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ORIGINAL PAPER

Instructional practices of science teachers from the Arab community in Israel

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Abstract

A significant amount of research is invested in examining instructional practices for science education. Many countries around the world have established reforms in science education, including how the sciences are taught. For instance, in 2013, many states in the United States established new standards for science education, the next generation science standards (NGSS). Similarly, in 2018, Israel's Ministry of Education published a "Portfolio of Lesson Plans" that emphasized the development of students' scientific skills and establishing a new era of instructional strategies in the sciences. In Israel's Arab community, science is considered an important discipline and it holds an important place in the educational system. Previous studies have shown that Arab teachers regularly use teacher-centered teaching strategies. The present study sought to identify instructional practices used by Arab science teachers, comparing these to the NGSS, and understand the beliefs underlying the choice of methods. It also examined how these practices are related to the teacher's years of experience. The study employed mixed methods. The quantitative portion was based on the science instructional practices survey. In accordance with teachers' self-reports, the results indicate that Arab science teachers in Israel primarily use traditional, non-NGSS instructional practices such as direct instruction; NGSS teaching practices, such as empirical investigations and critique, explanation, and argumentation, are used much less often. Novice teachers reported significantly more use of NGSS teaching practices than did experienced teachers. This difference was attributed to the hours of professional development dedicated to science instructional practices that novice teachers participated in as part of their in-service period. In addition, semi-structured interviews were conducted with eight teachers to gain further insight into the beliefs and motivations underlying their choice of teaching methods. The findings highlight the teachers' belief that their main role is to transmit scientific knowledge to students, who should acquire the knowledge in a passive manner.

Keywords Arab science teachers in Israel · Elementary and middle school science education · Next generation science standards · Science teaching practices

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Introduction and rationale

Instructional methods play an important role in shaping the skills and abilities that students gain as a result of participating in science classes (Hayes et al. 2016). Following on the Soviet Union's space achievements in the 1950s including the launch of the Sputnik in 1957, the United States, in the spirit of competition, saw a vast number of calls to improve and promote science education (Yager 2000). The common goal of these initiatives was to shift from teacher-centered educational strategies, which aim to transfer raw scientific data to passive students, to student-centered educational strategies, which seek to provide students with the contemporary scientific skills they need both in their daily lives and to grow to become professional scientists (Harris et al. 2015; National Research Council 2013; Yager 2000). To achieve this, science students must engage directly in learning activities that practice scientific methods and help them acquire skills, rather than rote memorization (McGinn and Roth 1999).

Hayes et al. (2016) performed a thorough literature review to identify key areas of science instructional practice. They found that science teaching strategies could be described as a continuum with teacher-centered strategies on one end and student-centered strategies on the other. The result of their review is summarized in Table 1. Briefly, teacher-centered instructional practices consist of direct instruction, direct scientific demonstration, and other methods that encourage students to memorize scientific data without practicing scientific skills; student-centered strategies include contemporary, NGSS-oriented methods in which students engage in scientific practices similar to scientists, such as empirical investigations, scientific evaluation, and explanation and communication of ideas (Hayes et al. 2016; National Research Council 2007, 2012). McGinn and Roth (1999) claim that research shows teacher-centered instruction to be less effective at generating is not well positioned to help generate student comprehension.

Table 1 Areas of literature pertaining to science instructional practices (Hayes et al. 2016, p. 139)

Literature area	Definition
Empirical investigation	Focus on investigation procedure: asking questions, determining what needs to be measured, observing phenomena, planning experiments, and collecting and analyzing data
Evaluation and explanation	Focus on modeling, evaluation, and argumentation: constructing explanations, evaluating appropriateness based on evidence, fitting models, and critiquing ideas
Science discourse and communication	Opportunities for participation in scientific discourse that enculturates students into scientific language and practices
Engaging prior knowledge	Engaging students' prior knowledge and real-world and home applications of science to bridge between science epistemologies and student experience
Traditional instruction	Traditional teacher-centered approaches, including direct instruction, demonstration, worksheet or textbook work

For more than three decades, experts and researchers in science education have emphasized the importance of science teachers' instructional practices (for example, Areepattamannil et al. 2020; Darling-Hammond 1996; Grossman et al. 2009; National Research Council 1996, 2012, 2013; Özdem Yilmaz et al. 2017; Pey-Yan 2021; Rutherford and Ahlgren 1990) on any reform in science education. In 1983, the U.S. National Commission on Excellence in Education published *A Nation at Risk*, and this led to reforms aimed to raise the science achievements of all students by applying new higher standards regarding science teaching in the United States (Von Secker and Lissitz 1999). In 1996, the National Research Council published the *National Science Education Standards*, a document that provided guidelines for effective science instruction at that time. The standards called for a pedagogical shift away from teacher-centered science instructional methods such as direct large-group instruction, demonstration, and worksheet or textbook work, which have not been shown to be effective for teaching higher-order thinking and problem solving (Anderson 1997; Darling-Hammond 1996), toward student-centered methods. These are characterized by socially interactive scientific inquiry, discussion of open-ended questions, and using scientific thinking skills in daily life. Such methods are expected to be more effective for promoting a deep understanding of science (Tekkumru Kisa and Stein 2015). Indeed, instruction that emphasizes inquiry as an essential precursor to scientific understanding is very different from the teacher-centered courses and vocabulary-dense texts (Von Secker and Lissitz 1999).

The National Research Council (2012) in the United States and the NGSS (National Research Council 2013) have called for significant shifts in science teaching from traditional teacher-centered approaches (using direct science instruction, science demonstration, and worksheet or textbook work) to those that enable all students to actively engage in scientific practices and apply cross-cutting concepts to core disciplinary ideas (National Research Council 2013). In-service and pre-service teacher educators are involved in supporting such shifts in teaching practices toward the NGSS student-centered standards (Huffman et al. 2003).

The aim of the current study was to assess the science instructional practices used by in-service science teachers from the Arab community in Israel. The findings may contribute to building a suitable professional development program for these teachers that updates their instructional practices in the new era of NGSS-oriented science teaching.

Conceptual framework and background literature

Measuring science teachers' instructional practices has been considered an important issue because of their impact on students' engagement in and learning of science (Kloser 2014). Moreover, research on teaching practice has recently gained importance among many researchers as an effective factor for improving student achievement and engagement in the learning process because it focuses on the "work of teaching" (Ball and Forzani 2009, p. 497; Gallimore et. al. 2009; Grossman and McDonald 2008; Kazemi et al. 2009; Windschitl et al. 2008). For example, Pianta et al. (2008) used measures of effective teaching such as the Classroom Assessment

Scoring System to assess classroom quality in prekindergarten through third grade, based on teacher–student interactions rather than the physical environment or a specific curriculum. Moreover, Kane and Staiger (2012) indicated that science teachers' practices are better predictors of student achievement than years of teaching experience or attainment of a master's degree. Common, foundational science instructional practices may affect the coherence of classroom practice and limit the ability of science teachers and science teacher educators to share a common language and understanding of classroom instruction (Roth and Garnier 2007).

Science education in the Arab sector in Israel—ethnic perspectives

Israel is a multicultural state. It is composed from a spectrum of different cultures and subcultures. The largest community is of Jews with Western (European or American) and Eastern (African and Middle Eastern) ethnic origins (Brodai and Israelashwili 1998; Florian et al. 1993). The Arab community in Israel is considered a minority group (Al-Haj 1995; Myres-JDC-Brookdale 2018), and is composed of Muslim Arabs (including Bedouins), Christian Arabs, Druze, and Circassians. The Arab minority constitutes approximately 19% of the population in Israel (Central Bureau of Statistics 2020), and is considered a non-assimilating minority that has limited access to the opportunity structure (Agbaria et al. 2015; Al-Krenawi 2016; Al-Haj 1995). Consequently, the Arab minority has a lower standing in all aspects of socioeconomic status (including education, occupation, and income) compared with the Jewish majority (Agbaria et al. 2015; Al-Haj 1995; Semyonov and Lewin-Epstein 1994; Tal 2020).

Although officially all government schools in Israel are open to all students, practically, the educational systems for the Arab community and Jewish community are segregated. The language of instruction in the Arab community is Arabic, and in the Jewish community it is Hebrew. Both systems are monitored by the State's Ministry of Education and they share the same science curricula.

Arab schools in Israel are characterized by a high level of formality (Abu-Asbah 2007; Kaplan and Yahia 2017; Myres-JDC-Brookdale 2018; Tal 2020). Moreover, Abu-Asbah (2007) indicated that teaching strategies in Arab schools in Israel are based mainly on frontal, traditional instruction or teacher-centered teaching methods, although there are increased calls to use alternative teaching strategies. According to Abu-Asbah (2007), classrooms in the Arab sector in Israel are characterized by the following principles:

A. The teacher is always correct. This perception prevents students from critical discourse with their teacher and from critical and creative thinking. This type of instruction might also be called autocratic.
B. There is minimal attention given to the different individual needs of students.
C. High-achieving students are those who generally dominate discourse with the teacher, whereas low achievers tend to stay quiet.
D. Within teacher-centered lessons, teachers' ability to cope with heterogenous classes is limited. As a result, the gaps between students are ever-growing.

A comparative study conducted by Dkeidek et al. (2011) revealed significant differences related to question-asking behavior of students in chemistry laboratory classrooms. The researchers found that in general, the number of questions asked by Arab students in an inquiry-type chemistry laboratory was significantly lower compared with their Jewish counterparts. Moreover, Dkeidek et al. (2012) found in a comparative study that Arab teachers perceive themselves to be the key to the learning process. In addition, because of students' lesser abilities and uncertainty, Arab teachers tend to perceive students as seeking help and support.

In a recent comparative study, Gross and Issa (2020) examined the disciplinary knowledge of science teachers from the Jewish and Arab communities in Israel and found that the Arab teachers have significantly more higher education than Jewish teachers. This finding is surprising in light of the results of international surveys (for example, the Programme for International Student Assessment [PISA], conducted in 2018) that test scientific knowledge of students in elementary and middle schools and find that the scores of Jewish students are significantly higher than those of students in the Arab community (Research Authority for Measurement and Evaluation 2019). Gross and Issa (2020) attributed this inconsistency to other aspects of the teaching and learning process, such as the effect of culture and science teaching practices within Arab science classrooms. Indeed, Kane and Staiger (2012) found that teachers' classroom practices are better predictors of student achievement than their years of teaching experience or the attainment of a master's degree (Pianta et al. 2008).

In accordance with a previous literature survey and conceptual framework (Dkeidek et al. 2011, 2012; Markic et al. 2016; Gross and Issa 2020) and the Research Authority for Measurement and Evaluation (2019), the current study aimed to examine the teaching practices science teachers from the Arab community in Israel use when they teach science. Because teaching practices affect students' development of scientific skills and scientific literacy, understanding these practices is necessary in order to construct a suitable intervention program that leads to future change.

Research questions

This study aimed to address the following questions:

(a) What science instructional practices do Arab teachers in Israel use in elementary and middle school science classes?
(b) How do the science instructional practices used by Arab teachers in elementary and middle school science classes in Israel align with NGSS science instructional practices?
(c) How are science instructional practices related to the teachers' number of years of in the teaching profession?

Methods

Participants

In Israel, Arab teachers mainly teach in the segregated schools where Arab students learn (Dkeidek et al. 2012). The research population consisted of science teachers from the Arab sector in Israel who were teaching in Arab schools.

The research sample included a total of 78 in-service Arab science teachers from Israel, who were teaching elementary and middle school science in 28 schools. The characteristics of these teachers are presented in Table 2.

The 28 participating schools were selected randomly, and the teachers who taught science in those schools were invited to complete the questionnaire voluntarily. Of the 78 science teachers who completed the questionnaire for the quantitative data analysis, 8 participants were randomly selected and agreed to take part in the qualitative portion of the study, involving semi-structured interviews. The ratio of experienced to novice teachers was maintained in the qualitative analysis; that is, 5 experienced and 3 novice teachers were interviewed.

Description of professional development courses in science education

All science teachers in Israel, including those from the Arab community, participate in professional development (PD) courses in science instructional practices and assessment during their career. The topics taught in these PD courses are (a) teaching science by inquiry, (b) teaching science by problem-based strategies, (c) investigation laboratories in science education, and (d) authentic assessment in science education. The courses typically consist of 30 h distributed over 10 weekly or biweekly meetings.

Research instruments

The study combined qualitative and quantitative methods, based on the assumption that this would allow for deeper understanding of the instructional practices

Table 2 Characteristics of the research sample

Characteristics	$N=78$
Males (%)	12.8
Females (%)	87.2
Novice teachers (less than 10 years of science teaching experience) (%)	42.3
Experienced teachers (more than 10 years of science teaching experience) (%)	57.7
Mean (SD) number of years of experience in science teaching	12.72 (3.93)
Mean (SD) number of professional development hours in science instructional teaching practices per teacher during his/her in-service career	23.46 (14.41)

used by science teachers in Israel's Arab community (Glaser and Strauss 1967; Tobin 1995).

The quantitative component was conducted using the Science Instructional Practices Survey (SIPS) developed by Hayes et al. (2016) and sought to assess the instructional practices used by participants, whereas the qualitative portion involved semi-structured interviews that investigated their science instructional behaviors.

Science instructional practices survey questionnaire

The SIPS questionnaire (Hayes et al. 2016) is intended for elementary and middle school science teachers. The survey questions ask teachers to rate the science instructional practices they use with their students during science teaching and learning classes. This questionnaire has been used previously (e.g., Bancroft et al. 2019; Hayes et al. 2019) to evaluate the application of science teachers' NGSS instructional practices within science classrooms.

The SIPS questionnaire was translated into Arabic to eliminate any language barriers that might serve as a source of error in our research results (Cassels and Johnstone 1984). Internal validity was assessed by sending the translated version to four science education experts for their feedback. The final version of the SIPS questionnaire was prepared according to the feedback before dissemination.

The original and translated SIPS questionnaire consisted of 24 items. Each item offered response options using a 5-point Likert scale, with 1 being *strongly disagree* and 5 being *strongly agree*. Internal consistency was conducted for the Arabic version of the SIPS questionnaire by calculating Cronbach's alpha. The result of the reliability test for the whole questionnaire was 0.812, which indicated that it was reliable.

The SIPS questionnaire includes six scales of instructional practice, four of them linked to NGSS science instructional practices and the other two related to traditional, non-NGSS instructional practices, namely, traditional instruction and teaching science using the students' prior knowledge. The 24 items were distributed randomly within the questionnaire. More details about the SIPS questionnaire can be found in Table 3.

The survey also collected background information about the teachers, including sociodemographic characteristics such as age and gender, seniority in science teaching, and details about participation in PD in science teaching during the previous three years, including the topics taught in the PD courses and the number of hours of learning. Participants had 15–20 min to complete the survey questionnaire.

Semi-structured teacher interview

Semi-structured interviews with eight of the Arab science teachers were conducted to better understand how they viewed their role during their instruction

Table 3 Descriptive information for SIPS questionnaire

Group	Scale	NGSS Science Education Practice	Sample item	Items
Student-centered teaching practices (NGSS-oriented)	Investigating an investigation	(1) Questioning (3) Planning and carrying out an investigation	Generate questions or predictions to explore	1–4
	Data collection and analysis	(3) Planning and carrying out an investigation (4) Analyzing and interpreting data (5) Using mathematical and computational thinking	Make and record observations	5–9
	Critique, explanation, and argumentation	(6) Constructing explanations (7) Engaging in argument from evidence	Explain the reasoning behind an idea	10–15
	Modeling	(2) Developing and using models	Use models to predict outcomes	16–18
Traditional teacher-centered teaching practices (not NGSS-oriented)	Traditional instruction	Not NGSS Science Education Practice	Provide direct instruction to explain science concepts	19–21
	Prior knowledge	Not NGSS Science Education Practice	Apply science concepts to explain natural events or real-world situations	22–24

NGSS next generation science standards in science classes and the reasons for the responses obtained from quantitative or qualitative data.

All semi-structured interviews were conducted in person by the researchers and were recorded using an audio recorder. Each interview lasted approximately half an hour and was conducted in a meeting-room at the teacher's school. The goal of the semi-structured interviews was to gain further insight into the background and beliefs underlying the participants' teaching practices.

This study was approved by the Research and Assessment Authority of the academic college, under the number 210819. Participation in the current study was voluntary and all participants signed an informed consent form.

Data analysis

Quantitative data analysis

The results of the quantitative questionnaires were analyzed statistically. Data from the questionnaires were recorded using Microsoft Excel and analyzed using the SPSS Statistics software program for statistical analysis.

Cronbach's alpha was estimated to determine the reliability of the findings.

The mean scores and standard deviations of each of the six individual factors were calculated, and a comparison between the means of the factors was done using one-way ANOVA and *t* tests.

Qualitative data analysis

Semi-structured interviews were conducted with a sample of the teachers who completed the questionnaire. The responses were recorded and then transcribed.

The protocol of the interviews was based on and inferred from questions in the SIPS questionnaire. The goal of the interview questions was to obtain a deep understanding of the instructional behaviors of science teachers from the Arab community in Israel and the reasons for these behaviors. The interviewees were asked (a) what teaching practices they mainly used when teaching science, (b) why they used those teaching practices, (c) what they thought was the purpose of teaching science to their students, (d) what they thought was the main role of their students during science lessons, and (e) what they thought about letting their students collect data, conduct scientific investigations, critique, explain, and so on.

Transcription was conducted by the researchers with the aid of an online transcription application (https://transcribe.wreally.com/). All identifying information was eliminated from the transcripts.

A narrative content analysis approach was employed to analyze the interview data (Riessman 2008; Goodson 2013). We applied the approach of "bathing in the data" (Goodson 2013, p. 40)—the transcripts were read through slowly, recording the main emergent and common ideas, and gauging when the common ideas and conclusions became saturated.

An inductive approach was used, which best fit the study's methodology. It helped us achieve descriptions and explanations of the science instructional practices that Arab science teachers use.

Results and discussion

Average rating of science instruction practices

The means and standard deviations of the scores for each of the six instruction-practice areas were calculated; the results are presented in Fig. 1.

One-way ANOVA was conducted to test statistical differences between the six instructional practices. Tukey post hoc tests were conducted to identify the source of the differences between the instructional practices. The results showed a significant difference between all scales of the science instructional practices ($F[5,78]=6.3$, $p<0.01$) except data collection and analysis and critique, explanation, and argumentation.

As shown in Fig. 1, the mean scores for prior knowledge and traditional instruction, which are not correlated to NGSS scientific skills, were the highest, whereas the mean scores of the other four practices (instigating an investigation, data collection and analysis, critique, explanation, and argumentation, and modeling), which are directly in the spirit of NGSS, were significantly lower.

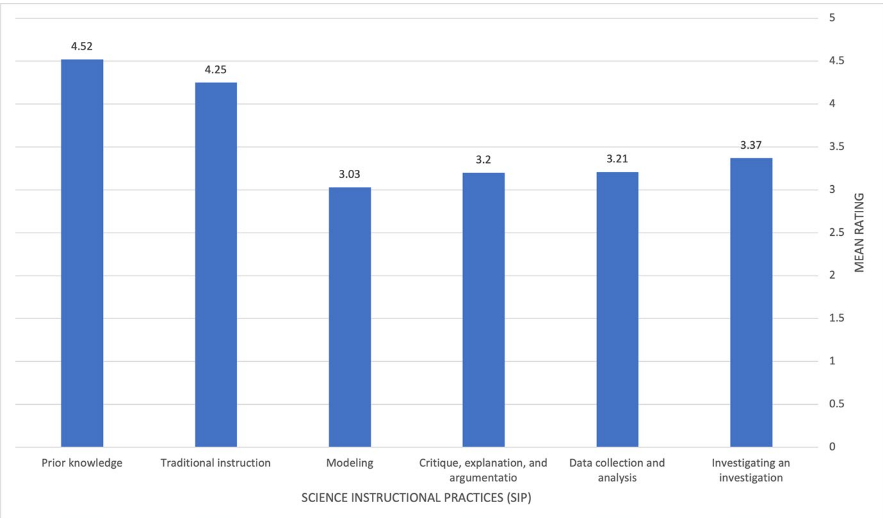

Fig. 1 Means of scores for science instruction practices (SIP)

Table 4 Statistical differences between groups of NGSS and non-NGSS science teaching practices used by Arab teachers

Teaching practices	Mean (SD) score	$t_{(78)}$	p
Student-centered (NGSS-oriented)	3.20 (0.49)	1.79	< 0.01
Teacher-centered (not NGSS-oriented)	4.41 (0.69)		

NGSS next generation science standards, *SD* standard deviation

Table 5 Statistical comparison between expert and novice teachers regarding using NGSS and Non-NGSS science teaching practices

Teaching practices	Novice teachers, mean (SD) score	Expert teachers, mean (SD) score	$t(78)$	p
Student-centered (NGSS-oriented)	3.58 (0.61)	3.07 (0.73)	2.10	< 0.01
Teacher-centered (not NGSS-oriented)	4.38 (0.59)	4.39 (0.54)	0.51	0.39

NGSS next generation science standards, *SD* standard deviation

The means and standard deviations of scores for science teaching practices were calculated for all participants. We divided the teaching practices into two groups; the first contained traditional instruction and prior knowledge, which we called a traditional, teacher-centered, non-NGSS-oriented approach. The second contained "student-centered," NGSS-style practices such as instigating an investigation, data collection and analysis, critique, explanation, and argumentation, and modeling. The division was made according to the scientific skills that each practice develops within the learner. A paired-sample *t* test was performed to test statistical differences between the two groups (teacher-centered and student-centered); the results are presented in Table 4.

As shown in Table 4, Arab science teachers tend to use non-NGSS science teaching practices significantly more than NGSS science teaching practices, despite the national and international call to follow standards based on student-centered science teaching practices, which lead to NGSS-oriented student performance (Beernaert et al. 2015; National Academies of Sciences, Engineering, and Medicine 2015; National Research Council 2012, 2013; Paniagua and Istance 2018).

Years of science teaching experiences and instructional practices

The last research question was "How are science instructional practices affected by the number of years of experience that the Arab teacher has?" We divided the participants into two groups: group 1 (expert teachers) had more than 10 years of experience in science teaching, and group 2 (novice teachers) had less than 10 years.

Independent *t* tests were conducted to identify significant differences between these two groups within the NGSS and non-NGSS instructional practice groups. The results are presented in Table 5.

According to the Israeli Ministry of Education, every science teacher must obtain a B.Ed. in science teaching from a teacher's college in Israel. All in-service science

Table 6 Differences in science instructional practices between novice and expert teachers

Scale	Expert teachers ($n=45$), mean (SD) score	Novice teachers ($n=33$), mean (SD) score	$t(78)$	p
Investigating an investigation	3.24 (0.75)	3.78 (0.62)	2.86	<0.01
Data collection and analysis	3.12 (0.88)	3.33 (0.88)	1.06	<0.01
Critique, explanation, and argumentation	3.04 (0.70)	3.44 (0.61)	3.23	<0.01
Modeling	2.91 (0.84)	3.81 (0.97)	1.26	<0.01
Traditional instruction	4.27 (0.59)	4.22 (0.59)	0.42	0.68
Prior knowledge	4.48 (0.58)	4.56 (0.48)	0.60	0.54

Table 7 Statistical comparison between expert and novice teachers regarding the average number of PD hours spent on science instructional teaching practices

	Novice teachers, mean (SD) score	Expert teachers, mean (SD) score	$t(78)$	p
Average number of PD hours	24.64 (14.11)	22.61 (14.52)	10.44	<0.001

NGSS next generation science standards, *PD* professional development, *SD* standard deviation

teachers, whether experts or novices, have completed a science teacher preparation program. In addition, during the in-service period, each science teacher in Israel participates in professional development in science instructional practices and science assessment during his or her career, as described previously.

An independent *t* test was conducted to compare expert and novice science teachers regarding their science teaching practices in the six scales. The results are presented in Table 6. Table 6 shows that novice teachers made greater use of instigating an investigation, data collection and analysis, critique, explanation, and argumentation, and modeling teaching strategies (mean [SD] score = 3.78 [0.62]) than their counterpart expert teachers (mean [SD] score = 3.24 [0.75], $p < 0.01$).

Tables 5 and 6 show that novice teachers used significantly more student-centered science teaching practices than their counterpart expert teachers. However, there were no significant differences between the two groups in terms of their use of traditional, teacher-centered practices (National Research Council 2012, 2013).

We calculated the total number of hours during which the average teacher had participated in science teaching PD during his or her entire in-service career, both for experienced and for novice teachers; the results are presented in Table 7. A statistical comparison shows that novice teachers participated in a significantly higher number of PD hours in science teaching practices during their career.

This difference in PD may enable novice teachers to acquire more up-to-date science instructional practices, such as teaching science by investigation, inquiry, and problem-based methodology—instructional practices leading to NGSS abilities (Hayes et al. 2016).

Qualitative results

We conducted semi-structured interviews with a sample of the in-service teachers who completed the SIPS questionnaire to understand how they perceive their role and their students' role and the reasons for their science instructional behaviors. During the interviews, the teachers were asked (a) which teaching practices they mainly used when teaching science in their classrooms, (b) why they used those teaching practices specifically, (c) what they thought was the purpose of teaching science to their students, (d) what they thought was the main role of their students during science lessons, and (e) what they thought about letting their students collect data, conduct scientific investigations, critique, explain, and so on.

Regarding the question of which teaching practices they mainly used when teaching science, the following are some sample responses:

- "Usually, I am directly explaining scientific facts to my students."
- "First of all, I have to give my students the scientific background that is relevant to the topic of each lesson by explanations and presentations."
- "I start my lessons with scientific principles and explanations; then I ask my students to read what is written the science textbook. After that, I stand in front of them and review what we learned."

Regarding the question of why they used these teaching practices specifically, the following are some sample responses:

- "The first and major responsibility of science teachers is to transfer scientific knowledge to their students."
- "If students do not remember the knowledge that they learned from science classes, there is no gain from these classes and the students will not benefit at all."
- "These are the science teaching strategies we acquired in the preparation program I participated in as a pre-service teacher."

Regarding the question of what they thought was the purpose of teaching science to their students, the following are some sample responses:

- "The main purpose of pupil participation in science classes is to gain scientific knowledge, such as facts, rules, principles…"
- "My role as a science teacher is to give my students scientific information, which they need in order to become scientifically-oriented people in their community."
- "My students must know science; they have to remember and understand science in order to use it when they get older. For example, if someone wants to be a doctor or engineer, he or she needs to understand science in order to be prepared for university studies."
- "I think that students must know the scientific knowledge in order to well understand sciences."

Regarding the question of what they thought was the main role of their students during science lessons, the following are some sample responses:

- “My students must listen to me during my explanation of scientific facts and theories. They don’t have any previous scientific knowledge, so they have to listen carefully to me during science lessons.”
- “The students have to listen to my explanations and stay calm. They have to acquire scientific knowledge, so they have to keep quiet and listen carefully to me.”
- “They must simply keep quiet and listen to my explanations.”

Regarding the question about letting their students collect data, conduct scientific investigations, critique, explain, and so on, the following are some sample responses:

- “As I told you, first of all, the students must understand science. Doing scientific investigations is not on my agenda.”
- “I think that what you mentioned to me—performing data collection, scientific investigations, et cetera—is not my first goal. Maybe in advanced levels or later after they finish the school. They can do that in the university.”
- “Sometimes, I ask my students to go to the library, find scientific information and data, and write a report as homework.”

In the interviews, it arose that the teachers tend to do the following:

1. Teach science mainly by using traditional teacher-centered practices, such as explaining scientific facts and theories in a frontal teacher-centered manner.
2. Perceive their role as being transmitters of scientific knowledge and data to their students.
3. Believe their role in teaching science is to provide adequate scientific knowledge that their students may need in the future.
4. Perceive their students as passive learners and that this is the way to teach them scientific knowledge.
5. Believe that NGSS-style, student-centered science teaching practices such as data collection, scientific investigations, critiquing, and explaining, are not the focus of teaching, although some use a basic level of these practices, such as having students search for scientific data in the library and use it to write a report as homework.

While the data obtained from the SIPS questionnaire enables us to identify the trends in science instructional practices among Arab science teachers, the interviews offer a unique opportunity to gain deeper insight into the reasons underlying these trends. The qualitative analysis indicates that Arab science teachers tend to choose teacher-centered science instructional practices because they perceive the core objective of sciences classes to be acquiring scientific knowledge; in this perspective, students are meant to absorb the knowledge in a passive manner.

Discussion, conclusions, and recommendations

The current study examined the science instructional practices that Arab teachers in Israel use in elementary and middle school science classes and how they are aligned with contemporary NGSS science instructional practices. It also looked at the differences between practices used among novice and expert teachers.

This study found that Arab science teachers in Israel seem to use teacher-centered teaching practices such as traditional instruction and using students' prior knowledge significantly more than student-centered NGSS instructional practices. This finding is in parallel to Abu-Asbah (2007), who indicated that teaching strategies in Arab schools in Israel are based mainly on frontal, traditional instruction and teacher-centered teaching methods, although there are increased calls to use alternative teaching strategies. Markic et al. (2016) found in a comparative study that Israeli Arab chemistry teachers' beliefs about the chemistry classroom are teacher-centered. In the present study, Arab science teachers' reports about their science teaching practices indicated they used transmission-oriented, teacher-centered science teaching practices. This has also been found among chemistry teachers in other Arab societies (Al-Amoush et al. 2012; Al-Amoush et. al. 2014).

In a comparative study among students in Israel's Jewish and Arab sectors who learned chemistry, which examined learning environment and the teacher-student relationship, Arab students reported low student involvement but a high degree of learning support from teachers. In contrast, the Jewish students reported a significantly lower degree of teacher-support and a higher degree of student involvement (Dkeidek et al. 2012). This aligns with the findings of the present study, which found that Arab teachers in Israel perceive themselves to be the key to the learning process and the one responsible for the learning, rather than the students themselves who are not expected to take an active role. The teaching strategies that are used are thus teacher-centered, focusing on traditional instruction and using students' prior knowledge; NGSS-style teaching practices that require active involvement from students such as investigation, data collection, etc., are not emphasized. This practice also seems to be informed by the teachers' perception of their students as needing help and support, and lacking in ability and knowledge (Dkeidek et al. 2012).

In a similar context, BouJaoude and Dagher (2009) claim that there are many problems with the quality of science education in 22 Arab states that they investigated in their study. They attributed the poor quality of science education to the use of outdated science curricula, and science teaching methods that emphasis the transfer of theoretical science content to students, making little use of hands-on, practical, and inquiry-based science teaching. They added that science teachers in Arab states lack or have limited access to suitable and up-to-date technologies, and also suffer from a lack of pedagogical support. This echoes the findings of the present study, which indicate that science teachers from the Arab community in Israel use more-teacher-centered practices than student-centered ones.

More recently, BouJaoude and Noureddine (2020), analyzed the content of science textbooks in six Arab countries (Egypt, Iraq, Jordan, Kuwait, Oman, Saudi Arabia, and Sudan), revealing that the most prevalent content in the textbooks related to scientific information. What was absent from the textbooks was content related to independent, self-directed skills and twenty-first-century themes such as the use of technological tools. Similarly, the current study found that science instructional practices among Arab science teachers from Israel are more traditional and teacher-centered, focusing on information rather than on independent, modern skills.

Dagher and BouJaoude (2011) recommend implementing innovative methods in science education in the Arab world that include "supporting a culture of open-mindedness and inquiry that puts more value on developing students' minds rather than filling them with static knowledge and on knowledge generation more than knowledge consumption" (Dagher and BouJaoude 2011, p. 94). This is not limited to the classroom. Dagher and BouJaoude (2011, p. 95) argue that a "cultural shift needs to be enacted at many levels, in curriculum goals, instruction, assessment and research practices (pre-school to college) and, most importantly, in the society at large." The current study highlighted the fact that science teachers from the Arab community in Israel had to show a willingness to shift from teacher-centered to student-centered science instructional practices if they want to keep up with modern trends and insights in science education. This could be achieved through suitable and targeted professional development programs.

The current study also found that novice Arab science teachers seem to use up-to-date student-centered practices than non-novice teachers. This finding was attributed to novice teachers' participation in a larger number of PD hours spent learning student-centered science teaching practices during their in-service period.

These findings suggest that it could be highly beneficial for Arab science teachers in Israel, especially those with more teaching experience, to participate in professional development programs to gain up-to-date, student-centered science teaching practices. Such practices, in line with the NGSS, would help students in the Arab community to obtain 21st-century science skills (National Research Council 2013).

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Author contributions All authors of the current study contributed equally.

Data availability All the data in the current study was recorded in Google spreadsheets via an electronic data collection system. The data is free and available for future use by any other researcher/s.

Declarations

Conflict of interest No conflicting interests existed between the participants of the current study and the researchers either in direct or indirect manner.

Ethical approval This research was approved by the Research and Assessment Authority of the academic college under the number 210819. Participation was voluntary and all participants signed an informed consent form.

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