Journal of Turkish Science Education, 2022, *19*(3), 852-871.
DOI no: 10.36681/tused.2022.153

Journal of Turkish Science Education
http://www.tused.org
© ISSN: 1304-6020

Omani Science Teachers' Perceived Self-Efficacy Beliefs for Teaching Science as Inquiry: Influences of Gender, Teaching Experience, and Preparation Programme

Mohamed A. Shahat[1], Abdullah K. Ambusaidi[2], David F. Treagust[3]

[1] Sultan Qaboos University, Sultanate of Oman, Aswan University, Egypt, m.shahat@squ.edu.om, ORCID ID: 0000-0002-9637-8192
[2]Ministry of Education, Sultanate of Oman, ORCID ID: 0000-0003-1463-0209
[3]Curtin University, Australia, ORCID ID: 0000-0001-5340-0970

ABSTRACT
This study aimed to explore Omani teachers' self-efficacy beliefs for teaching science as inquiry and investigate the influence of demographic characteristics such as gender, teaching experience, and preparation programme on their beliefs. The study was conducted with a sample of science teachers for grades 5-8 (n=588). Data collected from administering the standardized Teaching Science as Inquiry instrument (TSI) to the sample were analysed using a cross-sectional design. The results showed that teachers perceived themselves as highly successful in teaching science as inquiry. Female teachers had higher perceptions of themselves as highly successful in teaching science regarding Personal Self-efficacy beliefs (PE) and Outcome Expectations (OE) for science teaching as inquiry than male teachers. Moreover, teachers with more teaching experience perceived themselves as more highly successful in teaching science as inquiry than those with less experience. Regarding the type of teacher preparation programme, there was no statistically significant difference in teachers' self-efficacy beliefs. Omani teachers with more experience teaching science by enquiry reported higher mean scores on teaching science as inquiry. They had higher TSI scores than the teachers with low and moderate experience. Accordingly, new graduate science teachers need to increase their knowledge aspects and practices related to science as inquiry (SI). Therefore, the TSI could be used for science teachers in their training to examine how they conducted teaching science by enquiry in real classroom situations.

RESEARCH ARTICLE

ARTICLE INFORMATION
Received:
09.03.2022
Accepted:
13.08.2022

KEYWORDS:
Gender, teacher preparation programme, science teachers' self-efficacy beliefs, teaching experience.

To cite this article: Shahat, M.A., Ambusaidi, A.K. & Treagust, D.F. (2022). Omani science teachers' perceived self-efficacy beliefs for teaching science as inquiry: influences of gender, teaching experience, and preparation programme. *Journal of Turkish Science Education*, *19*(3), 852-871.

Introduction

Over the past few decades, the Oman education system has experienced significant reforms. One of those reforms includes developing science and mathematics curricula by signing, in 2017, an agreement with Cambridge University Press (Oman Educational Portal, 2020) to implement these curricula in 2018. This reform in science and mathematics happened at a time when students were not achieving a high level in international tests such as Trend in International Mathematics and Science Study (TIMSS) 2007, 2011, 2015, and 2019. Also, a goal of the reform was to meet Oman's vision 2040 that students are competitive on national tests. For example, in TIMSS 2019, the average science scores of Omani eighth-grade students were 457, which was significantly lower than the TIMSS average of 500, with Oman ranking 30th among the 64 participating countries (Mullis et al., 2020). A recent research study in Oman identified that one of the weakest aspects of students' performance in TIMSS was their inability to apply their knowledge to novel situations as well as their failure to understand shapes and graphs and relate science to daily natural phenomena (Shahat et al., 2022).

To address these findings and concerns, the new Cambridge curricula are directly designed in four content areas: Scientific inquiry, Biology, Chemistry, and Physics to develop scientific inquiry, problem-solving skills and assess the learner's performance in various ways. These curricula differ from the previous curricula in Oman by focusing on a structure for teaching and learning and a reference against which learners' ability and understanding can be checked. All these curricula have been translated into Arabic and used in Oman in 2017. However, without the high-quality instruction offered by science teachers in the classroom, it will not be possible to reach the goals of the curricula (Neumann et al., 2012). Central to how to achieve these goals are teachers' actions for instruction in the classroom that are affected by their self-efficacy beliefs (Bandura, 1989). Further, these beliefs have an influence on teachers' teaching competencies and sense of professionalism in classroom situations (Blömeke, 2014).

Before implementing the Cambridge science curricula as a basis for teaching inquiry science in Oman, there is a need to explore the actual situation of teachers' perceptions of their perceived self-efficacy for teaching science as inquiry. To support and increase student learning, educators of science teachers at a national and international level need to know more about teachers' self-efficacy beliefs about inquiry instruction (Kaya et al., 2021). Yet, no study has been conducted in the Arab context for these types of adapted Cambridge curricula. While this research is conducted in Oman, the findings of this study contribute to the broader literature on science teacher education and inquiry-based teaching and learning by understanding the factors of in-service teachers' beliefs and confidence associated with teaching science content using inquiry processes. An international contribution of this study is its demonstration of utilizing the Arabic version of the Teaching Science as Inquiry instrument (TSI) in Oman. The study shows how the instrument items can be successfully used for the Arab language and culture. The TSI can be used to assess pre-and in-service science teachers' competence in teaching science lessons with scientific inquiry processes in elementary, lower, and upper secondary schools in Oman and possibly, in other Arabic-speaking countries. In this way, the translated questionnaire can aid science education efforts in Oman as well as other Arab countries to implement inquiry learning with the goal, for example, to improve scores on TIMSS. An additional added value of this study is the detailed description of the instrument of TSI. The TSI can be used as a single diagnostic scale for education officials in Oman and other countries to identify further strengths and weaknesses in pre and in-service science teacher training programmes regarding the application of scientific inquiry processes. The results of the implementation may help science teachers meet their competence training needs and influence teacher training by helping establish teachers' confidence to teach effectively with scientific inquiry processes.

The Omani School System and the Teacher Reform

The Omani public school system comprises Basic Education and Post-Basic Education. Basic Education is divided into two cycles (grades 1 to 4 and grades 5 to 10). In cycle 1 (grades 1 to 4), boys and girls are taught in the same classes. The teachers in these grades are usually female. However, male and female students are taught in cycle 2 (grades 5 to 10) in separate schools. The teachers can be male and female (Al-Balushi et al, 2022). Science subjects are taught by one teacher, in grades 1 to 10 as integrated subjects using one single textbook for biology, chemistry, and physics. Post-Basic Education (grades 11 and 12) comes after the completion of Basic Education. The teachers can be either male or female. Students are taught science in separate courses such as physics, chemistry, and biology.

Students can study two or three courses if they want to specialize in science at the university level (Education Council-Oman (ECO), 2020).

In Oman, science teacher education is structured into Bachelor (BSc) program and a Teacher Qualification Diploma (TQD) program. The BSc program is jointly offered by the College of Science and the College of Education. The BSc program includes a focused academic discipline of the courses at the College of Science. Besides, there is professional preparation at the College of Education. The TQD program aims to prepare, in two semesters, qualified teachers in the fields of teaching after receiving their BSc in science (physics, chemistry, or biology) (Shahat et al., 2022).

Theoretical Background

Inquiry Processes as a Goal in Teaching Science

Learning by inquiry helps students develop more scientific ideas and develop their thinking from small ideas to 'bigger' ideas (Harlen & Qulater, 2014) and involves practical work, including inquiry-based activities and associated learning. Bennett (2003) and Harlen and Qulater (2014) suggested skills for any activity described as inquiry should include setting up investigations, collecting data, analysing data, and communicating findings. This is the focus of the Ministry of Education (MoE) in Oman (Oman Educational Portal, 2020). With the same intention in the USA, the National Science Teachers Association (2020) supported the National Science Education Standards (NSES), which identified five features of scientific inquiry as: 1) Learner engages in scientifically oriented questions, 2) Learner gives priority to evidence in responding to questions, 3) Learner formulates explanations from evidence, 4) Learner connects explanations to scientific knowledge, 5) Learner communicates and justifies explanations. These five features of inquiry provide the focus for the scientific inquiry approaches that have been implemented in the new science curricula in schools (Oman Educational Portal, 2020) and teacher professional development in Oman (Specialized Institute for Professional Training of Teachers (SIPTT), 2020). Furthermore, these features are the focus of the Cambridge international science curricula that are currently being implemented worldwide (Cambridge University Press, 2020). The study reported here followed the definition of Cambridge Assessment International Education (2018) about scientific inquiry which "is about considering ideas, evaluating evidence, planning investigative work and recording and analysing data" (p. 2). Higher-order cognitive processes include inquiry activities which are highly related to communication skills because protocols have to be written, arguments have to be developed, and discussions in groups have to take place (Gillies et al., 2011). Also, there is considerable research evidence that there is a positive impact of guided inquiry-based instruction (Furtak & Penuel, 2019) on students' learning gains (e.g., Stender et al., 2018). However, according to Smolleck et al. (2006) "many teachers believe that teaching science as inquiry is very difficult and cumbersome to implement and manage within classroom practice" (p. 140). Among the reasons for this situation is teacher lack of guidance or training in inquiry processes that facilitate students' discoveries in practice and thus their learning (Shahat et al., 2013, 2017). Although the importance of inquiry-based learning is substantial, several challenges influence teachers' practices in the classroom such as the length of lessons and their impact on choices available for teaching (Pozuelos et al., 2010), teachers' pedagogical and content knowledge (Crawford & Capps, 2018) as well as how professional development impacts on teachers' pedagogical knowledge and affects their confidence to teach by inquiry (Cheng & Li, 2020).

Following the low performance of Omani students on the TIMSS tests, in particular, in 2015, several teachers' professional development programmes have been conducted through the Specialized Institute for Professional Training of Teachers at the MoE. These activities include developing different professional competencies for early career and experienced teachers on global best practices and inquiry learning (Al-Balushi, 2019).

Teachers' Self-Efficacy for Teaching

Bandura's social cognitive theory has guided researchers to understand self-efficacy sources (Kitsantas & Baylor, 2001). In his theory, Bandura (1986, 1989) made links between self-efficacy and observational learning, defining self-efficacy as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 103). Christian (2017) defined teaching self-efficacy as (teachers') "belief in their own ability to foster learning with instructional tactics, is one predictor of classroom effectiveness" (p. 14).

According to Bandura's (1977) early work, there are four sources for self-efficacy of mastery experiences. These sources are expanded upon in later research: 1) mastery experiences are interpreted as successful if they raise confidence and experiences are interpreted as unsuccessful if they lower conviction (Bandura, 1989; Britner & Pajares, 2006); 2) vicarious experiences are weaker than mastery experiences in creating self-efficacy beliefs, but when teachers are uncertain about their own abilities or when they have limited prior experience they have less self-efficacy (Bandura, 1997; Britner & Pajares, 2006); 3) social persuasion, referring to verbal and nonverbal judgments of others when negative can work to defeat and weaken teachers' self-efficacy beliefs (Bandura, 1986; Britner & Pajares, 2006); and 4) physiological arousal, such as anxiety, stress, and mood states, during mastery experiences can likewise defeat and weaken teachers' self-efficacy beliefs (Bandura, 1986; Britner & Pajares, 2006).

Bandura also identified four phases of observational learning which illustrate the process of learning by watching others, retaining the information, and then later replicating the behaviours that were observed. These are: 1) attention to the required skill, which is impacted by the observer's perception of its similarity to the model, the competence of the model, and status (Christian, 2017; Smolleck et al., 2006; Smolleck & Mongan, 2011); 2) retention and required memory of the skill, which is acquired during mental or physical practices (Christian, 2017); 3) replication and testing the observer's ability to practice the skill (Britner & Pajares, 2006); and 4) an external or internal reason to imitate the model (Britner & Pajares, 2006). The research literature has reported evidence that teachers' self-efficacy impacts students' academic performance by influencing several behavioural and psychological processes (Bandura, 1986, 1989) and is positively associated with students' academic performance outcomes in several domains including science (Caprara et al., 2006). Recent research studies have shown a positive connection between the teachers' self-efficacy beliefs and the implementation of essential features of inquiry (e.g., Kaya et al., 2021). Science teachers who strongly believe that they can succeed in science learning activities will persevere and be guided by physiological indexes used to assess the mental load, which promotes confidence as they meet obstacles and work hard to complete activities successfully. In contrast, teachers who do not believe that they can succeed in science learning activities will avoid them if they can and will not perform to the best of their abilities (Britner & Pajares, 2006). Thus, developing self-confidence is essential for science teachers (Smolleck et al., 2006).

Currently, in Oman, preparation programmes connected to Cambridge science and mathematics curricula have a responsibility to support self-efficacy beliefs and establish teachers' confidence and self-competence through hands-on training and micro-teaching. In the practicum at schools, preservice teachers train on the real science curriculum, which focuses on science as inquiry. Therefore, the goal is for preservice teachers to have the confidence to teach by investigations upon graduation and are teaching classes (Al-Balushi, 2019). As a first step, several researchers developed instruments to measure science teachers' self-efficacy beliefs (Smolleck et al., 2006). One of these instruments, Teaching Science as Inquiry (TSI), was designed based on Bandura's social cognitive theory and the work of others (Smolleck et al., 2006; Smolleck & Yoder, 2008). TSI also considers the five features mentioned above of classroom inquiry stated by the NSES (NSTA, 2020). TSI has identified Personal Self-efficacy (PS) and Outcome Expectancy (OE) as predicting variables for human behaviour. Bandura (1997) defined personal self-efficacy as "a judgment of one's ability to organize and execute given types of performances, whereas defined an outcome expectation as "a judgment of the likely consequence such performances will produce" (p. 21).

Research Aim and Research Questions

The current study was designed to investigate the teachers' self-efficacy as a component of inquiry instruction in science classrooms in Oman. The following two research questions (RQ) guided the study:

RQ1: How do teachers perceive the level of their efficacy for teaching science as inquiry in the Sultanate of Oman?

RQ2: Do the demographic characteristics (gender, teaching experience, and preparation programme) have an influence on self-efficacy beliefs for teaching science as inquiry?

Methodology

Participants and Settings

The descriptive approach was used in this study. The study sample was selected using the stratified sampling method (Creemers et al., 2010) and the cross-sectional design involved observing data from a population at one specific point in time. A large national sample of science teachers (n=588) from Key Stage 1 (grades 1–4) and Key Stage 2 (grades 5–8) was selected for the study (see Table 1). Teachers who taught grades 1-8 were chosen because the new Cambridge curricula are only being implemented in these grades. Teachers gave their consent to participate voluntarily and allowed data collection for the study. The study was conducted in March 2020 with permission from the educational authorities at the MoE in Oman. Due to the Covid-19 pandemic, the survey was conducted and administered online using the Google Forms App, which provided a response rate of 96% without missing data.

Table 1

Description of the Sample in the Study (N=588)

Variable		n
Gender	Male	130
	Female	458
Major	Physics	104
	Chemistry	147
	Biology	111
	Science	226
Governate	Muscat	81
	Al-Dakhlyia	88
	North Al-Batienah	72
	South Al- Batienah	85
	North Al-Sharqyai	229
	Al-Thahra	33
Key Stage	Key Stage 1 (grades 1–4)	285
	Key Stage 2 (grades 5–8)	303
Qualification	BSc	470
	Diploma	104
	MA & PhD	14
Teaching experience	Low 1–4 years	97
	Medium 5-9 years	387
	High >10 years	104
Total sample (N)		588

Instrumentation

We adapted a standardized instrument (Smolleck et al., 2006) by considering the cultural differences, education settings, and the Arabic language in Oman. The Teaching Science as Inquiry (TSI) instrument (see Appendix 1 for the original and adapted Arabic versions) contained 69 items used to measure in-service teachers' self-efficacy regarding the teaching of science as inquiry (see Table 2). The TSI was constructed based on the five features of the National Science Education Standards (NRC, 2000) and the concept of self-efficacy according, in particular, to Bandura's social cognitive theory (Bandura, 1986, 1989, 1997). The TSI consisted of two subscales: Personal Self-efficacy (34 items) and Outcome Expectancy (35 items).

Table 2

Features, Dimensions, and Items Examples of Teaching Science as an Inquiry Instrument

National Science Education Standards (NSES) features	Personal Self-efficacy (PS)	Outcome Expectancy (OE)
	Example item	Example item
1. Learner engages in scientifically oriented questions.	I am able to guide students in asking meaningful scientific questions.	I expect students to ask scientific questions.
2. Learner gives priority to evidence in responding to questions.	I am able to encourage students to gather the appropriate data necessary for answering their questions.	My students derive scientific evidence.
3. Learner formulates explanations from evidence.	I am able to provide students with the opportunity to construct alternative explanations for the same observations.	I require students to develop explanations using evidence.
4. Learner connects explanations to scientific knowledge.	I am able to negotiate with students' possible connections between/among explanations.	I expect students to recognize the connections existing between proposed explanations and scientific knowledge.
5. Learner communicates and justifies explanations.	I am able to coach students in the clear articulation of explanations.	My students share and critique explanations while utilizing the broad guidelines provided.

Note. Illustrated by Mintzes et al., 2013

The teachers' responses were scored on a five-point Likert scale from "strongly agree" (coded as "5") to "strongly disagree" (coded as "1"). The internal consistency of the TSI was estimated by Smolleck et al. (2006), and the alpha values ranged from .66 to .76 for Personal Self-efficacy and .60 to .78 for Outcome Expectancy. The TSI's items were translated from English into Arabic with stringent quality control of the translation process, including back translation (Shahat et al., 2013).

The content validity of the survey was cross-checked with the work of Smolleck et al. (2006). The TSI has been used in other studies, all of whose results demonstrated TSI's acceptable content and criterion validity (Mintzes et al., 2013; Seung et al., 2019). To ensure the criterion validity of the Arabic version of TSI– an expert rating was conducted, including two professors who specialized in science education and focused on scientific inquiry in Oman. Two experts received a manual, including information about the five features of the National Science Education Standards (NRC, 2000). They were asked to consider the issued documents and comment on the adequacy of the items. The result was acceptable with the value of Cohen's kappa .88. Besides, the alpha values ranged from .63 to .78 for Personal Self-efficacy, and .70 to .82 for Outcome Expectancy (see Tables 4-5).

Data Analysis

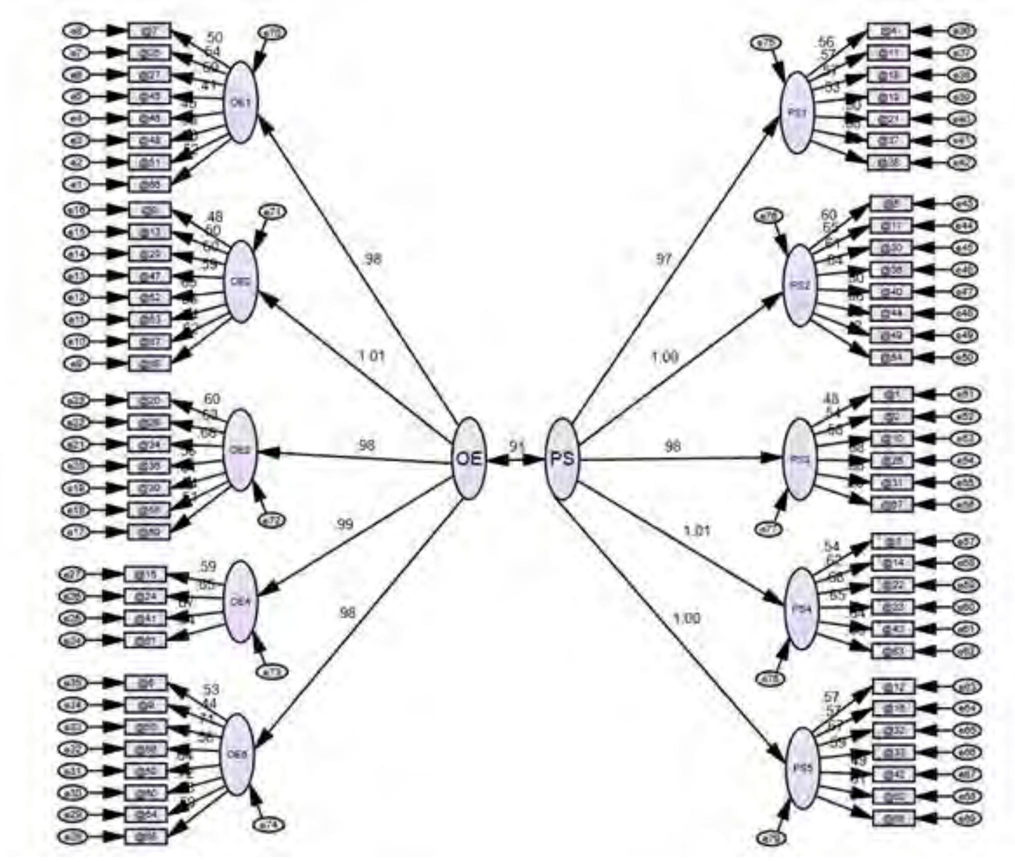
The data were analysed by using IBM® SPSS® Statistics, Version 25 for processing the data. To determine the internal validity of the adapted TSI items, correlation analyses (Field, 2009) were used. The reliability of the items was determined by calculating Cronbach's Alpha and alpha values higher than .70 would indicate that the TSI is a reliable instrument (Field, 2009). The expert ratings were calculated using Cohen's Kappa (K) (Field, 2009). We conducted Confirmatory Factor Analyses (CFA) IBM® AMOS, version 24 and used the Chi-Square difference test to confirm a theoretical two-factor model including 5 features with a general factor model. The normality of variance and homogeneity of data were checked by using Levene's test and Kolmogorov–Smirnov test respectively. To answer the research question (RQ 2), a t-test for independent samples and one-way ANOVA with normally distributed data and homogeneity of variance were used. According to Wu and Leung (2017), the Likert scale as ordinal data could be treated as an interval scale.

Results

The result of CFA confirmed the two-factor with a five features model with a general factor model (Figure 1).

Figure 1

Two-Factor Model of Components of Teachers' Self-Efficacy Beliefs in Teaching Science as Inquiry



Note. * $p < .05$; $\chi^2 = 6884.316$ (df = 2298, p = .000); CFI = .90; RMSEA = .06

Table 3

Reliabilities of Teaching Science as an Inquiry Instrument

National Science Education Standards (NSES) features	Personal Self-efficacy (PS)		Outcome Expectancy (OE)	
	No of items	α (total=.94)	No of items	α (total= .94)
1. Learner engages in scientifically oriented questions.	7	.75	8	.76
2. Learner gives priority to evidence in responding to questions.	8	.78	8	.80
3. Learner formulates explanations from evidence.	6	.63	7	.80
4. Learner connects explanations to scientific knowledge.	6	.77	4	.70
5. Learner communicates and justifies explanations.	7	.78	8	.82

The results of quality criteria (Table 3) also revealed good reliabilities: Cronbach's Alpha > .60 for the two dimensions (PS and OE) and the five features of NSES in both dimensions (Griethuijsen et al., 2014).

Descriptive Statistics

Table 4

Descriptive Statistics for TSI Scales and Total Score

Scale	N	Min.	Max.	M	%*	SE	SD
NSES–PS	588	54	170	141.15	83.03	.54	13.16
NSES–OE	588	49	175	138.85	79.34	.60	14.69
Total TSI	588	103	345	279.75	81.09	1.11	26.96

Note. *>75% were used as a formative benchmark for performance satisfaction (Oláh et al., 2010)

The descriptive statistics were calculated for the two dimensions (see Table 4) and their NSES features (see Table 5) and used to respond to research question 1 (RQ1).

Table 5

Descriptive Statistics and Correlations Regarding NSES Features of Inquiry

Features of TSI	No. of items	A	SD	NSES-_engage	NSES-evidence	NSES-_explanation	NSES-connect	NSES-communicate
NSES-PS_engage	7	4.08	.47	1	.74**(PS)	.72**(PS)	.77**(PS)	.73**(PS)
NSES-PS_evidence	8	4.15	.92		1	.75**(PS)	.81**(PS)	.80**(PS)
NSES-PS explanation	6	4.16	.87			1	.73**(PS)	.72**(PS)
NSES-PS connect	6	4.16	.79				1	.81**(PS)
NSES-PS communicate	7	4.17	.64					1
NSES-OE engage	8	3.92	.84	1	.78**(OE)	.73**(OE)	.71**(OE)	.76**(OE)
NSES-OE evidence	8	3.98	.83		1	.78****(OE)	.75**(OE)	.83**(OE)
NSES-OE explanation	7	4.02	.72			1	.72**	.75**(OE)
NSES-OE connect	4	3.90	.82				1	.76**(OE)

NSES-OE communicate	8	3.97	.77	1

Note. SI= scientific inquiry; NSES= National Science Education Standards; A= Average; ** p < .01

The descriptive results of the TSI showed high correlations > .50 (field, 2009) for five features of NSES in both dimensions (PS and OE). That means that generally, there are intercorrelations and dependence among these five features in each dimension (PS or OE) in the sample (Field, 2009). This result supported the internal validity of the two dimensions of TSI. Table 5 illustrates that teachers perceived themselves as highly productive in all five features of TSI (ranging for PS from A= 4.08 to 4.17; for OE from 3.90 to 4.02, in the 'frequently' range), suggesting that most of them have TSI in the range from 'agree to 'strongly agree'.

Response to RQ 1

As shown in Table 4, based on the whole instrument, teachers' responses to TSI indicated that they perceived themselves as successful in teaching science as inquiry (M = 279.75; >75%). The teachers also perceived themselves as being successful in teaching science as inquiry in the dimension of NSES-Personal Self-Efficacy (M = 141.15; >75%), and as successful in teaching science as inquiry in the whole instrument in the dimension of NSES-Outcome Expectancy (M=138.85; >75%).

Response to RQ 2

To answer RQ 2, the mean values, standard deviations, and independent samples t-test and one-way ANOVA were calculated.

Gender Differences

The results (Table 6) showed no statistically significant gender differences between the mean scores for teachers on the NSES-PS dimension of the TSI scale.

Table 6

Means, Standard Deviation, and t-test Values for the TSI Scale by Gender

Scale	Gender	n	M	SD	df	t
NSES–PS	Male	130	139.33	12.99	586	1.79
	Female	458	141.67	13.18		
NSES–OE	Male	130	136.35	14.72	586	2.21*
	Female	458	139.56	14.62		
Total TSI	Male	130	275.35	26.74	586	2.11*
	Female	458	281.00	26.92		

Note. NGSE-PS= personal self-efficacy scale regarding NSES; NSES–OE = outcome expectancy scale regarding NSES; * p < .05

The t-test results, t(586) = -1.79, p > .05, also revealed that males and females did not statistically significantly differ in their personal self-efficacy beliefs for teaching science as inquiry. However, the results showed statistically significant gender differences between the mean scores of teachers on the NSES-OE dimension of the TSI scale. The t-test results (t(586) = -2.21, p < .05) revealed that female teachers' outcome expectancy beliefs for teaching science as inquiry were significantly higher than male teachers. Similarly, the total results showed a statistically significant gender difference between the mean scores of teachers on the total score of the TSI scale in favour of female teachers' self-efficacy beliefs for teaching science as inquiry ($t(586) = -2.11$, $p < .05$).

Teaching Experience

Table 7

Means, Standard Deviation, and One-Way ANOVA Values for TSI Scale by Experience

Scale	Level of experience	n	M	SD	df	F
NSES–PS	Low 1-4	97	137.59	10.74	2	5.76**
	Medium 5-9	387	141.33	13.77	585	
	High >10	104	143.80	12.29		
NSES–OE	Low 1-4	97	134.96	12.68	2	5.04**
	Medium 5-9	387	139.16	15.44	585	
	High >10	104	141.33	12.84		
Total TSI	Low 1-4	97	272.31	22.69	2	5.81**
	Medium 5-9	387	280.21	28.23	585	
	High >10	104	284.99	24.38		

** $p < .01$.

Analysis of variance (see Table 7) showed a significant main effect of teaching experience on two dimensions of the TSI: for NSES–PS ($F(2, 585) = 5.76$, $p < .01$), for NSES–OE, ($F(2, 585) = 5.04$, $p < .01$), and total TSI ($F(2, 585) = 5.81$, $p < .01$). For NGSE–PS, post hoc analyses using Tukey's HSD indicated that TSI in NSES–PS was higher for teachers with high experience than for teachers with moderate experience, and for teachers with low experience. Regarding NSES–OE, post hoc analyses indicated that NSES–OE's TSI was higher for teachers with high experience than for teachers with moderate experience and teachers with low experience. Similarly, for total TSI, post hoc analyses using Tukey's HSD indicated that TSI was higher for teachers with high experience than for teachers with moderate experience and teachers with low experience.

Preparation Programme

Analysis of variance (see Table 8) showed no significant effect of preparation programme on the two dimensions of the TSI: for NSES–PS ($F(2, 585) = .44$, $p > .05$), for NSES–OE ($F(2, 585) = 1.65$, $p > .05$), and total TSI ($F(2, 585) = 1.03$, $p > .05$).

Table 8

Means, Standard Deviation, and One-Way ANOVA for TSI Scale by Preparation Programme

Scale	Programme	n	M	SD	F	df	*p*
NSES–PS	BSc	470	141.38	13.35	.44	2	0.64
	Diploma	104	140.45	12.77		585	
	Master & PhD	14	138.78	9.51			
NSES–OE	BSc	470	139.36	14.56	1.65	2	0.19
	Diploma	104	137.14	15.46		585	
	Master & PhD	14	134.36	11.66			
Total of TSI	BSc	470	280.48	27.11	1.03	2	0.36
	Diploma	104	277.38	27.06		585	
	Master & PhD	14	272.85	19.43			

Discussion

Teachers' self-efficacy is considered a factor that influences teachers' behaviour in the classroom (Caprara et al., 2006). The low performance of Omani students on TIMSS 2015 and 2019 may be due to being taught with the old curricula where teachers, unfortunately, did not focus on inquiry processes as a method of learning science (Shahat et al., 2022). Consequently, as a reform, the Cambridge science curricula were implemented (Oman Education Portal, 2020), and the sample of teachers (see Table 1) in this study was selected from teachers who are teaching Cambridge's new curricula (only grades 1 to 8) which focuses on inquiry processes.

Regarding the first research question, the findings indicate that Omani teachers believe that they can create a supportive and productive environment for their students to learn science by focusing on all features and processes of inquiry (CAIE, 2017; Kaya et al., 2021). The principle of Bandura's (1986) self-efficacy theory clarified that having a positive experience is the most powerful way to increase self-efficacy. Crawford and Capps (2018) and Kaya et al. (2021) have noted that teachers with strong content and pedagogical knowledge can provide a high level of self-efficacy when it comes to inquiry. As a result of these data, the Ministry of Education in Oman is expecting improved student results on international tests in the future.

For the second research question, in total, female teachers in Oman scored higher in reporting their perceptions of teaching science as inquiry in the classroom compared to males. This finding is consistent with other broader research literature in Oman that female science teachers have more positive perceptions of their Pedagogical Content Knowledge (PCK) and rated themselves more highly than their male peers (Ambusaidi & Al-Hajri, 2013). This disparity of perception may be due to the education system that relies mainly on the separation of male and female schools (Oman Educational Portal, 2020), which might be leading to differently implemented educational environments (Keller-Schneider et al., 2020). As noted in Table 1, females are represented almost 4:1 compared to males in the sample of this study and may influence the present mean findings. These findings are in agreement with those of other studies (e.g., Sarfo et al, 2015) which demonstrate that female teachers have more positive beliefs about their self-efficacy for teaching than do males in general.

Regarding the influence of teaching experience, Omani teachers with the most teaching science experience reported higher mean scores on NSES–PS and NSES–OE. They had higher TSI scores than did the teachers with low and moderate experience. These findings are in agreement with other studies (e.g., Cheng & Li, 2020) on the effect of teaching experience on self-efficacy beliefs. This result may be due in part to the ongoing teacher training programme implemented by MoE of Oman. Experienced science teachers have received numerous training opportunities about teaching methods in accordance with scientific inquiry and problem-solving and more than teachers with low or medium levels of experience (SIPTT, 2020).

Regarding the influence of programme preparation, there were no statistically significant differences in reported ratings of NSES–PS, NSES–OE or total scores of TSI. We have to keep in mind that all teachers have been educated as science teachers in their teacher education programme. This result needs to be discussed carefully due to the relatively small and restricted sample size. There are large differences in sample size (See Table 1) between the three types of programmes, especially between the Bachelor programme and postgraduate studies (MA and PhD), which might affect these results (Field, 2009).

These findings could be translated into reforms in the preparation of science educators by providing all preservice teachers with a deep understanding of the processes of inquiry and problem solving and their practices in the classroom (Syawaludin et al., 2022; Zorlu & Zorlu, 2021).

Limitations

The data in this study were collected from a selected sample using a cross-sectional design at a single point in time which limits causal inferences regarding the bidirectionality of the links. In addition, TSI was conducted and administered online due to Covid-19 pandemic restrictions. Another limitation of this study is that teachers' self-efficacy beliefs for teaching science were assessed using a self-report measure (Caprara et al., 2006). We could only see how the teachers perceived their self-efficacy and did not objectively measure their true efficacy in teaching. Therefore, we also recommend conducting future studies utilizing qualitative methods including interviews and observations in real practices in the classroom as well as quantitative methods such as questionnaires and tests for mapping and connecting teachers' perceptions with their students' learning outcomes. The sample of this study was drawn from a single country Oman and the six educational governorates but female teachers from North Al-Sharqyai as a location, with BSc qualifications and medium teaching experiences of 5-9 years were heavily represented in the study. To generalize the findings to other countries, we recommend replicating the study on a more prominent and representative sample of science teachers in various schools in different countries.

Implications

One contribution of this study is that the Arabic version of the TSI scale demonstrated good parameters and statistics for use in Oman and could be used in other Arabic countries to foster the assessment of teachers' beliefs on their self-efficacy for teaching science as inquiry. An additional theoretical contribution of this study is the detailed descriptions of two dimensions of personal self-efficacy and outcome expectancy as measured by the TSI (NSES–PS, and NSES–OE). These two dimensions could be used as a single diagnostic measure to further identify the strengths and weaknesses of teaching inquiry science. Such a measure might help science teachers meet the training expectations of education officials regarding teaching science by inquiry and enhance their confidence. Teachers could use peer evaluation to show the strengths and weaknesses of their performance when teaching science by inquiry. Afterwards, these reports could be used to document the best practices of inquiry processes in Omani science classrooms. Another added value of the study is that the findings indicate that male teachers among different grades may need further knowledge about scientific inquiry and need more in-service training to establish and enhance their capacity for teaching science as inquiry (Saglam & Şahin, 2017). This training is essential for achieving the quality of science instruction (Güven et al., 2019; Preechawong et al., 2021).

Moreover, this study provided evidence that teaching experience influences teachers' beliefs. Accordingly, new graduate science teachers need to increase their knowledge aspects and practices related to SI. Therefore, the TSI could be used by science teachers in their training regarding SI processes and how they conducted teaching in real classroom situations.

Disclosure Statement

The authors reported no potential conflict of interest.

Acknowledgment

Sultan Qaboos University supported the work in this article under a grant (RF/EDU/CUTM/20/01).

References

Al-Balushi, S. M. (2019, 12–14 March). Science and math teaching and learning in Oman: Opportunities and challenges. *Paper presented at the 3rd Excellence Conference in Teaching and Learning of Science and Mathematics*. King Saud University, Riyadh, KSA.

Al-Balushi, S.M., Al-Harthi, A.S., Shahat, M.A. (2022). Teacher education in Oman: Retrospectives and prospects. In: Khine, M.S. (eds) *Handbook of research on teacher education*. Springer, Singapore. https://doi.org/10.1007/978-981-19-2400-2_6

Ambusaidi, A., & Al-Hajri, F. (2013). Estimation of the importance of pedagogical content knowledge in science from the perspective of a sample of teachers in the Sultanate of Oman. *Dirasat: Educational Sciences*, *40*(1), 328-343.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Bandura, A. (1989). Social cognitive theory. In R. Vasta (Ed.), *Annals of child development: Six theories of child development*. JAI Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H. Freeman.

Bennett, J. (2003). *Teaching and learning science: A Guide to Recent Research and its Applications*. Continuum.

Blömeke, S. (2014). Framing the enterprise: Benefits and challenges of international studies on teacher knowledge and teacher beliefs—modeling missing Links. In S. Blömeke, F.-J. Hsieh, G. Kaiser, & W. H. Schmidt (Eds.), *Advances in Mathematics Education. International perspectives on teacher Knowledge, beliefs and opportunities to learn: TEDS-M Results* (pp. 3–19). Springer.

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching*, *43*(5), 485–499. https://doi.org/10.1002/tea.20131

Cambridge University Press (2020). *Education reform: Partnering with Oman's Ministry of Education*. https://www.cambridge.org/us/educationreform/case-studies/partnering-omans-ministry-education/

Cambridge Assessment International Education (CAIE) (2018). *Curriculum framework Cambridge primary science 0846*. Cambridge Assessment International Education. https://chartwell.edu.rs/images/pdf/0846_Primary_Science_Curriculum_Framework_2018_tcm142-498593.pdf

Caprara, G. V., Barbaranelli, C., Steca, P., & Malone, P. S. (2006). Teachers' self-efficacy beliefs as determinants of job satisfaction and students' academic achievement: A study at the school level. *Journal of School Psychology*, *44*(6), 473–490. . https://doi.org/10.1016/j.jsp.2006.09.001

Cheng, M. M. H., & Li, D. D. Y. (2020). Implementing practitioner research as a teacher professional development strategy in an Asia-Pacific context. *Journal of Education for Teaching*, *46*(1), 55–70. https://doi.org/10.1080/02607476.2019.1708627

Christian, B. (2017). Primary pre-service teachers' perceptions of course related factors that enhance instructional self-efficacy. *Australian Journal of Teacher Education*, *4*(2.2), 14–27. https://doi.org/10.14221/ajte.2017v42n2.2

Crawford, B. A., & Capps, D. K. (2018). Teacher cognition of engaging children in scientific practices. In Y. J. Dori, Z. Mevarech, & D. Baker (Eds.), *Cognition, metacognition, and culture in STEM education* (pp. 9–32). Springer.

Creemers, B. P. M., Kyriakidēs, L., & Sammons, P. (2010). *Methodological advances in educational effectiveness research*. Routledge.

Education Council-Oman (ECO). (2020). *Education in Sultanate of Oman*. https://www.educouncil.gov.om/en/

Field, A. P. (2009). *Discovering statistics using SPSS* (3rd ed.). SAGE.

Furtak, E. M., & Penuel, W. R. (2019). Coming to terms: Addressing the persistence of “hands-on” and other reform terminology in the era of science as practice. *Science Education*, *103*(1), 167–186. https://doi.org/10.1002/sce.21488

Harlen, W. & Qualter, A. (2014). *The teaching of science in primary schools* (6th ed.). David Fulton Publishers.

International Association for the Evaluation of Educational Achievement (IEA) and United Nations Educational, Scientific and Cultural Organization (UNESCO) (2021). *Female science and mathematics teachers: Better than they think?* (Spicail Issue). UNSECO/IEA.

Gillies, R. M., Nichols, K., & Burgh, G. (2011). Promoting problem-solving and reasoning during cooperative inquiry science. *Teaching Education*, *22*(4), 427–443. https://doi.org/10.1080/10476210.2011.610448

Griethuijsen, R. A. L. F., Eijck, M. W., Haste, H., Brok, P. J., Skinner, N. C., Mansour, N., Gencer, A. S., & BouJaoude, S. (2014). Global patterns in students’ views of science and interest in science. *Research in Science Education*, *45*(4), 581–603. https://doi.org/10.1007/s11165-014-9438-6

Güven, D., Mugaloglu, E. Z., Dogança-Küçük, Z., & Cobern, W. W. (2019). Teaching orientations of freshman pre-service science teachers. *Journal of Turkish Science Education*, *16*(4), 508–520. https://doi.org/10.36681/tused.2020.4

Kaya, K., Borgerding, L. A., & Ferdous, T. (2021). Secondary Science Teachers’ Self-Efficacy Beliefs and Implementation of Inquiry, *Journal of Science Teacher Education*, *32*(1), 107–121. https://doi.org/10.1080/1046560X.2020.1807095

Keller-Schneider, M., Zhong, H. F., & Yeung, A. S. (2020). Competence and challenge in professional development: Teacher perceptions at different stages of career. *Journal of Education for Teaching*, *46*(1), 36–54. https://doi.org/10.1080/02607476.2019.1708626

Kitsantas, A., & Baylor, A. (2001). The impact of the instructional planning self-reflective tool on preservice teacher performance, disposition, and self-efficacy beliefs regarding systematic instructional planning. *Educational Technology Research and Development*, *49*(4), 97–106. https://doi.org/10.1007/BF02504949

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). *TIMSS 2019 International Results in Mathematics and Science*. Boston College, TIMSS & PIRLS International Study Center. https://timssandpirls.bc.edu/timss2019/international-results/

Mintzes, J. J., Marcum, B., Messerschmidt-Yates, C., & Mark, A. (2013). Enhancing self-efficacy in elementary science teaching with professional learning communities. *Journal of Science Teacher Education*, *24*(7), 1201–1218. https://doi.org/10.1007/s10972-012-9320-1

National Research Council (NRC). (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. National Academy Press. https://doi.org/10.17226/9596

National Science Teachers Association (NSTA) (2020). *2020 NSTA/ASTE standards for science teacher preparation*. http://static.nsta.org/pdfs/2020NSTAStandards.pdf

Neumann, K., Kauertz, A., & Fischer, H. E. (2012). Quality of instruction in science education. In B. J. Fraser, K. G. Tobin, & C. J. McRobbie (Eds.), *Springer international handbooks of education* (Vol. 24). Second international handbook of science education (pp. 247–258). Springer.

Oláh, L. N., Lawrence, N. R., & Riggan, M. (2010). Learning to learn from benchmark assessment data: How teachers analyze results. *Peabody Journal of Education*, *85*(2), 226–245. https://doi.org/10.1080/01619561003688688

Oman Educational Portal. (2020). *Education in Oman*. Ministry of Education. https://home.moe.gov.om/?GetLang=en

Oman 2040. (2020). *Oman vision 2040.* https://www.2040.om/en/oman-vision-2040/about-the-vision/

Pozuelos, F., Travé González, G., & Cañal de León, P. (2010). Inquiry-based teaching: teachers’ conceptions, impediments and support. *Teaching Education*, *21*(2), 131–142. https://doi.org/10.1080/10476210903494507

Preechawong, S., Anmanatrakul, A., Pinit, P., Koul, R., & Easter, M. A. (2021). Relationship between mentoring and coaching experience, teaching self-efficacy and job satisfaction of vocational school teachers in Thailand. *Educational Studies*. Advance online publication. https://doi.org/10.1080/03055698.2021.1994374

Saglam, M. K., & Şahin, M. (2017). Inquiry-based professional development practices for science teachers. *Journal of Turkish Science Education*, *14*(4), 66–76.

Sarfo, F. K., Amankwah, F., Sam, F. K., & Konin, D. (2015). Teachers' self-efficacy beliefs: The relationship between gender and instructional strategies, classroom Management and student Engagement. *Ghana Journal of Development Studies*, *12*(1-2), 19. https://doi.org/10.4314/gjds.v12i1-2.2

Seung, E., Park, S., & Lee, M.-A. (2019). The impact of a summer camp-Based science methods course on preservice teachers' self-efficacy in teaching science as inquiry. *Journal of Science Teacher Education, 30*(8), 872–889. https://doi.org/10.1080/1046560X.2019.1635848

Shahat, M. A., Ohle, A., & Fischer, H. E. (2017). Evaluation of a teaching unit based on a problem-solving model for seventh-grade students. *Zeitschrift Für Didaktik Der Naturwissenschaften*, *23*(1), 205–224. https://doi.org/10.1007/s40573-017-0068-1

Shahat, M. A., Ohle, A., Treagust, D. F., & Fischer, H. E. (2013). Design, development and validation of a model of problem solving for Egyptian science classes. *International Journal of Science and Mathematics Education*, *11*(5), 1157–1181. https://doi.org/10.1007/s10763-012-9367-7

Shahat, M. A., Ohle-Peters, A., & Ambusaidi, A. (2022). Teaching with texts and pictures in science classes: Teachers' attitudes and motivational orientations at different school levels. *Journal of Science Teacher Education*, *33*(1), 107–123. https://doi.org/10.1080/1046560X.2021.1909231

Specialized Institute for Professional Training of Teachers (SIPTT) (2020). *Strategic training programs targeting science teachers*. http://havasapps.com/test/moe/ar/

Smolleck, L. A., & Mongan, A. M. (2011). Changes in preservice teachers' self-efficacy: From science methods to student teaching. *Journal of Educational and Developmental Psychology*, *1*(1), 133–145. https://doi.org/10.5539/jedp.v1n1p133

Smolleck, L. A., & Yoder, E. P. (2008). Further development and validation of the teaching science as inquiry (TSI) instrument. *School Science and Mathematics*, *108*(7), 291–297. https://doi.org/10.1111/j.1949-8594.2008.tb17842.x

Smolleck, L. D., Zembal-Saul, C., & Yoder, E. P. (2006). The development and validation of an instrument to measure preservice teachers' self-efficacy in regard to the teaching of science as inquiry. *Journal of Science Teacher Education*, *17*(2), 137–163. https://doi.org/10.1007/s10972-006-9015-6

Smolleck, L. D. (2004). *The development and validation of an instrument to measure preservice teachers' self-efficacy in regard to the teaching of science as inquiry* [Doctoral dissertation]. The Pennsylvania State University.

Stender, A., Schwichow, M., Zimmerman, C., & Härtig, H. (2018). Making inquiry-based science learning visible: the influence of CVS and cognitive skills on content knowledge learning in guided inquiry. *International Journal of Science Education*, *40*(15), 1812–1831. https://doi.org/10.1080/09500693.2018.1504346

Syawaludin, A., Prasetyo, Z. K., Jabar, C. S. A., & Retnawati, H. (2022). The effect of project-based learning model and online learning setting to analytical skills of discovery learning, interactive demonstrations, and inquiry lessons on the pre-service elementary teachers, *Journal of Turkish Science Education*, *19*(2), 608–621. https://doi.org/10.36681/tused.2022.140

Wu, H., & Leung, S.-O. (2017). Can Likert scales be treated as Iiterval scales?—A simulation study. *Journal of Social Service Research*, *43*(4), 527–532. https://doi.org/10.1080/01488376.2017.1329775

Zorlu, F., & Zorlu, Y. (2021). Investigation of the relationship between preservice science teachers' 21st century skills and science learning self-efficacy beliefs with structural equation model. *Journal of Turkish Science Education*, *18*(1), 1–16. https://doi.org/10.36681/tused.2021.49

Appendix 1: TSI (Smolleck, 2004)

When I teach science…

1. I will be able to offer multiple suggestions for creating explanations from data.
2. I will be able to provide students with the opportunity to construct alternative explanations for the same observations
3. I will be able to encourage my students to independently examine resources in an attempt to connect their explanations to scientific knowledge.
4. I possess the ability to provide meaningful common experiences from which predictable scientific questions are posed by students.
5. I have the necessary skills to determine the best manner through which children can obtain scientific evidence.
6. I will require students to defend their newly acquired knowledge during large and/or small group discussions.
7. My students will select among a list of given questions while investigating scientific phenomena.
8. I will provide opportunities through which children will obtain evidence from observations and measurements.
9. I will expect my students to make the results of their investigations public.
10. I will be able to provide opportunities for students to become the critical decision makers when evaluating the validity of scientific explanations.
11. I will be able to guide students in asking scientific questions that are meaningful.
12. I will be able to provide opportunities for my students to describe their investigations and findings to others using their evidence to justify explanations and how data was collected.
13. I will create (plan) investigations through which students will be expected to gather particular evidence.
14. I will be able to negotiate with students' possible connections between/among explanations.

15. I will expect students to independently develop explanations using what they already know about scientifically accepted ideas.

16. I encompass the ability to encourage students to review and ask questions about the results of other students' work.

17. I will be able to guide students toward appropriate investigations depending on the questions they are attempting to answer.

18. I will be able to create the majority of the scientific questions needed for students to investigate.

19. I possess the ability to allow students to devise their own problems to investigate.

20. My students will make use of data in order to develop explanations as a result of teacher guidance.

21. I will be able to play the primary role in guiding the identification of scientific questions.

22. I will be able to guide students toward scientifically accepted ideas upon which they can develop more meaningful understandings of science.

23. I possess the abilities necessary to provide students with the possible connections between scientific knowledge and their explanations.

24. I will expect students to recognize the connections existing between proposed explanations and scientific knowledge.

25. I will expect students to ask scientific questions.

26. I possess the skills necessary for guiding my students toward explanations that are consistent with experimental and observational evidence.

27. My students will investigate questions I have developed.

28. My students will create scientific explanations based on evidence, as a result of teacher assistance.

29. My students will derive scientific evidence from instructional materials such as a textbook.

30. I will be able to encourage students to gather the appropriate data necessary for answering their questions.

عأ كلِبدسكه ُرمدّى َبرج ومداخل نزرنزافغش ادي نلذن مٰرلزش جّ.

31. I will be able to offer/model approaches for generating explanations from evidence.

عأ كلِبدس كهُ رنس ت رلطخكه ُرلظبغخان اِكىخون فغش ادا.

32. I will be able to coach students in the clear articulation of explanations.

خالل كغّ انّشبسلكخ فنزافغش ادا عأ كلِبدس كمرُزويدان لطخغنفسطخ نُرنزافغش ادا وتشق الل غرظبءان ّ غخذيخ.

33. Through the process of sharing explanations, I will be able to provide students with the opportunity to critique explanations and investigation methods.

عأنٔهتي اِنلطخخثُبءاالثقبء انكِه اّخمبئأخ كمانرن مٰانكِ ّ.

34. I will require students to create scientific claims based on observational evidence.

عأشدغئجز ّ أ ّ قىلفكرنورلاف غش اديُطمخ أخبّ ، وانزّ ك ِ اعزخ الطبي نلذن مٰان ّمذو.

35. I will expect my students to think about other reasonable explanations that can be derived from the evidence presented.

عأع اعزكشفسبدانلطخ عاءان ّفززخ،انّغمخكمخاخ نزّحذانفشصىنّ ىند ّغ لكخ.

36. I will be able to facilitate open-ended, long-term student investigations in an attempt to provide opportunities for students to gather evidence.

عأعبكذ ئهجز كمرُم ر اعخان ّطروحةي اِن ّعلم أوان اِدارلِكه ّ ّخ، ولذ ف ّ ّروا بخطرج اعرظبعشمخ وىِرُدخ.

37. I will be able to help students refine questions posed by the teacher or instructional materials, so they can experience both interesting and productive investigations.

عٰلزاذوكرِوضانكِ ّهخ وانزّي خالنب ّغ ط ّغخانلطخرشلضغبوالرّى كهُ أعخلِمخ نال عزمظبء.

38. I will be able to provide demonstrations through which students can focus their queries into manageable questions for investigation.

عأدكّ انلطخ ن رنشطِرف غش ادشعزخذاونلذن مٰ.

39. I will require students to develop explanations using evidence.

سأستخدم أوساقاركٍ ّمكأطرنس ّخ رنزمدّى يد ّكخيِ اِنجَبد وتبهكخانلطخ خالل كغّ رسه مٰانجَبد.

40. I will be able to utilize worksheets as an instructional tool for providing a data set and walking students through the analysis process.

ّمو ئهجزشزرُم رفغشارّىيغزخيِ ّ كِاللبيسِنزّخيغانكِشانكِه ّخانمذّيخ.

41. My students will refine their explanations using possible connections to scientific knowledge that have been provided.

عأليشبنُرخ خنلطجز ّفّب ّخض الخشاءات أو انخطاد انطليخ اِلظبلان نِجانكِه ّخنه ظف.

42. I will be able to model for my students' prescribed steps or procedures for communicating scientific results to the class.

عأزود ئهجزنكِ اللبدان ّ لشخينكِنخانعلمية وانزّ ك ِ أ ّ شلِ طاف غشارّىِي خالنب.

43. I will be able to provide my students with possible connections to scientific knowledge through which they can relate their explanations.

عليذ ئهجزثبوخيِ أخم رسه ّب.

44. I will be able to provide my students with evidence to be analysed.

ع ّشغم ئهجزثب ّعخانز ّ لِي ذ ّئثب.

45. My students will engage in questions I have provided them.

عٌش غم ىٔہجز َ فـ ٱعۖخازڹ َ رمڼيـيظبسيڹ ُگـ خيئم:انڵوبةان ُذ س ع.

46. My students will engage in questions that are provided by a variety of sources such as the textbook.

عٌسہم ىٔہجزانجٍ َبد انزعزمذون َىف تلٌب ہوج رکپہ ٗبدانکیہی.

47. My students will analyse data that has been supplied, while following teacher instruction.

أرلغي ٍ ىٔہجزَ ہِکـ ر ٱعۖخانگـرو گـخن َىكمحانخہنكپہی انكہو.

48. I will expect my students to clarify the questions provided in an attempt to enhance science learning.

عٌإذ ىٔہجؤتبنجٍبد انيـخ رنگـى االنعمظبء.

49. I will be able to provide my students with the data needed to support an investigation.

ع ٗمونطخ ثبطم ورہی رفـغٌش ار َى ىٔ ُئجخان ظفـيغ خيٍ ٗ اِنخ طئل زخ ٗ َخارکپش كپخان َزوجن َى.

50. My students will communicate and justify their explanations to the class using broad guidelines that have been provided.

عٌخبس ىٔہجز َ ٱعۖخ انز َش غجٌ فـ َ اعزمظي ىبيلٍبىئُخي ٍ لڡي رمذو ن َى.

51. My students will choose the questions they would like to investigate from a list provided.

عٌسہم ىٔہجزانجٍ َبدان َزوجي اٍنكپہطشًمخ خيطخ.

52. My students will analyse teacher provided data in a particular manner.

عٌپك م ىٔجٍ رفـغٌش ار َىيغ خيٍ ٗ اِنفي مان َمذون َى.

53. My students will form their explanations using evidence that has been provided.

عأزودىٔجز َ ثد ٗ غ ٱكخان ٗطشئزش ںئفزاف غٌش ادي ٍ خالل اعٚيبٔ ب الزبس بكشة وقيّ اجانئزت.

54. I will be able to provide my students with all evidence required to form explanations through the use of lecture and textbook readings.

ع ٗمو ىٔہجزئُجٍء فغٌش ادي اٍنفي مٍيغ خيٍ ٗ ٍ اإلېبس انز َكـط َزن َى.

55. My students will construct explanations from evidence using a framework I have provided.

عٌجغ ىٔجز ىٔخجاءا ديس ذجي غيجہ گـ ُذرجٍش فغٌشرل ى.

56. I will expect my students to follow predetermined procedures when justifying their explanations.

عٌسذ ىٔہجز َ يبٌنذن َم اكثفىمٍجال خبثخگـ ٍ أعجٍزانكپہ َخ.

57. My students will determine what evidence will be most useful for answering their scientific question(s).

عٌظى ىٔہجز ٱال عٍمظبفي ہبصٕث َى، ويجہ َكپا ٱكخ ٱلکپرو ىٌخ ٱيٍ خبثخگـ ٍ عٕ ٱالکپ ٗ ٍ.

58. My students will design their own investigations and gather the evidence necessary to answer a particular question.

عٌعاو ٗ ىٔہجزكپ َ فـ َمحانخجُ جكپٍش َنمٌش بسىكخ فـ َوكـٍغيزاف غٌش اد و َمٌذب.

59. I will expect my students to collaborate with me in an attempt to construct criteria for sharing and critiquing explanations.

ع ٗمو ىٔہجغزبًش سيكخ ونقداريغٌش د ف تلٌبء اعز خذاوان خطئبالإلش بدخ ٱلمذ َي خن َى.

60. My students will share and critique explanations while utilizing broad guidelines that have been provided.

عغزخذو ىهجزان ظبلنمبىأخ كه الرشنت أو ياد أخ شن زطش اعزمظبهارى.

61. I will expect students to use internet based resources or other materials to further develop their investigations.

عأ رج إلسشبدا دلز عزجب ىهج كذيشبسلكخرافغش ا د و مذب.

62. I will be able to model for my students the guidelines to be followed when sharing and critiquing explanations.

عكى ىهج كه لازم ىل غم منوبعكيث فغشار ىلنج طخث ى وافلكبسركبه خ ل جنخ.

63. I will be able to instruct students to independently evaluate the consistency between their own explanations and scientifically accepted ideas.

أرلنعف بوض ىهجزي كجيب تيشسبكخ و منزافغش اد.

64. I will expect my students to negotiate with me the criteria for sharing and critiquing explanations.

عأ ثيغ ىهجزان خطئاركشكخ رز ط م ونقلانبئح وارفغش اد.

65. I will be able construct with students the guidelines for communicating results and explanations.

عكذ ىهجز طبغخ ا عهخ انزلني ذنى.

66. I will expect my students to refine questions that have been provided.

سأذود ىهجزنف غش اد.

67. I will be able to provide my students with explanations.

عجس ىهزن زافغش بلثبعزخذاو خط اد وإجراء ادكط ذنى.

68. I will expect my students to justify explanations using given steps and procedures.

عف ى ىهج رف غش ادأكبهىانذمخ ن ى.

69. My students will comprehend teacher presented explanations.