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A longitudinal study to identify prospective science teachers' beliefs about science teaching using the draw-a-science-teacher-test checklist

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This is a longitudinal study aimed at revealing the beliefs of prospective science teachers in the College of Education at Sultan Qaboos University/Sultanate of Oman about science teaching. To achieve this aim a Draw-A-Science-Teacher-Test Checklist (DASTT-C) tool was used. The study sample consisted of (45) prospective science teachers in the College of Education at Sultan Qaboos University. The instrument was applied to the sample three times: before the Science Method I course, after finishing this course and after finishing the Science Method II course and the Practicum. The results revealed that after completing the Science Methods I course, prospective science teachers shifted significantly from a teacher-centered approach to the intermediate state between the teacher-centered and student-centered. There was no significant change after the Science Methods II course and the Practicum. Furthermore, the results also showed that among the three different teaching styles: exploratory, conceptual and explicit indicated in the second part of the DASTT-C instrument, prospective science teachers in the current study were found to be at the conceptual teaching style, closer to the boundary with the exploratory teaching style. This teaching style remained consistent across the three administrations of the DASTT-C instrument.

Keywords: longitudinal study beliefs, prospective science teachers, DASTT-C, teaching – centered, teaching style

Introduction

Science teachers are seen as the key element in the successful implementation of the teaching and learning process. They have many responsibilities and duties both inside and outside the classroom such as planning the science lesson, designing inquiry activities, forming working groups and assisting students to acquire needed skills. Implied in these responsibilities and duties are beliefs about the effectiveness of the teaching and learning processes. Thus, the knowledge, beliefs, and theories a teacher holds about the nature of science and the teaching and learning of science determines to a great extent what science education will be for a given child (Levitt, 2001). Wallace & Kang (2004) stated that teacher beliefs about students, learning, teaching and nature of science influence teaching practices and form barriers to the implementation of reform-

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oriented curricula. These same facts are asserted by many educators including Chai (2010), Tsai (2002) and Pajares (1992).

Belief is a valuable factor not only in decisions made about curriculum and instructions, but also in the context of daily life. Pajares (1992:307) asserted that beliefs are "the best indicators of the decisions individuals make throughout their lives." Nespor (1987) argued that teachers rely on their beliefs system rather than academic knowledge when determining classroom actions. Pajares (1992) pointed out that beliefs are far more influential than knowledge in determining how individuals organize and define tasks and problems and are stronger predicators of behavior. Beliefs are made up of episodic knowledge, characterized by remembered stories and events, affective elements, such as feelings about students, and existential presumptions (Wallace & Kang 2004). The remembered events, feelings and presumptions are likely to play a large part in teachers' decisions about the steps taken in the teaching and learning processes. An individual belief is formed and expressed in social setting through communication, action and evaluation (Pajares, 1992). Hankcook & Gallard (2004) stated that beliefs influenced actions but not always consistent with those actions. For the purpose of the current study, a belief is an understanding held by prospective science teachers about science teaching that guide their intentions for actions.

Teachers' hold to a set of beliefs, practices, practical theories and craft knowledge that influence their approach to the implementation of the curriculum (Keys, 2007). Previous research has shown that knowing teachers' beliefs and designing instructions and experiences to explicitly confront those beliefs refinement of and/or transformation of beliefs and practices (Bryan & Abell, 1999). Since many of tomorrow's science teachers are today's prospective teachers, the beliefs they hold should be of concern to any teacher education program (Bursal, 2010; Nag, Nicholas & Williams, 2010; Bryan & Abell, 2002). Prospective teachers' beliefs are linked to the experiences that these teachers underwent through their study in elementary and secondary schools (Yilmaz-Tuzun, 2008). Calderhead & Robson (1991) stated that prospective teachers use good teachers as role models for developing their own images as teachers. Pajares (1992) proposed a number of assumptions about beliefs, these are:

- Beliefs are established early in the individual, and modified with time.
- Some beliefs are not controversial because of their nature.
- The pattern of beliefs plays a role in helping individuals to know and understand the world, as well as understand themselves.
- Beliefs strongly affect the perceptions of individuals, as well as their behavior.
- Beliefs affect the planning of tasks and decision-making.
- Prospective teachers' beliefs amalgamate better during their preparation in the teacher education institute.

From Pajares (1992) assumptions, it is clear that beliefs are established better during teacher preparation (pre-service). It has been well-documented that prospective teachers enter preparation programs with a well-developed belief system about the nature of teaching and learning that influence what they find relevant and useful in teacher education courses which in turn follow them into their first year of teaching (Smith, 2005). Consequently, teacher education institutions play an important role in exploring and developing teacher beliefs. Belief systems that prospective science teachers hold about teaching should be explored by the teacher training supervisors in order to be modified or developed. The ultimate goal of this is that prospective teachers after graduating and entering the real world of teaching will implement the teaching and learning process effectively.

Bryan (2003) argued that beliefs about teaching and learning are well established by the time prospective teachers enter preparation programs. Several studies have asserted this, such as Yilmaz-Tuzun (2008), Hancock & Gallard (2004), Bryan (2003), Lin, Hazareesingh, Talyor, Gorrell, & Carlson (2001), Bryan & Abell (1999), and Foss & Kleinsasser (1996). Exploring prospective science teachers' beliefs about teaching and learning will help decision makers select and implement the experiences within teacher education programs that best facilitate prospective teachers' development of professional knowledge. Leonard, Barnes-Johnson, Dantley & Kimber, (2010) argued that changing perspective teachers' beliefs is possible if they have a conversion experience. The same conclusion was reached by Lin et al. (2001), who asserted that under certain conditions prospective teachers' conceptions about teaching and learning may change during teacher education programs. Teacher education courses as well as college educators play a major role in the reform by providing prospective teachers with meaningful experiences. It is through theses experiences that teachers develop their own positive beliefs, attitudes, and knowledge with regard to science teaching (Choi & Ramsey, 2010).

Three major themes of beliefs about science teaching emerged from previous research (Simmons et al., 1999). The first is called explicit teaching style. This is a teacher-centered teaching style where the teacher is the conduit of most of the content knowledge to be transmitted to students. In this theme, teachers have responsibility to organize and deliver content knowledge to students and stress the factual and descriptive nature of science (content and process). Furthermore, teachers in this category employ principally teacher-directed instructional teaching method with minimal student input, rarely giving opportunities to students to generate and ask questions. The second theme is called conceptual teaching style. In this theme, science teachers emphasize the explanatory nature of science (i.e. content and processes are integrated). Teachers employ many teacher-centered instructional methods, seeks to change unscientific ideas. In addition, teachers in this category encourage student-student interactions and learner-initiated activities. Teachers also encourage students to raise questions. The content knowledge tends to be explanatory, organized around key ideas.

The third theme is what is called exploratory teaching style. It is a student-centered style. In this theme, science teachers stress the nature of science as negotiated understanding and inquiry, employ more student-centered instructional methods and investigations and focus questions on students' ideas and instructional goals. Furthermore, teachers encourage students' questions to be conceptual, encourage student-student interaction to focus on understanding and encourage students to initiate activities and contribute with examples and analysis (i.e. inquiry oriented).

Sultan Qaboos University, the only governmental university in Oman, science teachers are prepared in the College of Education. In this college, several courses are offered to students for their professional preparation. Four courses comprise the most fundamental courses for preparing prospective science teachers. These are Teaching Methods I, Teaching Methods II, Practicum I and Practicum II. It is intended that in these courses prospective science teachers are best develop the necessary knowledge and skills to succeed in their future careers. In our current research, we assumed that prospective science teachers' belief systems about teaching science could be identified and developed through these courses.

Methodology

Purpose of the Study

The purpose of this longitudinal study was to investigate pre-service science teachers' beliefs about themselves as science teachers and about science teaching styles. The study focuses on the following research questions:

1. What are prospective science teachers' beliefs about themselves as science teachers?
2. What changes in prospective science teachers' beliefs occur as a result of their engagement in science methods and the practicum courses?
3. What are prospective science teachers' beliefs about the styles of teaching in science?
4. What changes in prospective science teachers' beliefs about the styles of teaching in science occur as result of their engagement in science methods and practicum courses?

Sample of the Study

Forty-five prospective science teachers participated in the study. These students enrolled in the science education program at College of Education/ Sultan Qaboos University in their forth year. The main aim of the program is to prepare Omani science teachers in three science majors: biology, chemistry and physics for grades 5-12. The Science Teaching Methods Courses are offered to students in the third and fourth years of their study. Each course has two contact hours for theory and another two contact hours to practice what student are taught in the theory part in a peer teaching settings (i.e. microteaching). The practice in the microteaching is conducted under the supervision of the Teaching Method course instructor. The contents of the two courses cover wide range of science teaching topics such as the nature of science, aims of teaching science, planning science lessons, inquiry based learning, graphic organizers, role-playing, demonstration, cooperative learning, classroom questioning, and other methods of teaching science. The first Teaching Science Method Course is offered to students in the third year before they start practicing their teaching in real settings in public schools.

As for their practicum, student teachers go to schools for one day a week during Practicum I and two days a week during Practicum II. Each student teacher is assigned to a cooperative teacher who monitors their experience and arranges for their teaching practice in the school. Each cooperative teacher has one or two student teachers under her/his supervision. They teach a minimum of two different lessons per day. Cooperative teachers are asked to observe their assigned student teachers and provide them with a feedback regarding their teaching. In addition, student teachers are required to observe their cooperative teachers while teaching to benefit from their teaching experience. A university supervisor visits student teachers at their practicum schools around once a month and gives them a detailed feedback regarding their teaching. They are also required to submit a written reflective report to their supervisors via email after each practicum day stating the positive points, possible improvements and suggestions to improve their teaching. Furthermore, each student teacher gradually build a comprehensive electronic portfolio for their teaching practice documenting their teaching practice experience throughout the semester. It includes their philosophy of teaching, lesson plans, classroom activities and handouts, samples of students work, photos of their classroom activities, their reflective reports, a final report regarding their teaching experience and any other activities they conducted in the school.

The DASTT-C instrument was administered to the prospective science teachers on three occasions. The first one was at the beginning of Spring semester (Beginning of February 2009) before tacking Science Teaching Methods (I) course. The second one was at the end of the same semester (End of May 2009) after completing the Science Teaching Methods (I) course. The final one was at the end of the Fall 2009 semester (December 2009) after they completed both the Science Teaching Methods II and Practicum courses.

Research Instrument

Previous studies used different methods and approaches to identify science teachers' beliefs about teaching. Some of them used the conventional methods based on questionnaires or interviews, others used the Draw-A-Science-Teacher-Test Checklist (DASTT-C) and some of them used a questionnaire based on Azjen Theory of Planning Behavior. The current study used the Draw-A-Science-Teacher-Test Checklist (DASTT-C) instrument because it is based on drawing which could potentially reveal in depth prospective teachers' beliefs.

The Draw-A-Science-Teacher-Test Checklist (DASTT-C) was originally proposed by Chambers (1983), who designed an instrument called Draw-A-Scientist Test (DAST) and used it to identify students' beliefs about scientists. Then, Finson, Beaver & Cramond (1995) revised the instrument to make it easier to assess and judge its validity and reliability. A further revision was made to the instrument by Thomas, Pedersen & Finson (2001) who designed the DASTT-C to assess student teachers' beliefs about teaching science. The current study used this instrument after translating it into Arabic and then back into English.

The DASTT-C instrument consists of two parts. The first part asks prospective science teachers to draw themselves while teaching science and then elaborate more about their drawing by answering two questions about what both students and teachers do (Figure 1). The answers of the two questions were used both to assist the raters in scoring and the researchers to interpret the prospective teachers' drawing.

Draw a picture of yourself as a science teacher at work.

What is the teacher doing? What are the students doing?

_____
_____
_____
_____

Figure 1. Draw-A-Science-Teacher-Test Checklist (DASTT-C)

The scoring sheet of the drawing consists of three components: teacher, students and the learning environment. In the teacher and students components, two main criteria are considered while assessing students' drawing: the activity that the teacher and students do and the position of both of them in the classroom. In each of the three components, a couple of statements describe them. Each statement is scored either 1 if the action stated in the instrument appeared in the drawing or 0 if it is not (see Table 1). Each prospective teacher has a total score out of 13 so that the mean score of the sample as a whole was calculated. If the action is missed in the drawing, then it was scored 0. The total score ranges between 0 and 13. The closer the score to (0) means that prospective teachers' beliefs reflect student centered learning, whereas, the score closer to (13), means that the students' teacher beliefs reflect teacher-centered learning (Thomas & Pedersen, 2003).

Table 2 shows an example of scores allocated to one student (S1) in three applications of the instrument.

Table 1. The Three Components of Scoring Criteria

Component	Sub-component	Statements
Teacher	Activity	1.Demonstrating Experiment/Activity
		2. Lecturing/Giving Directions (teacher talking)
		3. Using Visual Aids (chalkboard, overhead, and charts).
	Position	4. Centrally located (head of class)
		5. Erect Posture (not sitting or bending down)
Students	Activity	6. Watching and Listening (or so suggested by teacher behavior)
		7. Responding to Teacher/Text Questions
	Position	8. Seated (or so suggested by classroom furniture)
Environment		9. Desks are arranged in rows (more than one row)
		10. Teacher desk/table is located at the front of the room
		11. Laboratory organization (equipment on teacher desk or table).
		12. Symbols of Teaching (ABC's, chalkboard, bulletin boards, etc.)
		13. Symbols of Science knowledge (science equipment, lab instruments, wall charts, etc.)

The second part of the DASTT-C instrument deals with prospective science teachers' beliefs about three general themes of teaching styles: exploratory, conceptual and explicit. Fifteen statements were randomly presented to prospective teachers in three columns with five rows (Table 3). Each column consists of five statements. Prospective teachers were asked to read each row and select the statement that best depicts their beliefs. Then, the check scores in each column were added together. Finally, the total score was compared with a continuum (0-4 exploratory teaching style, 5-9 conceptual teaching style, 10-13 explicit teaching style).

Validity and Reliability of the Instrument

Although the instrument is simple and mainly depends on drawing, its validity was checked in two ways. The first one is the translation from Arabic to English as the original language of the instrument was English. This was checked by two linguistic professors who were fluent in both Arabic and English. There were no changes in the wording of the first part of the instrument (i.e. drawing part) between translation and back translation. However, the second part (i.e. teaching styles) had some minor changes in wording to suit the Arabic language. After that, the instrument was given to seven science educators to check it again in terms of its content and language.

Two raters coded each paper using a checklist developed by the researchers based on the content of the instrument. The inter rater or coder reliability between the two raters was calculated by Pearson product moment correlation co-efficient (r). The value of correlation co-efficient between the two raters was 0.89.

Table 2. Example of Scoring to Student S1 in the three Applications (A) of the Instrument

Component	Sub-component	Statements	A1	A2	A3
Teacher	Activity	1.Demonstrating Experiment/Activity	0	0	1
		2. Lecturing/Giving Directions (teacher talking)	1	0	1
		3. Using Visual Aids (chalkboard, overhead, and charts, etc.).	1	0	0
	Position	4. Centrally located (head of class)	0	1	1
		5. Erect Posture (not sitting or bending down)	1	1	1
Component Score			*3*	*2*	*4*
Students	Activity	6. Watching and Listening (or so suggested by teacher behavior)	1	1	1
		7. Responding to Teacher/Text Questions	1	0	0
	Position	8. Seated (or so suggested by classroom furniture)	1	1	1
Component Score			*3*	*2*	*2*
Environment		9. Desks are arranged in rows (more than one row)	1	0	0
		10. Teacher desk/table is located at the front of the room	0	0	0
		11. Laboratory organization (equipment on teacher desk or table).	0	0	0
		12. Symbols of Teaching (ABC's, chalkboard, bulletin boards, etc.)	1	1	1
		13. Symbols of Science knowledge (science equipment, lab instruments, wall charts, etc.)	1	1	1
Component Score			*3*	*2*	*2*
Total Score			9	6	8

Results and Discussions

Prospective Science Teachers' Beliefs about Themselves as Science Teachers

Table (4) illustrates the means and standard deviations of the three test administrations. To classify teachers responses to the DASTT-C, Thomas et al. (2001) proposed that teachers' drawings might be organized into two distinct groups: teacher-centered (7-13 points) and student-centered (0-4 points). According to the results shown in Table 3, prospective science teachers in the current study were teacher-centered before taking the Science Methods I course (m= 8.58, SD= 2.57). A shift to an intermediate state between the teacher-centered and student-centered was noted after completing the Science Methods I course (m= 6.78, SD= 2.26). A minor change

occurred after they completed the Science Methods II and Practicum (m= 6.20, SD= 2.09). Figure (2) demonstrates these values.

Table 3. DASTT-C Teaching Style Continuum

Exploratory (0-4)	Conceptual (5-8)	Explicit (10-13)
Teacher believes students are capable of managing their own learning	Teacher believes students need themed, conceptual learning experiences	Teacher believes students lack knowledge and need assistance in learning
Curriculum is open to student interests	Content is exploratory, organized around key concept	The curriculum is focused on specific outcomes
Teacher leads and guides student activities/investigations	Teacher organizes the connecti-ons of content and process of science	Teacher is the knowledge conduit (telling is teaching)
Teacher focuses on student questions as an instructional goal	Teacher-centered lessons include hands-on activities, group work, and discussion of ideas	Teacher initiates activities. Stu-dent input is acknowledged but not expected
Alternatives assessment measures student learning and knowledge	Tests check for understanding of important concepts	Tests focus on science content knowledge
Column total----------	Column total----------	Column total----------

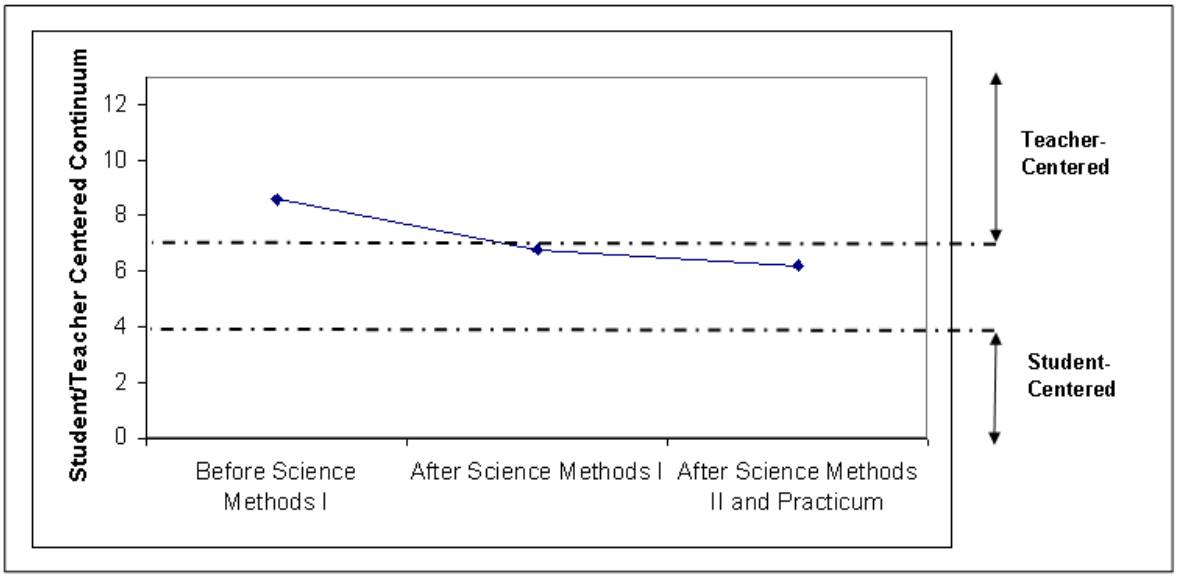


Figure 2. A small shift occurred in prospective science teachers' beliefs across the three administrations of the DASTT-C

To test the statistical differences among the three administrations of the DASTT-C instrument, A Wilks' Lambda repeated measures ANOVA analysis was used. There were statistical differences among the three administrations ($\lambda = 0.577$, $F = 15.76$, $P < 0.001$), with a large effect

size (partial η^2= 0.423). Table (5) shows ANOVA summary table. These results show that at least one mean difference among the three administrations of the DASTT-C is statistically significant. This implies that prospective science teachers' beliefs about themselves as science teachers were influenced by being part of at least one course: Science Methods I, Science Methods II or the practicum.

Table 4. Means and Standard Deviations of Science Prospective teachers' Drawings for the Three Administrations of the DASTT-C Instrument

Administration	n	m	SD
Before Science Methods I	45	8.58	2.57
After Science Methods I	45	6.78	2.26
After Science Methods II and Practicum	45	6.20	2.09

Table 5. ANOVA for Repeated Measures for the Three Administrations of the DASTT-C Instrument

Source	SS	df	s^2	F
Between groups	6969.630	1	6969.630	880.281
Error	348.370	44	7.918	

Follow-up comparisons in pair show that there were significant differences between the first and the second administrations ($P < 0.001$) and between the first and the third administrations ($P < 0.001$). There were no significant differences between the second and the third administrations. Based on these results, it might be plausible to suggest that the significant shift in prospective science teachers' beliefs was a result of their study in the Science Methods I course. Students-centered concepts and activities such as group discussions, group work, hands-on activities, creating concept maps, designing graphic and role playing are introduced to science prospective teachers for the first time in their program during the Science Methods I course. They are also given the opportunity to implement these instructional techniques in their microteaching lessons. The microteaching experience provides prospective teachers with a medium for putting the theoretical ideas, which they learn in the lectures, into practice when they plan, implement and evaluate their own lessons.

Figure 3 shows the drawings of two prospective teachers (S1 (female) and S2 (male) who changed their drawings to be less teacher-centered after the Science Methods I course experience. Instead of having students arranged in rows, group arrangements start to take place. Also, after finishing the Science Methods II course and the Practicum, it might be mentioned that some science lab-related implements, such as flasks and lab benches, started to appear. They might be a result of their experience as teachers with these equipments in the Practicum.

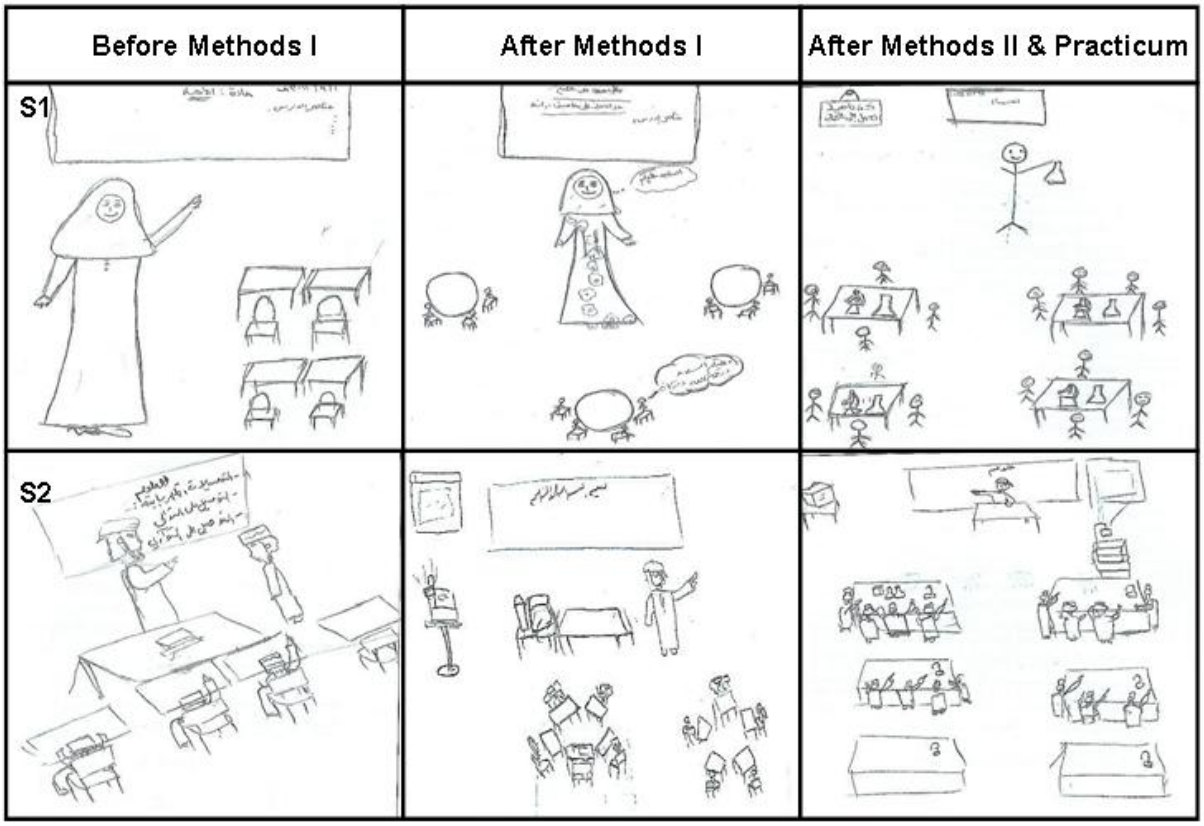


Figure 3. The drawings of two prospective teachers which start to reflect an indication of the student-centered approach after Science Methods I Course

Figure (4) illustrates a case of two prospective male teachers (S3 and S4) whose drawings did not reflect any indication of student-centered style until the end of the Science Methods II course and the Practicum. Figure (5) shows a case of two prospective teachers (S5 (male) and S6 (female)) whose drawings shifted from teacher-centered to a sort of student-centered and back to teacher-centered after the Science Methods II course and the Practicum. This back-shifting might be a result of facing difficulties in the real classroom environment when prospective teachers start to teach in local public schools. Prospective teachers are trained to teach in an ideal situation (environment) in the microteaching (peer teaching) sessions during the Science Methods I course. There are no concerns of class management and time restrictions. However, some prospective teachers struggle when they transfer to teach in the local public schools with real children, especially in their first weeks. From the practicum supervision experience of the authors, some prospective teachers, who do not have classroom management skills, face difficulties in controlling students in student-centered settings. They did not have these difficulties when they taught their first science lessons during the peer teaching, where they would apply student-centered methods comfortably. However, it might be anticipated that some of them are "shocked" with the real behavior of the children in the public schools. The authors have observed that some student teachers perform their microteaching lessons successfully with variety of student-centered activities such as inquiry-based learning or concept exploration in different stations. Nevertheless, they fall short when they go to schools to perform their teaching

practice and retract from avoid using different student-centered teaching techniques. When the authors discussed this issue with some of their students under their supervision, they justified that these techniques become time-consuming in schools because they require full control of the students. they need much control of students. Even some of them complained that school students perceive them as visitors rather than teacher and, therefore, find their lessons as an opportunity to misbehave and do not consider classroom activities conducted by students teachers as valuable as those conducted by their permanent teachers. This observation has also been recognized by other researchers (e.g. Mccormack & Thomas, 2005)

The notion of 'reality shock' in schools gets support from literature which documents a similar phenomenon (Hudson, Beutel & Hudson, 2008; Kallery, 2004; Mccormack & Thomas, 2005; Nahal, 2010). Hudson, Beutel & Hudson (2008) asserted that "reality shock" is a major characteristic of beginning teachers. Nahal (2010) elaborated that "reality shock" is a result of novice teachers' realization of the complexity of the teaching situation which sometimes differs greatly from what they expect. Nahal indicated that novice teachers felt that they were not prepared for classroom management, which became a source of frustration to them. Kallery (2004) found that one of the major problems faced by novice science teachers was managing the classroom during science activities. Taken together, student teachers in the current study might prefer a more teacher-centered approach, which gives them more control of the teaching situation and the challenges they face.

In addition, time management skills, which are found to be a major issue faced by novice teachers (Kallery, 2004; Nahal, 2010), play an important role in this matter. During the peer teaching experience, prospective teachers would implement different classroom activities for given topics with no real sense of a time line for the lesson. So they would take a sub-topic for a period of 30 minutes and design different student-centered activities for it. However, they discovered, during the practicum experience, that they have to combine two or more sub-topics to be taught in that 30 minutes period. Therefore, it might be plausible to conclude that a more teacher-centered approach in which lecturing and one-way teacher-student discussions become the preferred choice over time-consuming student centered methods.

Previous studies found a similar tendency towards the teacher-centered approach. For instance, Simmons et al. (1999) conducted a three-year longitudinal study in which they investigated the beliefs and practices of 116 beginning science and math teachers who graduated from 10 different universities in the United States. They observed that less than 25% of teachers had student-centered beliefs and less than 10% of them practiced using student-centered teaching style. Simmons and her colleagues justify that changing toward the use of more student-centered approaches such as inquiry-oriented teaching methods is not a simple process. It requires teachers to "learn, re-think, and adopt different knowledge, thoughts, and practices related to teaching (p.20)." El-Deghaidy (2006) used the DASTT-C instrument for Egyptian pre-service science teachers before and after a science methods class. She found that pre-service science teachers moved slightly from the teacher-centered area to the intermediate area between teacher-centered and student-centered. El-Deghaidy linked this limited impact of the science methods course on prospective teachers' beliefs of self as teachers to their experience in practical labs during their study of science courses. The author anticipated that less opportunity to manipulate tools and conduct hands-on experiments during the practical labs might slow prospective teachers' transformation from teacher-centered to student-centered.

Figure (6) illustrates a case of a female student teacher (S7) who shifted back to a very traditional classroom setting after the Science Methods II course and the Practicum, regardless of having some indications of student-centered approach in the first two administrations of the DASTT-C instrument. She started with a tendency towards a student-centered belief and ended

with a clear tendency towards a teacher-centered belief. She scored (4), which was within the student-centered range, in the first two administrations and (8), which was within the teacher-centered range, in the last one. According to the scoring criteria by Thomas et al. (2001) in Table (1), the teacher in the last drawing is clearly standing at the center of the classroom lecturing by the board with handwritings on it. In addition, desks are arranged in rows. These elements of the teacher-centered approach do not appear in the first two drawings which show the desks arranged for group work and the teacher is interacting with one of the groups.

Another interesting case is shown in Figure (7) of a female student teacher (S8). Although she showed a tendency towards tendency towards teacher-centered belief throughout the three administrations of the instrument (scored 10, 11 & 7 in the first, second and third administrations respectively), she kept the group-work desks arrangement in the three drawings. She mentioned in her response to the open questions that students were doing hands-on activities, taking measurements or discussing together the results of their investigations. One also might note that the stereotypical image of the teacher being at the front of the class explaining and instructing was also revered throughout the three drawings.

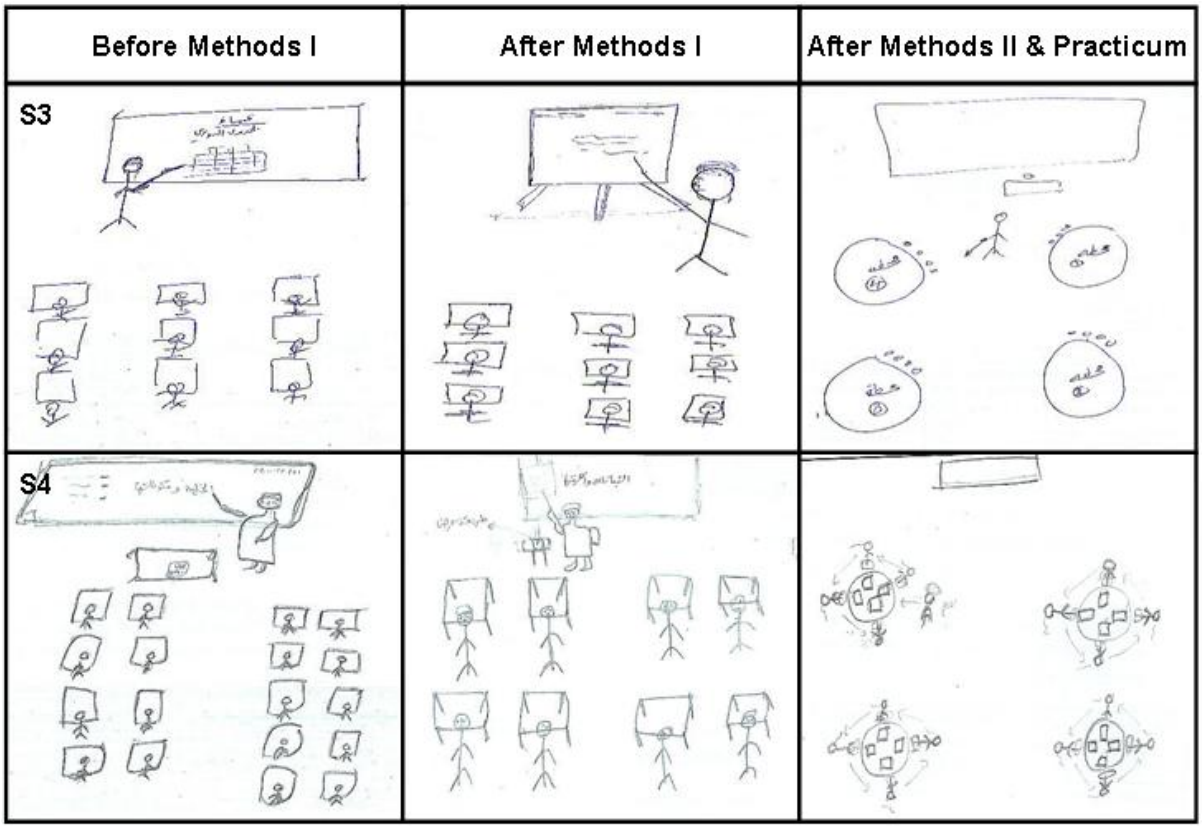


Figure 4. The drawings of two prospective teachers which did not give any indication of the student-centered approach until finishing the Science Methods II Course and the Practicum

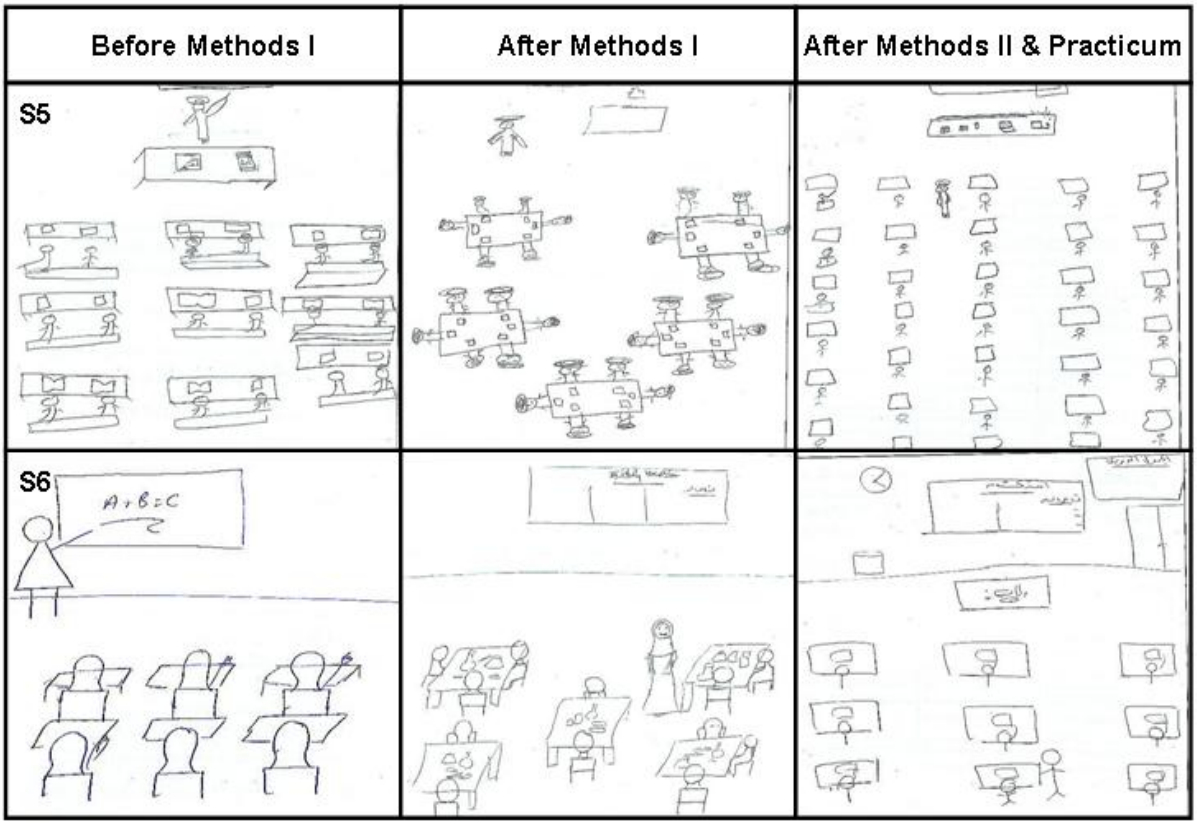


Figure 5. The drawings of two prospective teachers, which flipped back to a complete teacher-dominant style after the Science Teaching Methods II Course and the Practicum

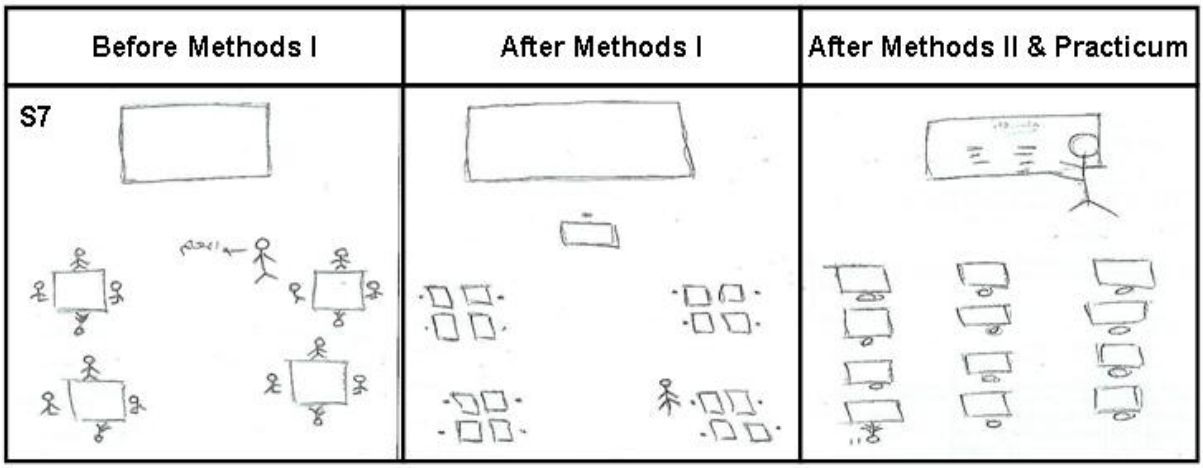


Figure 6. A rare case of a female student teacher who started with a tendency towards a student-centered approach and ended up with a tendency towards a traditional teacher-centered classroom setting

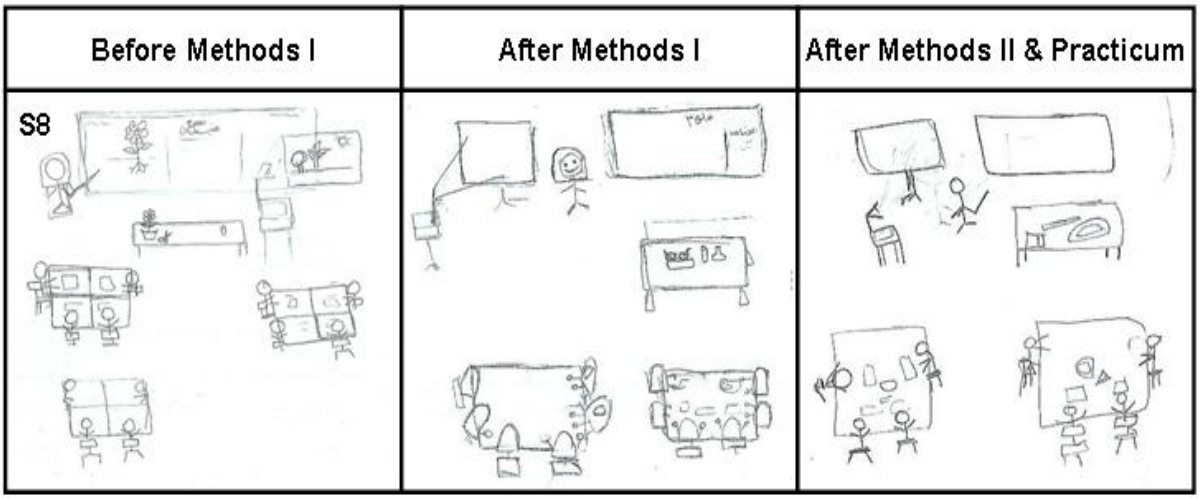


Figure 7. A female student teacher who maintained the group-work desks arrangement throughout the three administrations of the DASTT-C instrument regardless of her tendency towards teacher-centeredness

It is interesting to notice from prospective science teachers' drawings, regardless the type of the classroom arrangement, that the view of a teacher, who stands at the front of the classroom teaching, explaining and giving instructions, is the dominant view. This view was confirmed by both Yilmaz-Tuzun, (2008) and Calderhead and Robson (1991) who asserted that prospective teachers begin their teaching in the same way that they were taught by their teachers in elementary and secondary schools. In addition, the classroom arrangements found in pre-service teachers' drawings in the current study may not actually tell the whole story. Students might be setting in groups, facing each other, yet the teacher talks the whole time. Sometimes, students do not get much out of sitting in groups except backache as they twist their backs and necks to follow what the teacher has to say and writes on the whiteboard. Simmons et al (1999) found that, even though beginning teachers described their teaching as student-centered, they behaved in teacher-centered ways.

Prospective teachers, most of the time, are mimicking what they are used to seeing as students and what they have seen practiced throughout their school and college years (Anderson, Imdieke & Standerford, 2011; Kennedy, 1999). It seems that they did not reach the student-centered stage even after studying about different student-centered teaching methodologies during the Science Methods I and II courses such as inquiry-based learning, science stations, concepts mapping, learning cycle, projects-based learning, problem-based learning, mind mapping and the predict-explain-observe approach. Comparing the second and the third administrati ons of the instrument, their experience in the Science Methods II course and Practicum did not change prospective science teachers' beliefs much. It might be because of the reality of the teaching experience they face when they go to real teaching situations during their practicum where they start dealing with real students in real time restrictions. Similar results were found by Yilmaz et al (2007), who used the DASTT-C. They found that of 41% pre-service elementary teachers from three different Turkish universities, who already had six credits of teaching science, were teacher-centered, 20% were student-centered and 39% were between student-centered and teacher-centered. Also, Simmons et al. (1999) found that third - year beginning teachers

demonstrated less of a student-centered approach than did first and second - year teachers. Simmons et al. (1999) justified that this decline was as a result of the acculturation within the school environment. Fresh graduates tended to be more concerned with their students' needs in their first and second years. Issues like control of the classroom and tenure concerns started to be more important to them in the third year.

Some new teachers find it difficult to avoid being the dominant figure in the classroom. Simmons et al. (1999) found that novice teachers organized "their beliefs and actions toward teaching styles in which they were more dominant (teacher-centered) (p.446)." This might be a result of different factors. Some new teachers have little or limited training in a student-centered teaching environment. Personal effort plays a major role in their attempt to implement this approach. In addition, most of them have been taught in teacher-centered way for years. Even if they design student-centered activities, sometimes, their dominant role prevails. They unconsciously imitate what their schoolteachers and college professors practice in classrooms and lecture halls. In addition, the average classroom size in Oman is around 30 students. Some teachers find it difficult to control this number of vibrant young learners and carry on student-centered activities at the same time. To many of them, the teacher-centered approach gives them more control and helps them avoid different management issues. Furthermore, one national textbook is used in all Omani public schools for a given grade level. Science teachers have to cover the entire textbook in a given time. This puts pressure on prospective science teachers to accelerate their teaching process. Therefore, the teacher-centered approach becomes the preferred mean. A related issue is the nature of the science curriculum used in the public schools, which tends to be more content-based rather than processes-based. This might give limited opportunities for teachers to design student-centered classroom activities that engage all learners. Lecturing, dictation, classroom discussion and demonstration become the preferred teaching methods. Inquiry, problem-based learning, projects-based learning and the learning cycle might have little room in the content-based curriculum.

Teaching Styles

The second part of the DASTT-C instrument dealt with prospective science teachers' beliefs regarding three different teaching styles: exploratory, conceptual and explicit. Table (6) shows the means and standard deviations of prospective science teachers' teaching styles after each administration of the DASTT-C instrument. Thomas and her colleagues (2001) use the following identification system: 0-4 points for the exploratory teaching style, 5-9 points for the conceptual teaching style and 10-13 points for the explicit teaching style. This identification system puts prospective science teachers in the current study, across the three administrations of the DASTT-C instrument, at the conceptual teaching style, closer to the boundary with the exploratory teaching style. This is illustrated in Figure (8). Using Wilks' Lambda repeated measures ANOVA analysis, there were no significant differences among the three administrations of the DASTT-C instrument regarding the teaching styles ($\lambda = 0.972$, $F = 0.612$, $P = 0.547$). This suggests that prospective science teachers' beliefs regarding the three different teaching styles (i.e. exploratory, conceptual and explicit) investigated by DASTT-C did not change significantly by their experience during both Science Methods I and II and the practicum.

Table 6. Means and Standard Deviations of Prospective Science Teachers' Teaching Styles for the Three Administrations of the DASTT-C Instrument

Administration	n	m	SD
Before Science Methods I	45	4.96	0.64
After Science Methods I	45	5.22	1.51
After Science Methods II and Practicum	45	4.98	0.15

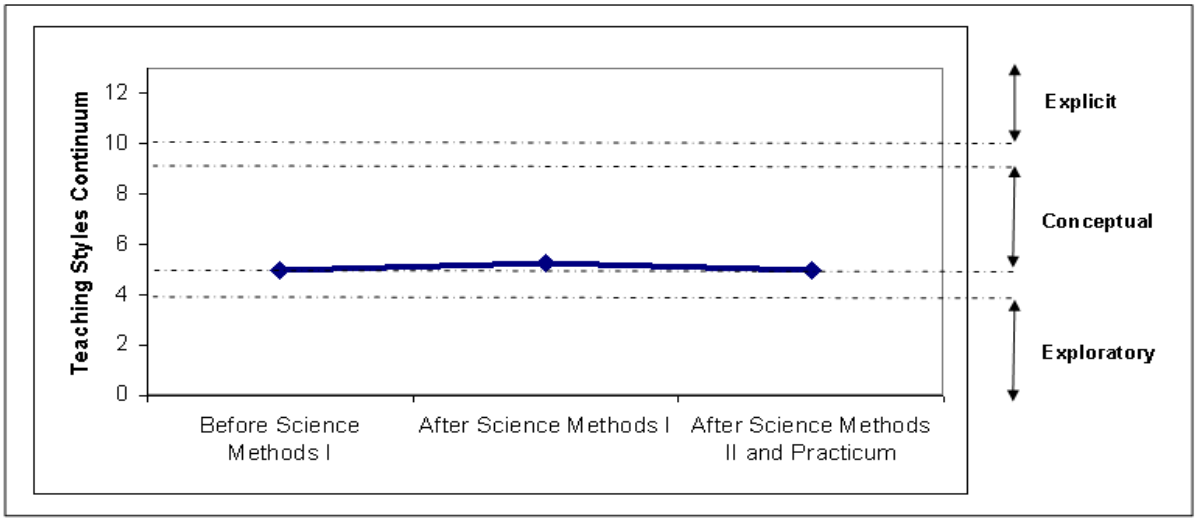


Figure 8. The conceptual teaching style is the dominant style for prospective science teachers across the three administrations of the DASTT-C

Teachers with a conceptual teaching style plan and conduct teacher-centered lessons that feature group work, hands-on activities and discussion of ideas (Thomas et al. 2001). From the experience of the authors with prospective science teachers during their practicum, it might be concluded that this is what most of prospective teachers practice. The exploratory teaching style, which takes into account students' interests and questions to design an open exploratory, learning environment, might become difficult to attain by prospective science teachers. One national science curriculum is used in Oman across the country with pre-determined learning objectives and classroom activities which tend to be implement structured-inquiry with a given discovery procedure. This gives science teachers little freedom to design their instructional materials around students' questions and interests. Al-Balushi (1998) found that in-service science teachers in Oman considered open-ended inquiry activities to be difficult to apply giving the "cook-book" nature of the national science curriculum. Al-Harthi (2008) reached similar results when he found that although science teachers in Oman believed positively about open inquiry, they thought that several inquiry-based learning requirements were difficult to secure and represented serious

obstacles. Some of these obstacles were large class size, long planning and preparation time, inexperienced teachers and unequipped school laboratories.

Major Conclusions

The current study builds on the literatures, which have examined science teachers' beliefs concerning their science teaching. This longitudinal study investigated prospective science teachers' beliefs about themselves as science teachers and about science teaching styles. Based on the data from the DASTT-C instrument, there was a significant shift from the teacher-centered approach to the intermediate state between the teacher-centered and student-centered approaches after completing the Science Methods I course. However, the change after the Science Methods II course and the Practicum was not significant. In addition, the data from the second part of the DASTT-C instrument, which dealt with three different teaching styles: exploratory, conceptual and explicit, indicated that prospective science teachers in the current study were at the conceptual teaching style, closer to the boundary with the exploratory teaching style. This was consistent across the three administrations of the DASTT-C instrument: before and after the Science Methods I course and after Science Methods II course and the Practicum course.

The current study has a few limitations. First, the repetition of the administration of the DASTT-C during this longitudinal design might have led few prospective teachers to express a minor frustration from repeating the same instrument for three times. Despite the humor while expressing their frustration, this might reflect their unwilling to put a sufficient effort to express their beliefs while completing the DASTT-C. Another shortcoming for this longitudinal study is that despite its duration for approximately one year and a half, some pedagogical beliefs might be resistant to change within this relatively short period of time. Therefore, it might be a better alternative to follow up science teachers for a longer period of time at their schools after their graduation and document the changes in their beliefs as they transit from being novice teachers to more experienced ones. This would also allow for investigating the influence of their beliefs on their teaching practices by tapping their beliefs and observing the reflections of these beliefs on their actual teaching experiences.

Recommendations

Implications for Science Teacher Education

The results of the current study show the prospective science teachers' tendency towards the teacher-centered approach and the conceptual teaching style. In the light of these results, the study recommends the following:

- The student-centered approach and constructivist-based classroom teaching methods should be supported during the prospective science teachers' preparation years.
- Student teachers of science should be encouraged to implement student-centered teaching style during their practicum.
- Practicum schools should be equipped in a way that encourages prospective teachers to practice a more student-centered approach. This experience might encourage them to continue with the student-centered approach when they are hired in schools.
- Prospective science teachers should be trained more in using the exploratory teaching style by encouraging them to design and implement lesson plans that are exploratory in nature, which take learners' questions and interests into consideration. This should be done both in their peer teaching (microteaching) and in the practicum.

- Teacher educators should re-design their lectures and seminars to be more student-centered and exploratory-oriented. This would, in turn, model these instructional approaches to the prospective teachers. For instance, teacher educators should lecture less and promote more discussions, exploratory activities, argumentations, debates, designing of concepts maps by student teachers and projects-based learning.

Recommendations for Future Studies

In the light of the results of the current study, the following research studies might be conducted:

- Conducting qualitative research by interviewing prospective science teachers regarding their beliefs about science teaching, specifically, the student-centered teaching style.
- Conducting a case study of a small group of prospective science teachers that looks at the transformations student teachers go through in their teacher preparation program in light of their beliefs about science teaching and their practices.
- Investigating in-service science teachers' beliefs and comparing them with pre-service teachers' beliefs would allow observing the effect of their school work involvement on their beliefs.

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Fen Bilgisi Öğretmen Adaylarının Fen Bilgisi Öğretmen Test Kontrol Listesini Çizerek Fen Bilgisi Öğretimi Hakkındaki İnançlarını Belirleyen Bir Boylamsal Çalışma

Bu araştırma, Sultan Qaboos University/Sultanate of Oman'daki fen bilgisi öğretmen adaylarının fen bilgisi öğretimine yönelik inançlarını ortaya çıkarmayı amaçlamıştır. Bu amacı sağlamak için Fen Bilgisi Öğretmen Test Kontrol Listesini Çizme (FBÖTK-Ç) aracı kullanılmıştır. Sultan Qaboos Üniversitesi Eğitim Fakültesine kayıtlı öğretmen adaylarından 45'i bu çalışmanın örneklemini oluşturmaktadır. Araç örnekleme üç kez uygulanmıştır: Fen Bilgisi Öğretimi I dersinden önce, bu dersin bitiminden sonra ve Fen Bilgisi Öğretimi II dersi ve Uygulama dersinden sonra. Fen Bilgisi Öğretimi I dersi bittikten sonra fen bilgisi öğretmen adaylarının, öğretmen merkezli yaklaşımdan öğretmen ve öğrenci merkezi arasında bir duruma geçtikleri sonucu ortaya çıkmıştır. Fen Bilgisi Öğretimi II ve Uygulama dersinden sonra anlamlı bir değişim bulunmamıştır. Ayrıca, bu araştırmada üç farklı öğretme stilinden (araştırmacı, kavramsal ve açık) FBÖTK-Ç aracının ikinci kısmında öğretmen adaylarının kavramsal öğretme stilinin araştırmacı öğretme stilinin sınırına daha yakın olduğu sonucu bulunmuştur. Kavramsal öğretme stili, FBÖTK-Ç aracının üç uygulamasıyla tutarlı kalmıştır.

Anahtar kelimeler: Boylamsal çalışma inançları, fen bilgisi öğretmen adayı, FBÖTK-Ç, öğretmen merkezli, öğretme stili.