

Science anxiety levels in Emirati student teachers

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Abstract

Research has shown that pre-service and in-service teachers who exhibit science anxiety are less likely to teach it effectively. It is therefore critical to gauge the science anxiety levels of student teachers early while there are still possibilities, perhaps, to prevent serious issues occurring later on as a result. This study takes place in the United Arab Emirates, where Emirati science teachers are already in the vast minority. Since this is the case and teacher attrition rates are high, it is important to offer as much support to student teachers as possible. We surveyed 113 student elementary school teachers to explore their science anxiety levels. Whilst some studies have shown that science anxiety can decrease as students take science content courses, thereby theoretically gaining confidence in science knowledge, this effect was not observed in our study except for a few aspects and only in those who had studied in the 'science track' at school. We also found that students educated in arts tracks in high schools had significantly higher science anxiety levels compared with those who followed science tracks.

قد أظهرت البحوث أن معلمي ما قبل الخدمة و المعلمين في الخدمة و الذين يظهرون قلقاً من مادة العلوم هم أقل احتمالاً لتعليم مادة العلوم بفعالية. ولذلك فمن الأهمية قياس مستويات القلق من مادة العلوم لمعلمي ما قبل الخدمة في وقت مبكر في حين لا يزال هناك احتمال ربما لمنع حدوث أي مشاكل في وقت لاحق نتيجة لذلك. وتجري هذه الدراسة في دولة الإمارات العربية المتحدة، حيث معلمي العلوم الإماراتيين هم أقلية. وبما أن هذا هو الحال ومعدلات تناقص المعلمين مرتفعة، فمن المهم تقديم أكبر قدر ممكن من الدعم لمعلمي ما قبل الخدمة. قمنا بمسح 113 من معلمي ما قبل الخدمة لاستكشاف مستويات قلقهم من مادة العلوم. في حين أظهرت بعض الدراسات أن القلق من مادة العلوم يمكن أن ينخفض مع استكمال الطلبة مساقات المحتوى العلمي، وبالتالي اكتساب الثقة في المعرفة العلمية، لم يُلاحظ هذا التأثير في دراستنا باستثناء بعض الجوانب و فقط لأولئك الذين اتخذوا المسارات العلمية في المدرسة. ووجدنا أيضاً أن معلمي ما قبل الخدمة الذين اتخذوا المسارات الفنية و الأدبية في المدارس الثانوية كان لديهم مستويات القلق من مادة العلوم أعلى بكثير من أولئك الذين اتبعوا المسارات العلمية.

Introduction

Abu Dhabi, the capital and largest of the seven emirates which make up the United Arab Emirates (UAE), has undergone significant educational reform and development over the past decade. A large impetus for the educational reform has been the gradual realization of the finite nature of the oil economy, and the urgent need to replace this economy with other forms (Kubursi, 2015). A knowledge economy, with a heavy emphasis on science, technology, engineering and maths (STEM) subjects would feed into this (Arab Knowledge Report, 2011). This requires human capital investment over a long period, for example increasing the number of young people choosing STEM subjects at tertiary level and increasing the quality of STEM education at all levels of the education system starting from primary. To this end, competent teachers of science, with high self-efficacy about the subject are desirable; this has been shown to be a prime factor in students' success in terms of attainment (Darling-Hammond, 1997).

Primary school science in Abu Dhabi government schools is taught by one generalist teacher through the medium of English; she or he teaches Science, Mathematics and English. Teacher training institutions therefore place equal emphasis on these three subjects in the teaching and practicum experience, designing their pedagogy courses and internship requirements to ensure as much as possible, that a graduating teacher is proficient in teaching all three subjects. The curriculum (currently called the 'Abu Dhabi School Model') used has been through various modifications since its inception in 2010. Central to its focus in science is a hands-on inquiry based, exploratory approach which aims to encourage student autonomy and critical thinking skills; these are key to the creation of future graduates who can contribute to the desired knowledge economy. Highly confident science teachers play an important role in the provision of these kind of educational experiences in science due to the link between teacher efficacy and likelihood of teaching in this manner described previously (Howit, 2007). Teacher-training colleges in the UAE are at the forefront of these challenges and having student teachers who exhibit science anxiety is anathema to these plans for the future. In this article we will describe the science anxiety levels of over one hundred student primary teachers, looking in particular at the effect of studying science courses on anxiety levels, and how their high school background (whether they had opted for the arts or science track offered in UAE high schools) affects their science anxiety levels.

Science anxiety and pre-service teachers

Anxiety, in general, is defined as a condition which creates agitation and distress in the individual and stimulates the central nervous system (Spielberg, 1972). Science anxiety can be considered to be a serious learning difficulty which can seriously impede student learning (Mallow, 2006). It is known to be quite distinct from general academic anxiety, since student teachers suffering from this are not observed to exhibit the same unease when taking other subjects, and the symptoms of anxiety are not always linked particularly to exam taking situations either. Student teachers who have experienced this phenomenon may be prevented from choosing subjects at a tertiary level (or in high school, where choices exist), which could well limit their career paths. Student teachers with high science anxiety take fewer science courses in college where they have the option, and have been reported to achieve lower SAT-Q scores (Brownlow, Jacobi and Rogers, 2000). Many people who have science anxiety as school pupils carry this with them to adulthood with detrimental results. This can have far reaching effects on general science understanding when applied to real-life situations (Greenburg and Mallow, 1982).

It is understood that teachers who suffer from science anxiety, and hold low science self-efficacy in the subject are far less likely to teach it well (Howit, 2007). Generalist elementary school teachers, who tend to hold general education degrees of which science is a part, normally have some autonomy in practice over the number of hours of science teaching they provide (Dorph et al., 2011). If they exhibit science anxiety, this may result in reduced numbers of hours of science education for the children in their care. Research has shown that student teachers who dislike science, or who place little value on it compared with the other primary school subjects such as mathematics and English, are likely to teach it poorly, and employ didactic approaches rather than inquiry-based activities (Bencze and Hodson, 1999; Bursal, 2008). In a USA based study, Udo et al. (2001) found that among the most science anxious university students are education majors, the teachers of the next generation. This may have consequences for their future teaching, if action is not taken during their pre-service teaching years to abate this anxiety. To our knowledge, no studies of this phenomenon have been carried out in the Gulf region, and certainly not in the UAE.

There is a gendered aspect to science anxiety, which potentially affects teacher-training colleges since they are predominantly populated with female students in most parts of the world (Stewart et al.,

2016). Seymour and Hewitt (1997) investigated reasons why women left the study of science, and found that they tended to leave for complex reasons, such as the interactions between emotions and learning, including science anxiety. When the concept of 'science anxiety' was first studied and coined by Mallow (1978), he found that the majority of attendees at his clinic were female. Investigating this further, Mallow (1994), and later Udo et al. (2004) also found that there was a strong gender bias in science anxiety. They suggested that one of the reasons for the gender significance could be the greater emphasis on biology rather than the physical sciences (particularly physics) during schooling as reported by their sample, possibly because of their own teachers' science anxieties.

Pre-service teaching is a critical time; this period provides opportunities to give positive experiences to students who exhibit signs of science anxiety so that they might manage these feelings (Watters & Ginns, 1994). It is important to gauge students' science anxiety levels early on whilst there are still possibilities to overturn some of the reasons behind these fears and avert serious issues occurring later. There is some evidence to suggest that altering teaching strategies for students can help alleviate science anxiety (e.g. Britner & Pajares, 2006; Jegede et al., 1990).

In the context of teacher training in the UAE, where Emirati teachers are already in the vast minority and attrition rates are high (Al Kaabi, 2005, Dickson et al, 2014), it is important to offer as much support to students as possible. If student teachers are graduating with high levels of science anxiety unabated, according to research there is a very real concern that as generalist primary school teachers, their science teaching will be far from optimal (e.g. Riggs & Enochs, 1990) and possibly shy away from use of student-centred learning strategies (Howit, 2007). This in turn means that the learning of young Emirati student teachers may be compromised.

As much as the country has rapidly been developing its educational system in recent years, this has to be contextualized within the relatively recent onset of institutionalized education in the UAE, which is a young country. The current generation of pre-service teachers in UAE have mainly been educated in public schools during a time of educational reform. Currently, the various emirate educational councils and ministries have piloted a variety of initiatives in science education, including inquiry based learning. Prior to this, though, it is generally accepted that the majority of their experience of science education has been primarily didactic, with little exposure to such ideas as inquiry based learning. This is contrary to the current vision of the UAE whereby critical thinking and learning through inquiry tie in closely to the goals of the Knowledge Economy. It is possible, then, that these schooling experiences have affected students' views and confidence of at least some aspects of science education. There is research which supports this idea of the quality of a science teacher's own science education experience affecting their teaching (e.g. Adams & Krockover, 1997) and indeed a study of Emirati student teachers found that they themselves linked their own schooling experience of didactic science practices to their lack of confidence in the science classroom (Dickson and Kadbey, 2014). In addition, in a didactic schooling system, Emirati students may have had few role models of the kind of teacher envisaged by the UAE National Vision.

Given that the situation in UAE English medium classrooms is that the teacher is required to teach maths, English and science too, it becomes obvious that alleviating student teachers' science anxiety is important to support their well-being and their exposure to and understanding of science, as well as allowing for a more comfortable career for the teacher her/himself. The contribution of this study to the UAE is important. Whilst science anxiety studies have been carried out in Europe, Turkey and in the US, we are not aware of any research in the Gulf region which has looked into this issue; yet STEM is highly prioritised in the UAE National Vision 2021 (*UAE National Vision 2021*) as evidenced by the key

performance indicators which include targets for maths and science. Therefore, our research not only is innovative, but also has relevance to national developmental goals in the UAE and the Gulf region.

Study aims

The aim of this research study was to ascertain the science anxiety levels of Emirati student teachers and to identify particular areas of relatively higher science anxiety, if applicable. We also explored whether students at the beginning of their science courses exhibit statistically significant differences in anxiety indices compared with those who have already undertaken three science content courses at college. This is based upon a theoretical framework which indicates that in some cases, science anxiety is related to lack of exposure to, or insecurity with, science content itself, and in some cases is alleviated by students' covering science material and therefore developing greater confidence in the subject (Czerniak, 1989). We compare the anxiety of students who have followed arts tracks at high school with those following science tracks, who would have taken a substantially greater number of classes in science, and in much greater depth. Finally, we make suggestions of possible ways in which the science anxiety could be alleviated.

The research questions which this study attempts to address are as follows:

- 1) How, if at all, does science anxiety differ with students' completion of three science knowledge courses, i.e. between Year 1 and Year 2 students?
- 2) How do the science anxiety levels of the students who followed an Arts track at high school compare with those who followed a Science track?
- 3) How do the science anxiety levels of the Year 1 students from the Science track compare to those of the Year 2 Science track students, and the same for Arts track students?

Study methodology

The study utilised quantitative methods of data collection; a survey questionnaire was administered to the students. This questionnaire was a modified version of that designed by Guzeller and Dogru (2012), which has been tried and tested for validity, reliability and internal consistency by these authors. The original instrument contained twenty eight questions. We omitted nine of these for a variety of reasons, such as our perception that some questions were not appropriate to our college setting (e.g. "I usually take a nap in the science lectures when I go to bed late and can't sleep well" – the college classes run in classroom settings and generally do not follow lecture formats). The instrument was originally designed to be administered to school students, but we felt that it was generic enough to be applicable to our first and second year college students. The items ask students to imagine themselves in certain situations and to rate their level of anxiety on a four degree Likert agreement scale where 1 corresponds to Strongly Disagree, and 4 to Strongly Agree. Examples of such survey items are "I get stressed just when entering the classroom if the class is science" and "I feel uncomfortable when I enter the science lab". A high level of agreement with the statements indicates a high science anxiety and conversely, a high level of disagreement (low mean) indicates lower levels of science anxiety. In order to minimize undue influence or swaying participants towards a particular answer, especially when a statement is quite negative, the original authors included some statements of a more neutral or factual nature. Overall it was felt that this balance of questions compensated for the possible effect of influencing participants, so that the trends which the questionnaire are able to indicate remain valid. The original authors of the survey examined its psychometric properties, construct validity and item and construct

reliability and found that these provided the required criteria and exhibited good internal consistency (see Guzeller & Dogru (2012) for more details).

Items are focused on perceptions of science learning and identity, with some statements relating to analogous situations such as studying for a science exam, entering a science classroom etc. The survey was analysed using descriptive statistics and for the inter-group comparative data (e.g. comparing those students at the beginning of their science courses with those at the end) we analysed using unpaired student t-tests.

A purposive sample of students (drawn from Years 1 and 2 of the Bachelor of Education course) were approached to participate in the study. The survey was created online using eSurveysPro™ and the link sent by email to all students; science faculty members were requested to give students time to do this at the end of their lessons in order to increase response rate. In each case, a third party, who was not the class teacher, administered the survey to the students to eliminate any possible bias due to researcher familiarity and a resultant pressure on the student to participate and perhaps even to give particular responses. The institute’s research and ethics committee had approved the study. The fact that the students’ participation was voluntary was made clear in two ways: by the initial introductory email and the first paragraph of the online survey. There, we added a statement to the effect that students should be aware that clicking ‘begin’ on the survey acknowledged their consent to participate, but reiterated that this was both voluntary and completely anonymous, and that they were free to withdraw at any time.

Findings and discussion

The invitation email was sent to all students in Years 1 and 2 – a total of 172 students. Of these, 113 students (65.6%) participated in the study. The majority of the study participants (80%) were aged between 18 and 27. 60.4% had followed the Art track at high school, compared to 39.6% the Science track. Of these, 93% were females, which is representative of the gender makeup of the college. The number of participants from each year group was similar: 59 from Year 1 and 54 from Year 2.

Table 1: Student demographic information.

Student Condition	Year 1 (n=59)	Year 2 (n=54)
Completed foundation year before entering the college	47%	44%
Graduated from high school more than 2 years prior to college entry	44% (20% graduated between 5-18 years earlier)	63% (46% graduated between 5-30 years earlier)
Marital Status	29% married 5% divorced 66% single	54% married 4% divorced 43% single
Gender	4 males 55 females	4 males 50 females

Both groups had a large proportion of students who were not direct school leavers: 44% of the Year 1 students had graduated from high school more than five years prior to joining the college, and 63% of the Year 2 students had done so. Close to half of the students in each year groups (47% of students in Year 1 and 44% of those in Year 2) had undertaken a foundation year prior to beginning their Bachelor degree;. Some demographic data for the two year groups was gathered, which lends some context to the study (Table 1). Data is presented as percentages of the participants from that year group.

Research question 1: Year 1 and Year 2

1. How, if at all, does the science anxiety index differ with students' completion of three science knowledge courses i.e. between Year 1 and Year 2 students?

In order to address RQ 1, we compared the responses from the Year 1 students (at the beginning of their first science content course) with those of the Year 2 students, who had just completed three science content courses.

Table 2 shows the students' responses (agreement levels) to the survey statements, and presents the p-values from the t-tests run on the comparison groups, where values less than 0.05 are considered significant and are highlighted. The standard deviations were low, indicating that the data is clustered around the means and that the mean values are therefore representative. The obvious limitation of this methodology lies in the intrinsic differences between year groups by virtue of being different students, as opposed to a longitudinal study which could compare the same students at different points in time. However, the trends give us some indication of possible effects of the science courses.

A visual inspection of the first three columns in Table 2 shows very little difference in means between the year groups, and we found that there was no significant difference between the responses of students in years 1 and 2. Most of the means are slightly less for Year 2, but given the lack of statistical significance, no conclusions could be drawn.

The content courses taught at the college also aim to develop students' investigative science skills. Each course has a different focus so that students have the opportunity to acquire and practice the basic skills (questioning, hypothesising, fair-testing, making observations, using equipment, drawing conclusions and evaluating science processes) over the three courses. Due to this, a greater positive change might be expected in the means for statements indirectly connected to analysing these skills, i.e.

- Doing science activities in the classroom makes me uncomfortable (Year 1 mean 2.35, Year 2 mean 2.29)
- I feel uncomfortable when I enter the science lab (Year 1 mean 2.02, Year 2 mean 1.92)

However, taking three science content courses appears to have had little effect on science anxiety levels overall. This suggests that the students' original predispositions to anxiety may over-ride the effect of increasing science content course, or perhaps that the content courses themselves are lacking in some way. The means for statements connected to learning in the physical area where science is taught are higher for the Year 1 students than for the Year 2, for example:

- I get stressed just when entering the science class! (Year 1 mean 2.31, Year 2 mean 2.04)

The drop in means of such statements among the Year 2 students may suggest that a certain familiarity and relaxation has occurred by their second year. Perhaps by then, even if students are not necessarily more comfortable and confident with the science content, they may be more familiar with the expectations of science courses. Each of the three science courses has a similar format and assessment structure, i.e. classwork (quizzes, practical work), mid-term exam, final exam, and are made up of a combination of biology, chemistry and physics topics in each course. In a small college environment, students also become familiar with the teachers themselves and may well have the same teacher at points, which may have reduced their anxiety. This may also be related to a general sense of reducing the situational anxiety with beginning college and leaving the high schools where they have studied for years previously. That none of these differences are statistically significant, though, may suggest that the science anxiety is deeply rooted in students.

Table 2: Reponses analysed by year group and high school track (Science or Arts).

Statement	Mean Year 1 (n=59)	Mean Year 2 (n=54)	t-test ¹ (Year 1 vs. Year 2) p-values	Mean Science track (n=45)	Mean Arts track (n=68)	t-test (Science track vs. Arts track) p-values
<i>I am afraid of science courses bringing down my overall GPA</i>	2.86	2.96	0.74 (ns)	2.26	3.00	0.01*
<i>I don't want to learn science if it is not mandatory</i>	2.85	2.61	0.38 (ns)	2.11	2.79	0.01*
<i>I am afraid of science exams more than any other exams</i>	2.71	2.72	0.96 (ns)	2.17	2.82	0.02*
<i>Thinking about learning new concepts, formulas, and definitions related to science make me nervous</i>	2.52	2.39	0.59 (ns)	2.14	2.41	0.83
<i>It is not necessary to learn science to be successful in my life (outside work)</i>	2.48	2.25	0.35 (ns)	2.23	2.30	0.62
<i>My mind goes blank in science exams and I can't think</i>	2.40	2.14	0.19 (ns)	1.91	2.29	0.21
<i>I usually feel unhappy when learning science</i>	2.40	2.22	0.42 (ns)	1.77	2.43	0.03*
<i>It always makes me anxious that science is a compulsory course in the curriculum</i>	2.38	2.33	0.84 (ns)	1.83	2.54	0.35
<i>Doing science activities in the classroom makes me uncomfortable</i>	2.35	2.29	0.32 (ns)	2.14	2.35	0.57
<i>I feel like I'm in a deep hole when solving questions related to science</i>	2.35	2.18	0.28 (ns)	1.83	2.32	0.049*
<i>I get stressed just when entering the classroom if the class is science</i>	2.31	2.04	0.25 (ns)	1.74	2.18	0.22
<i>It is not necessary to learn science to be successful in my career</i>	2.29	2.41	0.63 (ns)	2.03	2.33	0.10(ns)
<i>I worry that the teacher will ask me questions in the science class</i>	2.23	2.23	0.99 (ns)	1.91	2.28	0.12(ns)
<i>I become nervous when I have to do science homework</i>	2.21	1.96	0.25 (ns)	1.80	2.09	0.39(ns)
<i>I feel uncomfortable when I enter the science lab</i>	2.02	1.92	0.62 (ns)	1.69	1.96	0.32(ns)
<i>I usually daydream in the science class</i>	1.96	2.04	0.68 (ns)	2.03	1.91	0.37(ns)
<i>I don't answer in science class even when I know the answer in case my friends make fun of me</i>	1.83	1.94	0.56 (ns)	1.60	1.89	0.28(ns)
<i>I can't learn science no matter how much I study</i>	1.71	1.69	0.87 (ns)	1.54	1.71	0.38(ns)
<i>Everybody except me understands science</i>	1.69	1.65	0.77 (ns)	1.49	1.62	0.85(ns)

In addition to the main research questions, we also wanted to explore the idea of fear of science as a subject within the context of their other core subjects (namely maths and English) which the statement “I am afraid of science exams more than any other exams” allows. The high mean for this question (2.71

Year 1, 2.72 Year 1), for both year groups may suggest that the anxiety may be specific to science and not generalised to their other subjects.

The statements with which students in both year groups agreed most were related to reluctance to participate in science due to fear of poor results, and fear of the exam itself, e.g.:

- I don't want to learn science if it is not mandatory (Year 1 mean 2.85, Year 2 mean 2.61)
- I am afraid of science courses bringing down my overall GPA (Year 1 mean 2.86, Year 2 mean 2.96)
- I am afraid of science exams more than any other exams (Year 1 mean 2.71, Year 2 mean 2.72).

Research questions 2 and 3: Arts and Science track background

2. How do the science anxiety levels of the students who followed arts track at high school compare with those who followed science track?
3. How do the science anxiety levels of the Year 1 students from the science track compare to those of the Year 2 science track students, and the same for arts track students?

Table 22 shows that the means of responses for Arts track students are higher for every item, indicating a higher level of science anxiety, but of these, five are significantly different ($p < 0.05$). Our findings indicate that students who followed Arts tracks at school are significantly more likely to be science anxious, and to exhibit symptoms of science anxiety.

This could be as a result of a variety of factors. The sense of identity instilled in Arts track students may be an important factor, part of that possibly being that they 'cannot cope' with science, which may have been a factor for at least two years of high school. In addition, the very act of opting for the Arts track meant that, by definition, they were no longer exposed to a variety of science topics and miss out on both quantity and breadth or depth of science courses. As a general rule, under previous guidelines, Arts track high school students take around one third of the number of hours of science taken by Science track students. So, if theories which hold that increased exposure to science content courses may have an effect on reducing science anxiety levels, then students from high school Arts tracks were already at a disadvantage at their entry into the college.

Table 3: Responses showing significant difference between students coming from Arts/Science high school track.

Statement	Means, HS Science Track (n=45)	Means, HS Arts Track (n=68)	t-test
I feel like I'm in a deep hole when solving questions related to science	1.83	2.32	0.049*
I usually feel unhappy when learning science	1.77	2.43	0.03*
I don't want to learn science if it is not mandatory	2.11	2.79	0.01*
I am afraid of science courses bringing down my overall GPA	2.26	3.00	0.01*
I am afraid of science exams more than any other exams	2.17	2.82	0.02*

For ease of reference and discussion we have isolated the relevant statements in Table 3. Science track students hold less agreement with the statements (lower means), presumably due to an earlier

confidence in their own competence and abilities in science. As with the differences between Years 1 and 2 students, fear of science courses bringing down overall GPA pose concern; it would seem that Arts track students carry an identity of being weak at, fearful and anxious about, science, well into the college years. As Mallow (2006) postulates, students can bring science anxiety with them well into adulthood with negative results and this can be seen as a learning difficulty.

Finally, having compared the anxieties of Year 1 and Year 2 students and finding little differences, yet noting differences between science and arts high school tracks, we then separated each year group into its respective high school tracks (Science and Arts) in order to isolate the effect of taking three science content courses without the influence of their high school background. The results of the t-test between these groups can be seen in Table 4.

Table 4: Responses of Year 1 and Year 2 students from each High School track.

Statement	Mean Year 1 Science (n=21)	Mean Year 2 Science (n=22)	t-test (Year 1 Science vs. Year 2 science)	Mean Year 1 Arts (n=35)	Mean Year 2 Arts (n=31)	t-test (Year 1 Arts vs. Year 2 Arts)
<i>Thinking about learning new concepts, formulas, and definitions related to science make me nervous</i>	2.79	1.85	0.02*	2.36	2.74	0.19
<i>I am afraid of science courses bringing down my overall GPA</i>	2.52	2.2	0.47	3.06	3.45	0.26
<i>Doing science activities in the classroom makes me uncomfortable</i>	2.42	2.1	0.46	2.30	2.42	0.66
<i>I am afraid of science exams more than any other exams</i>	2.42	2.1	0.45	2.87	3.13	0.48
<i>I don't want to learn science if it is not mandatory</i>	2.39	1.95	0.31	3.12	3.03	0.79
<i>My mind goes blank in science exams and I can't think</i>	2.37	1.8	0.14	2.42	2.35	0.76
<i>I usually feel unhappy when learning science</i>	2.37	1.7	0.08	2.42	2.54	0.67
<i>I get stressed just when entering the classroom if the class is science</i>	2.36	1.65	0.07	2.30	2.29	0.97
<i>I feel like I'm in a deep hole when solving questions related to science</i>	2.16	1.7	0.17	2.47	2.39	0.76
<i>It is not necessary to learn science to be successful in my life (outside work)</i>	2.16	2.2	0.92	2.67	2.29	0.19
<i>I become nervous when I have to do science homework</i>	2.16	1.75	0.23	2.24	2.09	0.61
<i>It always makes me anxious that science is a compulsory course in the curriculum</i>	2.10	1.6	0.15	2.54	2.80	0.41
<i>I usually daydream in the science class</i>	2.10	2	0.75	1.88	2.06	0.40
<i>I worry that the teacher will ask me questions in the science class</i>	2.06	1.85	0.55	2.3	2.48	0.64
<i>I feel uncomfortable when I enter the science lab</i>	2.0	1.75	0.42	2.03	2.03	0.99
<i>Everybody except me understands science</i>	1.95	1.45	0.09	1.54	1.71	0.19
<i>It is not necessary to learn science to be successful in my career</i>	1.89	2.2	0.48	2.51	2.54	0.91

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<i>I don't answer in science class even when I know the answer in case my friends make fun of me</i>	1.89	1.65	0.44	1.78	2.12	0.17
<i>I can't learn science no matter how much I study</i>	1.68	1.5	0.47	1.72	1.81	0.68

Some of the means of responses are different between the Year 1 and 2 students in each track, with the majority less for Year 2 (Table 4), suggesting that taking the three science content courses may have had some effect on reducing the science anxiety for these students. It may be that this period of study also increased the students' familiarity with science content with which they were already fairly comfortable from high school, and that the anxiety was more related to the environment in the science classroom. However, only one statement shows significance at $p < 0.05$: "Thinking about learning new concepts, formulas, and definitions related to science make me nervous". Three statements show statistical significance if the threshold is increased to 0.1 (Table 4), which again suggests that familiarity with the content, skills taught, or even the environment in which they are taught, may reduce their anxiety levels. No differences are seen in the science anxiety levels between Years 1 and 2 arts track students, indicating that the three content courses have not had an effect on their science anxiety.

Implications

Our results show evident incidences of science anxiety within the researched student body, and that certain characteristics such as high school academic background seem to increase a likelihood of science anxiety. As discussed earlier, student teachers' own schooling experience has been shown elsewhere to be a significant precursor to science anxiety. The increase in science anxiety of students from Arts high school streams may possibly, then, be connected to a comparatively lower quality of science teaching from those students, at least in terms of provision of hands-on learning opportunities. A definite indication of causality would of course require further study.

Our results also inspire the obvious question: what can be done to try to reduce the science anxiety of our future Emirati science teachers? What has worked for others to alleviate science anxiety and is this indeed possible? Mallow (2008) listed practical strategies which had been proven to help science anxious student teachers overcome their anxieties, such as providing group work opportunities (which seemed to alleviate the tension of the lecture environment), allowing waiting time after asking a question, using theme-based curricula, and teaching science skills very explicitly, rather than making assumptions about the background knowledge of younger college students. The way in which content courses are taught at our institution could be examined in order to eliminate possible sources of science anxiety: not only in the skills and content taught but the way in which the courses are delivered. The way in which these may link into increased science anxiety cannot be ascertained at this stage but it is an area of possible future exploration, given the levels of science anxiety and the possibility that some of this may be due to a lack of innovation and use of engaging, inclusive teaching strategies. The provision of a more welcoming environment may in particular appeal to the first year students – see their high rates of science anxiety – who might be particularly sensitive to physical environment changes.

Other pedagogical strategies which have been found to effectively reduce science anxiety in students include concept mapping, in order to strengthen their understanding of relationships between concepts and thus lower their anxiety (Czerniak & Haney, 1998). These concept maps could be incorporated into the courses during periodic review. The anxieties triggered by the science class or lab environment (see students' responses above) may be alleviated by greater student ownership or involvement in the

development of the physical environment and layout of the rooms. Engaging, non-threatening activities conducted in the science classroom and lab may also help to relieve students' apprehensions regarding these spaces. High means for statements relating to science being necessary for success and that 'if science wasn't mandatory' they would not take it, are indicative of a fixed mindset regarding science, which may be helped with positive role modelling e.g. guest lectures by Emirati science teachers. Other research has shown this to be a useful tool in overcoming science anxiety (Udo et al, 2004) along with the provision of detailed qualitative feedback rather than quantitative. Use of quizzes and other forms of frequent continuous assessment other than mid-term or final exams, but perhaps less 'threatening' forms of assessment may help too (Ramey-Gassert & Shroyer, 1992). Innovative teaching approaches in science pedagogy courses have been seen to be associated with increased science teaching self-efficacy (Bleicher, 2006); this may be true of science anxiety, too.

One limitation here is that of course, these are our suggestions as authors based on both findings from other research, and our intuition. Unfortunately, we did not ask the students to make their own suggestions, which would have been beneficial in providing culturally relevant solutions to this group of students, and with hindsight it could have been included in the survey questionnaire. In future work, students could work within their science classes to engage in this discourse about science anxiety with their teachers in a workshop format, where they are presented with the key findings of this study, and then asked to identify possible areas where they could be helped with their science anxiety, and which could be taken up (where feasible) by the science department. Other clues as to areas which the students in this study have identified as contributing to science anxiety are indicated by the relatively high means with respect to certain survey items, e.g. "Thinking about learning new concepts, formulas, and definitions related to science make me nervous" and "Doing science activities in the classroom makes me uncomfortable" which are clear indications of a need for science teachers to work to create a classroom environment where students feel more familiar and comfortable with activities, and to reduce the fear around use of formulae and definitions possibly by creating games and problem-solving opportunities which students might consider less stressful. These kinds of games and activities could easily be incorporated into 'getting to know you' type activities at the beginning of a course, for example, but teachers would have to be led and guided to do this in a structured fashion.

Previous studies of this student body have shown a wide diversity of motivations for selection of teaching as a career, many of them not intrinsically linked to teaching itself but to other reasons such as family's preference of gender segregated workplaces for their daughters/wives, a desire to be better able to help their own children with homework, etc. (Sharif et al., 2014). Even among those who do enter teacher-training for intrinsic reasons linked to genuine desire to teach, many may not necessarily have selected to become science teachers, given a choice. In the past, Emirati student teachers were able to select their subject of choice to teach, even in primary schools. The generalist model was introduced by Abu Dhabi Educational Council only in 2007, and then brought in gradually. Student teachers now are being obliged to become science teachers when they may not have wished to. The effect of this is that students are coming into teacher training who may or may not be passionate about science teaching, or about teaching in general.

Conclusion

The main findings of the study indicate that in this dedicated teacher training institution for local (Emirati) students, relatively high degrees of science anxiety are observed. This may have implications for the future of science education in the UAE. Another issue which this study highlights is the evidence shown that there are some significant differences in levels of science anxiety between students coming

from high school Arts and Science tracks. This is notable, given that 67% of entrants to the college are from high school Arts tracks; and the pattern may be replicated across teacher-training institutions in the UAE. The lower numbers of Science track students entering teacher-training could be, at least in part, due to the plethora of STEM related opportunities offered to Emirati students graduating from science tracks. This, coupled with the generally low perceived status which teaching holds as a career for young Emiratis (Dickson, 2013), may well discourage students who are stronger in science from entering teaching. The implications of having science teachers in public schools exhibiting high levels of science anxiety are, as outlined earlier, possible avoidance of teaching science altogether, low quality teaching experiences for schoolchildren (Mallow et al, 2010; Udo et al., 2004), and in the longer term a possibility of transferring their science anxiety on to a further generation of Emirati schoolchildren. Riggs (1995) reported that teachers with lowest self-efficacy spent less time teaching science and tended to choose text-based over hands-on instruction; they also spent less time developing key science concepts.

In turn, further consequences of this may be far-reaching. If a teacher is science anxious, their future school children may receive a negative science educative experience and consequently may not opt for science electives later on in high school and then in higher education. Yet it is this uptake upon which the UAE vision heavily relies for the creation of its 2021 Vision of a knowledge based economy. In addition, as discussed earlier, there may be aspects of the science anxiety which originate from the students' own schooling experience as a result of the relatively young educational environment in the UAE, whereby they may not have observed role modelling of the kinds of science teaching to which institutions and councils now aspire. This may be alleviated in future by students having exposure to role models in future as students graduate with more hands-on skills and experience. Without a more detailed study analysing each science course's content and delivery, and their effects, it is difficult to speculate which particular elements of the course may have, or not have, affected anxiety levels specifically. There is a stark scarcity of studies such as this one, in the UAE and indeed across the Gulf, a void which we have attempted to begin to fill with this initial study. This now needs to be extended across other teacher training institutions (which we hope to do), by including more suggestions from students themselves on how their science anxiety might be alleviated, and tying these into changes of practice in science education in teacher-training colleges.

References

- Adams, P. E., & Krockover, G. H. (1997). Beginning science teacher cognition and its origins in the preservice secondary science teacher program. *Journal of research in Science Teaching*, 34(6), 633-653. [http://dx.doi.org/10.1002/\(SICI\)1098-2736\(199708\)34:6%3C633::AID-TEA6%3E3.3.CO;2-E](http://dx.doi.org/10.1002/(SICI)1098-2736(199708)34:6%3C633::AID-TEA6%3E3.3.CO;2-E)
- Al Kaabi, A.S. (2005). *Factors influencing teachers attrition in the United Arab Emirates*. Doctoral dissertation, University of Pittsburgh.
- Arab Knowledge Report. (2011). *Preparing future generations for the knowledge society*. Mohammed bin Rashid Al Maktoum Foundation. Retrieved from: <http://www.undp.org/content/dam/rbas/report/AKR2010-2011-Eng-Full-Report.pdf>
- Bencze, L. & Hodson, D. (1999). Changing practice by changing practice: toward more authentic science and science curriculum development. *Journal of Research in Science Teaching*, 36, 521-539.
- Bleicher, R.E. (2006). Nurturing confidence in preservice elementary science teachers. *Journal of Science Teacher Education*, 17, 165-187. <http://dx.doi.org/10.1007/s10972-006-9016-5>

- Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching*, 43(5), 485-499. <http://dx.doi.org/10.1002/tea.20131>
- Brownlow, S., Jacobi, T., & Rogers, M. (2000). Science anxiety as a function of gender and experience. *Sex Roles*, 42(1-2), 119-131.
- Bursal, M. (2008). Changes in Turkish pre-service elementary teachers' personal science teaching efficacy beliefs and science anxieties during a science method course. *Journal of Turkish Science Education*, 5 (1), 99-112.
- Czerniak, C. M., & Haney, J. J. (1998). The effect of collaborative concept mapping on elementary preservice teachers' anxiety, efficacy, and achievement in physical science. *Journal of Science Teacher Education*, 9(4), 303-320.
- Czerniak, C.M. (1989). *An investigation of the relationships among science teaching anxiety, self-efficacy, teacher education variables, and instructional strategies*. Doctoral dissertation, Ohio State University, Columbus.
- Darling-Hammond, L. (1997). The quality of teaching matters most. *Journal of Staff Development*, 18, 38-41.
- Dickson, M. (2013). Wide-scale educational reform in Abu Dhabi, United Arab Emirates: What do the teacher training students think? *Journal of Teachers and Teacher Education*. 1 (2), 223-229. Retrieved from: <http://www.jtee.org/document/issue2/3mak.pdf>
- Dickson, M. & Kadbey, H. (2014). "That's not the way I was taught science at school!" How pre-service primary teachers in Abu Dhabi, United Arab Emirates are affected by their own schooling experience. *Science Education International*, 24(3), 332-350.
- Dickson, M., Riddlebarger, J., Stringer, P., Tennant, L. & Kennetz, K. (2014). Challenges faced by Emirati Teachers. *Near and Middle Eastern Journal of Research in Education*, 1 (4).
- Dorph, R., Shields, P., Tiffany-Morales, J., Hartry, A., & McCaffrey, T. (2011). *High hopes, few opportunities: the status of elementary science education in California*. Strengthening science education in California. Center for the Future of Teaching and Learning at West Ed, University of Berkeley, CA. <http://files.eric.ed.gov/fulltext/ED525732.pdf>
- Greenburg, S.L & Mallow, J.V. (1982). Treating science anxiety in a university counseling center. *The Personnel and Guidance Journal*, 61(1), 48-50. <http://dx.doi.org/10.1002/j.2164-4918.1982.tb00809.x>
- Güzeller, C.O., & Dođru, M. (2012). Development of science anxiety scale for primary school students. *Social Indicators Research*, 109(2), 189-202. <http://dx.doi.org/10.1007/s11205-011-9894-6>
- Howit, C. (2007). Pre-service elementary teachers' perceptions of factors in an holistic methods course influencing their confidence in teaching science. *Research in Science Education*, 37, 41-58.
- Jegede, O. J., Alaiyemola, F. F., & Okebukola, P. A. (1990). The effect of concept mapping on students' anxiety and achievement in biology. *Journal of Research in Science Teaching*, 27(10), 951-960. <http://dx.doi.org/10.1002/tea.3660271004>
- Kubursi, A. (2015). *Oil, industrialization & development in the Arab Gulf states (RLE Economy of Middle East)*. London: Routledge.
- Mallow, J. V. (1994). Gender-related science anxiety: a first binational study. *Journal of Science Education and Technology*, 3(4), 227-238. <http://dx.doi.org/10.1007/BF01575898>
- Dickson, M., McMinn, M. & Kadbey, H. (2017). Science anxiety levels in Emirati student teachers. *Learning and Teaching in Higher Education: Gulf Perspectives*, 14(1). <http://doi.org/10.18538/lthe.v14.n1.250>

- Mallow, J. V. (1978). A science anxiety program. *American Journal of Physics*, 46(8), 862-862.
<http://dx.doi.org/10.1119/1.11409>
- Mallow, J. V. (2006). *Handbook of college science teaching*. National Association of Science Teachers. Retrieved from: <http://static.nsta.org/files/PB205X-1.pdf>
- Mallow, J.V. (2008). *Science anxiety: research and action*. National Science Teacher Association. Retrieved from: http://www.un.org/womenwatch/daw/egm/gst_2010/Mallow-EP.5-EGM-ST.pdf
- Mallow, J.V., Kastrup, H., Bryant, F.B., Hislop, N., Shefner, R. & Udo, M. (2010). Science Anxiety, Science Attitudes, and Gender: Interviews from a Binational Study. *Journal of Science and Educational Technology*, 19, 356-369. <http://dx.doi.org/10.1007/s10956-010-9205-z>
- Ramey-Gassert, L., & Shroyer, M. G. (1992). Enhancing science teaching self-efficacy in preservice elementary teachers. *Journal of Elementary Science Education*, 4(1), 26-34.
<http://dx.doi.org/10.1007/BF03173752>
- Riggs, I.M. (1995). *The characteristics of high and low efficacy elementary teachers*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco, CA.
- Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education*, 74(6), 625-637.
<http://dx.doi.org/10.1002/sce.3730740605>
- Seymour, E., & Hewitt, N. (1997). *Talking about leaving: why undergraduates leave the sciences*. Colorado: Westview Press.
- Sharif, T., Hossan, C. G., & McMinn, M. (2014). Motivation and determination of intention to become teacher: A case of B.Ed. students in the UAE. *International Journal of Business and Management*, 9(5), 60. <http://dx.doi.org/10.5539/ijbm.v9n5p60>
- Spielberg, C.D. (1972). Conceptual and methodological issues in anxiety research. *Anxiety: Current trends in theory and research*, 2, 481-493.
- Stewart, S., Coombs, L., & Burston, B. (2016). What's sex got to do with it? The preparation of elementary male teacher candidates. *Journal for Multicultural Education*, 10(1), 2-18.
<http://dx.doi.org/10.1108/JME-07-2015-0024>
- UAE National Vision 2021*. Retrieved from: <https://www.vision2021.ae/en/national-priority-areas/first-rate-education-system>
- Udo, M. K., Ramsey, G. P. & Mallow, J. V. (2004). Science anxiety and gender in students taking General Education science courses. *Journal of Science Education and Technology*, 13(4), 435-446.
- Udo, M.K., Ramsey, G.P., Reynolds-Alpert, S., and Mallow, J.V. (2001). Does physics teaching affect gender-based science anxiety? *Journal of Science Education and Technology*, 10(3), 237-247.
- Watters, J. & Ginns, I. (1994). Self-efficacy and science anxiety among pre-service primary teachers: origins and remedies. *Research in Science Education*, 24(1), 348-357.

¹ All t-tests are two-tailed, unpaired.