor variables: TEAS (nursing admission). Outcome variables: course grades, ATI course mastery tests (1st year BSN courses).	Two subcomponents of TI were predictors of success
Hernandez 2011, USA. Doctoral dissertation.	To examine the relationships between quantifiable cognitive preadmission variables (preadmission GPA, TEAS) and BSN program outcomes.	275 nursing students. Longitudinal design. Outcome variables: ATI Fundamentals of Nursing and RN Comprehensive Predictor (prior to graduation) tests, failure of nursing coursework, persistence, academic dismissal, graduation, and passing NCLEX-RN (1st attempt).	TEAS composite and sect outcomes more strongly th Science section were espe success. TEAS composite Fundamentals test benchm program. Student withdra the TEAS Composite sco
Herrera 2012, USA. Doctoral dissertation.	To understand the patterns of selection, preparation, retention and graduation of undergraduate pre-licensure clinical nursing students	584 nursing students enrolled in 2007 and in 2008. Design not stated. Independent variables: Prerequisite course grades (15 courses), Select GPA, Replacement courses, Number of Prerequisites at 4 Year School, Nurses Entrance Test (NET) (Math, reading, overall). Dependent variables: completion of the program (four terms).	Prerequisite courses of Hu Ethics, and Human Pathop completing the program in predict program completio
Hinderer, DiBartolo and Walsh 2014, USA. Research article.	To explore the HESI admission scores, preadmission cumulative GPA and science GPA as predictors of progression to nursing major and first-time success on the NCLEX-RN.	89 nursing students admitted 2008–2010 (three cohorts). An exploratory retrospective descriptive design. Independent variables: HESI scores, preadmission GPA, science GPA, and nursing GPA. Dependent variables: "timely" progression to nursing major, NCLEX-RN success.	Health Education Systems with nursing GPA and NC progression.

Jarmulowicz 2012, USA. Doctoral dissertation.	To examine the admission requirements of nursing programs to better understand the philosophical underpinnings and complexity of selection criteria.	13 BSN student handbooks and academic bulletins, extraction of admission criteria. 33 full-time teachers. Descriptive correlational design. Admission criteria: Cognitive (GPA, SAT/ACT, prenursing admission test, science GPA, aptitude test of reading, writing and math), Professional (e.g. writing ability, communication skills) (PAEI tool), Time-limit and Other (e.g. health care experience, motivation).	35 admission criteria were All education programs sh (university admission follo and high school transcript baccalaureate degree prog (n=34, mean 10.56, SD 2.
Lajoie 2013, USA. Doctoral dissertation.	To describe and compare reading comprehension of two groups of students, a pre-nursing student group and a senior nursing student group.	Two groups of students, a pre-nursing student group (n=44) and a senior nursing student group (n=44). A descriptive, quantitative, non-experimental design. Independent variable: The Nelson-Denny Reading Test (NDRT).	Pre-nursing and senior nu standardization norms for senior nursing students als values for other health pro level of education.
Lancia et al. 2013, Italy. Research article.	To investigate the role in predicting nursing students' academic success.	1006 BSN students (five cohorts), matriculated in consecutive academic years from 2004 to 2008. A retrospective observational study. Independent variables: sex, age, upper-secondary school attended, grade of upper-secondary diploma, admission test scores. Outcome variables: graduation (within the 6 semesters), final degree grades and GPA of exam scores (incl. 18 exams for all).	The upper-secondary diplo admission test score, corre grades and GPA of exam s within 6 semesters had lov secondary diploma course
MacDuff, Stephen and Taylor 2016, UK. Research article.	To interpret perspectives regarding on-site selection of student nurses and midwives.	72 nursing students, 36 lecturers and 5 members of clinical staff from 7 Scottish universities. Qualitative enquiry utilizing individual and focus group interviews.	Staff used a range of attrib working, confidence, prob motivations, commitment)
McGahee, Gramling and Reid 2010, USA. Research article.	To examine student academic variables from a BSN nursing program to determine factors predicting success in NCLEX-RN.	153 graduates of BSN nursing programs over a period of 3 years between fall 2006 and spring 2009. Retrospective correlational design, logistic regression. Independent variables: SAT/ACT scores, prenursing science GPA (incl. Anatomy, Physiology, Chemistry), critical thinking test score (the time/phase of the measurement not stated), writing portfolio score, individual nursing course grades, number of nursing course failures, all standardized test scores, graduating GPA, and number of semesters taken to complete the nursing program. Dependent variable: NCLEX-RN success or failure at first attempt.	Science GPA (prior to adr Chemistry) predicts succe
Newton and Moore 2009, USA. Research article.	To describe the relationships among scholastic aptitude, nursing aptitude, BSN student attrition prior to the final semester, and BSN student readiness for the NCLEX-RN.	94 BSN students. Exploratory descriptive design. Independent variables: scholastic aptitude (GPA of seven prenursing courses) and nursing aptitude (TEAS). Dependent variables: attrition (students not progressing to final semester on schedule because of academic failure) and NCLEX-RN readiness (percentage score on the RN Comprehensive Predictor exam).	The final model indicated aptitude was predictive of nursing aptitude was not (nursing aptitude predicted
Newton et al. 2007, USA. Research article.	To explore predictive value of scholastic and nursing aptitude of early academic achievement in a BSN program.	164 sophomore nursing students. Exploratory descriptive design. Independent variables: scholastic aptitude (final grades of seven prenursing) and nursing aptitude (TEAS scores). Dependent variable: 1st semester GPA.	Scholastic and nursing apt variance in early academic only 15.4% of the varianc important predictor of 1st s
Perkins et al. 2013, UK. Research article.	To gauge the students` reaction to the interview concept (MMI).	890 candidates and 82 interviewers completed a short questionnaire. Survey study.	Over 90% of all the partic acceptable. 65% of the ca traditional interviews. 71% positively.
Pitt et al. 2015, Australia. Research article.	To explore entry critical thinking scores (Health Sciences Reasoning Test) in relation to demographic characteristics, students' performance and progression.	134 BSN students. Longitudinal correlational study. Independent variables: previous nursing-related experience, motivation, critical thinking (HSRT total and subscale scores). Dependent variables: Academic failure (failing a course each semester), progression (program completion in 3 years/withdrawal/continued enrolment after 3 years).	Statistically significant rel students' entry critical thi and ability to complete the strongest predictor of acad HSRT-test subscale scores significant relationship to
Stuenkel 2006, USA. Research article.	To explore the predictive value of various standardized examinations and achievement measures for NCLEX performance.	312 BSN students from 6 graduating classes who took the NCLEX for the first time (1997-2001). An archival, correlational design. Predictor variables: entrance to Nursing Program, NLN Pre-Admission Examination Score, college GPA, Scholastic Achievement Test (SAT) (total score).	The entrance criteria varia total scores accounted for in NCLEX-RN) and ident correctly. The results of th predictors are related to N prerequisite GPA alone w
Underwood et al. 2013, USA. Research article.	To evaluate the use of HESI Admission Assessment (A2) exam as a predictor of student success.	184 BSN students. Design not stated. Variables: HESI exam scores and final course grades in the three first-semester nursing courses.	HESI scores predicted the first-semester nursing cou so did the final course gra
Wolkowitz 2011, USA.	To determine whether the version of the TEAS	172,721 examinees from (practical, associate degree, bachelor's degree, diploma) nursing programs who	Regardless of program typ second attempt at the exa

Research article.	examination (same or parallel) taken on a repeated attempt significantly influences the score earned.	completed either the TEAS 3.0 or 4.0. 12,875 (7.5%) examinees completed two or more attempts at either version of this assessment and 1,752 (1.0%) attempted the assessment three or more times.	first attempt by a statistica amount. The BSN group s ($p < 0.01$).
Wolkowitz and Kelley 2010, USA. Research article.	To determine the strength of TEAS subscores (science, math, reading, English) in predicting early nursing success.	4,105 RN students (associate degree, BSN nursing programs) who completed both ATI's Fundamentals assessment and TEAS versions 1.0 through 4.0 (admission process). Predictor variables: subscores of the TEAS.	Strongest predictor of earl science subtest, followed l mathematics. 14.9% of the program success was expl

Tabl Table 2. Learning skills assessed in undergraduate nursing student selection.

Categories	Items	References
Language and communication skills	English reading (ACT)	McGahee, Gramling and Reid 2010; Grossbach and Kuncel 2011; Jarmulowicz 2012; Elkins 2015
	English writing (ACT)	McGahee, Gramling and Reid 2010; Grossbach and Kuncel 2011; Jarmulowicz 2012; Elkins 2015
	reading comprehension (ACT, HESI, NLN, NDRT, NET)	Stuenkel 2006; McGahee, Gramling and Reid 2010; Grossbach and Kuncel 2011; Herrera 2012; Jarmulowicz 2012; Lajoie 2013; Underwood et al. 2013; Hinderer, DiBartolo and Walsh 2014; Crouch 2015; Elkins 2015
	reading (TEAS)	Newton et al. 2007; Newton and Moore 2009; Wolkowitz and Kelley 2010; Hernandez 2011; Wolkowitz 2011; Bremner et al. 2014; Cunningham et al. 2014; Harner 2014
	reading rate (NDRT)	Lajoie 2013
	vocabulary (NDRT)	Lajoie 2013
	vocabulary & general knowledge of the language (HESI)	Underwood et al. 2013; Hinderer, DiBartolo and Walsh 2014
	word knowledge (verbal) (NLN)	Stuenkel 2006; Crouch 2015
	literacy (MacDuff, MMI)	Perkins et al. 2013; Gale et al. 2016; MacDuff, Stephen and Taylor 2016
	English language usage (TEAS)	Newton et al. 2007; Newton and Moore 2009; Wolkowitz and Kelley 2010; Hernandez 2011; Wolkowitz 2011; Bremner et al. 2014; Cunningham et al. 2014; Harner 2014
	verbal (NLN, SAT)	Stuenkel 2006; McGahee, Gramling and Reid 2010; Grossbach and Kuncel 2011; Jarmulowicz 2012; Crouch 2015
	communication (MMI)	Perkins et al. 2013; Gale et al. 2016; MacDuff, Stephen and Taylor 2016
Reasoning skills	analysis (HSRT)	Pitt et al. 2015
	inference (HSRT)	Pitt et al. 2015
	evaluation (HSRT)	Pitt et al. 2015
	critical thinking (HSRT, WGCTA)	Crouch 2015; Pitt et al. 2015
	decision-making (MMI)	Perkins et al. 2013; Gale et al. 2016; MacDuff, Stephen and Taylor 2016
	deductive reasoning (HSRT)	Pitt et al. 2015
	inductive reasoning (HSRT)	Pitt et al. 2015
	logic (nationwide entry exam)	Dante et al. 2011; Lancia et al. 2013
	problem-solving (MacDuff, MMI)	Perkins et al. 2013; Gale et al. 2016; MacDuff, Stephen and Taylor 2016
Mathematical skills	math (HESI, NET, SAT, TEAS, nationwide entry exam)	Stuenkel 2006; Newton et al. 2007; Newton and Moore 2009; McGahee, Gramling and Reid 2010; Wolkowitz and Kelley 2010; Dante et al. 2011; Grossbach and Kuncel 2011; Hernandez 2011; Wolkowitz 2011; Herrera 2012; Jarmulowicz 2012; Lancia et al. 2013; Underwood et al. 2013; Bremner et al. 2014; Cunningham et al. 2014; Harner 2014; Hinderer, DiBartolo and Walsh 2014
	numeracy (MacDuff, MMI)	Perkins et al. 2013; Gale et al. 2016; MacDuff, Stephen and Taylor 2016
	basic calculations (NLN)	Stuenkel 2006; Crouch 2015
	algebra (NLN)	Stuenkel 2006; Crouch 2015
	geometry (NLN)	Stuenkel 2006; Crouch 2015

	conversions (NLN)	Stuenkel 2006; Crouch 2015
	graphs (NLN)	Stuenkel 2006; Crouch 2015
	applied math (NLN)	Stuenkel 2006; Crouch 2015
	word problems (NLN)	Stuenkel 2006; Crouch 2015
Natural sciences skills	chemistry (HESI, NLN, nationwide entry exam)	Stuenkel 2006; Dante et al. 2011; Lancia et al. 2013; Underwood et al. 2013; Hinderer, DiBartolo and Walsh 2014; Crouch 2015
	physics (HESI, NLN, nationwide entry exam)	Stuenkel 2006; Dante et al. 2011; Lancia et al. 2013; Underwood et al. 2013; Hinderer, DiBartolo and Walsh 2014; Crouch 2015
	biology (HESI, NLN, nationwide entry exam)	Stuenkel 2006; Dante et al. 2011; Lancia et al. 2013; Underwood et al. 2013; Hinderer, DiBartolo and Walsh 2014; Crouch 2015
	anatomy & physiology (HESI)	Underwood et al. 2013; Hinderer, DiBartolo and Walsh 2014

ACT= American College Test, HESI= Health Education Systems Inc, NLN= National League for Nursing, NDRT= Nelson-Denny Reading Test, NET= Nurse Entrance Test, SAT= Scholastic Aptitude Test, TEAS= Test of Essential Academic Skills, HSRT= Health Sciences Reasoning Test, WGCTA= Watson-Glaser Critical Thinking Appraisal, MMI= Multiple Mini Interview

Table 3. Onsite selection methods of assessing learning skills and relationship to academic performance.

Name or type of the selection method/developer (Reference)	**Aim of the selection method**	**Number of questions, scales, subscales/Format**	**Scores/Time to complete**	**Items**
STANDARDISED TESTS				
American College Test (ACT)/ACT 1) Elkins 2015 2) Grossbach and Kuncel 2011 3) Jarmulowicz 2012 4) McGahee, Gramling and Reid 2010	A standardized test for high school achievement and college admissions.	Not stated.	Four sub-scores and a composite score./Not stated.	English (reading, writi natural science**, soci
Health Education Systems Inc. (HESI) Admission Assessment/Elsevier 1) Hinderer, DiBartolo and Walsh 2014 2) Underwood et al. 2013	To assess academic skills in three areas: English language, math, and science.	English language category consists of three exams, the math category consists of one exam and the science category consists of four exams.	English score is the mean of the three component exams scores. Science score is the calculated mean of four exam scores. A2 scores range from 0% to 100%./Not stated.	English: reading comp vocabulary & general grammar. Math: Basic math skill Science: biology, chem anatomy & physiology
Health Sciences Reasoning Test (HSRT)/- 1) Pitt et al. 2015	To measure critical thinking in undergraduate health students.	Total critical thinking score and five subscales.	Total critical thinking skills (total CT) (0-33p), analysis (0-6p), inference (0-6p), evaluation (0-6p), deductive reasoning (0-10p) and inductive reasoning (0-10p)/Not stated.	Total critical thinking CT), analysis, inferenc deductive reasoning a reasoning.
National League for Nursing (NLN) pre-admission test/National League for Nursing Accrediting Commission, Inc. 1) Crouch 2015 2) Stuenkel 2006	To assess academic skills in three areas: Verbal-Word knowledge, math, science.	Not stated.	Raw scores ranging, possible 100./Not stated.	Not stated in the articl NLN-website (2017): Verbal – Word knowle reading comprehensio Basic calculations, wo algebra, geometry, cor graphs and applied ma

				General biology, chem and earth science**.
Nelson-Denny Reading Test (NDRT)/- 1) Lajoie 2013	Measures the level of reading comprehension.	1) Vocabulary (80 items): five answer choices for each vocabulary item. 2) Comprehension (38 items): five answer choices. 3) Reading rate: calculated during the first minute of the comprehension section.	Four scores: 1) vocabulary; 2) reading comprehension; 3) a total score (vocabulary and reading comprehension) and 4) reading rate./Approx. 45 minutes.	Vocabulary, reading comprehension, readir
Nurse Entrance Test (NET)/Educational Resources Inc. 1) Herrera 2012	To assess applicant eligibility for admission.	A computer-based test with six parts. All six parts must be completed to receive scores and be considered for admission.	An overall or composite score and 30 subscales. Only the math and reading scores used to calculate application eligibility./Math: 60 problems in 60 min. Reading comprehension: 33 questions in 30 min.	Math skills, reading co
Scholastic Aptitude Test (SAT)/- 1) Grossbach and Kuncel 2011 2) Jarmulowicz 2012 3) McGahee, Gramling and Reid 2010 4) Stuenkel 2006	To measure scholastic aptitude.	Not stated.	Total scores, verbal scores, math scores./Not stated.	Verbal, math.
Test of Essential Academic Skills (TEAS)/Assessment Technologies Institute (ATI) 1) Bremner et al. 2014 2) Cunningham et al. 2014 3) Harner 2014 4) Hernandez 2011 5) Newton and Moore 2009 6) Newton et al. 2007 7) Wolkowitz 2011 8) Wolkowitz and Kelley 2010	To assess basic academic knowledge in reading, mathematics, science and English and language usage (academic skills). TEAS does not measure nonacademic qualities, such as motivation or temperament.	Multiple choice assessment. Composite scores, several sub-scores are computed in each of the four content areas to assess specific content comprehension.	A total of 170 four-option, multiple-choice items on the exam/The time limit is 209 minutes, but is not intended to be a limiting factor in the exam.	Reading, mathematics science, earth science, science, human body s and English language
Watson-Glaser Critical Thinking Appraisal /Watson & Glaser 1) Crouch 2015	To measure critical thinking abilities.	Five subtests, consisting of 80 items in total.	Not stated/Approx. one hour.	Critical thinking.
OTHER SELECTION METHODS				
Literacy and numeracy tests/- 1) MacDuff, Stephen and Taylor 2016	To assess literacy and numeracy skills.	Not stated.	Not stated/Not stated	Literacy and numeracy
Multiple Mini Interview (MMI)/- 1) Gale et al. 2016 2) MacDuff, Stephen and Taylor 2016 3) Perkins et al. 2013	To test a range of cognitive and non-cognitive attributes (e.g. emotional intelligence) in a standardized way.	The MMI system of interviewing comprises a circuit with a number of interview stations.	Not stated./Not stated.	Cognitive attributes: n skills, literacy skill, communication, decisi skills, problem-solving
Nationwide Entry Exam/- 1) Dante et al. 2011 2) Lancia et al. 2013	Testing general education in order to rank applicants.	The test consists of 80 multiple choice questions on: Logic and general education (33 items), mathematics and physics	Range scores from 18 to 31/Not stated.	General education**, logic, biology, chemis

		(13 items), biology (21 items) and chemistry (13 items).		
Onsite student selection processes: Interview/- 1) MacDuff, Stephen and Taylor 2016	To assess interpersonal skills, team working, confidence, problem-solving, aptitude for caring, motivations, and commitment.	Not stated.	Not stated/Not stated.	Problem-solving.

*Results based on the studies that report the possible relationships to academic performance.
**Further categorization of the item has not been possible due to the general level description.
NCLEX-RN=National Council Licensure Examination-Registered Nurse, ATI= Assessment Technologies Institute, GPA=Grade Point Average

Table 3. Onsite selection methods of assessing learning skills and relationship to academic performance.

Figure 1. Flow diagram for the data search (Moher et al. 2009).