Research

The effect of self-efficacy on maths anxiety among paramedic students

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Abstract

Introduction

Maths anxiety is defined as feelings of tension that interfere with dealing with numbers and mathematical problems. Self-efficacy, which is related to maths anxiety, can be defined as perceptions of one's abilities to math problems, tasks and math-related course work. This study aimed to investigate the effect of gender, age and year level on maths anxiety and self-efficacy and to study the relationship between self-efficacy and maths anxiety among paramedic students.

Methods

A cross-sectional study of paramedic students at Monash University in Victoria was conducted. Participants completed a 15-minute paper-based questionnaire which is composed of Maths Anxiety Rating Scale – Revised (MARS-R), the Maths Self-Efficacy Scale (MSES) and demographic information.

Results

The questionnaires were completed and returned by 344 students. (81.3% return rate). The mean score for the MARS-R was 25.71 (SD=8.80) and for the MSES was 125.59 (SD=29.55). Females had higher maths anxiety levels (M=26.83, SD=9.00) than males (M=23.67, SD=8.26) and lower self-efficacy (M=119.59, SD=29.30) than males (M=135.73, SD=27.39). There was a significant negative relationship between MARS-R and MSES levels. Multiple linear regression indicated that maths self-efficacy (beta = -0.626, $p < 0.001$) made the strongest contribution to maths anxiety levels.

Conclusion

There was a significant negative relationship between maths anxiety and self-efficacy levels reported by the paramedic student cohort. Gender plays an integral part in determining maths anxiety and self-efficacy level. To improve maths performance and reduce anxiety during calculation tasks, such as dose determinations, targeted education should be developed to improve maths self-efficacy.

Keywords:

allied health personnel; paramedics; anxiety; maths anxiety; self-efficacy

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Introduction

Although historically associated with life support and other advanced skills for dealing with emergencies, the role of the current paramedic has evolved rapidly since 2000. For example, paramedics in the United Kingdom now provide more than just emergency care and are expected to manage a broad range of conditions in the out-of-hospital environment (1,2). This shift has been driven by growing healthcare system pressures such as hospital crowding and lack of hospital staff, and evolving views on how health care is conceptualised and delivered (2). For example, paramedicine has become recognised as a health profession whose growing clinical acumen and unique point-of-contact with the public can be leveraged to better serve their healthcare needs and meet policy goals; not only for those who contact paramedic services in a time of acute or emergent crisis (as is traditionally the case), but also for broader patient groups and needs (2,3). The nature of paramedics' work and responsibilities force them to work in situations where they must make critical decisions under stressful conditions, which might increase their anxiety toward accomplishing their tasks properly (4).

Anxiety is characterised by feelings of tension or worried thoughts and can manifest with physical changes such as increased blood pressure, heart rate and sweating (5). Richardson and Suinn (6) first described a subtype of anxiety related to maths. Maths anxiety is defined as 'feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide range of ordinary life and academic situations' (7). Others have described maths anxiety as negative emotional state created when engaging in activities requiring mathematical skills (8,9).

There are several listed causes of maths anxiety, including experiences in maths classes or with maths teachers, low self-efficacy or previous bad experiences with maths and low intelligence or poor maths ability (10). Unsurprisingly, students with high levels of maths anxiety tend to perform poorly on maths tasks (11-13). One of the critical risk factors associated with maths anxiety is one's self-efficacy level.

Bandura defines self-efficacy as 'the belief in one's ability to organise and execute the courses of action needed to manage and to perform a required task' (14). Low self-efficacy expectations regarding behaviour or task leads to avoidance. As self-efficacy increases, a corresponding rise in the frequency of behaviour or task performance should be observed (15). Self-efficacy related to maths, are the perceptions of one's performance abilities related to math problems, tasks and math-related course work (15).

Mathematics self-efficacy and anxiety influence maths achievement (16,17). Ahmed et al (16) reported findings that among 522 seventh grade students in the Netherlands, there was a reciprocal relationship between math self-concept and

anxiety. Although self-concept and anxiety are linked, students who have low self-concept are likely to be anxious. Still, students who have higher anxiety levels do not necessarily have a low self-concept of their math ability (16). Akin and Kurbanoğlu (17) examined maths self-efficacy, maths anxiety and math attitudes of 372 university students in Turkey. They found that maths anxiety was negatively related to positive attitudes and self-efficacy and that maths self-efficacy was positively associated with positive attitudes. They also found that self-efficacy was the proximal determinant of maths attitudes and maths anxiety in Turkish university students.

The type of anxiety that was addressed in the paramedic discipline was test anxiety (18). In their study, distance and campus-based students from all three years of the Bachelor of Health Science (Paramedic) program at Whitireia, New Zealand participated in this study by utilising a mixed-method data collection. Participants completed an online survey including the Westside Test Anxiety Scale, program-specific questions and free-response section to gather qualitative data. They found that high levels of anxiety were identified across the student body. There were significant differences in anxiety based on previous educational achievement and between full-time and part-time students. In this study, this demonstrates that different course delivery methods and student backgrounds may impact on paramedic student anxiety. Moreover, the thematic analysis of the qualitative questions in the survey revealed three broad themes that are related to maths anxiety: stressors, obstacles to learning, and negative experiences.

Most of the studies in the literature have focussed on the relationship between maths anxiety and self-efficacy in the secondary school stage, and some disciplines at the university level other than the paramedic discipline; other studies have focussed solely on test anxiety among paramedic students. Therefore, this study aimed to study the effect of gender, age and year level on maths anxiety and self-efficacy and the relationship between self-efficacy and maths anxiety among paramedic students.

Methods

Design and participants

A cross-sectional study with a convenience sampling of first, second- and third-year Bachelor of Paramedicine male and female students (N=423) studying at Monash University in Victoria were recruited during the first week of semester one, 2019. The participants completed an anonymous paper-based questionnaire during the last 15 minutes of one of their classes. Participation in the study was voluntary, and submission of the completed questionnaire implied consent. The Monash University Human Research Ethics Committee approved this study (project number 17969).

Instrumentation

The questionnaire was composed of three parts: non-identifiable

demographic information including age group, gender and year level; the Maths Anxiety Rating Scale – Revised (MARS-R) (19); and the Maths Self-Efficacy Scale (MESS) (19,20).

Maths Anxiety Rating Scale (MARS-R)

The original MARS is a 98-item questionnaire developed and used by Richardson and Suinn (6). One disadvantage of this scale is its length, which may lead to tool filling fatigue and bias due to time constraints. Due to these issues, alternative shorter maths anxiety scales with fewer items have been developed (21-23). We used in our study the MARS-R; a 10-item tool created by Betz and Hackett (19). The tool has good concurrent validity with 0.70 correlation with the original MARS (24) and reliability with a Cronbach alpha of 0.94 (20). It is scored on a 5-point Likert scale for each item (1 = strongly disagree, 5 = strongly agree). Scores are reported as a total score and as a percentage to determine anxiety severity.

Maths Self-Efficacy Scale

To determine how confident students felt in completing everyday mathematics-related tasks, the 18-question math task subscale of the MSES was used (19). For each item on the math task subscale, individuals were asked to indicate their confidence in their ability to successfully perform the math tasks on a 10-point scale ranging from 1 (no confidence at all) to 10 (complete confidence). The final score for the MSES task subscale can range from 18 to 180. The overall scale has good reliability with a Cronbach alpha of 0.92 for the task subscale as reported by Betz and Hackett (19) and Nielsen and Moore (25).

Data analysis

Data were compiled for analysis using SPSS software version 26. Data were presented using descriptive statistics, including means, $\pm$ standard deviations, median or frequencies where appropriate. MARS-R scores were converted to a percentage to give a severity rating of low (0–24%), medium (25–74%) and high (75–100%) (20). Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. To identify factors that were predictive of maths anxiety, multiple linear regression was

used. Before carrying out multiple linear regression analysis, the linearity between dependent and independent variables, normality, homoscedasticity and multicollinearity were checked. Independent variables (self-efficacy level, gender, age group) were analysed using a univariate regression with the dependant variable (maths anxiety level). Variables that were significant at $p < 0.20$ were then entered a multivariate model. The level of significance was assigned at $p < 0.05$, and the effect size was also calculated.

Results

The surveys were completed and returned by 344 (81.3%) of sampled students. The demographic profiles of the consenting participants are reported in Table 1. Most of the participants were from the first-year cohort (46.2%), female (63.1%) and aged from 20 to 24 years (50.6%).

Measure reliability

Cronbach's alpha reliability of the MARS-R in this study was 0.93, while the Cronbach's alpha reliability of the math task MSES in this study was 0.92.

Maths anxiety

The MARS-R scores are reported in Table 2. The MARS-R anxiety scores were normally distributed (skewness = 0.238; kurtosis = -0.552). Most respondents ($n=292$, 85%) were classified with a medium anxiety score, and the mean (SD) was 25.7 (8.9). The remaining respondents were evenly spread between the high (8%) and low anxiety (7%) classifications. There was a significant difference ($t(341) = -3.562$, $p < 0.001$, Cohen's $d=0.37$) between males (mean (SD): 23.46 (7.956)) and females (mean (SD): 26.94 (9.096)). Comparison of MARS-R scores identified a significant difference between year level groups ($F(2) = 3.185$, $p=0.043$, partial eta squared = 0.023), but not between age groups ($F(4) = 0.517$, $p=0.723$, partial eta squared = 0.006). Post-hoc comparisons indicated that the MARS-R mean score was significant between year one and year two $p=0.017$, while it was non-significant between year one and year three $p=0.884$ and between year two and year three $p=0.092$.

Table 1. Demographic data for first, second and third-year paramedicine students

	Year level	One	Two	Three	Total (%)
	N (%)	159 (46.2%)	86 (25%)	99 (28.8%)	344 (100%)
Gender n (%)	Male	52 (30%)	39 (47%)	34 (34%)	125 (36.6%)
	Female	105 (69.9%)	48 (53%)	65 (66%)	218 (63.1%)
	Prefer not to say	1 (0.001%)	0	0	1 (0.3%)
Age group (years) (n (%))	≤ 19	94 (59.5%)	29 (33.3%)	2 (2%)	125 (36.3%)
	20-24	47 (29.7%)	50 (57.5%)	77 (77.8%)	174 (50.6%)
	25-29	7 (4.4%)	2 (2.4%)	15 (15.1%)	24 (7%)
	30-34	5 (3.2%)	3 (3.4%)	5 (5.1%)	13 (3.8%)
	≥ 35	5 (3.2%)	3 (3.4%)	0	8 (2.3%)

Self-efficacy

The MSES scores are reported in Table 3. The MSES (self-efficacy) scores were normally distributed (skewness: -0.302; kurtosis: -0.364) and ranged from 24 indicating low self-efficacy level to 180 indicating the highest self-efficacy level. There was a significant difference in MSES scores ($t(341) = 5.471, p < 0.001$, Cohen's $d = 0.62$) between males (mean (SD): 136.66 (25.48)) and females (mean (SD): 119.37 (29.60)). Comparison of MSES scores between groups identified a significant difference between year level groups ($F(2) = 6.809, p = 0.001$, partial eta squared = 0.038), and age-groups ($F(4) = 5.213, p < 0.001$, partial eta squared = 0.058). Post-hoc comparisons indicated that MSES mean score was significant between year one and year two ($p = 0.001$) and between year two and year three ($p = 0.033$) while it was non-significant between year one and year three ($p = 0.620$). Post-hoc comparisons indicated that there were significant differences in MSES mean scores between students less than 19 years of age and those aged 25–29 years ($p = 0.001$) and between those aged 20–24 years and those aged 25–29 years of age ($p = 0.005$).

Factors associated with maths anxiety levels

Backward method of entry was used and results of the multiple regression, which included as independent variables year level, gender, age and maths self-efficacy level indicated a good fit ($R^2 = 37.63\%$) and the overall relationship was significant ($F(2341) = 104.49, p < 0.001$). Maths self-efficacy level ($\beta = -0.626, p < 0.001$) made the strongest unique contribution, when controlling for the other variables.

Discussion

To our knowledge, this study is the first in Australia to describe the relationship between self-efficacy and maths anxiety among paramedic students. It will add to the background knowledge derived from the literature and may provide a reference point for future research to enable practice change and improve patient care.

This study found that gender and year level are the factors that affect maths anxiety. In contrast, gender, year level and

Table 2. Paramedic students MARS-R mean, SD and 95% CI scores by year level, age group and gender

		Number	MARS: mean (SD)	Coefficient (95% CI)
Year level	Year 1	159	24.74 (8.04)	Reference
	Year 2	86	27.98 (9.04)	3.23 (0.92, 5.54)
	Year 3	99	25.27 (9.65)	0.532 (-1.68, 2.74)*
Age group (years)	=<19	125	26.52 (8.38)	Reference
	20-24	174	25.33 (8.89)	-1.18 (-3.23, 0.86)**
	25-29	24	24.71 (10.41)	-1.81 (-5.70, 2.08)
	30-34	13	26.08 (10.16)	-0.44 (-5.53, 4.65)
	=>35	8	23.75 (9.58)	-2.77 (-9.14, 3.60)
Gender	Male	126	23.46 (7.95)	Reference
	Female	217	26.94 (9.09)	3.47 (1.55, 5.39)***

* $p = 0.043$, ** $p = 0.723$, *** $p < 0.001$

Table 3. Paramedic students MSES mean, SD and 95% CI scores by year level, age group and gender

		Number	MSES: mean (SD)	Coefficient (95% CI)
Year level	Year 1	158	130.22 (26.30)	Reference
	Year 2	87	116.13 (32.74)	-14.08 (-21.65 to -6.52)
	Year 3	99	126.77 (28.97)	-3.447 (-10.71-3.81)*
Age group (years)	=<19	125	120.70 (24.84)	Reference
	20-24	174	124.94 (31.63)	4.240 (-2.35-10.83)
	25-29	24	146.62 (21.15)	25.92 (13.38-38.46)
	30-34	13	133.31 (29.10)	12.61 (-3.78-29.01)
	=>35	8	143.63 (32.20)	22.93 (115.66-125.73)
Gender	Male	125	136.66 (25.47)	Reference
	Female	218	119.37 (29.60)	-17.29 (-23.51 to -11.07)***

* $p = 0.043$, ** $p = 0.723$, *** $p < 0.001$

age are the factors that affect maths self-efficacy levels among paramedic students. Moreover, this study found a significant inverse relationship between maths self-efficacy and maths anxiety levels.

The severity of maths anxiety among the participants was similar to McMullan's findings on British nursing students in 2012 where 10% reported low levels of anxiety toward maths, 70% reported moderate levels and 20% reported high levels of anxiety. The results of our study showed that there were significant mean differences between males and females regarding their maths self-efficacy and maths anxiety scores, favouring males; which is consistent with previous studies (26-29). Our findings disagreed with Alves et al (30), who found that gender showed no differences in the perceived importance of maths anxiety. Why some people develop maths anxiety is because of their learned attitude from childhood, previous negative experiences, and their perception of an intense situation (31). According to the Australian Mathematical Sciences Institute, girls are more maths anxious and less confident in their mathematical ability than boys (31). However, there is no evidence that there is a gender difference in mathematical knowledge and ability.

An interesting finding of our study is that the age group did not play a significant role in the maths anxiety score, whereas it was significantly important in determining the maths self-efficacy scores. The effect of age on maths anxiety was studied by many researchers ending with inconsistent findings. For example, Hembree (32) and Zeidner (33) found that there is no significant effect of age group on maths anxiety level while Dew et al (34) reported that older students have more maths anxiety than younger students.

Another surprising finding of our study is that students who are at year two of their degree have more anxiety toward maths and lower self-efficacy levels than the students in years one and three. This might be explained by being in the midway of their degree, where they start to have more in-class clinical scenarios and placements that require drug calculations under stressful conditions, which might trigger their anxiety. On the other hand, students at year three have reached the final year of their degree and are more prepared to the actual work in the field, have been exposed to more stressors in their field placements that might increase their confidence and reduce anxiety levels.

The inverse relationship between maths anxiety level as measured by the MARS-R and the self-efficacy level as measured by MSES agreed with Akin and Kurbanoğlu's (17) findings in that maths anxiety-related negatively to self-efficacy. Our finding supports Bandura's social cognitive theory in which he argued that there was an inverse relationship between maths anxiety and self-efficacy. Self-efficacy develops after personal experiences or by learning from the experiences of others (vicarious learning), what a person is taught or convinced of

and how the experiences affected the person emotionally (14). Warwick (35) reported that a feedback loop for self-efficacy leads to engagement in learning that leads to outcomes; the positive effects will lead to re-engagement in the learning process (14). The feedback loop, however, can be positive or negative. Therefore, a negative self-efficacy may lead to less engagement and poorer outcomes and might determine some mental health issues as anxiety (35). The finding of our study supported with McMullan et al (20) a study of 229 British nursing students who found that a statistically significant relationship between anxiety, self-efficacy and ability. Anxiety was associated with self-efficacy and ability in a negative direction, whereas self-efficacy and ability had a positive association.

Improving the self-efficacy of students may increase their beliefs in their capabilities that will decrease their anxiety toward maths. Motivation is one of the techniques that can enhance self-efficacy because people like to succeed and avoid failing (36). Motivation in learning reflects a means for activating students' ability for academic achievement. Motivation may include role modelling sessions in which the participants observe the actions of others which help them in having an objective understanding of the performance. Moreover, enhancing motivation requires that the development of competencies be linked with rewards (14). Rewards, in turn, inform students that they are developing competence and raise self-efficacy (14).

Limitations

One of the limitations of this study is that it was carried out in one Australian paramedic program. Another limitation of this study is using self-reported data. This study utilised the maths task subscale of the MSES because it has 18 items to avoid the participants' survey fatigue. Finally, this study was not run in conjunction with any type of maths testing that could have correlated students' marks with their anxiety and self-efficacy scores.

Further research

This study was conducted with paramedic students studying in one Australian university, and for the generalisation of the findings, more paramedic students in universities offering paramedicine degrees should be researched nationally and internationally. Future research should also focus on measuring maths anxiety and self-efficacy levels among practising paramedics in the field. Further research on the association between maths anxiety and a maths-related paramedic skill such as drug dose calculation could be conducted since there was a significant inverse relationship between maths anxiety level and self-efficacy level among paramedic students. This could include an interventional teaching package, including motivational techniques, and role modelling techniques to improve self-efficacy, which could reduce maths anxiety.

Conclusion

This study addressed the relationship between self-efficacy and maths anxiety among paramedic students. Paramedic students reported medium to high maths anxiety levels and maths. Self-efficacy was negatively related to maths anxiety among paramedic students. Maths self-efficacy and maths anxiety levels differ between gender and the study year level.

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Competing interests

The authors of this paper declare no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement.

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