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The difference between reality and desirability in science teachers' pedagogical content knowledge as perceived by their students

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Abstract

The aim of the study is to investigate Omani science teachers' pedagogical content knowledge (PCK) from the perceptions of their students. A questionnaire with two versions consisting of 16 main items was used to assess these perceptions. In addition, a focus group interview was conducted to other participants. The questionnaire was administered to 1,400 Omani 10th grade students using a convenient method of sampling. The findings indicated that the level of agreement between what teachers practiced in reality and what their students preferred, overall, is very good. From the study results, there are two major issues in the PCK of Omani science teachers: one is related to traditionalism, abstraction and centrality of examination in science teaching and the other one is students' passiveness during the learning process. The study recommended more use of student-centred teaching and learning methods such as project-based learning, inquiry-based learning, problem solving and role-playing.

Keywords: Science teachers, PCK, perceptions, reality, desirability;

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1. Introduction

Pedagogical content knowledge (PCK) as described by Shulman (1987, 9) is 'utilising expressions, metaphors, examples and explanations, facilities and offers that are used by the teacher in order to make the content understandable to students. In his opinion, translating the scientific content into activities and behaviors is the core idea of PCK (Mulhall et al., 2003; Park et al., 2012). Shulman (1987) considered PCK as one category of the base knowledge for teaching. In his view, PCK consists of knowledge of the subject matter, knowledge of curriculum, general pedagogical knowledge (PK), knowledge of learners, knowledge of educational contexts and knowledge of educational purpose (Bioshop & Denley, 1997). However, Marks (1990) discussed the difficulty of distinguishing PCK from either subject matter knowledge (SMK) or general PK. He perceived that the development of PCK as an integrative process revolving around the understanding and interpretation of SMK and the specification of general PK (van Driel et al., 1998). Cochran et al. (1993) asserted that PCK is an integrated understanding of three components of pedagogy. These are subject matter content, student characteristics and the environmental context of learning.

Several researchers (Cochran et al., 1993; Fernndez-Balboa & Stiehl, 1995; Shulman 1987) consider PCK as a core component of a teacher's profession rather than a subcategory of any suggested knowledge. In this regard, the deviation in addressing PCK was surprising. While Shulman (1996; 1997) argued that the specific nature of PCK depends on the characteristics of each subject matter or content area, Fernandez-Balboa and Stieh (1995) opted for the common nature of PCK. In their point of view, some pedagogical aspects may exceed and extend beyond the subject matter or content areas. They have some concerns about the common elements of good instruction across several fields. Therefore, the categories of PCK that they suggested include (a) subject matters, (b) students, (c) numerous instructional strategies, (d) teaching context and (e) teaching purposes.

Gess-Newsome (1999) differentiate between two models of PCK; the transformative model and the integrative model. The transformative model represented a divergent interpretation of PCK in which all knowledge needed for teaching is transformed into a new form whose components cannot be separated (Soysal, 2017). The integrative model, on the other hand incorporated subject matter knowledge (SMK), context knowledge (CK), and pedagogical knowledge (PK). From the integrative model, Magnusson et al. (1999) developed a model components of science teaching including (1) orientation to teaching science, (2) science curriculum, (3) students' understanding of science, (4) instructional strategy and (5) scientific literacy assessment. All models developed for PCK have been added to Shulman's PCK original model incorporating several elements such as: instructional strategies, students' learning difficulties, orientations to teaching science, curricular knowledge, knowledge of content, context for learning, and general elements (Kind, 2009).

Lee and Luft (2008) argued that most of the attempts to define and understand PCK consider it from the point of view of the researchers. These definitions and understanding have resulted in limited representations and can have a direct impact on school reform efforts. In their opinion, it is necessary also to provide a representation of PCK that accurately reflects teachers' perspectives, given the field-based nature of this concept.

However, this is still not enough from other researchers' (Cochran et al., 1993; Krajcik et al., 1998; McCaughtry, 2005) point of view. They argued that taking students' perspectives to improve teaching is necessary too. Students are seen as one of pillars of the PCK and their presence in this process is essential to construct their teachers' PCK. It is a two-way process. On the one hand, teachers' PCK is developed during the communication process with students in classroom practice

(Grossman, 1990; Jang, 2010; Kind, 2009; Krajcik, et al., 1998). On the other hand, teachers benefit from this to understand the requirements of their students (Cochran et al., 1993).

Jang and Chen (2013) point out that investigating the views or perceptions of students about their teachers and their ways of teaching is a very important source for examining teachers' knowledge. This information can be used to evaluate and improve the teaching process (Keng & Fraser, 2014; Tuan et al., 2000). Moreover, using students' perceptions enables both researchers and teachers to understand in depth the instructional and environmental influences on students' learning processes, which then offer rich information for understanding students' thoughts (Tuan, Chang, Wang, & Treagust, 2000).

Tuan et al., (2000) pointed out that good teachers from students' perspective are those who know the subject well, explain things clearly, make the subject interesting, give regular feedback to them, give extra help to students, have a good sense of humour, and are fair and consistent with students. Moreover, students expect teachers to motivate them to learn more about the topic, think in new and different ways about what is taught, respect them, teach good skills, and be flexible and negotiable (Glenn, Patel, Kutieleh, Robbins, Smigiel, & Wilson, 2012).

Thus, the research on students' perceptions of teaching revealed that students expect teachers to have good PCK, which means that PCK represents a vision of good teaching (Fernandez-Balboa & Stieh, 1995). Van Driel et al. (1998) pointed out that PCK is highly related to students' learning and from students' perspectives; the nature of teacher's knowledge could improve their learning of science.

Recent studies have investigated the students' perceptions of their science teachers' PCK (Halim et al., 2014; Jang, 2010; Tuan et al., 2000). The objectives and the sample of these studies have varied. Similarly, the diversity of investigated PCK elements also strongly arose. For instance, Tuan et al. (2000) developed an instrument regarding student perceptions of teachers' knowledge. In this study, only four distinct aspects of teachers' knowledge were identified as being viable during the development process of the instrument. These are instructional repertoire, representation repertoire, SMK and knowledge of students' understanding. Jang et al. (2009) in their study developed an instrument that could be employed to assess the college students' perceptions of teachers' PCK. The results showed that the four categories of PCK constructed in the instrument were SMK, instructional representation and strategies, instructional objects and context (IOC) and knowledge of students' understanding (KSU). In another study, Jang (2010) used a mixed-method design with both quantitative and qualitative techniques to assess the students' perceptions of college teachers' PCK. The results indicated that only SMK and IRS showed a significant difference in the four categories of the survey, whereas IOC and KSU did not. Because of the usefulness of Jang et al. (2009) instrument to investigate students' perceptions of teachers' PCK, it was used by Criua and Marian (2014) to identify the influence of students' perceptions of teachers' PCK on the students' level of cooperation with teacher and their academic specialisation.

Halim et al. (2014) developed an instrument that investigates the level of science teachers' PCK from the perspective of students with different achieving abilities. They used six components of PCK: SMK, knowledge of teaching strategies, knowledge of concept representation, knowledge of teaching context, knowledge of students, and knowledge of assessment in learning science. The result revealed that the differences in science teachers' PCK identified by students were statistically significant.

In the current study, the researchers benefited from the previous literature for designing the study instrument and identifying the components of PCK. Here, the PCK is regarded as a key element of a teacher's profession. The three components of the integrative model, which are CK, SMK and PK, are also taken into account. The researchers have developed a model (Figure 1) that combines the categories of PCK as identified by Gess-Newsome (1999) and Magnusson et al. (1999). In the proposed model, the knowledge of teaching context (CK) includes two parts. The first part is the teachers' relationship with students, which includes teachers' personality, orientation and attention. The second part is the management of the learning process. It consists of how the teachers direct the learning process, motivate the students, manage the classroom and organise the place of learning science. The SMK consists of: 1) The goals of teaching science. 2) How science teachers plan the lesson? 3) How teachers deal with textbooks? 4) How science teachers conduct the science activities? Finally, the knowledge of instruction (PK) consists of teaching methods and assessment tools.

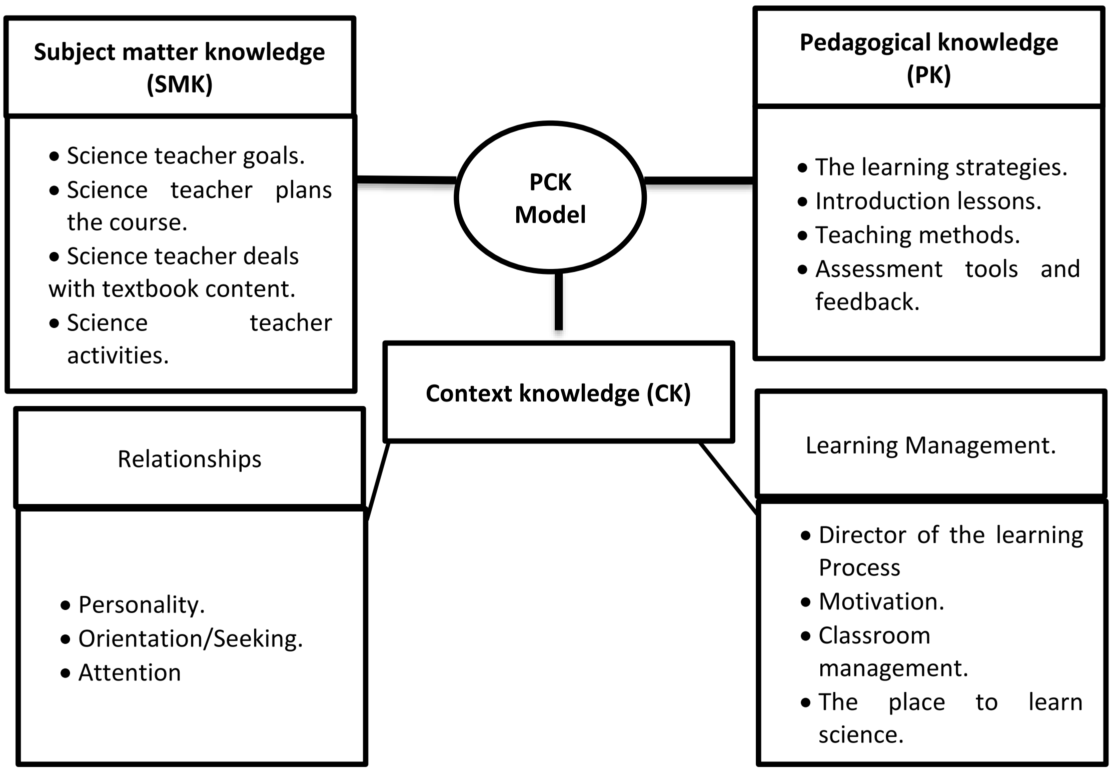

Figure 1. The PCK model proposed by the researchers

2. The status of science education in Oman

The Sultanate of Oman is situated in the far southeastern corner of the Arabian Peninsula. It shares borders with the Republic of Yemen to the southwest, the Kingdom of Saudi Arabia to the west and the United Arab Emirates to the north. Oman looks forward to meet the requirements of modern society through the development of its education system through development of students thinking and problem-solving skills. In this regard, many changes have been implemented in the education system to make science education as an exploratory education based on the student's centrality and participation in scientific activities (Ambusaidi & Al-Zain, 2008). However, for three consecutive cycles, the Omani students (fourth and eighth grades of basic education) who participated in 'Trends in International Mathematics and Science Study' (TIMSS) did not give satisfactory results. In fact, the results were lower than the international average (Martin et al, 2016; Ministry of Education, 2013).

On the other hand, the data about students' engagement in science classes in the three TIMSS cycles highlighted that the majority of students believed that they are fully integrated into the science classes. Besides, Omani science teachers reported that scientific enquiries and investigation accounted for half or more of their classes (Martin et al., 2016). However, there is a discrepancy between the statements of students and their teachers and the performances of students in TIMSS. This discrepancy has created a paradox: if students are properly integrated into science classes and if the scientific activities occupy half or more of the science classes' time, why the students' performance levels are unsatisfactory? If we recognise that TIMSS results reflect the actual level of Omani students' achievement in science, then there is a need to investigate this discrepancy. One way to do so is to study the students' perceptions in depth, especially those perceptions regarding the teaching process and the teachers' knowledge. In this regard, this study profits PCK literature by designing a special model for PCK elements, which focuses on observable practices, where students deal constantly, have continuous perceptions of them and have their own preferences regarding what they should be.

The current study focuses on Omani students' perceptions of their teachers' PCK. Its major aim is to benefit from these perceptions to understand Omani students' thoughts about how they learn science and how their teachers teach science. In addition, the study enables us to iidentify how science teachers construct the classroom learning environments with a focus on pedagogical and scientific content aspects in teacher's work. Thus, the researchers are trying to investigate Omani 10th-grade students' perceptions of their science teachers' PCK, as practiced in reality and as preferred by students. Halim et al. (2014) asserted that the studies carried out in the field to investigate the students' perceptions of science teaching PCK are still very limited. Therefore, the current research follows this recommendation and attempts to address the following two research questions:

RQ1: What are PCK elements do 10th-grade Omani students perceive their teachers to engage (or use) in science classrooms?

RQ2: What are PCK elements do 10th-grade Omani students prefer their teachers to engage (or use) in science classrooms?

3. Research Methodology

This study uses a mixed method, based on a questionnaire and a focus group, to collect the data from the participants. This is aligned with the recommendation of Abell (2008) study who emphasised using a combination of quantitative and qualitative methodologies in studying PCK. Two electronic versions of the questionnaire were designed: the first one is to identify the real PCK practiced by science teachers inside the classroom, which is used for Research Question (1), and the second version is to identify students' preferences regarding how their science teachers should practice PCK during science lessons, which is used for Research Question (2). The focus group was used to support the data obtained from the two versions.

3.1. Participants

The target sample of the study is drawn from 10th-grade students, which is the first grade in the upper secondary school in Oman. Students were selected using a convenience sampling method from four Omani educational governorates. The questionnaires were conducted online, using Google Docs. It was administered to 1,400 students. A total of 1,307 students answered the first version of the questionnaire completely, of whom 610 (46.7%) were female students and 697 (53.3%) were male students. For the second version, a total of 1,352 students answered the version completely, of whom 739 (54.7%) were female students and 613 (45.3%) were male students.

3.2. Instruments

The current study used two instruments to gather data from the respondents. The first one is a questionnaire to identify students' views about the reality of science teachers PCK and students' desired or preferred teachers. The second instrument is a focus group interview, which was conducted after the questionnaires were implemented.

Questionnaire

The first draft of the questionnaire was developed from a questionnaire constructed and implemented by Magnusson et al. (1999). Besides, the researchers were benefited from another study (Halim et al., 2014; Jang, 2010; Kaya et al., 2012) that investigated teachers' PCK from students' perceptions. The researchers translated it into Arabic and modified it (adding, removing and rewording) to suit the Omani context. Two versions of the questionnaire were constructed: the first one investigates the reality of science teachers' PCK, and the second one elicits the desired or preferred PCK. Both the questionnaires addressed the students' point of view. Each version consists of items distributed among three domains in PCK. These are (1) CK (relationships and learning management), (2) the SMK and (3) the PK.

For the first version of the questionnaire, which targets the reality of science teachers' PCK, a Likert-type scale, consisting of three categories (always, sometimes and seldom), was used. In the second version of the questionnaire, which focuses on the desired practices, an ordinary scale was used, where students were asked to order the given items in each category from more preferable to less preferable.

A panel of experts in science teaching checked the face and content validity of the questionnaires. It included university science educators, science teachers and school supervisors in science. Besides, back translation (from Arabic to English) was performed to the items that are adopted from the study of Magnusson et al. (1999). The reliability of both versions was checked by calculating the internal consistency using the Cronbach's alpha reliability coefficient (Table 1).

Table 1. Cronbach's alpha reliability coefficient for the two versions of the questionnaire

Domain of PCK	First version (the reality)		Second version (the desirability)	
	For the domain	For the items in the domain	For the domain	For the items in the domain
CK	0.91	0.90–0.91	0.86	0.84–0.86

SMK	0.92	0.91–0.92	0.85	0.84–0.86
PK	0.93	0.92–0.96	0.84	0.81–0.87
The questionnaire as a whole	0.92	0.90–0.96	0.85	0.84–0.87

Focus group interview

A focus group interview was utilized to investigate, in depth, students' realistic views about science teachers' PCK, as well as what they prefer. It is widely used in the qualitative type of research to gather the in-depth data about educational phenomena (Memduhoglu et al., 2017). It is a form of discussion between an interviewer and a group of participations (Cohen et al., 2000).

The interview was conducted after both the versions of the questionnaire were administered and analysed. It has two main purposes. The first purpose is to relate the questionnaire questions to the two research questions. In this case, the questions of the interview asked the students' views about both the actual or real practices of science teachers related to PCK components and what they prefer from their science teacher to practice. The second purpose is to validate the obtained results of the quantitative part (the questionnaire). The questions were designed based on the questionnaire items, and they were addressed to students. An experts' opinion about the questions was obtained from seven experts in science education. The group interview protocol followed a structured type as it is more convenient for the purpose of the study. Table 2 shows the final versions of the interview questions.

Table 2. Focus group questions

- What is the nature of assignments that are given to you?
- Which assessment tools do you think are interesting?
- Is it important that the teacher has equal relationships with all students?
- Do you mind that the teacher communicates with your parents?
- How does your teacher develop your thinking skills?
- How interested are you to learn science outside the classroom?
- Do you see any connection between what you study in the science curriculum and what you encounter in your life?
- To what extent would you like your teacher to be fun?
- Do you think there is any benefit for you if your teacher clarifies at the beginning of each lesson what you will be expected to do and achieve?
- What types of assessment tools do you prefer your teacher to use to assess you? In addition, what form of feedback do you like to get from your teacher about your work?

Eight students, both male and female, were interviewed in two separate groups. They were purposefully selected from the schools that were accessible to the researchers. The second author conducted an interview in two separate sessions: one for female students and one for male students, dated October 19 and 27, 2016, respectively. Each session lasted for about an hour and a half. They were conducted in suitable and comfortable places for both the researcher and students. They followed the protocol of the focus group which includes welcoming, introductory questions, the main questions and, finally, summarising and debriefing.

3.3. Data analysis

For the quantitative data, the percentage of students' selections of each category (always, sometimes and seldom) was calculated for the reality version of the questionnaire. For the actual version (Research Question 1), the percentage of each choice for each item was calculated and used to identify how its practice in the three rating categories (always, sometimes and seldom) by science teachers from their students' perspectives. For the desirable version (Research Question 2), the percentage of each item was calculated and then used to rate these items to identify the order of students' preference. The Statistical Packages for the Social Sciences (SPSS) version 16 was used to calculate the percentage for each item.

Concerning the data from the focus group (qualitative part), students' responses were categorised according to the three main domains of the PCK that the current study was adopted and used to support the results of the quantitative part. They are SMK, PK and CK. The views of both male and female students were also presented. However, in the current paper, there will be less emphasis on the gender differences, and only a few examples are presented. The in-depth comparisons between two male and female students will be subjected to another paper.

4. Results

To answer the two research questions, the researchers divided the results according to each domain. The first domain is the 'CK' that includes two parts: the relationships and the learning context. Part 1 consists of the students' perceptions related to the teachers' personality, his or her orientation/seeking and their attention into the students. Part 2 deals with the learning management, how science teachers direct and motivate the students, how they manage the classroom and, finally, the places where students learn science.

4.1. CK: the relationship sub-domain

Table 3 shows PCK elements that are actually utilised by science teachers and the preferred situation according to their 10th-grade students' perceptions.

Table 3. The percentage of each item in 'context knowledge: the relationships' part' domain

22		Percentage %			
No.	Item	Always	Sometime	Seldom	Prefer as first choice
1	Personal characteristic				
1.a	Fun and simple	32.5	37.2	30.8	25.4
1.b	Seriousness in work	55.5	29.9	14.8	21.7
1.c	Arrange his/her work	60.5	25.6	13.9	20.2
2.	Orientation				
2.a	Develop his/her performance	37.7	36.8	25.5	32.6
2.b	Simplify content	45.8	30.3	24.3	29.9
2.c	Solve previous tests	52.7	28.5	18.9	9.50
3.	Attention				
3.a	All students	53.0	28.1	19.6	58.7

The results in Table 3 demonstrate that the majority of students perceived (RQ1) their science teachers as always having the ability to arrange, as well as displaying seriousness in their work. For students' preferences (RQ2), 25.4% of the samples preferred that their teacher be fun and simple. They justified as one female student (3) pointed out:

> 'Yes, I prefer that my teachers to have some fun with students in order to attract them and love the subject, of course not all the time, sometimes she should be serious with students' (Focus group interview dated October 19, 2016).

More than half the samples (52.7%) showed that their teacher concentrates on training them on how to solve tests (RQ1). Nearly, 46% of the students noticed that their teachers seek to simplify the content. For RQ2, the results showed that 32.6% of the samples preferred that their teacher develops their own performance, and male student (1) defensible this as:

> 'Students will not get bored' (Focus group interview dated October 27, 2016).

Hence, 53% of the students (RQ1) perceived that their teachers give attention to all students, which is applied as a preferred situation (58.7%) (RQ2). In the focus group discussion, there was a consensus amongst the students (7 students out of 8, stating that if the teacher is biased or in favour of one student, this will lead to the oppression of the rest. However, a female student (3) stated that:

> 'I like that my teacher takes care of weak students because they have the right to raise their academic performance, while good students can depend on themselves'. (Focus group interviews dated October 19, 2016)

4.2. CK: The learning context sub-domain

Table 4 shows the PCK elements that are actually utilised by science teachers and the preferred situation according to their 10th-grade students' perceptions.

Table 4. The percentage of each item in 'context knowledge: the learning context part' domain

		Percentage %			
No.	Item	Always	Sometime	Seldom	Prefer as first choice
4	Directs learning				
4.a	Addressing me directly	42.3	35.2	22.5	51.8
4.b	Informing my parents	19.0	28.1	52.9	4.2
5	Motivation				
5.a	Diverse activities	50.7	28.4	20.9	37.8
6	Management				
6.a	Fully control	44.3	32.9	22.7	40.5
7	Place of learning				
7.a	Classroom	70.8	17.0	12.2	33.3
7.c	Outdoors	15.7	13.4	70.9	30.9

The results in Table 4 showed that 42.3% (RQ1) perceived that their teachers directly communicate with them. This was also consistent with their preferences for 51.8% of the students (RQ2). Female student 3 appreciated her teacher:

'I want my teacher to show me the points that negatively affect my performance and to tell me how to deal with them'.

In terms of communication with their parents, students indicated that there was weak. Only 19% of the students perceived that this was happening, and in the focus group interviews, one female student (2) said:

'They are afraid of the pressure the parents put on their children to study.'

Male students (4) confirm that:

'Student refusal indicates that they are afraid of their parents'

Regarding motivation, agreement between students' perceptions and their desire, over half of the samples (50.7%) perceived their science teachers using diverse activities to raise their motivation (RQ1), and 37.8% of them preferred RQ2. In terms of classroom management, 44.3% of the students highlighted that their teachers always take full control of actions and tasks in the classroom (RQ1). This was also consistent with their preferences (40.5%) (RQ2). Male student 1 commented:

'To avoid riot, behaviourally or verbally'. Another male student

Student 2 emphasised this by stating:

'The teachers should be strict and able to control students' actions**'**

Finally, regarding the place of learning, 70.8% of the students stated that, in an actual learning situation, they learn in the classroom. They are rarely taught in the laboratory or outdoors. However, this is not the case for the preferred situation (RQ2), 30.9% of the sample preferred to see their teachers teach science outside the classroom (outdoors). Students never decline to study science inside the classroom entirely, and it does not seem significant. Nearly 33.3% of students still preferred that their teachers use the classroom as a place of learning science**.**

4.3. SMK domain

Table 5 shows the percentage of each item in 'SMK' domain, which includes how the teacher plans, deals with the textbook and designs the activities from students' perceptions

Table 5. The percentage of each item in 'SMK' domain

No.	Item	Percentage %			
		Always	Sometime	Seldom	Prefer as first choice
8		Goals			
8.a	Developing thinking	49.9	31.6	18.5	45.6

8.b	Successfully pass tests	42.4	36.1	21.5	33.1
9		Plans			
9.a	Present tasks at the beginning of the semester	65.3	21.3	13.4	67.4
10		Textbook			
10.a	Information	47.8	33.1	19.1	36.4
10.b	Inquiries and experiments	48.2	32.0	19.8	12.2
10.c	Questions and exercises	67.4	19.0	13.6	9.40
11		Activities			
11.a	Easy and clarify	50.0	32.3	17.7	47.9
11.b	Innovative	40.2	37.4	22.4	23.8

The results in Table 5 showed that 49.9% of the samples highlighted that their science teachers always focused on developing their thinking (RQ1), which is consistent with what 45.6% of students preferred (RQ2). In discussions with students in the focus group interviews about the meaning of scientific thinking, the majority of them indicated that the teachers should provide them with arithmetic problems and exercises, which prepare them for the examinations. In addition, regarding the second main teacher's goals, 42.2% of the samples stated that their teachers' goals are to prepare them to pass the tests and get high scores (RQ1), which is consistent with the first choice of 33.1% of the students as preferred (RQ2). In the focus group interviews, it seems that students had confusion between two concepts: problem-solving and successfully passing the tests. Students think that if they solve more exercises, they will achieve high scores. For instance, a female student (1) stated:

> 'I prefer that my teacher focus on how to solve exam questions and how to provide the right answer for these questions'.

Besides, male student (1) said,

> 'I prefer that my teacher prepare us for the exams and give us samples of these exams'.

In terms of the way that the science teacher plans his/her teaching, 65.3% of the sample (RQ1) perceived that their teacher always illustrates the goals and types of assessment at the beginning of the semester. This is consistent with what the majority of students (67.4%) preferred (RQ2). Students' responses in the focus group substantiate this view. Female (4) said:

> 'We do not want teachers to go into details about assessment tools, as it will be sufficient to discuss them in general.'

Regarding what teachers focus on a textbook, 67.4% of the samples indicated that their teachers deal with the content through 'questions and exercises', 48.2% through 'inquires and experiments' and 47.8% by adding new information (RQ1). However, for the preferred situation (RQ2), they preferred that teachers provide them with new information (36.4%). Finally, for the classroom activities (RQ1), half of the samples (50%) found that the classroom activities are always easy and help them to understand. According to 40% of the samples, these activities are innovative, which is consistent with the desirable situation (RQ2, 47.9%).

4.4. PK domain

Table 6 shows the percentage of each item in the 'PK' domain, which includes teaching and learning methods, feedback and assessments from students' perceptions.

Table 6. The percentage of each item in 'PK' domain

No.	Item	Percentage %			
		Always	Sometime	Seldom	Prefer as first choice
12		Learning strategies			
12.a	Collective learning	54.1	25.9	20.1	46.1
12.c	Small Groups	36.7	20.3	40	20.5
13		Introduces lesson			
13.a	Lecture	45.5	32.9	21.6	-
13.c	Video and visual presentations	32.3	34.3	33.4	38.8
13.d	Asking questions	56.7	27.2	16.1	9.9
14		Teaching methods			
14.a	Direct teaching	48.3	31.8	19.8	31.8
14.b	Solving questions	59.9	26.5	13.6	20.3
14.f	Video display	32.8	32.1	35.1	33.3
14.m	Field trips	17.9	16.7	65.4	25.4
15		Assessment			
15.a	Variety of difficulty	46.3	31.2	22.4	39.3
15.b	Accuracy	43.4	34.0	22.6	30.9
16		Feedback			
16.a	Sticking to the answer	48.2	30.9	20.9	35.0
16.b	Showing the progress	43.6	33.2	23.3	36.3

The results in Table 6 revealed that many Omani science teachers use collective learning (whole class learning) as the main teaching strategy (54.1%) as students perceived it (RQ1). Only 36.7% of students responded that their science teachers sometimes organised students into small groups (4–6 students). This is highlighted by student 2 (male student), who stated that: 'The group work is not practiced at all in my science class, even if there are some activities; teacher let us work only in pairs'. For the preferred situation (RQ2), students still preferred that as the main strategy for working (46.1%). In this case, the interview with students, both male students (1) and (4), noted that:

> 'Working in a small group may lead to dependency on one student to do the work and consequently teachers will be unfair in their assessment of students' work assessment of students' work'.

There is a correspondence between introducing lessons and teaching methods in the students' precipitancies and their preference; more than half of the samples (56.7% and 59.9%, respectively, RQ1) asserted that their teachers used question and answer method as main teaching methods. Teachers use the lecture and direct methods (45.5% and 48.3%, respectively) as teaching methods become next. However, it is not the case of preferred situation (RQ2). About 38.8% of students preferred (RQ2) to see video or visual presentations for introducing lessons and 33.3% for teaching method, whereas 31.8% of students preferred to have the learning through lecturing. In the focus group interview, students were asked whether they prefer that their science teachers use new technology in teaching or not. The results showed that male students are not supportive of this tendency, and they want their teachers to continue using the whiteboard while teaching. However, female students had a different view, as they want their teachers to use advanced technology.

For the actual practice by science teachers (RQ1), 46.3% of the sample confirmed that their teachers use assessment tools, which can assess the student's different cognitive levels. The second most prevalent element (43.4%) is the tools that have a high level of 'accuracy' in determining the level of each student. In the preferred situation (RQ2), there is a consensus with reality as 39.3% and 30.9%, respectively.

Finally, 48.2% of the students emphasised that their teachers are always accurate feedback about their work (RQ1). Then, the teachers embrace the students' work and appreciate their efforts (43.6%). However, in the preferred situation (RQ2), 36.3% of the students believe that their teachers should appreciate their efforts. Then, with a minor difference in the percentage, 35% of the students preferred their teachers be accurate to determine a perfect answer. All the responses in the focus group interviews emphasised that the teachers should use a combination of both of them; the accuracy in marking, as students asserted, will train them on how to deal with the final examinations, whereas tolerance is needed, so students do not lose marks. Female student (1) commented:

> 'I prefer tolerance at the beginning but later the teacher should draw our attention to the mistakes in order not to lose marks'.

One male student (3) agreed with her:

> 'The teacher should be precise in order not to lose marks and also to prepare us for the final exams. But he should also be a little bit flexible during the corrections of the written work or exams so that no student will be oppressed'.

5. Discussion

The investigation of 10th Omani students' perceptions of their science teachers' PCK shows the high levels of agreement (11 of 16) between what practiced in reality and as students desired; for example, students correspond with their teachers' in their attention, their ways of direct learning and motivation. They praised the aspects of their teachers' personality, such as ability to arrange the work, which is consistent with perceptions of other students' as (Al-Ani et al., 2012; Fernandez-Balboa & Stieh, 1995; Halim et al., 2014). In addition, Omani students applauded the abilities of their teacher to have good relationships with all students, which appear continuously from them (Al-Ani et al., 2012; Al Barwani et al., 2012; Al-Mahrooqi et al., 2015).

Moreover, science teachers' personality as in students' perceptions is firm and serious, with a bit of fun in their classrooms, which prevails amongst science teachers (Brok et al., 2010). The same appeared in the desire situation, where the students would also like to see their teachers have some fun in their classrooms. The previous studies (Halim et al., 2014; Shadreck & Isaac, 2012; Wilson & Mant, 2011) have indicated that good teachers show some sense of fun during teaching.

From the results, it can be concluded that students are happy about some of their teachers' professional practices such as cleat the goal of the lesson, logic sequence of the lesson, appropriate of classroom activities style and consideration of students on their assessment tools used and feedback given. The students' satisfaction on their reality situation of teaching science appeared continuously in Omani students' results in the previous three TIMSS studies (Martin et al., 2008; 2012; 2016). The same results reported in other studies such as Halim et al. (2014) and Fernandez-Garcia, et al. (2019). These practices indicate the high professionalism of Omani science teachers, which is in corresponds with ideal teaching as described by Wilson and Mant (2011) and Jang et al. (2009). It is also consistent with what science teachers have reported in TIMSS study (Cycle, 2015) about students' engagement in science classes and scientific enquiries (Martin et al., 2016). The consequences of these practices will undeniably have a positive impact on students' learning. However, the new developments of Omani science curricula, which were started in 2018, will improve more students' performance as they have a great emphasis on inquiry-based learning, in which problem-solving and thinking skills are the fundamental components.

However, the data provide other indicators, which appear to be contrary to the above. For example, collective learning and lecturing are prevalent in Omani classrooms and limiting use of advanced technology. The study which is consistent with Jang et al. (2009) reached the same results. The results of the current study emphasise a series of studies that underline the traditional practices of the Omani science teacher such as the studies of Ambusaidi and Al-Balushi (2012), Al-Balushi et al. (2020) and Al-Rasbi et al. (2012). However, the results have created a paradox. Although the main goal of science teachers is to develop students' thinking and problem-solving skills by delivering contents through inquiries and experiments, the oral presentations are the main teaching methods. Here, two questions are raised. How can students' thinking be developed using lectures based teaching? Why was the teachers' effectiveness according to students do not reflected in their academic achievement? The study data provide a different vision, which does not strongly support what students stated that their science teachers are trying their best to develop their thinking skills. For example, problem-solving just means—in students' perceptions–solving arithmetic problems or training to answer the test questions. According to students, one of the major trends of the science teachers is to prepare students to pass the examination, by focusing on the content and giving exercises. This trend seems common in different places and not only unique to Oman (Halim et al., 2014; Jang, 2016).

Regarding the assessment process, students' responses divided between matching the typical or model answer (accuracy of the answer) and the difficulty levels of assessment tools accommodate students' different mental growth. The concern that teachers took to match students' answer with model or typical answer is an additional indicator of tendency towards teaching science for the examination. The assessment process should go beyond that and used to improve the teaching and learning process (Lee & Lufta, 2008).

The other indication of the traditional practices of Omani science teachers is the weak communication with students' parents. This may lead to the low achievement of grade 10 students in Oman. Similar results are found by Al-Rasbi et al. (2012) .

The place of learning is another indicator, which showed that science teaching in Oman in a higher grade is moving to be more class-based than the field-based. Unfortunately, a few lessons are conducted by Omani science teachers outside the classroom. This is no doubt will affect students' perceptions of a better place for learning science. Most students in this study still prefer to learn science inside the classroom. They are many reasons for this, but one of them stated by students during the interview is that studying science outside the classroom will distract them. This practice needs further investigation by researchers because science is a subject that highly connected to nature and, therefore, should be taught outside the classroom. Nowadays, there is much attention given by science educators' place-based learning (Ambusaidi, 2018; Cost & Orlandi, 2016). Ark, Liebtag and McClennen (2020) stated that learning with place will increase students' engagement, learning outcomes and community involvement.

It seems that, from all previous indictors, the tendency in science teaching is towards preparing students for the examination and isolating students from society and environment. This leads to restricting science learning to be in a narrow space and a highly abstracted area. The teacher's effort will focus on preparing students to pass the examination, and less attention is given on preparing students for their future career, to be effective citizens in the society, and finally, helping them to grasp the scientific basis of contemporary issues in their daily lives. This is similar to the results by Bevins et al. (2005). This way of teaching will not contribute to preparing good citizens. There is a need that the Omani education system should go beyond teaching and learning for the examination and testing, by focusing on preparing Omani students to be good citizens (Ministry of Education, 2001). Preparing students to be good citizens could be done by the content of various school curricula including the science curriculum and by using suitable and effective teaching methods such as problem-solving, inquiry-based learning, role play and case study (Rowe, 2001). Problem-solving will help students to connect themselves to their surroundings. If students are trained on how to solve real-life problems, they will become more aware of the problems facing the society, in which they live and hence become responsible citizens.

An in-depth analysis of students' preferences showed that there is a tendency amongst students towards being a passive receiver or learners. For instance, they preferred to receive textbook information by lectures or video display instead of inquiry-based learning. The studies by Al Barwani et al. (2012) and Al-Mahrooqi et al. (2015) tend to confirm this result. In their studies, teaching strategies were not rated as highly as one of the main factors of effective teaching. The preferences of not learning science by inquiry-based learning will negatively affect students' performance both at national and international levels such as TIMSS.

In addition, students preferred their teachers to look at their teaching performance in order to be more effective (i.e., take care of their professional development). This could explain in two different ways; first, teacher performance is not up to the level that improves students' performance although this is not consistent with most indicators in the current study. Second, it just promotes the negative reception of students, who want the teacher to do all the work, and takes all the responsibility. These results were supported by some previous studies such as Logan and Skamp (2012) and Shadreck and Isaac (2012) study.

In general, students' perceptions about their science teachers' PCK display prosperity in social aspects, satisfaction on the teacher's practices and his/her relationship with students. On the other hand, there are low expectations that keep the learning process in the context of negative reception and the centrality of the teacher, which represents an obstacle to active learning, wide interaction or achieving high levels of thinking.

6. Conclusions and Recommendation:

Science educators should not ignore the voices of students, even at the school level, because their work is ultimately targeted to them and should reflect the way that they prefer to be taught and to learn. Listening to students is now becoming a new area of research in science education, and this study may encourage further research, both nationally and internationally.

The results of the current study highlighted the importance of involving students more in the learning process through student-centred teaching and learning methods such as project-based learning, inquiry-based learning, problem-solving and role-playing. They want to see more technology applications inside the classroom. In addition, a combination of inside and outside learning activities are required to develop students' performance and change their attitudes towards science.

Educators who are responsible for training science teachers, in either pre- or in-service training, are called on to the results of this study to improve the teaching science in the Omani schools through developing teachers' skills. Besides, the results of this study may help the Omani Ministry of Education (MoE) to find out solutions to low performance of students in international studies such as TIMSS. It appears from the current study that the focus of teaching and learning science is preparing students for examinations. If such so, MoE should work towards improving the assessment process and train teachers to link it to the teaching and learning processes. Ultimately, this will help students' performance in science at the national and international levels.

One of the implications of the study is to use the questionnaire as an inventory of PCK elements that can be used for training teachers in judging their effectiveness of teaching science. The inventory consists of many indicators that characterise teacher's practices, which can be used to judge the effectiveness of the teaching process.

Finally, further researches are recommended in the area of Omani science teachers' PCK, especially taking into account the culture of teaching science (teachers' beliefs, their attitudes and perceptions about teaching, relationships between teachers, etc.) amongst Omani science teachers both male and female, which may lead to a more effective change in students' performance in science. Another study might be carried out to look at the size of the school in terms of the number of students and to what extent it affects the students' perceptions of teachers' PCK. Newman et al. (2006) reported that teachers and students at smaller schools are more likely to have positive perceptions of their school environment .

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