

What Kind of Future Science Teachers Might They Be? Pre-service Primary School Teachers in Abu Dhabi, United Arab Emirates amidst Educational Reform

Martina DICKSON¹ , Hanadi KADBEY²

¹Assist. Prof., Science Education Faculty, Emirates College for Advanced Education, Abu Dhabi-UAE

² Science Lecturer, Science Education Faculty, Emirates College for Advanced Education, Abu Dhabi-UAE

Received: 15.07.2013

Revised: 12.12.2013

Accepted: 14.12.2013

The original language of article is English (v.10, n.4, December 2013, pp.136-150)

ABSTRACT

Significant educational reform has taken place in Abu Dhabi in the United Arab Emirates since 2007. Science had traditionally been taught using a fairly didactic and teacher-centered approach, with a heavy focus on textbook use. The New School Model rolled out by Abu Dhabi Educational Council requires a new breed of teacher and a modern approach towards teaching science, one where a far greater focus is on practical activities and student-centered learning. Science courses at this teacher training college have been tailored to address this and now have a high practical work proportion in both science content and educational courses. However, research suggests that pre-service teachers have their beliefs about science education embedded from their experiences prior to their education degree, including its importance as a subject. This research employed a survey questionnaire to explore the science education perceptions of 176 pre-service teachers. The findings suggest that they have the potential to become the kind of effective science teacher which the education reform in the UAE requires to successfully fulfill its ambitions for science education. It appears that the teacher training courses have been effective in over-turning some of the experiences and beliefs based on schooling, but it was also found that the PSTs have fairly low confidence levels in science inquiry skills. Teacher training courses have to focus more on teaching these skills, to improve confidence and therefore future use.

Keywords: Pre-Service Science Teachers; Science Teaching; Teacher Training; Perceptions.

INTRODUCTION

Educational Reform in Abu Dhabi, UAE

In 2006, wide-scale educational reform began in Abu Dhabi, initially in Cycle 1 schools under the auspices of Abu Dhabi Educational Council (ADEC). Advisers were assigned to most schools, either from private consultancy companies or from ADEC itself. These advisers had a remit to work alongside local teachers to improve pedagogy by providing professional development for teachers where needed to enable them to implement lessons which utilized modern, internationally recognized as effective, teaching strategies. A new



curriculum for science, adopted from the Australian New South Wales curriculum, was drafted in 2007-2008 and gradually implemented into Cycle 1 schools. In 2009, ADEC began to employ thousands of English medium teachers from countries such as U.S.A., Canada, U.K., Australia and New Zealand who would teach the subjects of mathematics, English and science using the medium of English in Cycle 1 schools through the 'New School Model' system adopted by ADEC. In addition to the new science content of the curriculum, there were a series of standards relating to science skills that had to be taught, and which teachers had to be proficient in to be able to teach the curriculum effectively.

Therefore, preparing capable teachers was necessary for activating science education (Ergul, 2009). Teacher-training colleges in the U.A.E. needed to rapidly develop and adapt their courses to prepare teachers to fit this model and cope with its demands. Taskin-Can, (2011) writes of the educational reform in Turkey where schools are adapting to the National Science Education Standards (NSES) that "the purpose of teacher education programs should be to create the best teachers possible for realizing the vision of the NSES" (p 219). This is equally true for teacher education programs in the context of educational reform in Abu Dhabi, where new curricula have been introduced. These emphasize critical thinking rather than rote learning (Davidson, 2010). In education reform, focus should not be only on elements like curriculum and assessment but should be extended to have a well-prepared teaching force that is vital for effective science education (Weiss, Banilower, McMahon & Smith, 2001).

The Significance of Pre-Service Teachers' Beliefs and Self-Efficacies

Some of the ways in which effective science teaching can be characterized are that "students are engaged with inquiry, ideas and evidence, classroom science is linked with the broader community and students are challenged to develop and extend meaningful conceptual understandings" (Hackling & Prain, 2005, p.19). Effective teachers can be characterized as "ones who adopt an approach that will result in inquisitive, researching, questioning and producing individuals" (Buyuktaskapu, 2010). This is very much in keeping with the ideology behind ADEC's New School Model, with teachers expected to develop students as "thinkers and problem-solvers, curious, investigative, thinking scientifically" (ADEC New School Model Documentation, 2009, p. 15). Stronge, Ward, Tucker and Hindman (2007) discuss how the fundamental unit of educational reform is the classroom and the primary catalyst for improvement in schools is the effective teacher. In this case, understanding and identifying beliefs of teachers is critical because they affect classroom practice (Haney, Czerniak & Lumpe, 2003). Attitudes and beliefs, too, defined by some as a form of personal science teaching efficacy, form an important indicator of likelihood of effective teaching practice. Studies have shown that teachers with low personal science efficacy (for example, a lack of confidence in their capabilities to teach science effectively) are more likely to use teacher-centered methods, lecture and rely on textbooks (Enochs, Scharmann & Riggs, 1995). By contrast, a case-study of a highly effective science teacher in Australia noted that her "beliefs seem to have a significant influence on her practice in terms of how she teaches science in the classroom, and why she teaches the way she does" (Fitzgerald, Dawson & Hackling, 2008, p 21).

So, the confidence and competence which teachers feel about some of the more modern and therefore less familiar approaches to teaching science, inquiry-based learning being one of these, can have a large effect on their eventual use of such strategies. Howit (2007) echoes this idea: "Lack of confidence towards science is a major factor in the avoidance of teaching science at elementary school" (p 41). This is critical for generalist primary school teachers who in practice have some autonomy as to how much and how often to teach science in their classroom. Plourde and Alawiye (2003) discuss how the individual teacher's "belief and

ambition to act may be either cultivated or inhibited during his or her early experiences as a pre-service teacher". This would suggest that in order to be on the 'cultivating' side, student teachers need to be exposed to a variety of best practice teaching strategies early on in their teacher-training. Research has shown that pre-service teachers (PSTs) 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 & Hodson, 1999). Furthermore, studies have shown that students generally learn more from teachers with high self-efficacy than from teachers with low self-efficacy (Ashton & Webb, 1986).

Teachers' self-efficacy in science teaching correlates with their use of particular science teaching strategies. This is particularly true of more complex, higher level teaching skills such as the application of science concepts to new situations, inquiry-based learning, etc. A study in the U.S.A. found that teachers had quite different conceptions of teaching for inquiry learning in science in elementary schools, and the authors suggest that "understanding teachers' conceptions has implications for both the enactment of inquiry teaching in the classroom as well as the uptake of new teaching behaviors during professional development, with enhanced outcomes for engaging students in science" (Ireland, Watters, Brownlee & Lupton, 2012, p. 159). Many science educators believe that engaging students in authentic scientific inquiry is key to scientific literacy: "It is critical that teachers understand and appreciate what authentic inquiry involves" (Hume, 2009, p 35). These are important skills which students need to have frequent exposure to in science lessons in order to master, but in order to have this exposure, their teachers need to be confident about teaching them. It is important to identify these areas of low confidence in science content and teaching in order to conduct training to reinforce and strengthen the teachers' approach to them, so that they will be able to teach them effectively in the future.

These teachers must be capable of implementing the ADEC New School Model in the way that it was intended, and in the way which is needed to up-skill young Emirati school students in science to become independent, critical thinkers. It is clear, then, that the beliefs and attitudes of the PSTs are of great importance in determining the likelihood of them becoming the highly efficacious, effective teachers this requires.

Rationale of the Study

We aimed to explore the kind of science teachers which the PSTs anticipate becoming, as well as general perceptions of the ways in which young students can best learn science concepts. Science courses at the teacher-training college where this research took place have been designed in an attempt to meet this demand and now have a high practical work proportion in both science content and educational courses. However, some evidence suggests that PSTs have their own beliefs about science education embedded from their prior experience which for some may not have been in fitting with ADEC's vision of the way science should ideally be taught. This research also explores the perceptions which the PSTs have of the importance of science education, specifically set among a generalist teaching system of EAL students where the same elementary teacher should cover three English-medium subjects; science, mathematics and English. Ultimately, the research will serve as a guidepost and indication of the kinds of future science teachers which the college is nurturing, and may provide some guidelines for ways in which beliefs about science education can be altered for the best prior to the students graduating to be more in keeping with ADEC's New School Model and vision for science teachers in Abu Dhabi in 2013.

Whilst similar research has been undertaken in other countries such as the U.S.A. and Turkey, we have found an absence of such research in the Gulf and certainly none specific to

the unique reform context of the UAE, a country which is rapidly developing its education systems. Therefore, the research has novelty and value at a national level, but may also be of interest internationally to other countries undergoing educational reform trying to train science teachers to teach in a manner which may be radically different in the way that they themselves learned as students.

METHODOLOGY

a) Research Questions

1. What perception do the PSTs hold of the importance of science as a subject among three English-medium subjects at primary level?
2. What are the ways in which PSTs perceive that young students learn best in science?
3. How confident are they in different areas of science skills teaching?
4. How do PSTs anticipate that they themselves will teach science in the future?

b) Participants

The 173 participants involved in this study were undergraduate students at a teacher training college, studying on a four-year Bachelor of Education program. We included all year groups in the study to enable comparisons of year groups, particularly first and fourth year groups to enable us to extract possible indicators of the effect of science pedagogy courses and the effect of the degree course overall on their perceptions. The data was collected at the beginning of the second semester, prior to the fourth year PSTs embarking on their final and major ten week school internship.

c) Data Collection Instrument

The instrument used for data collection was a 45 item survey questionnaire composed of four sections; each relating to a different research question. The items were developed by the researchers based upon a conceptual framework developed to align with literature findings, such as that there is a relationship between beliefs and eventual teaching practice. The questions were reviewed by two objective pre-viewers who gave feedback on the relevance of the survey to the research questions; they were then piloted with two students who were not partaking in the study in order to assess question reliability, meaning that respondents understand the true meaning of the question as it is stated. Adjustments were made on the basis of this feedback. The survey utilized four-point Likert-scale questions (Strongly Agree, Agree, Disagree, Strongly Disagree). It was administered as a hard-copy and collected at the same time resulting in an almost 100% survey return rate of those present. The established protocols for undertaking quantitative research of this nature were followed: participants were briefed in advance of the study both verbally and in writing about the purpose and procedure of the survey questionnaire, and informed consent was obtained.

FINDINGS

PSTs' Perceptions of the Importance of Science amongst the Three English Medium Subjects: English, Mathematics and Science

The PSTs were asked to rate the three subjects of English, mathematics and science in order of their importance. Science occupies slightly less suggested teaching time than mathematics and English in ADEC government schools, with science attributed four lessons per week compared to six per week for Mathematics and English. The value a primary

generalist teacher places on science as a subject is extremely important since, as explained earlier, pre-service teachers (PSTs) who dislike science, or who place little value on it compared with the other primary school subjects such Mathematics and English, are likely to teach it poorly (Bencze & Hodson, 1999). Surveying these attitudes may give an indication as to the likelihood of science being taught, finally, by these PSTs with the emphasis which ADEC's New School Model requires. Table 1 illustrates the importance the different year group PSTs place upon science.

Table 1. *The Relative Importance Which PSTs Assign to Science as One of Three English Medium Subjects in Primary School*

Statement	First Year PSTs n=40 % rated	Second Year PSTs n=44 % rated	Third Year PSTs n=44 % rated	Fourth Year PSTs n=45 % rated
Science is the most important subject of the three English medium subjects (English, Mathematics, Science)	14	24	9	25
Science is the least important subject of the three English medium subjects (English, Mathematics, Science)	37	33	34	24

The perception that science is the most important subject of the three seems to be variable. A quarter of fourth year PSTs, soon to graduate and become novice teachers, named science as the most important of the three. This is somewhat of a contrast with the third year PSTs, only one year behind them on the degree course, only nine percent of whom thought it the most important subject, a fact which would not appear to bode well for this particular cohort's eventual teaching of science. The second year PSTs, on the other hand, rated it similarly to the fourth year students. More clear, perhaps, are the responses of perception that science is the least important subject of the three. Here, there appears to be a decreasing trend; more than a third (thirty-seven percent) of the first year PSTs selected science as the least important subject, while only a quarter of the fourth year PSTs thought this. It remains to be seen whether the views of the first, second and third year PSTs would alter by their final year.

PSTs' Perceptions of the Way that Young Students Learn Best in Science

As discussed in the literature review, PSTs' perceptions of best practice for student learning has a direct correlation to their eventual practice and use of particular strategies, even if these are in contradiction to what they learned during their teacher-training courses. Therefore, it was important to survey these attitudes for an indication of the kinds of science teachers they may become in the future. They were asked to rate their agreement with statements concerning ways that young people learn science best. Questions were designed so that high relative scores on the Likert scale (with a maximum score of four) indicated a strong personal conviction of the benefits of students learning effectively independently of the teacher, through various means, such as collaborative learning, inquiry-based learning and independent reflection. For clarity, the questions were categorized into these areas, based loosely around the earlier discussion of how effective teaching and learning can be defined, as well as the vision of ADEC for their new breed of teacher. This will ultimately be the definitive 'effective teacher' description since most, if not all, of the teachers graduating from

this college will go on to teach in Abu Dhabi government schools. The questions, and the mean scores of the PSTs responses, are shown in Tables 2 and 3.

Table 2. *The Ways in Which PSTs Perceive That Young Students Learn Best in Science, Mean Scores for Agreement with Individual Survey Statements*

	Statement	Mean Scores			
		First Year n=40	Second Year n=44	Third Year n=44	Fourth Year n=45
Cooperative and Collaborative Student-centered practices	1. Students learn science more effectively when they work in groups and share ideas.	3.46	3.59	3.58	3.71
	2. Students understand science best when they discuss concepts with their partners.	3.22	3.58	3.47	3.45
	3. Students broaden their scientific inquiry skills by communicating, sharing and reviewing each other's results.	3.36	3.55	3.49	3.36
Providing opportunities for students to learn independently, including by inquiry	4. Students' interest in learning science increases when they pose their own questions and discover the answers by themselves.	3.08	3.52	3.53	3.45
	5. Students remember a scientific fact when they discover it by exploring and observing by themselves rather than when they read it.	3.28	3.70	3.78	3.67
	6. Students remember a scientific fact when they discover it by exploring and inquiring by themselves rather than when they hear about it from their teacher.	2.90	3.36	3.69	3.47
Providing opportunities to reflect	7. Students understand scientific concepts better when they are given time to think before answering questions in class and time to reflect on their learning.	3.50	3.66	3.56	3.60
	8. Students develop a deeper understanding of scientific concepts when they regularly record their findings in a science journal.	3.28	3.66	3.53	3.40

Table 3. *Overall Mean Scores of the Ways in Which PSTs Perceive That Young Students Learn Best in Science*

Year	n	Belief Scores	
		mean	SD
First	40	3.26	0.20
Second	44	3.58	0.11
Third	44	3.58	0.10
Fourth	45	3.52	0.13

Inspection of the scores shown in Tables 2 and 3 would suggest that in general, the PSTs hold strongly student-centered beliefs, all being above 3, which corresponds to 'agree' on the Likert scale. Closer examination of the mean scores across the year groups shows that the first year PSTs' responses reveal a lower mean score than the second, third and fourth year PSTs (Figure 1). Since the questions reflect an approach which encourages students to learn in science independently in some ways, this may be indicative that the first years are less comfortable with the idea of the teacher moving away from the centre of the classroom. We have broken down the comparison of mean scores into the sections, and then focused on particular questions which show a large difference between mean scores from first to fourth years (Figures 1-3). These figures show that no consistent pattern emerges between the mean scores of the second, third and fourth year PSTs.

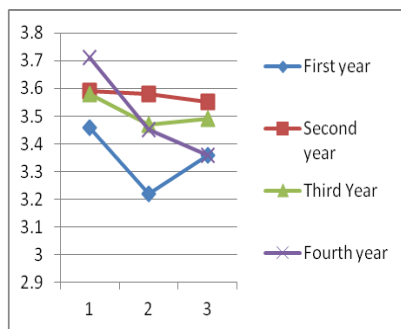


Figure 1. Mean scores of ways in which PSTs perceive that young students learn best in science, in different years of training: collaborative learning

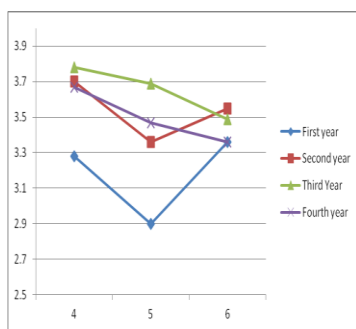


Figure 2. Mean scores of ways in which PSTs perceive that young students learn best in science, in different years of training: students learning independently by inquiry

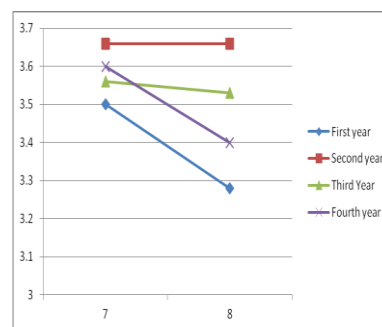


Figure 3. Mean scores of ways in which PSTs perceive that young students learn best in science: students having opportunities to reflect independently

For some statements, for example that ‘students learn best in science by having time and opportunity to reflect independently’, the mean scores of the second year students are the highest, and much higher than the first year students, which suggests that courses taken on their degree and exposure to school environments whilst on practicum experience between first year and second year may have had a significant impact on their student-centered beliefs. However, third year students have the highest mean scores of the second, third and fourth year groups for most of the statements related to ‘students learning independently and by inquiry’, and much higher than the first years. The limitations, of course, in analyzing this data for emerging trends are that the sample numbers within year groups are small, meaning that a difference of 0.1 or 0.2 may not be significant, but score differences of the order of 0.7, 0.8 are surely indicative of emerging trends. The striking trend which emerges from this data is that for all three categories of student-centered teaching and learning (co-operative learning methods, inquiry-based learning, and reflecting on what has been learned) first year PSTs lagged behind the other year groups’ beliefs. We can postulate that this may be for two reasons: firstly, that they have not yet been exposed to the pedagogical practices in their courses which the other year groups have been, and two, this is suggestive that the recent schooling experiences of the first year PSTs in government schools may not have been particularly student-centered, despite what we know of the educational reform in Cycle 3 schools, if they are holding onto these kinds of beliefs about best practice in science education.

We also analyzed the responses as percentages of agree/strongly agrees for ease of reporting the overall perceptions of the PSTs, as opposed to those within their year groups. To link back to the main question of this research regarding whether or not these PSTs look likely to become effective science teachers in government schools, it looks very positive: the majority of those surveyed agreed that students learn science best through cooperative learning, inquiry-based methods and when they reflect on what they have learnt, for example 96 % of all students agreed or strongly agreed that students learn best when they work in groups and are given opportunities to discuss with their partners in groups. Statements connected with reflective learning scored very highly, such as that students learn best when they are given ‘thinking time’ before answering a question (100% of the PSTs agreed or strongly agreed with this) or that they should record their findings in a reflective journal independently (92% agreed or strongly agreed). In general, the responses of most students

were in agreement with the idea that students should be at the center of the learning process. However, a much smaller percentage (68%) of all students agreed or strongly agreed that students learn best when they explore or observe by themselves rather than when they are given information directly from the teacher. This figure was strongly influenced by the lower mean scores of the first year students, as discussed earlier

Which Areas of the Science Skills Curriculum are the PSTs Most Confident and Comfortable with?

As discussed in the literature review, research tells us that how confident teachers feel about their abilities to teach particular areas of science curricula has a direct bearing on their effectiveness in teaching these areas and indeed their teaching of science at all. This in turn relates to the frequency of exposure, and effectiveness of the students' learning of these areas in science. Confidence in a wide range of both science skills and content were surveyed, partly to inform practice and course adaptations at a college level. For the purpose of this article, we focus on the data related to confidence in teaching inquiry skills and higher order skills of evaluation, for two reasons: one, since in our teaching experience these are areas which students struggle with, and two, because student competency in inquiry-based learning is repeatedly emphasized as being desirable by ADEC and indeed internationally, as having far reaching effects into students' ability to think critically, 'outside of the box' and being able to apply these skills to areas outside of science too. They were asked to rate their agreement with a confidence and comfort statement relating to four science skill areas (Table 4).

Table 4. *The Confidence PSTs Hold about Certain Science Skills*

Statement: I feel confident and comfortable about:		First Year PSTs n=40		Second Year PSTs n=44		Third Year PSTs n=44		Fourth Year PSTs n=45	
		Agree or Strongly Agree %	Disagree or Strongly Disagree %	Agree or Strongly Agree %	Disagree or Strongly Disagree %	Agree or Strongly Agree %	Disagree or Strongly Disagree %	Agree or Strongly Agree %	Disagree or Strongly Disagree %
Skills	Inquiry skills: Making predictions, planning and procedure	63	37	38	62	49	51	42	58
	Inquiry Skills: Fair testing and controlling certain variables	63	37	58	42	69	31	60	40
	Recording results and writing conclusions	67	33	67	33	73	27	74	26
	Evaluation, repeatability, reproducibility of experiments	59	41	69	31	73	27	76	24

The first year PSTs were more confident than the other year groups in one of the inquiry skills areas relating to making predictions and planning procedures (63 % confident, as opposed to 38,49,42 % in the other year groups 1,2,3 respectively). The large difference in confidence levels between the first and second year responses for this skill is perhaps surprising, although the first years had had some experience of these skills in the previous college semester so maybe this was fresh in their minds. Confidence in fair testing, controlling variables were fairly similar across the year groups (63,58,69,60 %) , as was confidence in recording results and drawing conclusions (confidence 67-74 % across year groups). The only surprise here was that percentages were not higher for all year groups, as 'recording results' was not anticipated as being a difficult skill to master. Additionally, these

skills had been repeatedly addressed in courses which all year groups had been taken. Since we were interested in looking at the effect of the entire course overall on the students' perceptions, we again isolated the scores from the first and fourth year PSTs to draw indications of the changes which may have occurred as a result of their courses and practicum experiences (Figure 4).

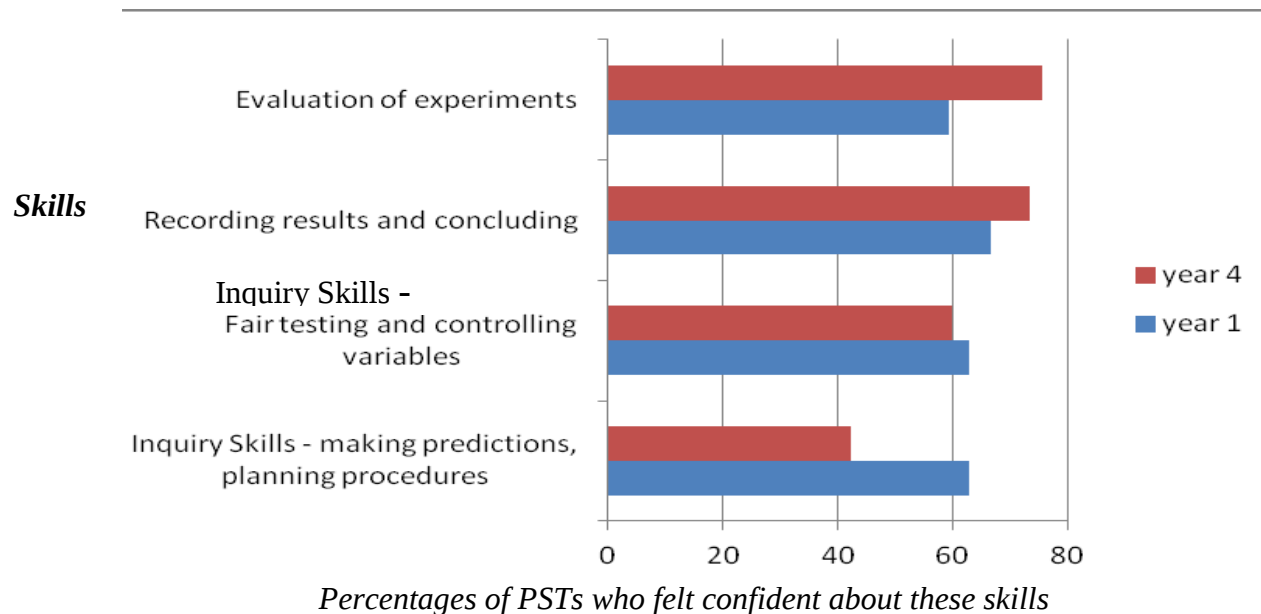


Figure 4. Comparing the confidence of the first and fourth year PSTs in particular science skills

Fourth year PSTs are apparently more confident than first years in evaluation of experiments, possibly due to a recent exposure to this skill in a science pedagogy course, and of course their exposure to various science experiments whilst on second and third year teaching practicum. However, first year PSTs were more confident than fourth years about inquiry skills, such as making predictions and planning procedures, possibly because of changes in teaching methodology while they were at school where they may have been more exposed to these skills in very recent years as their teachers began to be trained in teaching these skills. This is not necessarily an indication that they were taught in any less of a didactic fashion than earlier year groups, since their earlier beliefs of how students learn best in science did not indicate this. Planning methodology which strictly follows the scientific method, for example, can be taught very traditionally. That only 42% of the fourth year students, who were soon to graduate, felt confident about this particular skill, is troubling and suggests that the teaching and reinforcement of this skill at college level is in need of address and emphasis. The application of skills, too, may need practice, as even understanding ideas in theory may not help when faced with new school situations and unfamiliar experiments.

How do the PSTs Anticipate that They Will Teach Science in the Future?

The PSTs were asked to rate their agreement with statements regarding their predictions of eventual teaching practice in order to gauge the type of science teacher they are likely to become (Table 5). This data has the obvious limitation of being not only a prediction, but a self-reported prediction. Nevertheless, it does give an indication of how well the PSTs may match with the new kind of science teacher which government schools in their country are requiring in order to improve to international standards in science education, as per ADEC's ambitious plans.

Table 5. Mean Scores of the Ways in Which PSTs Believe That They Will Teach Science in the Future

	First Year n=40	Second Year n=44	Third Year n=44	Fourth Year n=45
1. I will allow my students to explore and discover science concepts on their own with minimal teacher input.	3.08	3.11	3.40	3.44
2. I will teach new science concepts to my students first, and then allow them to carry out related questions, activities and practicals.	3.54	3.69	3.55	3.40
3. I will involve students in class debates and discussions.	3.56	3.67	3.73	3.69
4. I will actively involve students in hands-on activities and investigations.	3.54	3.77	3.82	3.71
5. I will give my students time to record findings and reflect in their journals.	3.44	3.50	3.67	3.62
6. I will incorporate scientific inquiry skills in my science classes.	3.50	3.50	3.62	3.67
7. I will encourage collaborative learning among my students	3.65	3.64	3.76	3.80
8. I think it will be important to use ICT tools in my science class.	3.63	3.69	3.62	3.82
9. I will arrange library lessons and field trips connected to the science topics	3.54	3.60	3.58	3.58
10. I will relate science concepts studied in class to our daily life and to the real world.	3.71	3.80	3.87	3.71
11. I will use different assessment tools, not only projects and exams.	3.54	3.60	3.67	3.62
12. I will demonstrate practical work to my students first before they begin the work.	3.67	3.53	3.49	3.55
13. I will help my students to make connections between science and other subjects.	3.54	3.62	3.64	3.78

Scores of most of the statements showed a clear general trend of an increase in mean scores from first year to fourth year PSTs, although in some cases, responses from first and second years were similar. This would make sense, since at the time of surveying, the second year PSTs had studied science content courses, but not yet science pedagogy courses, which may have affected the perceptions of the later year groups. For three of the statements (1,6 and 7, from Table 4), the mean scores for the first and second year PSTs were almost identical, and substantially lower than the mean scores of both third and fourth years:

- I will allow my students to explore and discover science concepts on their own with minimal teacher input
- I will incorporate scientific inquiry skills in my science classes
- I will encourage collaborative learning among my students

For all statements except two, the first year responses have the lowest mean score, although as described, the lowest position is shared with the second years two of these statements. Since most of the statements reflect a student-centered, hands-on approach which is mostly independent of the teacher (reflecting a teacher as a facilitator), this again indicates that the first (and sometimes, the second years too) are not entirely comfortable with the relinquishing of teacher autonomy which a student-centered approach encompasses. The largest difference in mean scores between the first and fourth year groups were for statements specifically referring to students learning independently of the teacher such as 'I will allow my students to explore and discover science concepts on their own with minimal teacher input' which showed a relatively large difference in mean of 0.36.

The only statements which showed the opposite trend, i.e. that mean scores for the first years were not the lowest, and which were higher than for the onwards to fourth years were for the following statements (2 and 12 from Table 4):

- I will teach new science concepts to my students first, and then allow them to carry out related questions, activities and practices.
- I will demonstrate practical work to my students first before they begin the work.

Careful consideration of these questions will reveal that although both statements appear positive, they are both also leaning towards a teacher-centered approach, since the idea of 'teaching' a new concept first, only to repeat or reinforce with activity, rather than reach the concept through activity, is a didactic trait. Demonstration of a practical procedure, to be repeated by students, was commonplace in science classes in government schools, according to one experienced advisor (Personal Communication, 2013) and the idea that this was not actually serving the students' best interests has yet to unfold for the first year students, apparently. This again suggests that, despite the professional development which Cycle 3 teachers were receiving through the schools reforms, the classroom environments may still have been quite teacher-centered.

If we look at the responses to the statements in Table 4 as percentages of those who agreed or strongly agreed with the statements, and again isolate the first and fourth year PSTs responses for clarity (figure 5), we see clearly that for most statements, whilst the analysis of the mean scores did show some differences for particular responses, overall, percentages of agreement are very high for both year groups. It would appear that, should the correlation between beliefs, self-efficacy and eventual teaching practice be upheld, these PSTs stand a very good chance of being the kind of effective teachers which schools demand. The caveat to this is observed by examination of figure 5 to see the large 'dip' in the first year percentage agreement for the statement that 'I will allow my students to explore and discover science concepts on their own with minimal teacher input'; the gap between the first and fourth year scores are highly suggestive that much work still has to be done to over-turn the teacher-centered views held by the first year PSTs which have surfaced in this data. In the previous section which looked at confidence in teaching science skills areas, the first year PSTs were most confident of all the groups about inquiry skills, yet their mean score for "I will allow my students to explore and discover science concepts on their own with minimal teacher input" was lowest. This echoes the finding in 'perceptions of how students learn science best' and suggests that there is still a strong element of teacher-centeredness in students at the beginning of the degree course, which has apparently changed by the end, presumably with the influence of education courses and practicum experience.

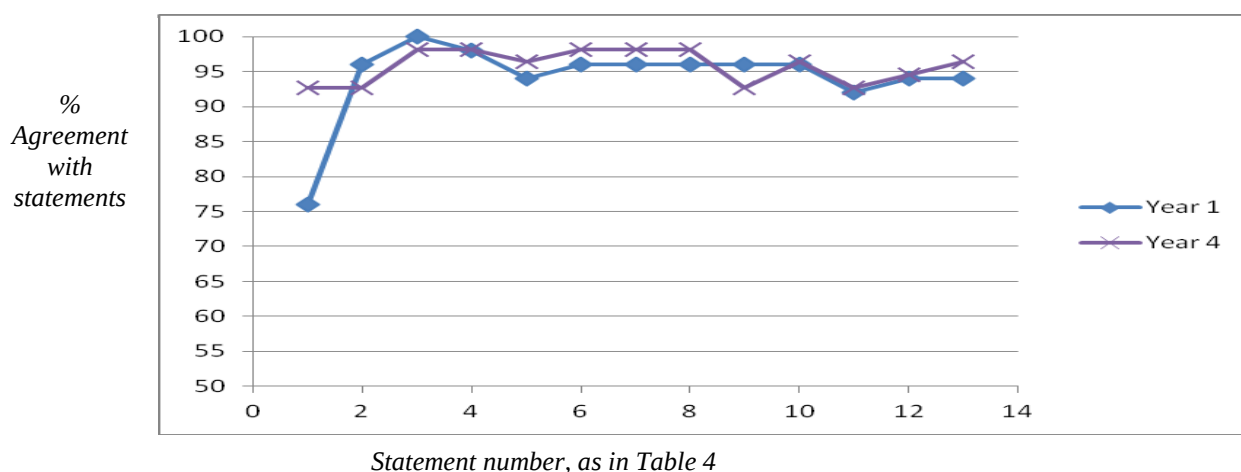


Figure 5. Graph comparing the first and fourth year PSTs beliefs of how they will teach science

DISCUSSION

Will the Pre-Service Teachers be Effective Teachers?

We now link our findings to the effective teacher indices used in the survey tool, which was based on a combination of literature findings and ADEC New School Model documentation. These were that effective teaching occurs when:

- Students are engaged with inquiry, ideas and evidence
- Classroom science is linked with the broader community
- Students are challenged to develop and extend meaningful conceptual understanding

The findings described in this paper certainly suggest that overall, the PSTs from this teacher training college have a good understanding of the practices which will make them effective teachers and are generally aware, particularly for later year groups, of accepted good practice in terms of how students learn best, and how to teach best to facilitate this learning. For example, we have shown that, of those students who are to graduate as teachers either this year or the next:

- 100% of third year, and 98% of fourth year PSTs said they would incorporate inquiry skills in their science classes
- 100% of third year, and 96% of fourth year PSTs said they would relate science concepts studied in class to our daily life and to the real world, while 100% of third year, and 98% of fourth year PSTs said they would arrange science library lessons and field trips connected to the science topics
- 98% of third and fourth year PSTs will allow students to explore and discover science concepts on their own with minimal teacher input

Since the prominent literature research suggests a high correlation between confidence in and understanding of a science skill or topic, and effective teaching of that item, we probed further to look at correlative statistics between certain key items (Table 6).

Table 6. *Correlations between Mean Scores of Survey Items Relating to PSTs' Confidence in Science Skills and How They Predict Will Teach Science in the Future*

	First Year (n = 49)	Second Year (n = 44)	Third Year (n = 44)	Fourth Year (n = 55)
Correlation Value	R=0.661	R=0.764	R=0.071	R=0.336

For the first and second year students. There was a medium-high statistical correlation between their confidence in science skills, and the way in which they believe they will teach science in the future. Why this would not be also true for the third and fourth years is not entirely clear, but probably due to their lack of confidence in certain inquiry skills, which were not matched by a poor desire to teach inquiry skills – in fact the fourth years were extremely positive about all aspects of future teaching. Second, third and fourth years' have similar confidence in science skills such as inquiry and fair testing, but in some areas first year PSTs' confidence was greater than the fourth years. In general, and particularly when we compare the confidence in science skills with those of other areas such as 'how I will teach science in the future', confidence levels in inquiry are not high overall for any year group, and particularly weak in some areas for the fourth students who are soon to graduate.

The majority of these fourth year PSTs were educated in government schools in Abu Dhabi, graduating from high school in around 2005-2007, when teaching was in some ways didactic, exam and text-book driven (Shaw, Badri & Hukul, 1995, Sonleitner & Khelifa, 2005) . This is significant, because there is some research to support the idea that science

teachers often teach science the way that they themselves were taught as students, regardless of the content or quality of the teacher training they received (e.g. Adams & Krockover, 1997). The way in which the PSTs' own schooling may influence their future use of teaching strategies will be examined in-depth in a future paper. Some researchers show a positive change in PSTs' views on science teaching over the course of their teacher-training (e.g. Ucar, 2012). Lumpe, Haney and Czerniak (2000) believe that teachers' beliefs are 'precise agents' in the education reform. Some researchers note that education courses have a limited effect on over-riding poor pedagogical practices experienced during their own schooling, and that everything students learn on teacher-training courses is viewed and received through a filter of their own schooling experience. This does not appear to be true for the PSTs overall in this study, in particular the fourth years who may have had a very different experience on the teacher-training course to their own schooling experience, yet the findings suggest that they have indeed over-turned the beliefs formed then, and are predicting a very student-centered teaching future for themselves. By contrast, only 68% of first year PSTs agreed that "students remember a scientific concept when they discover it by exploring and observing", which is in direct contradiction to the teachings and practices of the science education courses at their teacher-training college, where allowing students to work through process-oriented guided experiments independently is strongly encouraged, suggesting that the first years' own schooling does indeed continue to hold powerful influences over their science education belief systems.

CONCLUSION

It is clear that the beliefs and attitudes of novice teachers are of great importance in determining the likelihood of them becoming effective teachers. These teachers must be capable of implementing the ADEC New School Model in the way that it was intended, and in the way which is needed to fulfill the ideology of the educational reform in Abu Dhabi. The findings presented in this study suggest that graduates from this teacher-training college have the potential to become the kind of effective science teacher which the education reform in the UAE requires to successfully fulfill its ambitions of up-skilling young Emirati students to become independent and critical thinkers in science. The very positive predictions of using student-centered strategies and inquiry based learning methods to teach science, and high percentages in beliefs and efficacies in most areas would suggest that eventual teaching practice in science for these PSTs would be dynamic in most areas. Also, it appears that the teacher training courses have been effective in over-turning some of the experiences and beliefs based on schooling, since we have observed positive trends in the belief systems of students over the course of the four year degree. Of concern however, and in need of urgent address are the PSTs' generally low confidence levels in science inquiry skills. Teacher training courses have to focus more on teaching these skills, to improve confidence and therefore future use. It remains to be seen whether or not the actual, eventual practices will match up to the PSTs predictions. This will be followed up with the next part of this long-term, longitudinal study as we follow the graduates into schools as novice teachers next year, re-examine their perceptions and observe their science lessons.

ACKNOWLEDGEMENTS

The authors would like to whole-heartedly acknowledge and thank the students who took part in this research and gave so much thought and time to their answers.

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