Workplace Project Portfolio Part C

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Preface

Student's role

Overall contributions to project

My involvement in this project spanned from just prior to the commencement of data collection through dissemination of results. Throughout my involvement in the project I provided progressive input and advice during data collection, data entry and management, data analysis, and writing up study results for dissemination, including assistance in drafting of a conference abstract and a draft manuscript for publication to a peer-reviewed journal. My major role in the research team revolved around data analysis and management, as well as dissemination of results, and I played more minor roles in data collection and entry.

Overall value added to project

I have added value throughout the various stages of the project, contributing in a variety of ways. At a team meeting prior to data collection, I advised the research team regarding the delivery of structured and standardised information to the target population, and emphasised the need of obtaining complete data to facilitate analysis and linkage. This was necessary due to the complexity of collecting data at hundreds of tutorials over multiple campuses; it was essential to ensure all participants were adequately informed.

During the data collected stage of the project, I created a database template to facilitate data entry. In so doing, I decided upon user-friendly software (Microsoft Excel) for data entry to allow any team member to enter and view the data throughout the data entry process, in a format that could be easily imported to statistical programs for analysis. During data entry, I made major contributions to the entry of baseline data, and established procedures for identifying study cases, cleaning data and dealing with missing data.

I was the principal team member responsible for the analysis of entered data, with some support from my statistical supervisor as well as one other research team member. I decided upon the best statistical methods and software to use in data analysis, and presented these results to the team. Finally, I contributed to the dissemination of results, providing minor assistance in the drafting of one conference abstract, and playing a larger role in the drafting of the background, methods and results sections of a manuscript for peer-reviewed publication. I was lead author of the results section of this manuscript, and second author overall.

Reflections on Learning

Although my experience and knowledge in biostatistics and research has been increasing over the years, I had no idea what to expect when I started this project. Despite my experience working as part

of a research team, and theoretical knowledge of statistical principles, I had limited experience working as an independent member of a research team, and having significant responsibility in a project throughout the process from data collection to dissemination of results.

Communication skills

My primary form of communication with the research team throughout the project was via teleconference meetings and emails, with some face-to-face contact with certain team members as well. At the beginning of my involvement in the project I was less confident in my statistical and research skills, and this made me more reserved in my communication with the team. As the project progressed, I became more confident with putting forward my perspectives to the team in meetings and contributed more heavily in discussion regarding the project. I proposed statistical methods I perceived to best fit the data and address the study aims, and discussed any queries or issues the team had. Verbally explaining the statistical results in meetings to team members who had limited experience in quantitative research and statistical principles was challenging, yet rewarding, and I found the use of written reports supplemented discussion well.

Work patterns/planning

I began planning this project upon my completion of the previous semester to ensure I had my project and supervisor organised by the start of semester. This project involved a large amount of data collection and analysis, and although it afforded me a breadth of experience in statistical principles and methods, it required a substantial time investment. As such, I developed a timeline to guide and monitor my progress on the project and ensure I completed the required tasks. I endeavoured to regularly engage with the research team from the beginning of semester, and I employed the time before data was available to assist with data collection and entry, as well as progressing some sections of the project report. Although I tried to plan as much of my time as possible, factors beyond my control, such as project funding and delays in data entry necessitated flexibility and adaptability in my time management.

Statistical principles

This project drew upon my knowledge regarding a variety of statistical principles obtained through units such as Principles of Statistical Inference (PSI), Clinical Biostatistics (CLB), Linear Models (LMR) and Categorical Data and GLMs (CDA). Specifically, the content from these units regarding non-parametric statistical inference, reliability and validity analysis, linear regression models and generalised linear models assisted me in determining statistical methods and models that would best address the research hypotheses, and performing diagnostics on the resulting models.

Statistical methods

This study involved a range of statistical methods, including analysing the internal consistency of psychometric instruments to ensure sufficient coherence within the scales to use their total scores.

Although CLB had covered reliability analysis in the forms of inter- and intra-rater reliability, it had not explored the concept of internal consistency, nor had it covered statistical methods of validating psychometric tools, such as exploratory and confirmatory factor analysis. Thus, this project provided me with experience in assessing internal consistency using Cronbach's alpha statistics, as well as conducting exploratory and confirmatory factor analysis.

I was also required to decide upon the regression models to be used to predict baseline self-efficacy, as well as assessment performance. The binary nature of both assessment grades made the choice of the model for this data easy; logistic regression models were found to best fit these data. However, self-efficacy scores were more complicated to model, and were more of a challenge to fit models to. As these continuous variables were not interval data and not normally distributed, it was ultimately decided that logistic regression models would best suit these data as well.

Statistical computing

Statistical computing was conducted in Stata/IC version 14. I applied skills learnt through Data Management and Statistical Computing (DMC) to use Stata for data management and cleaning, and applied commands learnt in PSI, LMR and CDA to use Stata for analysis of the data. In addition, as the research team did not have access to Stata software, I was required to have a working knowledge of importing and exporting excel files to and from Stata, while ensuring that numerical and date/time variables retained appropriate formatting.

Teamwork

Communication with other team members

Throughout the project, I have had to display a range of communication skills in providing instruction and advice to the team regarding data collection, discussing study aims and hypotheses to guide data analysis, presenting statistical results to the team, and collaborating with team members in the drafting of manuscripts and conference abstracts. Throughout regularly held team meetings, I have been required to report my progress to the team, liaise with other team members and negotiate timelines for progression of the project.

Negotiating roles and responsibilities

During data entry, I liaised and negotiated with the team regarding the role I was happy to have in the project, and the amount of time I could commit. I indicated that I was willing to undertake some data entry, and indicated an amount of time that I would be able to commit to entering questionnaire data. Further, the team was aware that I would have to play a major role the data analysis for the project, and was happy to accommodate this as only one other member had extensive experience in quantitative research and data analysis. Negotiation was also required in the dissemination of results; particularly which investigators would head various sections of the manuscript and the order of

authorship. The team was very supportive in allowing me to take major responsibility in the writing of the manuscript, and as such we agreed on listing me as the second author on the paper.

Working within timelines

Due to the volume of data analysis required, as well as the fact that data collection was still in progress with the last data collection timepoint scheduled near the end of semester, this project required careful time management and planning to ensure it could be completed on time. I was required to manage my time around the various data collection time points, and complete as much of the project report as possible while waiting for further data collection and entry. In addition, I had to consider the time requirements of the team and negotiate appropriate deadlines for each stage of the project. There were a few delays in data entry as funding for data entry was sought, and the inclusion of some questions unrelated to numeracy in the numeracy examination necessitated obtaining students' exam papers and entering the individual grades for numeracy-specific questions. These unforeseen delays required flexibility and adaptability in my time management skills.

Helping others to understand statistical issues – teaching

Most team members did not have extensive experience in quantitative research or statistics, and as such, it was necessary to explain statistical issues and report results in a way that did not assume prior statistical knowledge. This involved explaining the meaning of various test statistics, such as odds ratios, and how to interpret them in the context of the study. Being involved in the project prior to data collection gave me the opportunity to brief the team on how participants should be informed during data collection to minimise missing data, and how missing data could affect the statistical results. Further, I was required to instruct the research assistants who were entering the data regarding the database template being used, what information needed to be entered and how to code the entries.

Ethical considerations: NHMRC ethics guidelines

Ethical approval to conduct the study was obtained from the Western Sydney University human research ethics committee (Approval number: 10338). I was included as an approved investigator on this ethics application, where my role in data management, analysis and dissemination of results was disclosed. All students were provided information sheets in their classes, as well as on their online learning site, and informed consent was obtained in class prior to participation.

Confidentiality issues

Being an employee at Western Sydney University, I had signed a staff confidentiality agreement, and was thus responsible for ensuring that the confidentiality of students was maintained. In addition, data was de-identified prior to linkage with student grades, with the only identifier remaining on the dataset being student ID. No identifying information was presented in the study findings, and only aggregate data was presented.

Professional responsibility

This research was undertaken in accordance with the Western Sydney University code of conduct and confidentiality agreements.

Front Sheet

Project title

Student's Self-Efficacy in Numeracy and Skill Performance in first year: The SYNAPSE-STARS Project

Location

Western Sydney University, Sydney

Dates

7 July 2017 – 30 November 2017

Context

In June 2017, a group of academics at the Western Sydney University School of Nursing and Midwifery commenced a research project looking at undergraduate nursing students' experiences in an introductory unit to medication administration. They sought to explore the relationship between numeracy and clinical skills self-efficacy and undergraduate students' performance in respective numeracy and clinical skills assessments of this unit. To complete my workplace project portfolio, I was involved as part of this research team to assist with data analysis.

Contribution of student to the project as a whole

- Advising team regarding data collection
- Data entry
- Cleaning and management of database
- Deciding upon statistical methods to be used
- Analysis of data
- Dissemination of results

Statistical issues involved

- Confidentiality issues
- Treatment of missing data
- Reliability analysis
- Analysis of non-normal data
- Fitting logistic regression models
- Model diagnostics

Signed declaration by student

I declare this project is evidence of my own work, with direction and assistance provided by my project supervisor. This work has not been previously submitted for academic credit.

29 November 2017

……. ……

Amy R Villarosa Date

Supervisor statement

Amy was instrumental in providing advice on data collection, management, and in planning and undertaking analysis of the data and providing interpretation and dissemination of results. The resulting work has been written up for a conference presentation and a manuscript for publication. Amy demonstrated not just her ability to grasp statistical issues but to communicate often complex concepts to those who are not as conversant with statistics in the research team. She has worked independently and effectively in the team.

29 November 2017

……. ……

Dr Sungwon Chang Date

Project report

Project description

Medication administration is primarily the responsibility of nurses in hospitals and other healthcare settings.[1-3] Although one of the most common nursing activities, this complex clinical skill is not often performed in isolation, but executed while juggling multiple other activities that demand the attention of the nurse at any one time [4]. Not surprisingly, the act of medication administration is inherently prone to error.

It has been purported that nearly two-thirds of medication errors are made by nurses, and the most common types of these errors are incorrect dosage or infusion rates.[5] Of concern is that these types of medication administration errors can result in serious harm to patients, often classified as adverse medication events [6]. Although multifactorial, recognised causes of medication administration errors include not possessing the necessary clinical and numeracy skills.[7] These essential skills include: i) the ability to correctly identify medications; ii) have sufficient knowledge regarding action of medications that are being administered; iii) correct verification of patient identity; iv) operation of equipment such as infusion pumps; and v) correct calculation of medication dosage.[8]

Ensuring all nursing students are competent in the essential foundational medication-related clinical and numeracy skills remains a challenge in undergraduate nursing education in Australia. This is exacerbated by the changing teaching demands, of having to meet the needs of students from diverse university entry pathways. Admission requirements for undergraduate courses have changed in recent years, and students are no longer required to undertake education in pre-requisite subjects such as mathematics and biology to gain admission into undergraduate nursing studies. Consequently, more nursing students are being admitted into nursing programs with no foundational mathematics education.

Compounding this challenge is Australia's concerning numeracy levels, ranking 14th in the world for numeracy, with 20% of Australians aged 16-19 falling below the minimum standard for numeracy, and 15% of Australian university graduates aged 20-34 having low numeracy skills.[9, 10]

Numeracy and simulated clinical skill assessments are typical of most Australian universities.[11] Although anxiety, negative attitudes and previous experiences can contribute to poor test performance among nursing students, self-efficacy and confidence are shown to be facilitators to academic performance.[12] Self-efficacy is defined as "people's beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives".[13] Self-efficacy is a construct highly specific to the context in which it is defined. Those with high self-efficacy in one area may have low self-efficacy in another.[14] Further, the degree of an individual's self-efficacy is

fluid, and can increase and decrease over time as a person's knowledge and experience changes.[15] Self-efficacy has also been associated with gender, with males generally more often having higher self-efficacy than females.[16]

In the academic context, self-efficacy comprises a student's judgements regarding their ability to attain certain levels of academic achievement. Among university students' first year of study, self-efficacy has been shown to be one of the strongest predictors of academic performance. [17] This is not surprising as the same study also showed that students with high self-efficacy to perceive academic work demands as a challenge rather than a threat.[17] However, due to their limited experience and awareness of the demands of the academic tasks, studies of first-year students also indicate that some students are more susceptible to inaccurate self-efficacy judgements, highlighting an inability to judge ability from performance feedback.[18]

Although there are some studies that have explored the relationship between self-efficacy and numeracy skills, or self-efficacy and clinical skill performance, none explore the relationship between self-efficacy in both numeracy tests and clinical skill performance, and their actual performances in these two skills, as would be seen in medication administration tasks. Understanding the complex relationship between self-efficacy in numeracy and clinical skill performance and academic performance is essential if pedagogical approaches are to be refined, thereby improving nursing students' success in numeracy and clinical skill performance and reducing risk of medication error.

Study setting

The study was undertaken with nursing students at a university located in the western Sydney region. In this undergraduate nursing program, two distinct assessments provided the first points of contact for drug calculations used in medication administration and medication-related clinical skills. Students' proficiency in drug calculations was assessed with an examination requiring mastery (a score of 100%) to pass. Students' clinical skills in relation to medication administration were assessed using a simulated environment, for example, the Objective Structured Clinical Assessment (OSCA), where students are required to role play a medication administration scenario.

Aims

This study aimed to examine predictors of nursing students' self-efficacy in: i) numeracy; and ii) clinical skills performance. The study also examined the relationship between each of these self-efficacies and their actual performance. It is envisaged that findings from this study would provide insights into further curricular and pedagogical improvements in the teaching and assessment of numeracy and clinical skills, to prepare graduate nurses for safer medication administration practices.

To guide statistical analysis, hypotheses were generated by the research team. These hypotheses were:

1. Specific demographic (i.e. males, international students who completed their high school education overseas) and academic-related characteristics (i.e. completed advanced mathematics education in high school, had shorter time lapse since receiving this education, had high Grade Point Average [GPA] in previous semester), are positively associated with high mathematics self-efficacy prior to receiving numeracy instruction in this unit of study.

2. There will be a significant increase in mathematics self-efficacy following numeracy instruction.

3. High mathematics self-efficacy following numeracy instruction will predict a satisfactory grade in students' first numeracy test, controlling for the following demographic and academic factors: gender, international students, GPA, highest formal mathematical education, and time lapse since receiving this education.

4. Prior to receiving clinical skills instruction, high clinical skills self-efficacy is positively associated with the following demographic and academic-related characteristics among nursing students: i) males; ii) completed their high school education overseas (i.e. international students); iii) Australia-born; iv) speak English at home; and v) high GPAs.

5. There will be a significant increase in clinical skills self-efficacy following clinical skills instruction.

6. High clinical skills self-efficacy following clinical skills instruction will predict a satisfactory grade in students' first clinical skills assessment, controlling for the following demographic and academic factors: gender, international students, Australian born students, students who speak English at home, GPA, and campus.

Description of Design

Study design

This study utilised a prospective survey design conducted over two phases to determine whether students' self-efficacy could predict performances in numeracy and clinical skill assessments. The first phase focused on the students' numeracy self-efficacy and performance in their first numeracy exam, testing Hypotheses 1-3. The second phase tested hypotheses 4-6, focussing on students' clinical skills self-efficacy and performance in their first clinical assessment.

Sampling and setting

Recruitment for this study took place across four campuses of a university in Greater Western Sydney. Students who were enrolled in the Bachelor of Nursing, and were undertaking their introductory course to medication administration were eligible to participate. A purposive sampling technique was used whereby students were invited to participate in the study during class at the commencement of their unit of study. Class tutors were provided information about the study and a link to a short video to play in class, as a standardised way of obtaining informed consent. Students

were also provided with participant information sheet (PIS) and consent form, which were also made available to students through the institutional online learning management system (LMS).

Ethical issues

Ethical approval to conduct the study was obtained from the University Human Ethics Committee [Approval number: H10338]. Although project information (PIS, video and consent form) was available on the LMS for the duration of the study, written consent was obtained only at baseline. Hence, assessment grades of students who did not consent at baseline but completed the surveys in later time points were excluded from analysis as consent for data linkage could not be verified.

Data management

Obtaining data

This two-phase project (Phase 1: Numeracy; Phase 2: Clinical Skills) collected data at three time points for each phase.

For Phase 1, a baseline questionnaire containing items regarding numeracy self-efficacy and demographic characteristics was administered at the beginning of semester. A follow-up survey was administered 6 weeks later (1 week before first numeracy test) to assess if self-efficacy changed over the semester with numeracy instructions. Their first numeracy test scores were then retrieved from the online student administrative database.

For Phase 2, baseline clinical self-efficacy data was also collected at Week 6, the same time when the second numeracy self-efficacy was collected. The follow-up clinical self-efficacy survey was administered in Week 14, 8 weeks following the initial skills self-efficacy survey, which was a week prior to their clinical assessment. Finally, participants' clinical assessment grades were collected from the same online database. The questionnaires administered at weeks 1, 6 and 14 can be seen in Appendix 1.

Measures

Along with student ID and demographic characteristics such as age, previous attempts at the unit, whether students were endorsed enrolled nurse, highest level of mathematics studied, and when mathematics was last studied, a standardised measure was used in the questionnaire; the nursing students' self-efficacy for mathematics (NSE-Math) instrument This instrument, initially developed to assess the confidence of second year students regarding performing various mathematical problems related to medication calculations, was used to measure the numeracy self-efficacy of nursing students. This validated scale consists of 12 items on an 11-point Likert scale ranging from 0 (no confidence at all) to 10 (complete confidence) and has been shown to have high internal consistency (Cronbach's alpha = 0.88).[19]

In addition, a 12-item clinical skills self-efficacy scale was developed by the investigators., This scale also used an 11-point Likert scale, ranging from 0 (no confidence at all) to 10 (complete confidence).

Following data entry, questionnaire data was linked with data from university administrative databases using provided student IDs. Data linked included students' grades in the respective numeracy and clinical skill related assessments, gender, country of birth, enrolment category and language spoken at home.

Data cleaning/manipulation

Raw data from questionnaires was inspected for any outlying numbers that may have been erroneously entered. Any potential errors were investigated by verifying the value against the original completed questionnaire where possible, otherwise any implausible values were excluded from analysis casewise. Following this, missing data were inspected. As self-efficacy scales were to be collapsed into total scores, cases with missing data in any of the self-efficacy items were excluded from analysis. Those who did not provide student ID numbers could not have demographic data, grades and follow-up measures linked to baseline measures, therefore these respondents were also excluded from analysis.

As the students' first numeracy examination included some questions that were not related to numeracy, these questions were excluded from analysis of numeracy-self-efficacy, and a satisfactory/unsatisfactory score was generated purely based on the numeracy questions. Students were required to get 100% to achieve a satisfactory grade. Responses to the self-efficacy instrument were also added into total scores. As the categorical variable detailing time since maths was last studied had insufficient numbers in some categories for inferential analysis, it was dichotomised as close as possible to the median.

Statistical methods

Statistical issues

There were specific statistical requirements to test each of the study hypotheses. Hypotheses 1 and 4 involved the investigation of a continuous variable, and required the use of a model that could control for a range of variables. Hypotheses 2 and 5 required a pairwise analysis of continuous measures to investigate change over time. Finally, hypotheses 3 and 6 involved the investigation of a binary outcome variable, and required the use of a model to control for potential confounders.

Statistical methods chosen

Except for factorial validity (exploratory factor analysis and confirmatory factor analysis), all other data analyses for this study were completed in Stata/IC 14.2.[20] A full do-file for analysis can be seen in Appendix 2. A thorough descriptive analysis was conducted for all variables, including the mean, standard deviation, median, minimum and maximum of continuous variables, and frequencies and percentages for categorical variables. Shapiro-Wilk tests were also conducted to assess the normality of continuous variables.

The SPSS software version 24 was used for exploratory factor analysis (EFA) to examine the number of components in both standardised scales used in this study, the Nursing Self-Efficacy in Mathematics (NSE-math) scale and the Clinical Skills Self-Efficacy (CSSE) scale. EFA was conducted using principal component analysis with baseline survey data for NSE-math scale and 6-week survey data for CSSE scale. The number of components retained in the EFA was established using scree plot. Items with component loadings of > 0.4 were included. For confirmatory factor analysis, the AMOS version 24 software was used. The 6-week survey data was used for the CFA of NSE-math (Phase 1), and the 8-week survey data was used for the CFA of the CSSE (Phase 2). Fit indices selected in the CFA were: chi-square, Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), Adjusted Goodness-of-Fit Index (AGFI), and Root Mean Square Error of Approximation (RMSEA). Values of > 0.95 for the TLI, CFI and AGFI, and a value of <0.08 for the RMSEA suggest good fit.[21]

Cronbach's alpha for the two self-efficacy standardised tools were calculated to ensure internal consistency of the scales. Change in self-efficacy scores over time were analysed using paired *t*-tests for normally distributed data, and Wilcoxon sign rank tests for non-normal data.

Bivariate analyses were conducted as a preliminary investigation of variables associated with baseline self-efficacy and assessment performance. Associations between continuous variables were analysed using Pearson's correlation coefficients, and associations between categorical variables were analysed using Pearson's Chi-squared tests. To examine for differences in measures of central tendency of continuous variable cross categorical variables, independent *t*-tests and ANOVA tests were used for normally distributed binary variables and normally distributed variables with more than two categories respectively. Mann-Whitney and Kruskal-Wallis *H* tests were used for non-normal binary variables and variables with more than two categories respectively.

Finally, four multivariate models were constructed to investigate Hypotheses 1, 3, 4 and 6. For Hypotheses 1 and 4, multiple linear regression models were initially constructed using the continuous measures of baseline self-efficacy as the outcome variable. However, as the residuals of these models were heteroscedastic and non-normally distributed, the assumptions of these models were violated (see Appendix 4). As such, the continuous baseline self-efficacy scores were dichotomised at the mean, and a logistic regression model was constructed with these binary variables. Logistic regression models were also fitted for the binary dependent variables for Hypotheses 3 and 6. Goodness of fit was tested for all models using Hosmer-Lemeshow goodness-of-fit statistics, predictive power was evaluated using McFadden's *R*-squared values and assumptions of linearity were evaluated using the Box-Tidwell test.[22] When constructing the model for Hypothesis 6 to predict performance in the clinical skills assessment, it was found that GPA was not linearly related to clinical skills assessment performance. As such, it was necessary to dichotomise GPA at the median and treat it like a categorical variable.

Justification of methods chosen

Logistic regression models were chosen to model the binary exam performance data as they are one of the most commonly used regression models for binary data. Although the choice to dichotomise the continuous self-efficacy variables resulted in a loss of information, the assumptions of linear regression models could not be met with the data at hand, despite attempts to transform data to normalise the distribution to enable the use of parametric tests.[23] Dichotomising the data allowed for the use of a logistic regression model involving fewer assumptions, which study data could meet.

Interpretation of results

Summary of results

A total of 743 respondents returned a study questionnaire at baseline, of which 672 respondents were included in analysis as they completed all 12 items on the NSE-Math scale at baseline and provided student ID numbers. Out of the 879 participants at the 6 week follow-up, 525 were included in analysis as they participated at baseline, completed all 12 NSE-Math items, and provided student ID numbers. Similarly, for the clinical skills phase, a total of 529 out of 879 were included in baseline analysis, with 479 out of 835 participants included at follow-up as they participated at baseline, completed all 12 clinical skills self-efficacy items and provided student ID numbers. The mean GPA and clinical skills self-efficacy of included participants was significantly higher than those who were excluded (Table 1), as were the number of participants who spoke English at home, who were born in Australia, and who passed the clinical skills and numeracy assessments (Table 2). A significantly higher proportion of students were included from Campuses 1 and 2, with fewer included from Campus 3 (Table 3).

Table 1: Descriptive statistics for included continuous variables, and comparison with excluded cases

Variable	Included Mean (*SD*) (*n*=672)	Excluded Mean (*SD*) (*n*=71)	Wilcoxon rank-sum	Wilcoxon signed-rank	Shapiro Wilk test of normality
Age (years)	25.66 (8.00)	27.30 (9.03)	1.787 (*p*=0.074)		9.820 (*p*<0.001)
Grade point average	4.72 (1.18)	4.18 (1.59)	-5.789 (*p*<0.001)		7.947 (*p*<0.001)
NSE-Math score at baseline	84.10 (23.92)	84.06 (22.55)	-0.066 (*p*=0.947)	9.792 (*p*<0.001)	5.431 (*p*<0.001)
NSE-Math score at 6 weeks	91.59 (20.00)	90.86 (21.42)	-0.181 (*p*=0.856)		5.843 (*p*<0.001)
Baseline clinical skills self-efficacy	100.49 (16.45)	100.42 (17.39)	0.290 (*p*=0.772)	11.735 (*p*<0.001)	8.627 (*p*<0.001)
Clinical skills self-efficacy at 8 weeks	109.05 (12.56)	107.00 (12.38)	-2.347 (*p*=0.019)		9.387 (*p*<0.001)

Table 2: Descriptive statistics for included binary categorical variables, and comparison with excluded cases

Variable	Included *n* (%)	Excluded *n* (%)	Pearson's chi-squared (1df)
Male	107 (15.92)	126 (19.06)	0.080 (*p*=0.777)
Previously undertook unit	41 (6.07)	5 (7.94)	0.342 (*p*=0.559)
Enrolled endorsed nurse	7 (1.04)	0 (0.00)	0.612 (*p*=0.434)
Speaks English at home	372 (54.63)	307 (40.72)	27.771 (*p*<0.001)
Enrolled as international student	110 (16.37)	112 (16.97)	0.087 (*p*=0.769)
Australian-born	300 (44.05)	257 (34.08)	14.971 (*p*<0.001)
Passed numeracy assessment	543 (90.05)	429 (84.78)	7.050 (*p*=0.008)
Passed clinical assessment	540 (80.12)	427 (70.35)	16.484 (*p*<0.001)

Table 3: Descriptive statistics for included categorical variables, and comparison with excluded cases

Variable	Included *n*(%)	Excluded *n*(%)	Pearson's chi-squared (1*df*)
Maths level			
○ Year 10 (or equivalent)	164 (24.30)	17 (27.42)	1.759 (*p*=0.881, 5*df*)
○ Year 12 (2-unit general maths, MIS/MIP course or equivalent)	294 (43.56)	29 (46.77)	
○ Year 12 (2-unit advanced maths or equivalent)	77 (11.41)	6 (9.68)	
○ Year 12 (3-unit maths, extension I or equivalent)	21 (3.11)	1 (1.61)	
○ Year 12 (4-unit maths, extension II or equivalent)	38 (5.63)	4 (6.45)	
○ Other	81 (12.00)	5 (8.06)	
Year of last education in mathematics			
○ 2010-2016	423 (62.48)	36 (57.14)	0.484 (*p*=0.486, 3*df*)
○ 2000-2009	181 (26.74)	17 (26.98)	
○ 1990-1999	54 (7.98)	7 (11.11)	
○ Before 1990	19 (2.81)	3 (4.76)	
Campus			
○ Campus 1	194 (28.87)	136 (20.57)	40.726 (*p*<0.001, 3*df*)
○ Campus 2	177 (26.34)	123 (18.61)	
○ Campus 3	288 (42.86)	397 (60.06)	
○ Campus 4	13 (1.93)	5 (0.76)	

In total, the mean age of the sample was 25.7 years (Table 1), and almost 16% were male (Table 2). More than half of respondents were born outside Australia, with 16% being international students (Table 2). Just over one-quarter of respondents had attained a mathematical education at a high school Year 10 level or below, with almost two thirds receiving their mathematical education in the last 7 years (Table 3). The average GPA achieved by respondents was high, with a median 4.8 out of a total 7 points (Table 1).

NSE-Math scale (Phase 1, EFA - baseline data and CFA – 6-week survey data): Using PCA extraction procedure, one component was extracted with an eigenvalue of 7.14, explaining 59% of total item variance. All 12 items of the NSE-Math loaded highly (0.67 to 0.86) on one component, well above the 0.4 component loading threshold. This one-component structure was further confirmed in the CFA using the NSE-Math scale data collected during the 6-week survey. All path estimates of the 12 items were statistically significant at the 5% level, with standardised factor loading ranging from 0.54 to 0.84 (Figure 1, Appendix 3). Fit indices of this one-factor structure indicated satisfactory fit ($\chi 2$ = 130.52, *df*: 36, *P* <0.001, TLI = 0.98, CFI = 0.99, AGFI = 0.95, RMSEA = 0.55).

CSSE scale (Phase 2, EFA – baseline survey data and CFA – 8-week survey data): Using PCA extraction procedure, one component was extracted, with an eigenvalue of 7.49, explaining 62% of total item variance. Similarly, all 12 items of the CSSE loaded highly, ranging from 0.74 to 0.84. The CFA of the one-component structure using AMOS using the 8-week survey data collected in Phase 2 yielded standardised factor loadings ranging from 0.62 to 0.86, which were statistically significant at the 5% level (Figure 2, Appendix 3). Fit indices of this unidimensional model indicated satisfactory fit ($\chi 2$ = 147.42, *df*: 40, *P* <0.001, TLI = 0.97, CFI = 0.98, AGFI = 0.95, RMSEA = 0.57).

At baseline, students had a median NSE-Math scale score of 86 points out of a total possible score of 120. At the 6-week follow-up, median NSE-Math scores increased to 94, and grades of their first numeracy test undertaken the following week showed that the majority (88%) were able to achieve a satisfactory grade (Table 2). Baseline clinical self-efficacy scores were higher, with a median of 104 out of 120, and increased to a median of 111 at 8 weeks. The clinical assessment also had a high pass-rate, with 80.12% of students achieving a satisfactory grade (Table 2). All instruments had a high internal consistency, ranging from a Cronbach's alpha of 0.836 to 0.940 (Table 4).

Table 4: Reliability of self-efficacy instruments at each time point

Instrument	Cronbach's Alpha
NSE-Math Baseline (Phase 1)	0.937
NSE-Math 6 Weeks (Phase 1)	0.917
NSE-Clinical Baseline (Phase 2)	0.940
NSE-Clinical 8 weeks (Phase 2)	0.836

Predictors of high NSE-Math scores at baseline

In testing the first hypothesis, an initial descriptive analysis of the data confirmed potential associations between NSE-Math scores at baseline and GPA, gender, enrolment category, highest level of maths education and time lapse since receiving this education (Tables 5, 6 and 7).

Table 5: Pearson correlation of grade point average and age with NSE-Math score at baseline

Variable	*R*	*p*
Grade point average	0.106	0.006
Age (years)	0.052	0.179

Table 6: Bivariate statistics comparing mean NSE-Math scores at baseline with binary variables

Variable	Mean NSE-Math score at baseline	*SD*	Mann Whitney *U* test
Gender			
○ Male	95.11	23.01	-5.593 (p<0.001)
○ Female	82.07	23.56	
Enrolment category			
○ International	92.60	22.08	-4.109 (p<0.001)
○ Domestic	82.49	23.95	

Table 7: Bivariate statistics comparing mean NSE-Math scores at baseline with categorical variables

Variable	Mean NSE-Math score at baseline	*SD*	Kruskal Wallis *H* test
Highest level of education in mathematics			
○ Year 10 (or equivalent)	75.15	24.56	63.142 (p<0.001, 5df)
○ Year 12 (2-unit general maths, MIS/MIP course or equivalent)	81.87	23.36	
○ Year 12 (2-unit advanced maths or equivalent)	93.19	20.46	
○ Year 12 (3-unit maths, extension I or equivalent)	99.76	17.42	
○ Year 12 (4-unit maths, extension II or equivalent)	95.71	19.01	
○ Other	91.73	22.58	
Year of last education in mathematics			
○ 2010-2016	84.94	23.76	2.114 (p=0.549, 3df)
○ 2000-2009	82.66	24.33	
○ 1990-1999	82.69	25.33	
○ Before 1990	80.47	20.46	

These five variables were entered simultaneously into a logistic regression model as potential predictors of NSE-Math scores at baseline. Gender and mathematical education emerged as significant predictors of high baseline NSE-Math scores when controlling for all other variables. Those who were male had over 2.5 times higher odds of a high NSE-Math score (OR 2.86, 95% CI: 1.65 to 4.25). The odds of a high NSE-Math score increased with each level of mathematical education, peaking at those with a high school extension 1 mathematics level education or equivalent with over 9 times the odds of high NSE-Math scores (OR 9.43, 95% CI: 2.95 to 30.13). The chi-square statistic of Hosmer–Lemeshow goodness-of-fit test was 4.36 (df=8, p = 0.823), the McFadden's R^2 value was 0.091, and the Box-Tidwell test indicated no violation of linearity (0.051, p=0.821). The full logistic regression model can be seen in Table 2.

Table 8: Predictors of high NSE-Math scores at baseline

Variable	Coefficient	*z*	*P*>|*z*|	OR	95% CI for OR	
Gender						
○ Female (reference)	0.000			1.00		
○ Male	0.950	4.05	<0.001	2.86	1.654	4.247
Enrolment category						
○ Domestic (reference)	0.000			1.00		
○ International	0.425	1.60	0.110	1.53	0.909	2.576
Highest mathematical education equivalent						
○ Year 10 (reference)	0.000			1.00		
○ Year 12 (2-unit general maths))	0.862	3.85		2.37	1.527	3.678
○ Year 12 (2-unit advanced)	1.494	4.77	<0.001	4.46	2.412	8.236
○ Year 12 (extension I)	2.244	3.79		9.43	2.950	30.127
○ Year 12 (extension II)	1.375	3.39		3.95	1.786	8.753
Year maths subject was last studied						
○ 2010-2016 (reference)	0.000			1.00		
○ 2000-2009	0.020	0.09	0.777	1.02	0.671	1.549
○ 1990-1999	0.009	0.03		1.01	0.523	1.946
○ Before 1990	-0.569	-1.02		0.57	0.189	1.693
Grade point average	0.106	1.37	0.170	1.11	0.956	1.294
Constant	-1.575	-3.71	<0.001	0.21	0.090	0.476
McFadden's *R*-squared	0.091					
Hosmer-Lemeshow goodness-of-fit (8 *df*)	4.36 (*p*=0.823)					
Box-Tidwell test (nonlinear dev.)	0.051 (*p*=0.821)					

Increased NSE-Math scores from baseline to week 6

Comparing scores of respondents who had completed all items of the NSE-Math scale in both the baseline and 6-week follow-up surveys, mean NSE-Math scores increased from 84.10 to 91.59 (Table 1). This increase was statistically significant (Z=9.792, p<0.001).

Predictors of a satisfactory grade in the first numeracy test

The third hypothesis was also first explored using an initial descriptive analysis of the data. This confirmed potential associations between satisfactory numeracy examination grades and GPA and NSE-Math score at 6 weeks (Tables 9, 10 and 11).

Table 9: Bivariate statistics comparing mean grade point average and NSE-Math score at 6 weeks at baseline by satisfactory/unsatisfactory numeracy exam grade

Variable	Mean (Satisfactory)	*SD*	Mean (Unsatisfactory)	*SD*	Mann Whitney *U* test
Grade point average	4.84	1.12	4.06	1.36	-4.458 (p<0.001)
NSE-Math score at 6 weeks	92.81	19.48	85.06	21.09	-2.515 (p<0.012)

Table 10: Bivariate statistics comparing binary variables by satisfactory/ unsatisfactory numeracy exam grade

Variable	Maths test grade *N*(%)		Pearson's χ^2 (1*df*)
	Satisfactory	Unsatisfactory	
GPA			
○ Less than 5	463 (64.76)	252 (35.24)	51.119 (p<0.001)
○ Greater than or equal to 5	495 (82.36)	106 (17.64)	
Self-efficacy at 6 weeks			
○ Self-efficacy greater than or equal to 94	229 (93.09)	17 (10.11)	5.733 (p=0.017)
○ Self-efficacy less than 94	198 (86.46)	31 (13.54)	
Gender			
○ Male	89 (90.82)	9 (9.18)	0.080 (p=0.777)
○ Female	453 (89.88)	51 (10.12)	
Language spoken at home			
○ English	293 (88.52)	38 (11.48)	1.917 (p=0.166)
○ Languages other than English	250 (91.91)	22 (8.09)	
Mode of enrolment			
○ International	95 (94.06)	6 (5.94)	2.192 (p=0.139)
○ Domestic	447 (89.92)	54 (10.78)	
Country of birth			
○ Australia	235 (88.35)	31 (11.65)	1.542 (p=0.214)
○ Overseas	308 (91.39)	29 (8.61)	

Table 11: Bivariate statistics comparing categorical variables by satisfactory/ unsatisfactory numeracy exam grade

Variable	Maths mark *N*(%)		
	Satisfactory	Unsatisfactory	Pearson's χ^2
Highest level of education in mathematics			
○ Year 10 (or equivalent)	127 (90.07)	14 (9.93)	
○ Year 12 (2-unit general maths, MIS/MIP course or equivalent)	239 (87.87)	33 (12.13)	
○ Year 12 (2-unit advanced maths or equivalent)	61 (95.31)	3 (4.69)	4.004 (*p*=0.549, 5*df*)
○ Year 12 (3-unit maths, extension I or equivalent)	18 (94.74)	1 (5.26)	
○ Year 12 (4-unit maths, extension II or equivalent)	32 (91.43)	3 (8.57)	
○ Other	61 (91.04)	6 (8.96)	
Year of last education in mathematics			
○ 2010-2016	334 (89.30)	40 (10.70)	
○ 2000-2009	146 (91.82)	13 (8.18)	1.381 (*p*=0.710, 3*df*)
○ 1990-1999	43 (87.76)	6 (12.24)	
○ Before 1990	16 (94.12)	6 (5.88)	

In addition to the same five predictor variables in the first logistic regression model, NSE-Math score at 6-week follow up was added into this second logistic regression model to explore potential predictors of satisfactory math grades in the first numeracy test. Only one statistically significant predictor of satisfactory math grade emerged from this model, high GPA. Each unit increase in GPA increased the odds of a satisfactory numeracy exam grade by 1.8 times (OR 1.817, 95% CI: 1.60-7.23). This model also had a satisfactory fit, with a Hosmer–Lemeshow goodness-of-fit chi-square statistic of 8.55 (8 *df*, $p = 0.637$) and a similar predictive power to the first model (McFadden's $R^2 = 0.100$). The Box-Tidwell test indicated no violation of linearity by either NSE-Math at 6 weeks or GPA. Refer to Table 12 for the full regression model.

Table 12: Predictors of satisfactory numeracy exam grades

Variable	Coefficient	z	P>|z|	OR	95% CI for OR	
NSE-Math score at 6 weeks	0.014	1.76	0.079	1.01	0.998	1.030
Gender						
○ Male (reference)	0.000			1.00		
○ Female	0.244	0.53	0.595	1.28	0.519	3.133
Enrolment category						
○ Domestic (reference)	0.000			1.00		
○ International	0.210	0.39	0.694	1.23	0.433	3.520
Highest level of education in mathematics						
○ Year 10 or below (reference)	0.000			1.00		
○ Year 12 2-unit general maths equivalent or above	0.069	0.17	0.863	1.07	0.491	2.339
Year maths subject was last studied						
○ Prior to 2010 (reference)	0.000			1.00		
○ 2010 or later	0.004	0.01	0.990	1.00	0.496	2.033
Grade point average	0.598	4.66	<0.001	1.82	1.414	2.337
Constant	-2.071	-2.03	0.042	0.13	0.017	0.932
McFadden's *R*-squared	0.100					
Hosmer-Lemeshow goodness-of-fit (8 *df*)	7.86 (p=0.447)					
Box-Tidwell test (nonlinear dev.)						
Numeracy self-efficacy at 6 weeks	0.412 (0.521)					
Grade point average	0.126 (0.722)					

Predictors of high clinical skills self-efficacy scores at baseline

Upon an initial examination of the data through descriptive analysis, none of the hypothesised variables were identified to be significantly associated with baseline clinical self-efficacy score (Tables 13 and 14). Simultaneous entry of these five hypothesised variables into a logistic regression model to predict clinical skill self-efficacy scores at baseline produced no significant predictors. The of Hosmer–Lemeshow goodness-of-fit chi-square statistic was 9.56 ($df=8$, $p = 0.297$), and as expected, the model had very little predictive power with the McFadden's R^2 value at 0.004. The full logistic regression model can be seen in Table 15.

Table 13: Correlation of grade point average and age with clinical skills self-efficacy score at baseline

Variable	*R*	*p*
Grade point average	0.058	0.186
Age (years)	0.072	0.099

Table 14: Bivariate statistics comparing mean clinical skill self-efficacy scores at baseline with binary variables

Variable	Mean self-efficacy at baseline	*SD*	Mann Whitney *U* test
Gender			
○ Male	98.2	20.85	0.530 (*p*=0.596)
○ Female	100.91	15.51	
Language spoken at home			
○ English	99.94	16.27	1.001 (*p*=0.317)
○ Languages other than English	101.17	16.7	
Mode of enrolment			
○ International	102.2	14.02	-0.617 (*p*=0.537)
○ Domestic	100.16	16.87	
Country of birth			
○ Australia	99.38	16.68	1.366 (*p*=0.172)
○ Overseas	101.36	16.25	

Table 15: Predictors of baseline clinical skills self-efficacy

Variable	Coefficient	*z*	*P*>|*z*|	OR	95% CI for OR	
Gender						
○ Male (reference)	0.000			1.00		
○ Female	0.157	0.64	0.519	1.17	0.726	1.885
Enrolment category						
○ Domestic (reference)	0.000			1.00		
○ International	0.135	0.52	0.605	1.14	0.687	1.904
Language spoken at home						
○ Languages other than English (reference)	0.000			1.00		
○ English	0.077	0.34	0.734	1.08	0.692	1.687
Country of birth						
○ Australia (reference)	0.000			1.00		
○ Overseas	0.164	0.68	0.499	1.18	0.733	1.892
Grade point average	0.109	1.42	0.155	1.12	0.960	1.295
Constant	-0.779	-1.54	0.125	0.46	0.170	1.240
McFadden's *R*-squared	0.004					
Hosmer-Lemeshow goodness-of-fit (8 *df*)	9.56 (*p*=0.297)					
Box-Tidwell test (nonlinear dev.)	0.127 (*p*=0.722)					

Increased clinical skills self-efficacy scores from baseline to week 8

A comparison of mean clinical skill self-efficacy scores at baseline and 8 weeks showed that mean NSE-Math scores increased from 100.49 to 109.05 (Table 1). This increase was statistically significant (Z=11.735, p<0.001).

Predictors of a satisfactory grade in the first clinical skills assessment

Table 16: Bivariate statistics comparing GPA and mean clinical skill self-efficacy scores at 8 weeks with clinical skills assessment grade

Variable	Mean (satisfactory)	*SD*	Mean (unsatisfactory)	*SD*	Mann Whitney *U* test
Grade point average	4.88	1.08	4.06	1.32	-6.966 (*p*<0.001)
Self-efficacy at 8 weeks	109	11.61	110.58	16.67	0.165 (*p*=0.869)

Table 17: Bivariate statistics comparing clinical skills assessment grade with binary variables

Variable	Clinical skills grade *N*(%)		Pearson's χ^2 (1*df*)
	Satisfactory	Unsatisfactory	
GPA			
○ Less than 5	231 (71.52)	92 (28.48)	31.227 (*p*<0.001)
○ Greater than or equal to 5	306 (88.70)	39 (11.30)	
Gender			
○ Male	84 (78.50)	23 (21.50)	0.268 (*p*=0.605)
○ Female	455 (80.67)	109 (19.33)	
Language spoken at home			
○ English	294 (79.03)	78 (20.97)	0.615 (*p*=0.433)
○ Languages other than English	246 (81.46)	56 (18.54)	
Mode of enrolment			
○ International	88 (80.00)	22 (20.00)	0.009 (*p*=0.925)
○ Domestic	451 (80.39)	110 (19.61)	
Country of birth			
○ Australia	242 (80.67)	58 (19.33)	0.102 (*p*=0.750)
○ Overseas	298 (79.68)	76 (20.32)	

Table 18: Bivariate statistics comparing clinical skills assessment grade with categorical variables

Variable	Clinical skills grade *N*(%)		Pearson's χ^2
	Satisfactory	Unsatisfactory	
Campus			
Campus 1	167 (86.53)	26 (13.47)	
Campus 2	145 (81.92)	32 (18.08)	12.031 (*p*=0.007, 3*df*)
Campus 3	215 (74.65)	73 (25.35)	
Campus 4	12 (92.31)	1 (7.69)	

Descriptive analysis used to explore data for the final hypothesis confirmed potential associations between satisfactory clinical skills assessment grades, GPA and campus (Tables 16, 17 and 18). A logistic regression model including the five hypothesised predictor variables in hypothesis 4, campus and clinical skills self-efficacy score at 8-week follow up was fitted to predict satisfactory grades in

the clinical skills assessment. There was a need to re-fit the model with a binary form of the GPA variable (dichotomised at the median) due to non-linearity (See original model in Appendix 5). Further, language spoken at home was excluded from the re-fitted model, as it was highly associated with campus, and it was decided that being enrolled as an international student was a more accurate measure of English language proficiency. Significant predictors that emerged from the final model were high GPA and campus. Those with a higher GPA had over three times the odds of a satisfactory clinical skills assessment grade (OR 3.048, 95% CI: 1.731-5.368), and those who studied at campus 1 and 2 had over three (OR 3.014, 95% CI: 1.439-6.312) and two (OR 2.091, 95% CI: 1.009-4.333) times the odds respectively of achieving a satisfactory clinical skills assessment grade. This model also had a satisfactory fit, with a Hosmer–Lemeshow goodness-of-fit chi-square statistic of 5.29 (8 *df*, $p = 0.726$) and a similar predictive power to the first model (McFadden's $R^2 = 0.068$). Refer to Table 19 for the full regression model.

Table 19: Predictors of satisfactory clinical skill assessment grades

Variable	Coefficient	*z*	*P*>|*z*|	OR	95% CI for OR	
Clinical skills self-efficacy at 8 weeks	-0.003	-0.28	0.781	1.00	0.974	1.020
Gender						
○ Male (reference)	0			1.00		
○ Female	0.114	0.31	0.759	1.12	0.542	2.320
Enrolment category						
○ Domestic (reference)	0			1.00		
○ International	-0.037	-0.10	0.924	0.96	0.453	2.052
Country of birth						
○ Australia (reference)	0			1.00		
○ Overseas	0.108	0.34	0.736	1.11	0.594	2.091
Campus						
○ Campus 1	1.103	2.93		3.01	1.439	6.312
○ Campus 2	0.738	1.98	0.008	2.09	1.009	4.333
○ Campus 3 (reference)	0			1.00		
Grade point average						
○ Less than 4.8 (reference)	0			1.00		
○ 4.8 or higher	1.114	3.86	<0.001	3.05	1.731	5.368
Constant	1.098	0.80	0.426	3.00	0.201	44.728
McFadden's *R*-squared	0.068					
Hosmer-Lemeshow goodness-of-fit (8 df)	5.29 (*p*=0.726)					
Box-Tidwell test (nonlinear dev.)	1.578 (0.209)					

Discussion

Those who dropped out of the study were more likely to have lower self-efficacy scores, spoke languages other than English at home, born outside Australia, and had a lower pass rate in both assessments. These results were expected, since the surveys were administered during class time, and academic engagement, indicated by class attendance, has been showed to be associated with academic success.[24] Consistent with these findings was that more students from Campus 3 dropped out of the study; this campus had lower pass rates in the clinical skills assessment, as well as higher rates of those who spoke languages other than English at home. The high loss to follow-up rates at this campus was attributed to a higher number of staff who did not adhere to data collection instructions, or who did not collect data at all.

This study identified two significant predictors of baseline NSE-Math scores, gender and mathematical education. Males had significantly higher NSE-Math scores is no surprise, other studies have also highlighting this pattern among male students, having higher self-efficacy than their female counterparts, both in mathematics and other subject areas.[16, 18, 25] One study suggests that this higher confidence in mathematics among males is linked to the masculine sex-role orientation, as mathematics is seen as a traditionally masculine domain, therefore males are more often encouraged to pursue these subjects.[26] Further, the relationship between mathematical education and NSE-Math scores was expected, as self-efficacy has a strong relationship with previous experience.[15] Another study highlighted that receiving a high school education in a subject results in higher self-efficacy in that subject at the beginning of the semester.[18] Conversely, this study was unable to identify any significant predictors of baseline clinical self-efficacy.

Both numeracy and clinical measures of self-efficacy significantly increased over the semester as knowledge in respective mathematics and clinical skills domains increased. This phenomenon has also been reported in other studies.[12, 18]

Although there was an association between NSE-Math score at 6 weeks and satisfactory numeracy assessment grades, there was insufficient power to confirm this as a significant predictor. Interestingly, students' GPA in their first semester of study at the university was strongly associated with achieving satisfactory numeracy examination and clinical skills assessment grades. This is consistent with previous findings that students who have performed well in the past were more likely to have better outcomes in future assessments.[27] Campus emerged as a significant predictor of clinical skills grades, that could be attributable to variability in stringency and leniency of assessors, previously reported in these types of assessments.[28] These findings suggest the need to identify and support students at risk of under-achievement early in undergraduate studies, as these students are more likely to continue to under-perform throughout their undergraduate studies.

Limitations

This study has several limitations, including an apparent inequality in sampling between campuses, which may have greatly impacted the generalisability of results. Further, collection of informed consent only at baseline raised the requirement to exclude many participants from analysis who were not present at baseline and therefore did not provide consent for data linkage. This reduced the power of statistical analysis and is the primary reason for being unable to identify a NSE-Math score at 6-week follow-up as a significant predictor of a satisfactory grade in students' first numeracy examination. Further limiting the power of analysis is the known inaccuracy of self-efficacy among first year university students, particularly as they had little previous experience with medication administration, and had not yet had any assessments to affirm their self-efficacy. Although the numeracy examination had objective solutions and therefore should have high inter-rater reliability, the clinical skills assessment was graded subjectively by university staff. This process is known to be highly variable between assessors,[28] and therefore clinical skills grades may not be a robust measure of competence in clinical skills among nursing students. Analysis in this study attempted to control for this by including campus in the regression model for Hypothesis 6, however the number and characteristics of assessors within each campus was unknown and hence, could not be controlled for. Finally, the use of dichotomised outcome variables, particularly examination grades where most students passed both exams, could have resulted in reduced power and loss of information in analysis.

Conclusions

This study provides unique insight into the factors that affect the development of students' medication administration skills in their first year of study. It found that gender and mathematical education are associated with high baseline NSE-Math scores when controlling for all other variables, however no predictors of clinical self-efficacy were identified in this study. NSE-Math and clinical skills self-efficacy both significantly increased following instruction, yet these were not strong predictors of performance in respective numeracy and clinical skill assessments. GPA was the only factor significantly associated with achieving a satisfactory numeracy examination grade, with satisfactory clinical skills assessment grades also associated with GPA, as well as campus.

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Appendices

Appendix 1: Study Questionnaires

Baseline Questionnaire

Baseline Student Feedback: PPE2

Student ID:_____

Students' self-efficacy in numeracy and skill performance in first year: The SYNAPSE-STARS Project

Please answer all questions. Most questions require you to tick a box(es) to indicate your answer. Choose the box(es) that best matches your answer

General information about yourself		
1. Age (at 1 Aug 2017)	☐☐ years	
2. Have you completed PPE1?	☐1 Yes (*Year completed*) _____	☐0 No
About your PPE2 assessment experience		
3. Have you attempted PPE2 previously?	☐1 Yes (*Year attempted*) _____	☐0 No
4. Are you an Endorsed Enrolled Nurse (EEN)?	☐1 Yes (*Year endorsed*)_____	☐0 No

5. Your highest level of maths you have studied

1☐ Year 10 (or equivalent)

2☐ Year 12 (2-unit General Maths, MIS/MIP course or equivalent)

3☐ Year 12 (2-unit Advanced Maths or equivalent)

4☐ Year 12 (3-unit Maths, Extension I or equivalent)

5☐ Year 12 (4-unit Maths, Extension II or equivalent)

6☐ Other (*Please specify*) _____

6. In what year did you last study a Maths subject?

1☐ 2010-2016

2☐ 2000-2009

3☐ 1990-1999

4☐ Before 1990

Other:_____

Numeracy Confidence in PPE2

Instructions: ***Please select the most appropriate response to indicate how much confidence you have in successfully performing the following skills:***

1. Compare 2 fractions and determine when one is larger (e.g. compare 5/8 with 2/3).

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

2. Add two large numbers (e.g. 93499 + 76582) without using a calculator.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

3. Subtract two large numbers (e.g. 67225 – 23899) without using a calculator.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

4. Multiply two large numbers (e.g. 5621 x 349) without using a calculator.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

5. Divide one number with another (e.g. 1000 ÷ 9) without using a calculator.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

6. Convert a drug dose from grams (g) to milligrams (mg).

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

7. Convert a fluid volume from litres (L) to millilitres (ml).

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

8. **Calculate IV drip rates (e.g. give 500 ml over four hours using a giving set with a drip factor of 20 drops/ml).**

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

9. **Solve problems involving injection drug dose calculations (e.g. the volume of drug required to obtain 5 mg from an ampoule that contains 20 mg in 5 ml).**

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

10. **Solve problems to determine the dosage of IV medications being administered per hour (e.g. Give 500 mcg of drug per hour from a drug solution with 5 mg in 100 ml).**

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

11. **Determine the amount of medication (in mg) when the medication is labelled as a proportion (e.g. 1: 1000 of adrenaline).**

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

12. **Determine the number of tablets to be given when the medication stock available is of a different strength (e.g. administer 0.25 mg of the drug from a medication stock of 62.5 mcg per tablet).**

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

Thank you very much for your time

Week 6 Questionnaire

Mid-semester Feedback: PPE2

Student ID:_____

Students' self-efficacy in numeracy and skill performance in first year: The SYNAPSE-STARS Project

Numeracy Confidence in PPE2

Instructions: ***Please select the most appropriate response to indicate how much confidence you have in successfully performing the following skills:***

1. **Compare 2 fractions and determine when one is larger (e.g. compare 5/8 with 2/3).**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

2. **Add two large numbers (e.g. 93499 + 76582) without using a calculator.**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

3. **Subtract two large numbers (e.g. 67225 – 23899) without using a calculator.**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

4. **Multiply two large numbers (e.g. 5621 x 349) without using a calculator.**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

5. **Divide one number with another (e.g. 1000 ÷ 9) without using a calculator.**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

6. **Convert a drug dose from grams (g) to milligrams (mg).**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

7. **Convert a fluid volume from litres (L) to millilitres (ml).**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

8. **Calculate IV drip rates (e.g. give 500 ml over four hours using a giving set with a drip factor of 20 drops/ml).**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

9. **Solve problems involving injection drug dose calculations (e.g. the volume of drug required to obtain 5 mg from an ampoule that contains 20 mg in 5 ml).**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

10. **Solve problems to determine the dosage of IV medications being administered per hour (e.g. Give 500 mcg of drug per hour from a drug solution with 5 mg in 100 ml).**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

11. **Determine the amount of medication (in mg) when the medication is labelled as a proportion (e.g. 1: 1000 of adrenaline).**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

12. **Determine the number of tablets to be given when the medication stock available is of a different strength (e.g. administer 0.25 mg of the drug from a medication stock of 62.5 mcg per tablet).**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

Numeracy Content and Teaching Strategies in PPE2

1. Please indicate on the scale below, rate your perception of usefulness, of the PPE2 numeracy sessions, in preparing you for your numeracy test.

No useful at all										Extremely useful
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
0	1	2	3	4	5	6	7	8	9	10

Reason for your rating:_____

_____

2. What aspects of the numeracy components in this unit did you find easy for you?

_____

_____

_____

_____

3. What aspects of the numeracy components in this unit did you find difficult for you?

_____

_____

_____

_____

4. Further comments about all numeracy content covered to date in PPE2 (401004)?

_____

_____

_____

_____

Confidence in Clinical Skills Performance in PPE2

Instructions: ***Please select the most appropriate response to indicate how much confidence you have in successfully performing the following skills:***

1. Accurately confirms patient identity before medication administration.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

2. Accurately identifies what constitutes a valid medication order.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

3. Describe clearly to the assessor the purpose of the drug, appropriate drug dosage and possible side-effects.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

4. Identifies correctly all the five-rights of drug administration.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

5. Knows exactly when to perform each of the three drug checks.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

6. Demonstrates evidence of therapeutic interactions with patient throughout the procedure.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

7. Select the correct sites for intramuscular injections.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

8. Select the correct sites for subcutaneous injections.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

9. Dispenses medications and adheres to standard precautions.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

10. Calculates the correct dosage according to medication order.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

11. Knows when to accurately complete the medication chart.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

12. Disposes of, or cleans and returns equipment appropriately.

No confidence at all — Some confidence — Complete confidence

☐ 0 — ☐ 1 — ☐ 2 — ☐ 3 — ☐ 4 — ☐ 5 — ☐ 6 — ☐ 7 — ☐ 8 — ☐ 9 — ☐ 10

Thank you very much for your time

Week 14 Questionnaire

End-of-semester Feedback: PPE2

Student ID:_____

Students' self-efficacy in numeracy and skill performance in first year: The SYNAPSE-STARS Project

Confidence in Clinical Skills Performance in PPE2

Instructions: ***Please select the most appropriate response to indicate how much confidence you have in successfully performing the following skills:***

1. **Accurately confirms patient identity before medication administration.**

No confidence at all — Some confidence — Complete confidence

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

2. **Accurately identifies what constitutes a valid medication order.**

No confidence at all — Some confidence — Complete confidence

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

3. **Describe clearly to the assessor the purpose of the drug, appropriate drug dosage and possible side-effects.**

No confidence at all — Some confidence — Complete confidence

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

4. **Identifies correctly all the five-rights of drug administration.**

No confidence at all — Some confidence — Complete confidence

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

5. **Knows exactly when to perform each of the three drug checks.**

No confidence at all — Some confidence — Complete confidence

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

6. **Demonstrates evidence of therapeutic interactions with patient throughout the procedure.**

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

7. Select the correct sites for intramuscular injections.

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

8. Select the correct sites for subcutaneous injections.

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

9. Dispenses medications and adheres to standard precautions.

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

10. Calculates the correct dosage according to medication order.

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

11. Knows when to accurately complete the medication chart.

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

12. Disposes of, or cleans and returns equipment appropriately.

No confidence at all — Some confidence — Complete confidence

0 1 2 3 4 5 6 7 8 9 10

Numeracy Content and Teaching Strategies in PPE2

1. Please indicate on the scale below, rate your perception of usefulness, of the PPE2 OSCA practice sessions, in preparing you for your OSCA

No useful at all										Extremely useful
0	1	2	3	4	5	6	7	8	9	10

Reason for your rating:_____

_____

2. What aspects of the clinical skills in this unit did you find easy for you?

_____

_____

_____

_____

3. What aspects of the clinical skills in this unit did you find difficult for you?

_____

_____

_____

_____

4. Please briefly comment about clinical skills component in PPE2 (401004), and your suggestions for improvement?

_____

_____

_____

_____

Thank you very much for your time

Appendix 2: Do-File of statistical analysis

```
/********************** NUMERACY *******************/

/*** Generating total numeracy SE score (baseline) ***/

generate se_baseline = semath1 + semath2 + semath3 + semath4 + semath5 +
semath6 + semath7 + semath8 + semath9 + semath10 + semath11 + semath12

/*** Dichotomising total numeracy SE score (baseline) ***/

tabulate se_baseline

summarize se_baseline, detail

gen se_bl_86=0*se_baseline if se_baseline<86

replace se_bl_86=(0*se_baseline)+1 if se_baseline>=86

tabulate se_bl

/*** Generating highest maths education (exc. other)***/

gen math_level=1 if mathslevel==1

replace math_level=2 if mathslevel==2

replace math_level=3 if mathslevel==3

replace math_level=4 if mathslevel==4

replace math_level=5 if mathslevel==5

/*** Dichotomising yearmath ***/

tabulate se_bl_86 yearmath /*** shows that cell numbers are too small to
regress in 4 categories***/

gen yearmath_2010earlier=1 if yearmath==1

replace yearmath_2010earlier=0 if yearmath==2

replace yearmath_2010earlier=0 if yearmath==3

replace yearmath_2010earlier=0 if yearmath==4

/*** Dichotomising highest maths education ***/

gen math_bin=0 if mathslevel==1

replace math_bin=1 if mathslevel==2

replace math_bin=1 if mathslevel==3

replace math_bin=1 if mathslevel==4

replace math_bin=1 if mathslevel==5

/*** Generating total math exam score ***/
```

```
gen math_exam=mathstest_q1a + mathstest_q1b + mathstest_q1c + mathstest_q1d
+ mathstest_q5 + mathstest_q6 + mathstest_q7 + mathstest_q8

/*** Dichotomising total math exam score (pass/fail) ***/

gen math_exam_pass=0*math_exam if math_exam<8

replace math_exam_pass=0*math_exam+1 if math_exam==8

/*** Generating total numeracy SE score (6 weeks) ***/

generate se_6w = semath1_2 + semath2_2 + semath3_2 + semath4_2 + semath5_2
+ semath6_2 + semath7_2 + semath8_2 + semath9_2 + semath10_2 + semath11_2 +
semath12_2

/*** Dichotomising total numeracy SE score (6 weeks) ***/

tabulate se_6w

gen se6w_94=0*se_6w if se_6w<94

replace se6w_94=(0*se_6w)+1 if se_6w>=94

tabulate se6w_94

/*** Dichotomising GPA***/

gen gpa_bin=0 if gpa<5

replace gpa_bin=1 if gpa>=5

replace gpa_bin=. if gpa==.

/*** Generating numerical campus variable ***/

gen campus=1 if location=="CAM"

replace campus=2 if location=="HAW"

replace campus=3 if location=="PAR"

replace campus=4 if location=="LITHGOW"


/*** Reversing variables with negative coefficients***/

gen overseasborn=1 if austborn==0

replace overseasborn=0 if austborn==1

tabulate austborn overseasborn

gen domestic=1 if international==0

replace domestic=0 if international==1

tabulate domestic international

gen mathedcd_rev=2 if mathedcd==1
```

```
replace mathedcd_rev=1 if mathedcd==2

tabulate mathedcd mathedcd_rev

gen yearmath_2010rev=1 if yearmath_2010==0

replace yearmath_2010rev=0 if yearmath_2010e==1

gen female=1 if male==0

replace female=0 if male==1

gen nonenglish=1 if english==0

replace nonenglish=0 if english==1


/*** Generating inclusion variable ***/

gen final_inclusion=se_baseline+personid

gen final_inclusion_bin=1 if final_inclusion!=.

replace final_inclusion_bin=0 if final_inclusion==.


/*** Reliability of scales ***/

alpha semath1 semath2 semath3 semath4 semath5 semath6 semath7 semath8
semath9 semath10 semath11 semath12 if final_inclusion_b==1

alpha semath1_2 semath2_2 semath3_2 semath4_2 semath5_2 semath6_2 semath7_2
semath8_2 semath9_2 semath10_2 semath11_2 semath12_2 if
final_inclusion_b==1


/*** Comparing included vs excluded ***/

ranksum gpa, by(final_inclusion_bin)

by final_inclusion_bin, sort: summarize gpa

ranksum age, by(final_inclusion_bin)

by final_inclusion_bin, sort: summarize age

ranksum se_baseline, by(final_inclusion_bin)

by final_inclusion_bin, sort: summarize se_baseline

ranksum se_6w, by(final_inclusion_bin)

by final_inclusion_bin, sort: summarize se_6w

tabulate final_inclusion_b mathpass, row chi2

tabulate final_inclusion_b male, row chi2
```

```
tabulate final_inclusion_b mathslevel, row chi2
tabulate final_inclusion_b yearmath, row chi2
tabulate final_inclusion_b prevppe2, row chi2
tabulate final_inclusion_b een, row chi2
tabulate final_inclusion_b english, row chi2
tabulate final_inclusion_b international, row chi2
tabulate final_inclusion_b austborn, row chi2

/*** Descriptives - overall ***/
summarize gpa if caseid!=.
summarize ageyears if caseid!=.
summarize se_baseline se_6w, detail
tabulate prevppe2
summarize yearprev, detail
tabulate een
summarize yeareen, detail
tabulate mathslevel
tabulate mathedcd
tabulate yearmath
tabulate english if caseid!=.
tabulate international if caseid!=.
tabulate austborn if caseid!=.
swilk gpa ageyears se_baseline se_6w if caseid!=.

/*** Descriptives - self efficacy total score only***/
summarize gpa if se_baseline!=.
summarize ageyears if se_baseline!=.
summarize se_baseline se_6w if se_baseline!=., detail
tabulate prevppe2 if se_baseline!=.
summarize yearprev if se_baseline!=., detail
tabulate een if se_baseline!=.
```

```
summarize yeareen if se_baseline!=., detail
tabulate mathslevel if se_baseline!=.
tabulate mathedcd if se_baseline!=.
tabulate yearmath if se_baseline!=.
tabulate english if se_baseline!=.
tabulate international if se_baseline!=.
tabulate austborn if se_baseline!=.
swilk gpa ageyears se_baseline se_6w if se_baseline!=.

/*** Descriptives - student ID and self efficacy total score only***/
summarize gpa if final_inclusion!=.
summarize ageyears if final_inclusion!=.
summarize se_baseline se_6w if final_inclusion!=., detail
tabulate prevppe2 if final_inclusion!=.
summarize yearprev if final_inclusion!=., detail
tabulate een if final_inclusion!=.
summarize yeareen if final_inclusion!=., detail
tabulate mathslevel if final_inclusion!=.
tabulate mathedcd if final_inclusion!=.
tabulate yearmath if final_inclusion!=.
tabulate english if final_inclusion!=.
tabulate international if final_inclusion!=.
tabulate austborn if final_inclusion!=.
swilk gpa ageyears se_baseline se_6w if final_inclusion!=.

/*** Descriptives - relationships with baseline self-efficacy ***/
pwcorr se_baseline gpa ageyears if final_inclusion!=., sig
by mathslevel, sort: summarize se_baseline if final_inclusion!=.
by mathedcd, sort: summarize se_baseline if final_inclusion!=.
by yearmath, sort: summarize se_baseline if final_inclusion!=.
by yearmath_2010e, sort: summarize se_baseline if final_inclusion!=.
```

```
by male, sort: summarize se_baseline if final_inclusion!=.
by english, sort: summarize se_baseline if final_inclusion!=.
by international, sort: summarize se_baseline if final_inclusion!=.
by austborn, sort: summarize se_baseline if final_inclusion!=.
ranksum se_baseline if final_inclusion!=., by(mathedcd)
ranksum se_baseline if final_inclusion!=., by(male)
kwallis se_baseline if final_inclusion!=., by(mathslevel)
kwallis se_baseline if final_inclusion!=., by(yearmath)
ranksum se_baseline if final_inclusion!=., by(english)
ranksum se_baseline if final_inclusion!=., by(international)
ranksum se_baseline if final_inclusion!=., by(austborn)

/*** Descriptives - relationships with maths performance ***/
by mathpass, sort: summarize gpa if final_inclusion!=.
by mathpass, sort: summarize se_6w if final_inclusion!=.
tabulate se6w_94 mathpass if final_inclusion!=., row chi2
tabulate mathslevel mathpass if final_inclusion!=., row chi2
tabulate mathedcd mathpass if final_inclusion!=., row chi2
tabulate yearmath mathpass if final_inclusion!=., row chi2
tabulate yearmath_2010e mathpass if final_inclusion!=., row chi2
tabulate male mathpass if final_inclusion!=., row chi2
tabulate english mathpass if final_inclusion!=., row chi2
tabulate international mathpass if final_inclusion!=., row chi2
tabulate austborn mathpass if final_inclusion!=., row chi2
ranksum gpa if final_inclusion!=., by(mathpass)
ranksum se_6w if final_inclusion!=., by(mathpass)

/*** Baseline and follow-up comparison of self-efficacy***/
signrank se_6w=se_baseline if final_inclusion!=.
```

```
/*** Logistic regression model: predictors of numeracy self-efficacy
(baseline) ***/

regress se_baseline i.male i.international gpa i.math_level i.yearmath if
final_inclusion!=.

predict r_mathse, residuals

qnorm r_mathse

swilk r_mathse

rvfplot


logistic se_bl_86 i.male i.international gpa i.math_level i.yearmath if
final_inclusion!=.

estat gof, group(10)

fitstat

testparm i.math_level

testparm i.yearmath

boxtid logistic se_bl_86 male international gpa math_level yearmath if
final_inclusion!=.


/*** Logistic regression model: does numeracy self-efficacy (6 weeks)
predict performance ***/

logistic mathpass se_6w i.female i.international gpa i.math_bin
i.yearmath_2010e if final_inclusion!=.

estat gof, group(10)

fitstat


boxtid logistic mathpass se_6w female international gpa math_bin
yearmath_2010e if final_inclusion!=.


logistic mathpass i.se6w_94 i.male i.domestic gpa i.math_bin
i.yearmath_2010e if final_inclusion!=.

estat gof, group(10)

fitstat


/**************************** CLINICAL SKILLS **************************/
```

```
/*** Generating total skills SE score (baseline) ***/

gen seskills_baseline = seskills1 + seskills2 + seskills3 + seskills4 +
seskills5 + seskills6 + seskills7 + seskills8 + seskills9 + seskills10 +
seskills11 + seskills12


/*** Generating total skills SE score (8 weeks) ***/

gen seskills_8w = seskills1_2 + seskills2_2 + seskills3_2 + seskills4_2 +
seskills5_2 + seskills6_2 + seskills7_2 + seskills8_2 + seskills9_2 +
seskills10_2 + seskills11_2 + seskills12_2




/*** Comparing included vs excluded ***/

ranksum seskills_baseline, by(final_inclusion_b)

by final_inclusion_b, sort: summarize seskills_baseline

ranksum seskills_8w, by(final_inclusion_b)

by final_inclusion_b, sort: summarize seskills_8w

tabulate final_inclusion_b osca_grade, row chi2


/*** Reliability of scales ***/

alpha seskills1 seskills2 seskills3 seskills4 seskills5 seskills6 seskills7
seskills8 seskills9 seskills10 seskills11 seskills12 if
final_inclusion_b==1

alpha seskills1_2 seskills2_2 seskills3_2 seskills4_2 seskills5_2
seskills6_2 seskills7_2 seskills8_2 seskills9_2 seskills10_2 seskills11_2
seskills12_2 if final_inclusion_b==1


/*** Descriptives - student ID and self efficacy total score only***/

summarize gpa if final_inclusion_b==1

summarize ageyears if final_inclusion_b==1

summarize seskills_baseline seskills_8w if final_inclusion_b==1, detail

tabulate prevppe2 if final_inclusion_b==1

summarize yearprev if final_inclusion_b==1, detail

tabulate een if final_inclusion_b==1

summarize yeareen if final_inclusion_b==1, detail
```

```
tabulate english if final_inclusion_b==1
tabulate international if final_inclusion_b==1
tabulate austborn if final_inclusion_b==1
swilk gpa ageyears seskills_baseline seskills_8w if final_inclusion_b==1

/*** Descriptives - relationships with baseline self-efficacy ***/
pwcorr seskills_baseline gpa ageyears if final_inclusion_b==1, sig
by male, sort: summarize seskills_baseline if final_inclusion_b==1
by english, sort: summarize seskills_baseline if final_inclusion_b==1
by international, sort: summarize seskills_baseline if final_inclusion_b==1
by austborn, sort: summarize seskills_baseline if final_inclusion_b==1
by campus, sort: summarize seskills_baseline if final_inclusion_b==1
kwallis seskills_baseline  if final_inclusion_b==1, by(campus)
ranksum seskills_baseline if final_inclusion_b==1, by(english)
ranksum seskills_baseline if final_inclusion_b==1, by(international)
ranksum seskills_baseline if final_inclusion_b==1, by(austborn)
ranksum seskills_baseline if final_inclusion_b==1, by(male)

/*** Descriptives - relationships with osca performance ***/
by osca_grade, sort: summarize gpa if final_inclusion_b==1
by osca_grade, sort: summarize seskills_8w if final_inclusion_b==1
tabulate male osca_grade if final_inclusion_b==1, row chi2
tabulate english osca_grade if final_inclusion_b==1, row chi2
tabulate international osca_grade if final_inclusion_b==1, row chi2
tabulate austborn osca_grade if final_inclusion_b==1, row chi2
tabulate campus osca_grade if final_inclusion_b==1, row chi2
tabulate gpa_bin osca_grade if final_inclusion_b==1, row chi2
ranksum gpa if final_inclusion_b==1, by(osca_grade)
ranksum seskills_8w if final_inclusion_b==1, by(osca_grade)

/*** Baseline and follow-up comparison of self-efficacy***/
```

```
signrank seskills_8w=seskills_baseline if final_inclusion!=.


/*** Logistic regression model: predictors of clinical skills self-efficacy
(baseline) ***/

regress seskills_baseline i.male i.english i.austborn i.international gpa
ib3.campus if final_inclusion!=.

predict r_skillse, residuals

qnorm r_skillse

swilk r_skillse

rvfplot


logistic seskills_base104 i.female i.english i.overseasborn i.international
gpa if final_inclusion!=.

estat gof, group(10)

fitstat


boxtid logistic seskills_base104 female nonenglish austborn domestic gpa if
final_inclusion!=.


/*** Logistic regression model: predictors of osca performance***/

logistic osca_grade seskills_8w i.female i.nonenglish i.overseasborn
i.international gpa ib3.campus if final_inclusion!=.

estat gof, group(10)

fitstat


boxtid logistic osca_grade seskills_8w female nonenglish austborn domestic
gpa campus if final_inclusion!=.


logistic osca_grade seskills_8w i.female i.overseasborn i.international
i.gpa_bin ib3.campus if final_inclusion!=.

estat gof, group(10)

fitstat

testparm i.campus
```

```
boxtid logistic osca_grade seskills_8w female austborn domestic gpa_bin
campus if final_inclusion!=.
```

Appendix 3: Factor Analysis

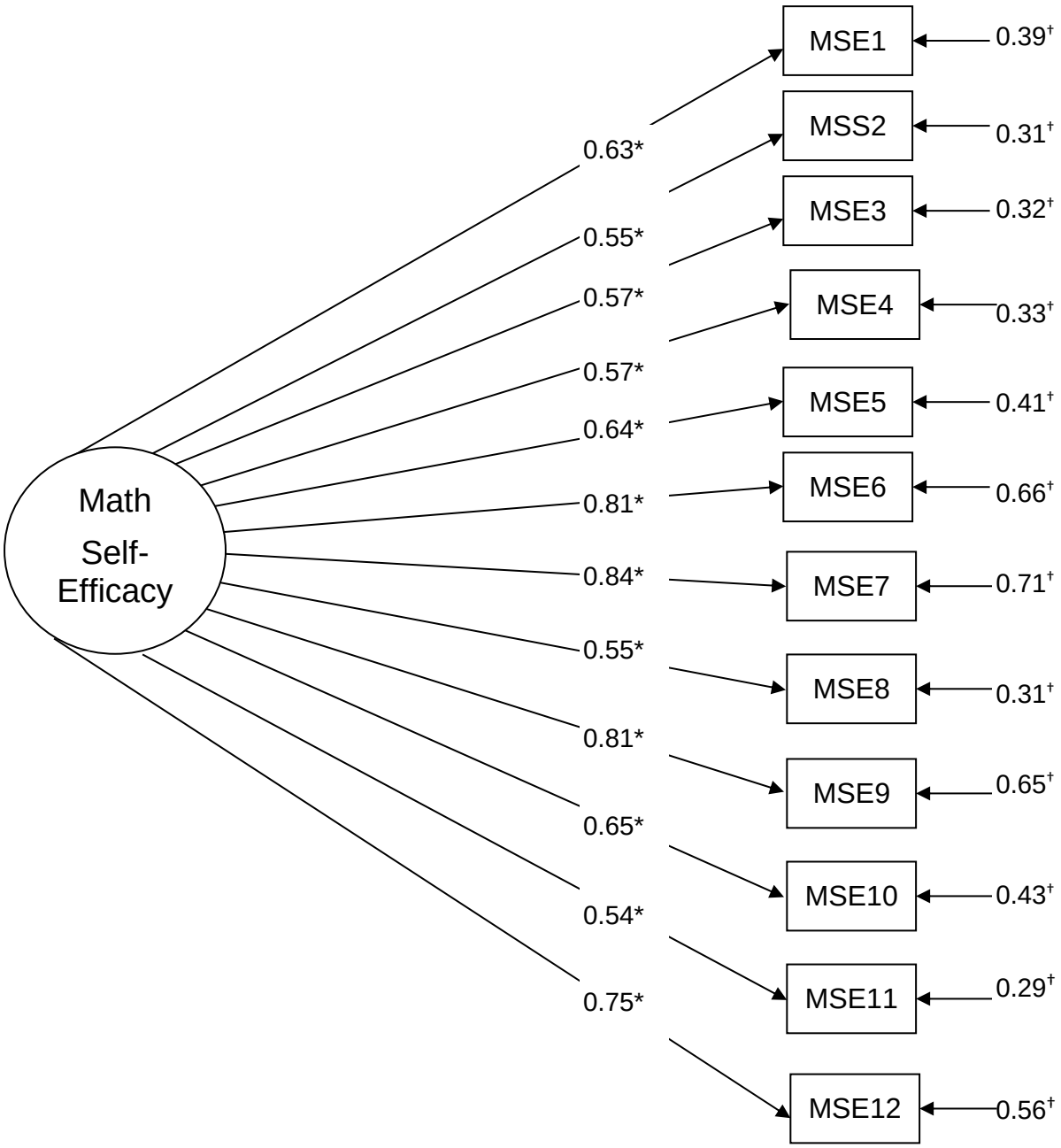

Figure 1 The 1-factor solution Confirmatory Factor Analysis of Math Self-Efficacy Scale using 6-week Follow-up Data

*Factor loadings (i.e. correlation with a single component), p<0.05

†Error terms

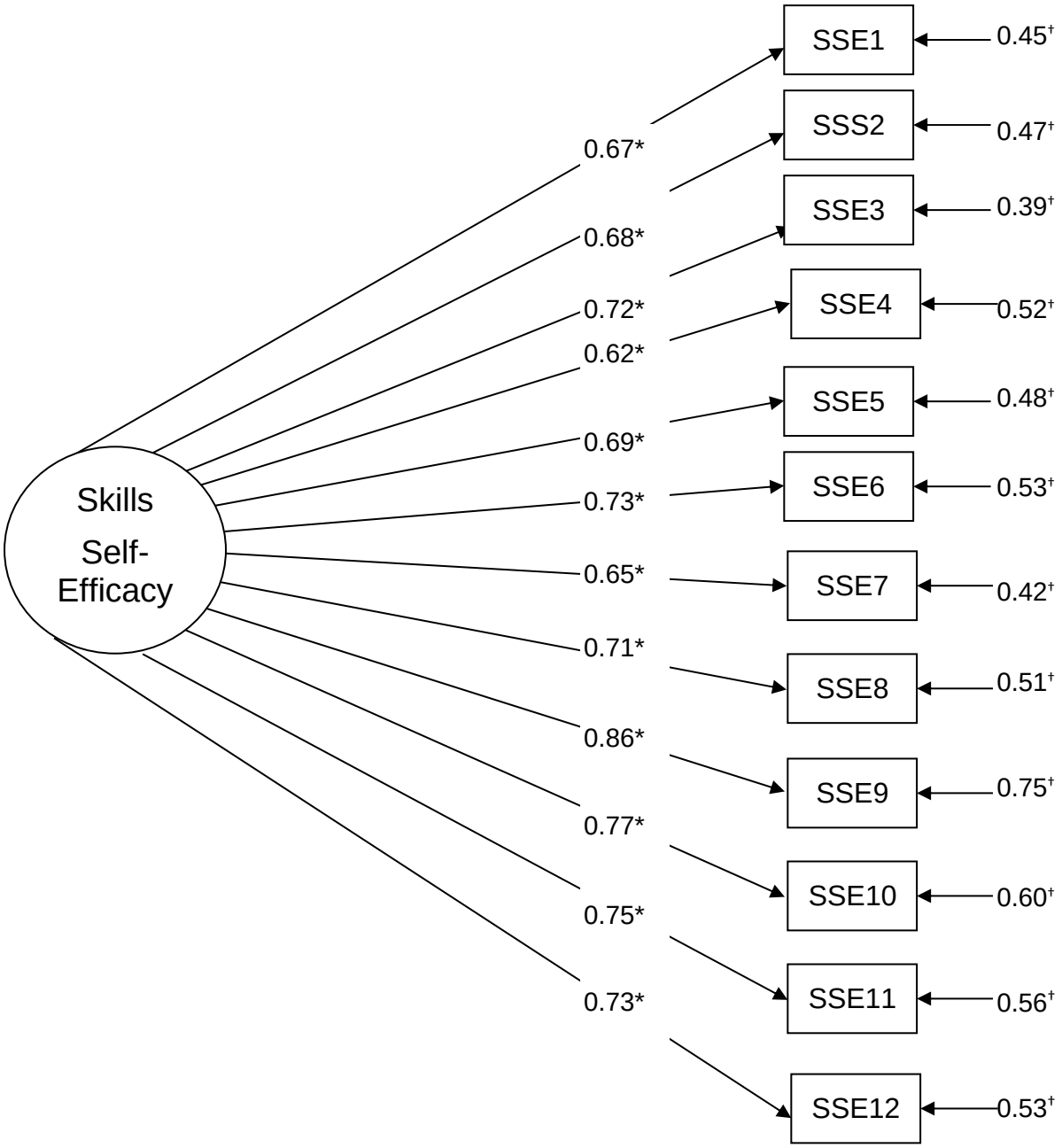

Figure 2 **The 1-factor solution Confirmatory Factor Analysis of Skills Self-Efficacy Scale using 14-week Follow-up Data**

*Factor loadings (i.e. correlation with a single component), $p<0.05$

†Error terms

Appendix 4: Inspecting residuals from linear regression models of self-efficacy

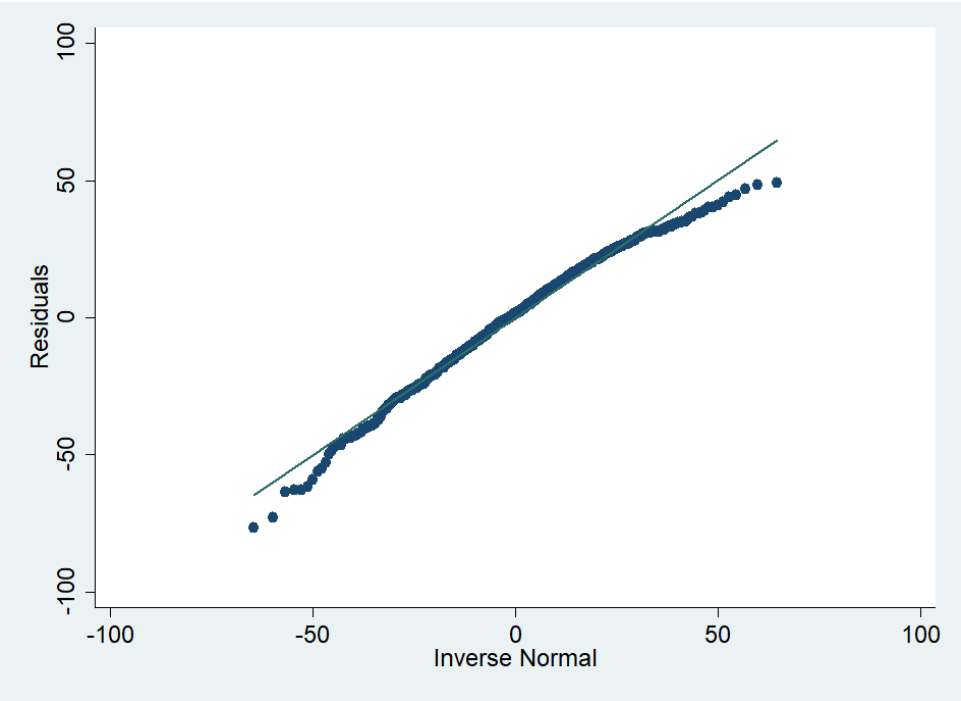

Figure 3*: Q-Q plot of residuals of linear regression model with dependent variable baseline NSE-Math score, and gender, enrolment category, highest level of mathematical education, years since last mathematical education and GPA as explanatory variables*

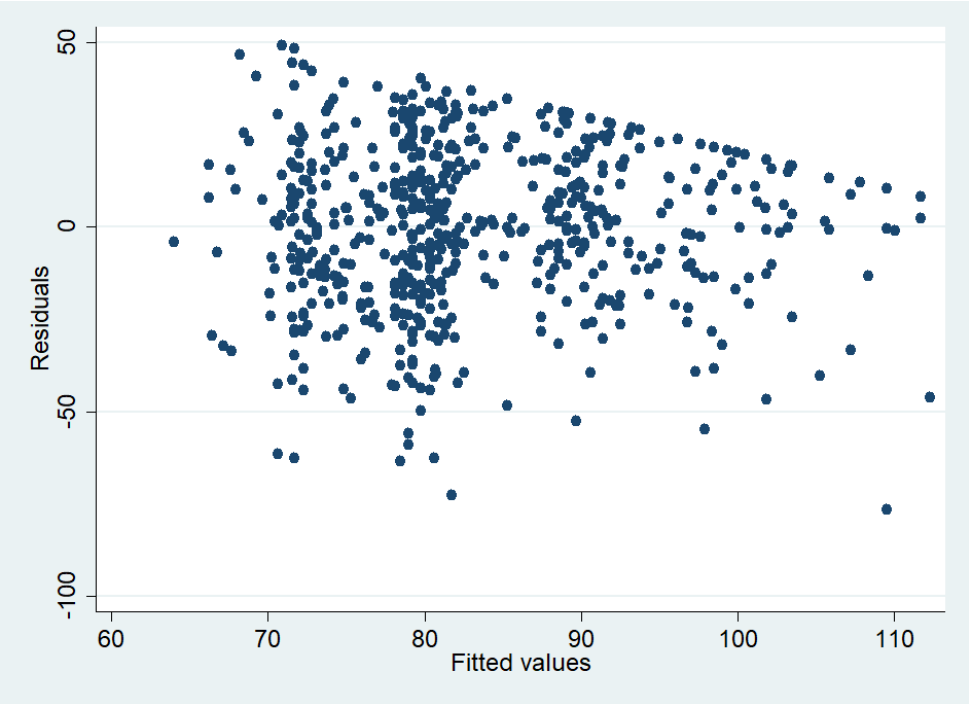

Figure 4*: Plot of residuals versus fitted values for linear regression model with dependent variable NSE-Math score at 6 weeks, and gender, enrolment category, highest level of mathematical education, years since last mathematical education and GPA as explanatory variables*

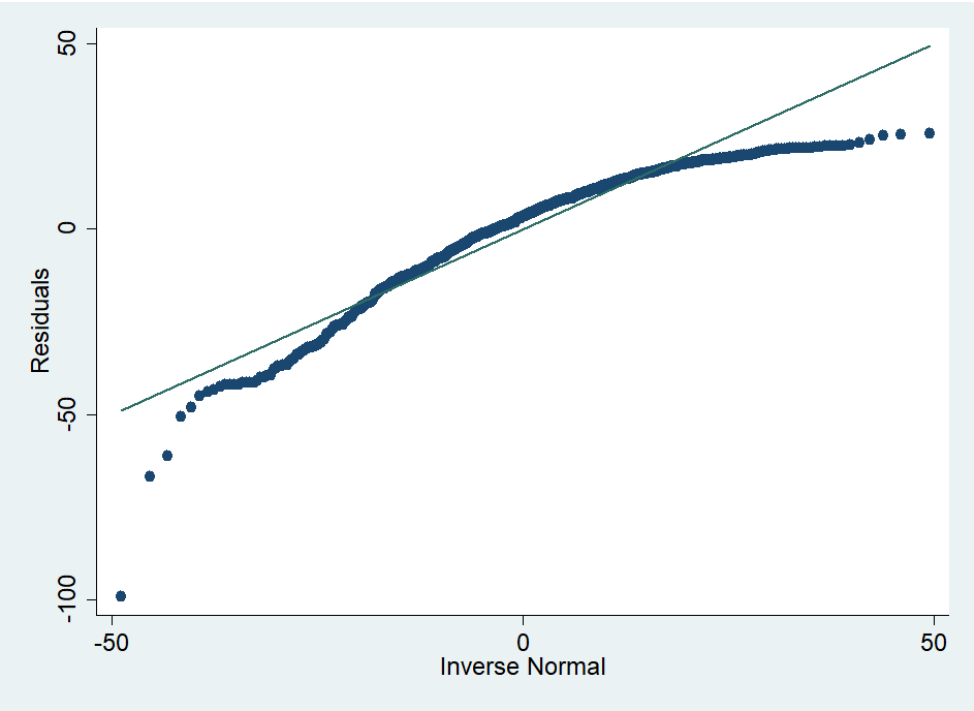

Figure 5*: Q-Q plot of residuals of linear regression model with dependent variable baseline clinical self-efficacy score, and gender, enrolment category, Australian born, English spoken at home, campus and GPA as explanatory variables*

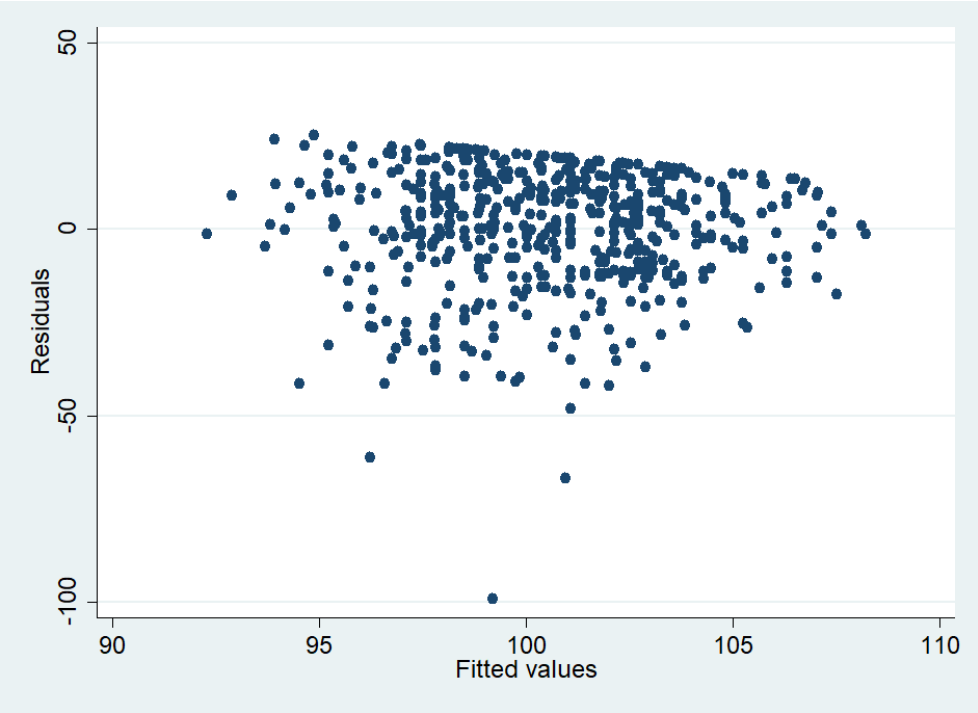

Figure 6*: Plot of residuals versus fitted values for linear regression model with dependent variable clinical self-efficacy score at 8 weeks, and gender, enrolment category, Australian born, English spoken at home, campus and GPA as explanatory variables*

Appendix 5: Initial logistic regression model to predict satisfactory clinical skill assessment grades

Variable	Coefficient	*z*	*P*>|*z*|	OR	95% CI for OR	
Clinical skills self-efficacy at 8 weeks	-0.008	-0.62	0.538	0.992	0.969	1.017
Gender						
○ Female (reference)	0.000			1.000		
○ Male	0.210	0.56	0.577	1.234	0.590	2.581
Enrolment category						
○ Domestic (reference)	0.000			1.000		
○ International	-0.048	-0.12	0.902	0.953	0.441	2.058
Language spoken at home						
○ Languages other than English	0.751	2.11	0.035	2.120	1.054	4.264
○ English (reference)	0.000			1.000		
Country of birth						
○ Australia (reference)	0.000			1.000		
○ Overseas	-0.217	-0.57	0.567	0.805	0.384	1.691
Campus						
○ Campus 1	1.444	3.13		4.237	2.235	8.031
○ Campus 2	0.928	2.44	0.003	2.530	1.201	5.327
○ Campus 3 (reference)						
Grade point average	0.471	4.07	<0.001	1.602	1.277	2.010
Constant	-0.387	-0.26	0.791	0.679	0.039	11.940
McFadden's *R*-squared	0.080					
Hosmer-Lemeshow goodness-of-fit (8 df)	6.54 (*n* =0.587)					
Box-Tidwell test (nonlinear dev.)						
Clinical skills self-efficacy at 8 weeks	1.646 (0.200)					
Grade point average	6.116 (0.013)					