

Introducing School Gardens to the Omani Context: A Preliminary Study with Grade 7 Classes

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ABSTRACT

The Sultanate of Oman is beginning to experience a rapid increase in 'lifestyle' diseases, most notably diabetes and cardiovascular diseases. These may be linked to increasing poor dietary habits, and a more sedentary lifestyle, amongst the younger generation. In a number of Western contexts, school gardens have been shown to improve not only student attitudes to diet but also improved learning and affective outcomes. A pilot school gardening project involving a mixed method quasi-experimental design was undertaken in Oman with a number of Grade 7 classes. While the outcomes of this study should be treated tentatively, the quantitative findings indicate that employing school gardens as an educational resource might improve learning outcomes in the area of science skill development. The qualitative findings suggested that the project had a positive impact on the affective domain of students and in some cases encouraged them to pursue healthier eating habits.

Keywords: diet, mixed methods, Oman, pilot study, school gardening

INTRODUCTION

This article reports on the findings of a pilot school gardening project started in the Sultanate of Oman in 2014. The project established school gardens in six schools and research was conducted with Grade 2 and Grade 7 students (Years 2 and 7 of schooling in Oman respectively), who were involved in establishing and maintaining the gardens while also receiving a science teaching intervention that employed the gardens as a resource. The research involved a quasi-experimental mixed methods design and was intended to address the following research question:

Can school gardens be an effective pedagogical resource in schools within the Sultanate of Oman?

This question was broken down into three sub-questions:

- Does school gardening improve students' content knowledge in science?
- Does school gardening improve students' process skills in science?
- Does school gardening encourage students to consume more fruit and vegetables as part of their everyday diet?

For each research question, findings for experimental groups who were exposed to school gardens were compared with control groups who received the same teaching but without the use of the school garden as a resource. This paper presents the findings for the Grade 7 cohort only. Those for Grade 2 will be reported in a future article.

CONTEXT AND LITERATURE REVIEW

Located on the eastern edge of the Arabian Peninsula, the Sultanate of Oman has an extensive coastline that includes the strategically important mouth of the Persian Gulf, the Gulf of Oman and the Arabian Sea. On its western side, Oman is bordered by the United Arab Emirates, Saudi Arabia and Yemen (**Figure 1**). The country occupies an area of 309,500 square km. Its coastal regions are generally verdant and fertile but much of the interior is "sandy, treeless, and largely waterless", inhabited only by Bedouin nomads (Crystal & Peterson, 2016).

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Contribution of this paper to the literature

- In this article we present the finding of a pilot study employing a mixed methods methodology on the introduction of school gardens to the Sultanate of Oman. This is the first study of its kind to be undertaken in this country.
- The quantitative findings indicated that using school gardens in Oman as pedagogical resource in science may improve learning outcomes in the area of science skills.
- There was strong evidence from interviews with students and teachers that the school gardens had a positive impact on the affective domain of students.



Figure 1. Map of the Sultanate of Oman with neighbouring countries

Like its neighbours, Oman is heavily dependent on oil resources, which generate 84% of government revenue (CIA World Factbook, 2016). However, dwindling oil reserves and reduced prices for oil internationally, along with increased demands for social welfare benefits in the wake of the Arab Spring uprisings of 2011, have pushed the country's budget deficit to \$6.5 billion. The government is pursuing a diversification, industrialisation and privatisation plan, aiming to reduce the oil sector component of GDP from its current 46% to 9% by 2020. Expansion of tourism and gas-based industries are key aspects of this strategy (CIA World Factbook, 2016).

Oman has a population of 3.35 million, 40% of whom are immigrants, mostly low-paid, unskilled workers from South Asia and the Philippines (CIA World Factbook, 2016). In 2015, GDP per capita was \$US15305, equivalent to 121% of the world's average (Trading Economics, 2016). With almost half the population being under the age of 25 and the population growing by an estimated 2.05% per year, rising numbers of young Omanis are seeking to enter the workforce (CIA World Factbook, 2016); therefore, a national policy of 'Omanisation' has been attempting to replace expatriate workers with locals.

In 1970, the newly-crowned Sultan Qaboos bin Said established a Ministry of Health charged with making dramatic improvements to Oman's health care system. Financed by the nation's oil and gas revenues, Oman imported medical expertise from other developing nations and prioritised the provision of free, universal primary health care (Treacy, 2014). Within three decades, Oman's public health system was ranked eighth best in the world (World Health Organization [WHO], 2000, p.154). In 1958, the country had only two hospitals and 13 physicians; by 2008, the country had 58 hospitals and over 5,000 physicians (Treacy, 2014).

However, the last decade has seen rapid increases in the chronic 'lifestyle' diseases that are common in affluent, urbanised societies (Ambusaidi & Al-Balushi, 2012). In urban areas, where three-quarters of the Omani population live, Al-Moosa et al. (2006) report a high prevalence of type II diabetes, obesity, hypertension and high cholesterol. These authors suggest changes to dietary and physical activity patterns as probable causes. They also point to the likelihood of an escalation in diabetes and associated coronary diseases as the relatively young population in Oman ages, unless effective lifestyle interventions are undertaken, such as reduction in the consumption of high-fat, high-calorific food.

A newspaper article in the Times of Oman, titled 'Parents declare war on junk food in schools', indicates that an increase in childhood obesity is causing concern amongst Omani parents. Parents were demanding that "low quality meat, French fries, fizzy drinks and chocolates" be removed from the canteen menu, and that children should be encouraged to eat a more balanced diet (Al Shaibany, 2011). The establishment of school gardens, in which children grow their own fresh produce, may help promote healthier dietary choices among young Omanis.

International research on school gardens is accumulating evidence demonstrating benefits both in terms of health and educational outcomes. For example, a report evaluating the Royal Horticultural Society's school gardens campaign in the UK (Passy et al., 2011) found students who took part in school gardening projects developed a positive attitude to healthy food choices, became more willing to try new vegetables and incorporate them into their diet, and also improved in terms of their behaviour, emotional wellbeing and fine motor skills. Educational benefits for the students included greater scientific knowledge, enhanced literacy and numeracy, and better awareness of food production (Passy et al., 2011). Similarly, another major review of school gardening projects conducted by Desmond et al. (2002) for the United Nations reported that school gardens could positively impact nutrition and health as well as academic performance, ecological literacy, school environment/culture, community linkages and vocational education. They suggested that garden based learning "has the potential to enrich basic education in all cultural settings" (p. 20).

SCHOOL GARDENS AND EDUCATIONAL OUTCOMES

As an experientially-based, flexible teaching and learning tool, school gardens can be adapted to suit the needs and objectives of individual teachers. Having specialised gardening knowledge and experience is not a prerequisite; however, what school garden projects do demand from teachers, principals and schools are time, energy, support and funding (Passy, Morris & Reed, 2011). Integrated into the curriculum, the hands-on learning environment offered by a school garden can be used to teach core academic subjects, including science, environmental science, mathematics, arts and language (Graham et al., 2005).

Evidence has been accumulating for several decades that school gardening projects can lift academic performance across a range of areas. Using standardised testing, Sheffield (1992) demonstrated that higher mathematics and literacy scores were achieved by an experimental group of gardening students as compared to a control group of non-gardening students. More recently, Passy, Morris and Reed (2011), in their report on UK school garden projects, found teachers nominated a wide range of enhanced cognitive outcomes for students engaged in garden-related activities. Within the domain of science, teachers saw improvements in the children's understanding of concepts (e.g., taxonomy), methods (e.g., experimentation), knowledge (e.g., life cycles) and in use of appropriate scientific language. Mathematically, the students improved in measurement, estimation, and use of data and graphs. Literacy was also impacted, via reading and writing of various text types, from reading seed packets through to producing imaginative work such as poems and riddles inspired by the garden.

Improvements in self-confidence and self-esteem can be another beneficial effect of school gardens, particularly for underachieving students (Sheffield, 1992; Hoffman et al., 2004). Ruiz-Gallardo et al. (2013) found school failure and disruptive behaviour decreased and skills, academic performance and self-esteem improved amongst 'at-risk' secondary students in Spain after a two-year garden-based learning program. Exploring the therapeutic associations of horticulture, Smith and Aldous (1994) found that gardening resulted in students with learning disabilities feeling more valued as individuals. Clarke (1997) noted that gardening promotes responsibility, and encouraging children to care for plants and respond to living things offers a rare opportunity to guide them in an affective style of learning. Another study of children in the USA indicated that they developed better interpersonal skills and attitudes toward school by engaging in a school gardening program (Waliczek et al., 2001).

THEORETICAL CONSIDERATIONS

Less formal settings such as school gardens can allow learning to be more autonomous and independent, which are aspects students value (Falk & Dierking 2000; Paris, 1997). Out-of-class settings enrich students' learning experiences, motivate them to learn science, encourage lifelong learning and expose them to future careers (Tal, 2012; Bamberger & Tal, 2007). As these settings tend to be informal and idiosyncratic, learning is more influenced by the students' personal and social context.

Table 1. Sample size for each dataset per school

	Control Group			Experimental Group		
	*SPS	#SCK	^ASGHDH	*SPS	#SCK	^ASGHDH
School 1 (All Females)	30	47	51	47	60	64
School 2 (All Males)	60	63	61	54	55	58
School 3 (All Females)	63	65	65	64	50	60
School 4 (All Males)	50	50	50	68	68	64

*SPS=Science Process Skills; #SCK=Science Content Knowledge; ^ASGHDH=Attitudes to science, gardening and healthy dietary habits

Personal identities are influenced during out-of-class activities through 'learning talk', which may constitute up to 89% of students' conversation time in school gardens (Griffin, 2007; Leinhardt & Gregg, 2002). Students see learning outside the classroom as part of their social environment, and small group work gives them an optimal context for sharing information and finding answers to complex issues (Falk & Dierking, 2000; Paris, 1997). Students appreciate socially-mediated learning environments that allow them to exercise choice and control (Griffin, 2004).

METHODOLOGY

The focus of this study – Can school gardens be an effective pedagogical resource in schools within the Sultanate of Oman? – falls within a larger research project whose preliminary design was presented in an earlier paper by Ambusaidi et al. (2015). This study involved six schools within three geographical regions, Muscat (Seeb), Al-Dakhlyai (Nizwa and Samail) and Batinah South (Wadi Al-Maael). The schools were selected from Basic Education Schools Grades 1-10, with two being co-educational Grade 1-4 schools and four being single-sex Grade 5-10 schools (two male and two female). Schools were chosen based on their willingness to participate in the project and the presence of a teacher willing to oversee the management of the garden, preferably someone with some expertise in gardening. However, none of the schools involved had ever previously had a school garden, as such a concept is unknown in Oman. The project employed three research assistants, one in each location. The research assistants reported to the principal investigators, advised on maintaining the school gardens, provided advice on pedagogy and collected data from the project (Ambusaidi et al., 2015). The project involved a quasi-experimental design employing a mixed-methods methodology and was run in a series of phases described below:

Phase 1 - Pre-intervention Data Collection

Three pre-test instruments were developed for and administered to Grade 7 students in both the control and experimental groups. These were designed to test content knowledge, process skills and attitudes towards science, gardening and healthy dietary habits (Table 1). Some of the items were adapted from existing questionnaires employed by Block and Johnson (2009) in their evaluation of the Stephanie Alexander Kitchen Garden Program in Australia.

The content knowledge instrument comprised 24 items with eight being multiple-choice items and the remainder being short-answer items. The science process instrument comprised 18 objective items covering six skill sets each made up of three items: observation, drawing inferences, data interpretation, prediction, hypothesising and identification of variables.

Finally, the attitudinal instrument comprised 32 Likert items with three response options (agree, disagree, neutral). This instrument was designed to assess student attitudes towards the three subscales of healthy dietary habits, science and gardening.

Phase 2 - Establishing the School Gardens

In this phase, the researchers worked with each of the six selected schools to establish the gardens (Figures 2 and 3). Compost bins were also established in each school to provide an ongoing source of growing medium for each garden.



Figure 2. Grade 7 students preparing beds and planting school gardens



Figure 3. Grade 7 students sorting seedlings

Phase 3 – Linking Gardening to the Curriculum

During this phase, the researchers worked with teachers to develop a set of garden activities that linked to the school curriculum at the Grade 7 level. This involved conducting an in-depth analysis of the Omani curriculum from Grades 1-7 inclusive, and then adapting existing published activities to the Oman context and developing some new ones to match curricular outcomes.

There was considerable scope for linking school garden activities to the formal curriculum in Oman, predominantly the science curriculum, which also encompasses key aspects of environmental and health education (see Ambusaidi & Elzain, 2008; Ambusaidi & Al-Rabaani, 2009; Ambusaidi & Al-Balushi, 2012). For the purposes of this research project, the focus of the teaching was science, and specifically plants, at Grade 7, and a series of draft activities were developed around these topics and produced as unit booklets.

Phase 4 – The Intervention

Following the establishment of the school gardens and preliminary data collection, a three-month teaching intervention took place at each of the six schools. During this period teachers used the draft activities written in Phase 2. At each school, specific teachers were provided with initial intensive training in using the activities. As part of this training, the researchers modelled some of the activities with the students and the teachers to allow them the opportunity to experience the garden as a learning resource from a learner's perspective. Parents and other members of the local community were invited to an open day at each participating school, at which point the project was outlined in detail, including the nutritional and health benefits of growing and consuming their own vegetables, and they were given instructions on establishing small scale vegetable gardens in their own localities.

The same curriculum content was delivered in the control and experimental schools. However, in the control schools it was delivered without the use of school gardens as a resource. The content was linked to the Omani Science Curriculum in Grade 7 and covered topics such as plant structure and the functions of the various structures, germination and plant growth, transpiration and photosynthesis. The activities in the experimental group involved amongst other things, examining and observing the main parts of plants, growing plants for seeds and cuttings, and measuring and graphing plant growth to determine growth rate. The control classes covered the same content but did so according to their normal practice, which in Oman is generally guided inquiry, although many teachers employ a more didactic approach to teaching science (Ambusaidi & Elzain, 2008).

Phase 5 – Post-intervention Data Collection

At the end of the teaching intervention, students from both control and experimental groups completed three post-tests using the pre-intervention data collection instruments on content knowledge, process skills and attitudes towards the three subscales of healthy dietary habits, science and gardening. A series of post-intervention interviews were undertaken with a subset of participants from the experimental group to help with data triangulation.

ANALYSIS OF DATA

All statistical analysis was undertaken with SPSS version 24. Independent samples T-test was used to analyse the science process skills and the science content knowledge data. Furthermore, a one-way between-groups multivariate analysis of variance was performed to assess group and gender differences in attitudes to healthy dietary habits, science and gardening.

A number of semi-structured interviews were conducted with Grade 7 students and teachers who had been involved in the gardening project. These interviews were conducted in Arabic then fully transcribed and translated into English. They were then coded based upon a number of themes, such as learning, enjoyment, family involvement and dietary change. Excerpts from the interviews with students and teachers are reported below under qualitative findings.

FINDINGS

Quantitative Findings

The science process skills test

The independent samples T-test indicated that within the experimental group (N = 233), taught using the school garden as a resource, there was a statistically significant improvement in overall performance between the pre-test

Table 2. Independent samples T-test summary for individual science process skills for experimental group

	Observation Skills		Inferring Skills		Interpretation Skills		Prediction Skills		Hypothesizing Skills		Identification of control variable Skills	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
N	233	234	233	234	233	234	233	234	233	234	233	234
Mean	57.51	61.68	38.2	39.6	34.41	42.17	40.41	46.87	36.34	46.72	25.32	33.9
Std. Deviation	22.84	20.862	27.205	27.599	32.678	33.623	29.905	30.253	34.506	34.163	25.759	28.383
Std. Error Mean	1.496	1.364	1.782	1.804	2.145	2.198	1.959	1.978	2.261	2.233	1.688	1.855
Sig. (2-tailed)	.04*		.58		.012*		.021*		.001*		.001*	

Statistically significant (* $p < .05$)

Table 3. Independent samples T-test summary for individual science process skills for control group

	Observation Skills		Inferring Skills		Interpretation Skills		Prediction Skills		Hypothesizing Skills		Identification of control variable Skills	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
N	203	203	203	203	203	203	203	203	203	203	203	203
Mean	62.97	66.42	38.34	46.72	36.86	39.57	51.31	50.41	39.08	43.6	33.91	33.09
Std. Deviation	21.4	19.16	29.958	27.101	30.935	32.062	26.862	29.267	32.874	34.149	27.67	28.89
Std. Error Mean	1.502	1.345	2.103	1.902	2.171	2.25	1.885	2.054	2.307	2.397	1.942	2.028
Sig. (2-tailed)	.088		.003*		.387		.746		.175		.770	

Statistically significant (* $p < .05$)

($M = 39.46$, $SD = 14.186$) and post-test ($M = 45.31$, $SD = 15.719$; $t(465) = -4.22$, $p = .000$, two-tailed). However, although there was a small improvement in the control group ($N = 203$) performance between the pre-test ($M = 44.47$, $SD = 14.19$) and post-test ($M = 47.1$, $SD = 13.91$; $t(404) = -1.889$, $p = .06$, two-tailed), this was not statistically significant.

Males in the control group ($N = 110$) showed a statistically significant difference in overall performance between the pre-test ($M = 43.86$, $SD = 14.764$) and post-test ($M = 48.52$, $SD = 15.519$; $t(218) = -2.283$, $p = .023$, two-tailed). A similar result was also shown by the males in the experimental group ($N = 122$) with a statistically significant difference in overall performance between the pre-test ($M = 37.28$, $SD = 13.597$) and post-test ($M = 45.81$, $SD = 16.414$; $t(243) = -4.429$, $p = .000$, two-tailed). The results indicated a higher gain in mean test score for the experimental group.

No statistically significant difference was noted for the females in the control group ($N = 93$) when their pre-test scores ($M = 45.19$, $SD = 13.524$) and post-test scores ($M = 45.42$, $SD = 11.587$; $t(184) = -.127$, $p = .899$, two-tailed) were compared. A similar finding was noted for females in the experimental group ($N = 111$) when their pre-test scores ($M = 41.85$, $SD = 14.491$) and post-test scores ($M = 44.75$, $SD = 14.966$; $t(220) = -1.466$, $p = .144$, two-tailed) were compared.

In the six skill areas, the experimental group showed a statistically significant improvement in five of the skill areas, the exception being the skill of inferring (Table 2). Interestingly, for the control group, the skill of inferring was the only skill to show a statistically significant improvement (Table 3). In terms of gender within the experimental group, only females made a significant improvement in observation, inferring and prediction skills.

The science achievement test (content)

In the case of the achievement test for content knowledge, the control group ($N = 225$) showed a statistically significant difference in overall performance between the pre-test ($M = 33.61$, $SD = 11.69$) and post-test ($M = 57.97$, $SD = 17.095$; $t(448) = -17.644$, $p = .020$, two-tailed). A similar result was also shown by the experimental group ($N = 233$) with a statistically significant difference in overall performance between the pre-test ($M = 33.23$, $SD = 11.87$) and post-test ($M = 51.84$, $SD = 18.352$; $t(464) = -12.993$, $p = .000$, two-tailed). Thus the use of the school garden as a resource had impacted positively on the learning of content knowledge but was apparently no more effective in this domain than normal teaching without this resource.

These results were also reflected within gender. A statistically significant difference was noted for the males in the control group ($N = 113$) when their pre-test scores ($M = 34.46$, $SD = 12.929$) and post-test scores ($M = 52$, $SD = 17.299$; $t(224) = -8.633$, $p = .000$, two-tailed) were compared. Similarly, males in the experimental group ($N = 123$) showed a statistically significant difference when their pre-test scores ($M = 29.92$, $SD = 13.155$) and post-test scores ($M = 49.96$, $SD = 20.492$; $t(244) = -9.125$, $p = .000$, two-tailed) were compared.

A similar finding was noted for females in the control ($N = 112$) and experimental groups ($N = 110$). A comparison of pre-test scores ($M = 32.75$, $SD = 10.276$) and post-test scores ($M = 63.99$, $SD = 14.662$; $t(222) = -18.467$, $p = .000$, two-tailed) for females in the control group showed a statistically significant difference. Similarly, females in the experimental group showed a statistically significant difference when their pre-test scores ($M = 36.94$, $SD = 8.943$) and post-test scores ($M = 53.94$, $SD = 15.441$; $t(218) = -9.995$, $p = .000$, two-tailed) were compared.

Attitudinal survey

Overall there was a statistically significant improvement in attitude towards gardening in the experimental group, $F(3, 466) = 3.67$, $p = 0.012$; Wilks' Lambda = .98, but not in the other two subscales of healthy dietary habits and attitudes towards science. The analysis also indicated that females within this group showed a significant improvement in their attitude towards science, gardening and the combined score of the three subscales, $F(3, 466) = 3.67$, $p = 0.014$; Wilks' Lambda = .98. There was no change in any of these scales for the control group.

Qualitative Findings - Student Interviews

Eight female students and fifteen male Grade 7 students were interviewed upon completion of the intervention in the experimental groups. They were asked about a range of issues, including what they felt they had learnt, how the project could be improved and the extent to which their parents had taken an interest in the project.

Some comments from the Grade 7 female students are summarised below (all have been given pseudonyms). Many of the girls mentioned that they had appreciated the change in their learning environment. For example Nasren commented:

I felt a change in the learning atmosphere. I learnt about how plants grow and my observation skills improved, so yes I would like it if the project continues.

This sentiment was also expressed by Amal:

I liked the change in the learning environment, because for me learning outdoors increases my desire to learn, and I also liked how the project encourages the usage of natural resources in learning.

While Muna mentioned that she enjoyed the group-work with her friends but also the sense of depending on herself throughout the while caring for her growing plants.

Fatima commented on a number of issues she found favorable, including the change of learning environment:

It was a great experience for me for many reasons: we first had a change of atmosphere from a boring classroom to a garden. I also liked planting different vegetables, which made me like eating them more. In addition, I learnt planting methods and I loved watching the plants grow. I'd love it if the project continues in every school because my brothers and sisters enjoyed working with me at home.

Like Fatima, all of the girls interviewed claimed that they had engaged their families in the project mainly by taking some plants home and growing them there with the help of their parents.

All of the girls felt they had learnt a lot about plants and plant husbandry, and some claimed that they had changed their dietary habits. Hanan commented that she had learnt a lot of things about gardening, and her appetite for fruits and vegetables had increased. She claimed to love going to the garden and hoped that the project would continue.

Overall, as Nawal commented, the garden was a source of considerable motivation for the students:

I loved studying inside the garden. The ways we worked and did stuff in the garden were a big motivation to learn.

These female students appeared to find that the school garden offered an entirely new learning environment compared to the one they had previously experienced in science classes. By its very nature, gardening is a hands-on activity that lends itself to working in groups, and this may have been quite a novel approach to learning science for these female students. Furthermore, the project was designed to engage with families, and it was encouraging

to note that all of those students interviewed had involved their families. Another encouraging finding was the claim by some participants that they were now eating more fruit and vegetables as a direct result of this gardening project.

The male Grade 7 students who were interviewed were also enthusiastic about the school garden project. As with the female students, the males claimed to enjoy the practical, hands-on approach that the garden offered. Ahmed commented:

The science classes this year have become very interesting and I am waiting it with eagerly because of their importance in our educational, practical and professional life. I hope to be an agricultural engineer in the future. I hope that the project will be implemented for all grades due to its benefit and fun we had at the same time.

Mohammed expressed similar views about the nature of his experience:

The science lessons when we were taught through the project made me active because it combined theoretical and practical side and this in itself earns a lot of knowledge that you may not get it in the subject that lacks practical side. The project changed a lot of things in my life, especially in my diet and the benefits of agriculture in the health, environmental and economic fields.

The issue of health and diet was a common theme emerging from the male interview data.

The school garden project changed a lot of my wrong food habits and I wish to continue in the project and be an integral part of the school curriculum because it teaches students a lot of knowledge about healthy food (Abdul- Aziz).

This theme of health and healthy eating was mentioned by half of the cohort interviewed.

I become an expert in the manufacture of healthy meals at home and this is due to school garden project, which allowed me to learn by doing. I also became interested in the cultivation of crops such as tomatoes, cucumbers, carrots and peppers because of their great importance in my personal health and the health of my family members (Said).

A number of the males also made the link between gardening and agriculture more generally. For example Farooq commented:

I started to be interest in agriculture...I want to work in an agricultural research centre. I learned from the project methods of plant reproduction. The project has contributed to higher achievement level to me and my colleagues. I would like to be added in the project, some knowledge about agricultural pests, the types of drugs (chemicals) used to combat them.

The themes emerging from the interviews with male students were rather different than those from the females, and this may have reflected different teaching approaches with male and female students, as in Oman all secondary schools are single-sex. However, there appeared to be common enthusiasm for the project regardless of gender.

Teacher Interviews

Four Grade 7 science teachers (two females and two males) were also interviewed as to their impressions of the gardening project and the benefits or otherwise for their students. One female teacher felt that the project had a number of benefits, particularly for low-achieving students.

The project contributed in improving the level of students' achievements especially those low achiever students and those with low self-concept and self-esteem. In addition, the project improved students' skills in agriculture and their attitudes towards science.

She went on to say that the project had helped to enhance the level of communication between students, teachers and parents, and in particular she believed that some of the students were displaying better communication skills as a result of having to explain their activities throughout the project. She also felt that if implemented on a long-term basis such projects had the potential to reduce dependency on imported foods and teach students how to develop small enterprises related to agriculture.

The second female teacher working at an all girls' secondary school spoke specifically about the affective and psychological benefits of developing and working with a school garden in the context of what is otherwise a very arid and barren environment.

The school garden project is one that enrich both the teachers and students especially...personally I learnt a great deal about planting methods, organic and industrial fertilizers, growing plants and combating insects and pests. In addition the project improves the curriculum of science in Grades 5-10 through adding more live practical experiments, which increases the students' drive to learn, as well as enriching lessons related to contemplating God's creations such as Islamic studies and Arabic. I was drawn to how my students loved the gardening lessons, and how much they enjoyed mixing soils and watching the plants grow. The project also helped create a positive atmosphere for both the teachers and students through working in a beautiful place filled with greenery. An example of such an effect was when the school psychological specialist referred girls who were suffering from depression and loneliness to spend some time in the garden, and the improvement in their psychological condition was evident. Most girls that were involved in the project went to the garden whenever they had free lessons, a testament to how much they enjoyed being there.

One of the male teachers said that the project helped to strengthen the relationships between students and teachers through changing the way of teaching and use of the school environment as a place of learning science. He was also happy that the school now had a garden that could be used to teach science in future and hoped it would encourage other teachers to use it with other classes in their teaching.

Like the female teacher, the second male teacher interviewed commented that the project had enhanced communication between students, teachers and the parents. He went on to comment:

This project had a major role in raising the enthusiasm and motivation of the students and for me personally to use farm tools as well as to provide the student with a safe environment and create an attractive learning environment for students. It also inspired the spirit of teamwork and created an attractive learning environment for the students.

Overall these teachers were delighted that the gardens would remain after the research project was over. One did, however, comment that to conduct science activities within the context of a garden was quite time-consuming and the amount of lesson time allocated for science was rather short.

DISCUSSION

This research project was underpinned by the overarching question: Can school gardens be an effective pedagogical resource in schools within the Sultanate of Oman? The following sub-questions informed this broader question:

- Does school gardening improve students' content knowledge in science?
- Does school gardening improve students' process skills in science?
- Does school gardening encourage students to consume more fruit and vegetables as part of their everyday diet?

This project was very much a pilot study, as prior to this research, school gardens were unknown in Oman. Consequently, the findings have been treated very tentatively. However, there are initial indications from this pilot that establishing school gardens may benefit students in terms of learning outcomes, and in particular the development of science process skills. There were also some indications from both the survey and interview data that the intervention did impact positively on some students' attitude towards gardening and agriculture.

However, perhaps the most encouraging finding, albeit with a small sample of students and teachers who were interviewed, was the apparent positive impact in the affective domain of students, who seemed to find the experience of teaching and learning within a school garden very satisfying. Thus overall, on the basis of this pilot, it appears that introducing gardens to school could be beneficial in the context of Oman.

While the quantitative data did provide some evidence of improved understanding of science concepts, this was not significantly different from that of the control group taught in a more traditional manner. However, in the area of science process skills, there did appear to be a greater gain for the experimental group than with the control group. This may have resulted from the opportunities afforded by the garden for more hands-on student centred activities and seems to be in keeping with at least some of the findings of Passy et al. (2011) who reported improved scientific skills amongst students who had undertaken a school garden project in the UK.

The attitudinal survey indicated that the gardening project provided students in the experimental group with a more positive view of agriculture and gardens. This is important, as traditionally, employment in agriculture has been viewed as rather menial in Oman. Hence, migrant workers largely undertake the limited work that exists in agriculture. However, it was rather disappointing that the project did not appear to improve attitudes towards

healthy eating. More time may be required to develop a more positive attitude in this area. Having said this, there was evidence from the qualitative findings that some students were considering issues of diet and health.

The interview data indicated that both male and female students really appreciated the change in the learning environment away from the classroom and towards a more practical approach. This appears to be consistent with the findings of Waliczek et al. (2001), who found that students in the USA who engaged in gardening projects developed better attitudes towards school. There was also a sense from the responses, which as Falk and Dierking (2000) and Paris (1997) reported, the students may have enjoyed more autonomy and independence of learning, in the less formal environment of a school garden.

Although only anecdotal, one teacher reported that she felt teaching and learning in the school garden was particularly beneficial for low-achieving students and it impacted positively on their self-esteem. This was very much in keeping with research reported by Hoffman et al. (2004) for students in the UK, suggesting that some benefits of school gardens may apply across cultural contexts. In fact, it was encouraging that in a conservative Islamic country such as Oman, one female teacher suggested that the use of a school garden for teaching was very much in tune with Islam. The same teacher reported that girls with depression were being encouraged to spend time in the garden.

So clearly there were a number of positive outcomes from this pilot study. This particular study focused only on the science curriculum, but as suggested by Morris et al. (2002) there would be scope for integrating the school garden with many other curricular areas. However, as Passy et al. (2011) caution, integrating school gardens into the curriculum requires time, energy, funding and effort. It also requires student and staff support, especially from the school principal, and it was notable in this study the impact that enthusiastic teachers made to the establishment and maintenance of a garden and ultimately the effect on teaching. School gardens require ongoing attention, particularly in a harsh arid environment like Oman, which has a predominantly desert climate, so identifying staff and students within a school who are willing to work on the garden, even after the 'novelty' of such a project has worn off, is crucial.

Establishing school gardens in Oman is quite costly as initially at least soil has to be purchased and because of the arid conditions and intense sunshine, crops generally need to be grown in raised beds and under shade cloth. Furthermore, although fresh water is generally available, much of this comes from reverse osmosis desalination, a costly and potentially environmentally damaging process producing large quantities of salt. If the Sultanate of Oman decides to pursue the establishment of school gardens, it may be worth conducting trials using hydroponics as an alternative cultivation method to circumvent some of these issues.

Finally, a further complication in Oman and other countries in the Gulf region has been the collapse in the price of oil in recent times. This is now putting severe restrictions on many projects, and could well jeopardise any plans to extend the introduction of school gardens to a larger number of schools. In our opinion this would be unfortunate, as despite the tentative nature of our findings they do suggest that school gardens have potential benefits for both teachers and students in Oman, and at the very least an extended trial appears to be merited.

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