**Science Instructional Practices of Science Teachers from Arab community in Israel**

**Abstract**

The importance of science teachers’ content knowledge and science teachers’ pedagogical content knowledge on students’ learning of sciences has got a great attention among science education researchers and science education educators. Despite the importance of these topics, they are still not sufficient to predict teachers’ impact on student learning sciences.

Science instructional practices and research that is related to it, are recently considered important issues that attract researchers and policymakers in science education particularly, and other disciplinary education in general.

Many countries around the world establish reforms in science education teaching and learning including science teaching practices. For instance, in the United States, new standards for science education, Next Generation Science Standards (NGSS), had been established in many states in 2013. Similarly, here in Israel, Package for Learning Plans (PLP) had been published by the Israeli Ministry of Education in 2018, which emphasized using science education in order to develop scientific skills within science education learners and to establish new era student-centered instructional strategies.

Science education in the Arab community in Israel is considered an important discipline, it is an essential lever of the whole educational system in the sector. Previous researches showed mainly that Arab teachers regularly use teacher-centered teaching strategies during their teaching.

The current study came to identify science instructional practices that are used by Arab science teachers through the lens of the Next Generation Science Standards (NGSS) and how they are affected by the teacher's number of years of experience.

The research done by using mixed methods. The quantitative part was done based on the Science Instructional Practices Survey (SIPS), a questionnaire developed by Hayes et. al. in 2016.

It is found from the current study that Arab science teachers mainly reported that they use non-NGSS traditional instructional practices such as direct instruction, demonstration, worksheet or textbook work, while NGSS science teaching practices such as empirical investigations, and Critique, Explanation, and Argumentation were significantly less used by Arab science teachers.

In addition, it was found that novice teachers reported significantly used NGSS science teaching practices higher than expert teachers, this difference was attributed to the type of teacher’s preparation programs that each group got during their preparation period.

**Introduction and Rationale**

Science teaching instructional methods play an important role in shaping the skills and abilities that the pupil gains as a result of participating in science learning classes (Hayes, Lee, DiStefano, O’Connor, & Seitz, 2016). In the United States (US), the National Research Council (National Research Council [NRC], 2012) and *Next Generation Science Standards* (NGSS) (NRC, 2013) call for significant shifts in science teaching from traditional instruction teacher-centered approaches that include direct science instruction, science demonstration, worksheet or textbook work to those that enable all students to actively engage in scientific practices and apply crosscutting concepts to core disciplinary ideas (NRC, 2013).

Earlier in 1983, National Commission on Excellence in Education in the US published *A Nation at Risk* document, as a result, reforms have been adapted that aimed to raise the achievement in the sciences of all students by applying new higher standards regarding science teaching in the US (Secker, Lissitz, 1999). NRC (1996) published the National Science Education Standards, a document that guidelines effective science instruction at that time. The Standards call for a pedagogical shift from teacher-centered science instructional methods such as direct large-group instruction, demonstration, worksheet or textbook work, that have not been shown to be effective for teaching higher-order thinking and problem solving (Anderson, 1997; Darling-Hammond, 1996). to student-centered science instructional methods that enable students to be a more socially scientific inquiry interactive and facilitates scientific thinking skills throughout their daily lives.

For the more than three decades, experts and researchers in science education emphasize the importance of science teachers’ instructional practices (for example, Darling-Hammond, 1996; Grossman et.al. 2006; NRC, 1996; 2012; 2013; Rutherford & Ahlgren, 1990) on any reform in science education. Inservice and pre-service teacher educators are involved in supporting teacher shifts in practice toward the NGSS standards that focus on student-centered instructional practices (Huffman, Thomas, & Lawrenz, 2003). Instruction that emphasizes inquiry as an essential precursor to scientific understanding is very different from teacher-centered courses and vocabulary-dense texts that are typical of high schools in the 1990s (Secker, Lissitz, 1999). Student-centered instruction, which is characterized by inquiry and discussion of open-ended questions, is expected to be more effective for promoting a deep understanding of science (Tekkumru Kisa, & Stein, 2015).

***Conceptual Framework and Background Literature***

Measuring science teachers’ instructional practices is considered one of the important issues recently, this is due to the importance and influence on students’ engagement in and learning of science (Kloser, 2014). Moreover, research on teaching practice has recently gained importance from many researchers as an effective factor for improving student engagement in learning process and achievement because it focuses on the “*work of teaching*” (Ball & Forzani, 2009, p. 497; Gallimore, Ermeling, Saunders, & Goldenberg, 2009; Grossman & McDonald, 2008; Kazemi, Franke, & Lampert, 2009; Windschitl, Thompson, & Braaten, 2008). For example, Pianta, La Paro, and Hamre (2008) had used instruments such as Classroom Assessment Scoring System (CLASS) that assess classroom quality in pre-kindergarten through grade 3 based on teacher-student interactions rather than the physical environment or a specific curriculum as a Measures of Effective Teaching (MET). 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. Science teachers’ enactment has an important influence on students’ scores and outcomes in learning sciences and recognizing a core set of Arab science teachers’ instructional practices will be particularly helpful for Arab science teachers in Israel. 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 & Garnier, 2006).

A wide variety of science instructional methods can be used by science teachers, ranging from those that are teacher-centered to those that are more student-centered (Hayes, Lee, DiStefano, O’Connor, & Seitz, 2016; Treagust, & Tsui 2014). Hayes, Lee, DiStefano, O’Connor, and Seitz reviled a comprehensive literature review regarding science instructional methods and find out that they can be categorized into five major areas on a continuum started from teacher-centered to student-centered, more specifically, (a) Traditional Instruction, (b) Engaging Prior Knowledge, (c) Science Discourse and Communication, (d) Evaluation and Explanation, and (e) Empirical Investigation.

***Science Education in the Arab sector in Israel - Ethnical Perspectives***

In Israel, a cultural composition is existed and may be said to reflect the whole spectrum of this global continuum due to its subcultural variation, ranging from the culture of Jews of Western origin (e.g., Europe, America), which is characterized as most individualistic, through Jewish culture of eastern origin (e.g., Africa, Middle East), then to the Christian Arab culture, followed by the Druze, and finally to the minority culture considered most collectivist—Muslim Arab culture (including Bedouin). Thus, Israeli Arabs and Druze, comprising altogether about 20% of the Israeli population, live in a collectivist society that is characterized by Arab and Jewish researchers alike as being progressively influenced by the individualistic culture of the Jewish majority (Al-Haj, 1995; Brodai & Israelashwili, 1998; Buda & Elsayed-Elkhuoly, 1998; Florian, Mikulincer & Weller, 1993).

The Arab collectivist view traditionally places great emphasis on the authority of teachers and adults, and on the need for respect. In traditional society, learning and children’s obedience to adults is highly regarded (Al-Haj, 1995; Eilam, 2002; Haj-Yahia, 1995).

Arab schools in Israel are characterized by a high level of formality (Abu-Asbah, 2007). Moreover, Abu-Asbah indicated that teaching strategies in Arab schools in Israel are based mainly on frontal, traditional instruction, teacher-centered teaching methods, although there are raised calls to use alternative teaching strategies.

According to Abu-Asbah, classrooms in the Arab sector in Israel are characterized by:

1. The teacher is always correct - this perception prevents students from critical discourse with their teacher, critical thinking, creative thinking. This type of instruction can be called autocratic!
2. There is no attention given to the different individuals that are existed in the classrooms.
3. High-achiever students are those who mainly manipulate discourse with the teacher, while low-achievers are not and stay behind alone.
4. Therefore, the ability to accommodate the frontal-oriented classroom is very limited, and thus the gaps between the students are growing more and more.

A comparative study conducted by Dkeidek, Mamlok-Naaman, and Hofstein (2010) revealed significant differences related to question asking behaviour of students in the chemistry laboratory classroom. It was found that in general the number of questions that asked by Arab students in an inquiry-type chemistry laboratory was significantly lower compared to their Jewish counterparts. Moreover, Dkeidek, Mamlok-Naaman, and Hofstein (2012) found in a comparative study The Arab teachers perceive themselves to be the key to the learning process, and they are the responsible person during their teaching, in addition, the Arab teachers perceive always their students as help-seekers and support-askers due to their inability and uncertainty.

Moreover, recently in a comparative study, Gross and Issa (2020) examine the disciplinary Knowledge of science teachers from Jewish and the Arab community in Israel, they found that achievements of Arab teachers are significantly higher than the Jewish teachers, this finding is contrary to the results of international surveys (for example PISA) that test scientific knowledge of students in elementary and middle school, where the scores of Jewish students are significantly higher than the scores of students in the Arab community. They contributed this no-constancy to other aspects of the teaching learning process such as the culture effect on the teaching and learning process and the science teaching practices within the Arab science classrooms.

**Research Questions**

1. What are the science instructional practices do Arab teachers in Israel use in elementary and middle-school science classes?
2. How science instruction instructional practices do Arab teachers in Israel use in elementary and middle science classes aligned with NGSS science instructional practices?
3. How are science instructional practices affected by the number of years of experience that the Arab teacher has?

**Methodology**

**Participants**

In Israel, Arab teachers are mainly teaching in segregated schools that Arab students learned in them (Dkeidek, Mamlok-Naaman, & Hofestein, 2012). The research population consisted of science teachers from Arab sector in Israel who are teaching Arab schools only.

The research sample included a total 78 in-service Arab science teachers from Israel, who are teaching in 28 schools and middle-high school science teachers. The characteristics of these teachers are presented in Tables 1 below.

All the 78 science teachers had filled the questionnaire for the quantitative data analysis, while 8 of these teachers participated in the qualitative parts of this study.

**Table 1**. Characteristics of the research sample

|  |  |  |
| --- | --- | --- |
|  | N=78 |  |
| **Males (%)** | 12.8 |  |
| **Females (%)** | 87.2 |  |
| **Average number of years of experience in science teaching (SD)** | 12.72  (3.93) |  |
| **Percentage of those who participated in professional development in the last 3 years** | 58.3 |  |

**Research Instruments**

This study employed a mixed-method approach. The quantitative component conducted using Science Instructional Practices Survey (SIPS) developed previously by Hayes, Lee, DiStefano, O’Connor, and Seitz (2016), while the qualitative part conducted using semi-structured interviews.

***Science Instructional Practices Survey Questionnaire***

Science instructional practices survey questionnaire (SIPS) was developed previously by Hayes, Lee, DiStefano, O’Connor, and Seitz (2016). The survey was intended for elementary and middle school science teachers. The survey questions ask teachers to rate their science instructional practices that they apply with their students during science teaching and learning classes. This questionnaire was used previously by researchers (eg. Hayes, Wheaton, & Deborah, 2019; Bancroft, Herrington, & Dumitrache, 2019) to evaluate the application of science teachers Next Generation Science Standards (NGSS) instructional practices within science classrooms.

SIPS questionnaire was translated to Arabic in order to eliminate the language effect as a source of error in our research results (Cassels, & Johnstone, 1984).and internal validity had been assessed by sending the translated version to four science education experts to give their feedbacks, then the final version of the SIPS questionnaire had been prepared according to the feedbacks before the dissemination of the final version of the questionnaire.

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 for the reliability test for the whole questionnaire was 0.812 which indicates that it is reliable.

The SIPS questionnaire includes six scales of instructional practice, four of them linking to the NGSS science instructional practices, and the other two scales are related to traditional non-NGSS instructional practices; namely, traditional instruction and teaching sciences using prior knowledge that the student had. More details about the SIPS questionnaire could be found in Table 2.

In addition, the survey collected backgrounded information of the teachers such sociodemographic characteristics, age, gender, Seniority in science teaching, did he/she Join professional development in science teaching during the past three years.

**Table 2**. Characteristics of the research sample

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Group | Scale | NGSS Science Education Practice | Sample item | Items |
| NGSS Practices | Instigating 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 |
| Modelling | 2) Developing and Using Models | Use models to predict outcomes | 16-18 |
| Non-NGSS Traditional Practices | Traditional Instruction | None | Provide direct instruction to explain science concepts | 19-21 |
| Prior Knowledge | None | Apply science concepts to explain natural events or real-world situations. | 22-24 |

***Semi structured teacher interview***

Semi-structured interviews with the Arab science teachers and were conducted. The teachers were interviewed in order to better understand how they viewed their role during their instruction in the science classes and the reasons that are standing after their responses that we got either from quantitative or qualitative data.

*Administration of SIPS questionnaire*

Participating in the current study was done in a volunterly manner, which means that answering the questionnaire was optional and the teachers had the choice to answer the SIPS questionnaire. Arab science teachers were handed the questionnaire. We gave them approximately 15-20 minutes to complete it.

**Data analysis**

***Quantitative data analysis***

All the results of the quantitative questionnaires were analyzed statistically. The data from all the questionnaires were recorded on the computer using Excel® and analyzed using the SPSS® program for statistical analysis.

Cronbach alpha was estimated in order to determine the reliability of the findings.

The averages and standard deviations of scoring of each individual six factors were calculated. Then a comparison between the means of each factor done using one-way ANOVA and t-test.

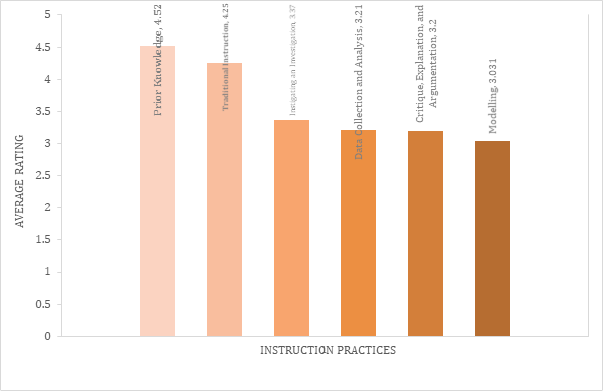
***Qualitative data analysis***

Semis-structured interviews were conducted with a sample of Arab science teachers who already filled the questionnaire. The responses were recorded, and then transcribed using Microsoft Word. The aim of these interviews is to deeply understand the reasons that stand after the selection of the specific science instructional practices that each science teacher uses during science classes.

**Results and Discussion**

***Average rating of science instruction practices***

The averages and the standard deviations for each of the six instruction practices areas were calculated, the results are presented in Figure 1 below.



**Figure 1.** Average and standard deviations of science instruction practices

One-way ANOVA was performed in order to test statistical differences between the six instructional practices. Moreover, Tukey post-hoc tests for identifying the source of the differences between the instructional practices were also performed. The results showed a significant difference between all scales of the science instructional practices (F(5,78) = 6.3, p < 0.01), except between Data Collection and Analysis, and Critique Explanation and Argumentation.

From Figure 1, it is obvious that prior knowledge and traditional instruction were averaged significantly the highest from one side, which are not correlated to NGSS scientific skills, whereas the four practices: instigating an investigation, data collection and analysis, Critique, explanation, and argumentation, and modelling, which are directly the spirit of NGSS, were significantly the lower.

The averages and the standard deviations for science teaching practices were calculated for all participants. We divided the teaching practices into two groups; the first one contains: traditional instruction, and prior knowledge that we called non-NGSS traditional science teaching practices, while the other one contains: instigating an investigation, data collection and analysis, (critique, explanation, and argumentation), and modelling that we called NGSS science teaching practices. The division was made according to the scientific practices and skills that each scale develope within the learner. A paired sample t-test was performed in order to test statistical differences between the two groups (NGSS and non-NGSS traditional practices), the results are presented in Table 3.

**Table 3**. Statistical analysis of the difference between NGSS and non-NGSS science teaching practices groups that Arab teachers use.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NGSS | non-NGSS | t(78) | p |
| Mean | 3.20 | 4.41 | 1.79 | < 0.01 |
| SD | 0.49 | 0.69 |

It is obvious from Table 3, that Arab science teacher tend to use non-NGSS science teaching practices significantly higher than NGSS science teaching practices despite the national and international call and standards for using new era NGSS science teaching practices (A framework for K-12 science education for the 21st century, National Research Council, 2012 (NGSS); National Academies of Sciences, Engineering, and Medicine, 2015; NGSS Lead States, 2013; Beernaert, et.al, 2015, Paniagua, & Istance, 2018).

We performed semi-structured interviews with a sample of those teachers who filled the SIPS questionnaire, in order to deeply understand who do they perceive their role, how do they perceive their pupils role and reasons that stand after their science instructional behaviours. Here are a sample of there responses:

* “*I think that pupils must know the scientific knowledge in order to well understand sciences*”
* “*the main purpose of pupil participation in science classes is to gain scientific knowledge, such as facts, rules, principles, …*”
* “*if pupils did not remember the knowledge that they learned from science classes, there is no gain from these classes and the pupils will not benefit at all*”
* “*my role as a science teacher is to give my pupils scientific data that they need in order to become scientifically-oriented people in their community*”
* “*the first and major responsibilities of science teachers is to transfer scientific data to their pupils*”

It is obvious and could be inferred from the previous quotations that Arab science teachers perceive their role as transmitters to scientific knowledge and data to their pupils, and they seemly think that their pupils have to gain that scientific knowledge in a passive manner.

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

Independent t-test was performed in order to examine the existence of significant differences between these two groups in the NGSS and non-NGSS traditional science instructional practices. The results are presented in Table 4.

**Table 4**. Statistical comparison between expert and novice teachers regarding using NGSS and non-NGSS traditional science teaching practices groups.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Novice teachers | Expert teachers | t(78) | p |
| Mean (SD) | Mean (SD) |
| NGSS | 3.58 (0.61) | 3.07 (0.73) | 2.10 | < 0.01 |
| non-NGSS | 4.38 (0.59) | 4.39 (0.54) | 0.51 | 0.39 |

Table 4 shows that novice teachers were significantly higher in using NGSS during science teaching than their counterparts expert teachers from one side, while from another side, there were no significant differences between these two groups in non-NGSS traditional science teaching practices.

The statistical analysing for each of the six instruction practices areas were calculated, the results are presented

Moreover, an independent t-test was performed between expert and novice science teachers regarding their science teaching practices in the six scales, the results are presented in Table 5.

**Table 5.** Statistical analysis of the difference between novice and expert teachers science instructional practices

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scale | **Expert teachers (n= 45)** | **Novice teachers (n= 33)** | **t(78)** | **p** |
| Mean (SD) | Mean (SD) |
| **Instigating 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 |
| **Modelling** | 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 |

\* p<0.01

From Table 5, It seems that novice teachers used Investigating an Investigation, Data Collection and Analysis Critique, Explanation, and Argumentation, and Modelling teaching strategies significantly (p< 0.01) higher (M=3.78. SD=0.62) than their counterparts' expert teachers (M=3.24, SD=0.75).

The results that raised from Tables 4 and 5, could be referred to the fact that novice teachers finished their teacher preparation program recently, and they already gained and prepared according to the up-to-date NGSS science teaching strategies, whereas expert teachers finished there preparation programs since more than ten years (before the year 2010), and it is probably that at that time science education standards were totally different from the new and up-to-date science education standards (NRC, 1994; Schoen, 1987; Shulman, 1987) and accordingly the science teaching practices that the expert teachers uses were non-NGSS traditional .

**Summary, 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 to the new and up-to-date NGSS science instructional practices. Moreover, science teaching practices were compared between novice and expert teachers.

It is found that Arab science teachers in Israel seem to use non-NGSS traditional science teaching instructional practices significantly, such as traditional instruction, using prior knowledge, more than NGSS instructional practices, such as Investigating an Investigation, Data Collection and Analysis Critique, Explanation, and Argumentation, and Modelling. 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, teacher-centered teaching methods, although there are raised calls to use alternative teaching strategies. Markic et. al. (2014) found in a comparative study that the Israeli Arab chemistry teachers’ beliefs about the chemistry classroom are very self-centred in contrary to the modern science education teaching standards that call for student-centered NGSS science teaching practices (NRC, 2013; National Academies of Sciences, Engineering, and Medicine, 2015; NGSS Lead States., 2013). Arab science teachers’ reports about their science teaching practices are teacher-centred and transmission-oriented as it was described for chemistry teachers in other Arab societies (Al-Amoush, Markic, & Eilks, 2012; Al-Amoush et. al., 2014).

In a similar manner, Dkeidek (2012) found that Arab teachers in Israel perceive themselves to be the key to the learning process, and they are the responsible person during their teaching. This perception seems to lead them to use non-NGSS science teaching practices that focus on traditional instruction and using prior knowledge during teaching sciences, with lower focus on NGSS science teaching practices that require the student to perform investigation, data collection, criticism and argumentation, and modelling. That seems to be a result of their perception of their students as *help-seekers and support-askers due to their inability and uncertainty* (Dkeidek et. al., 2012).

Moreover, it is found in the current study that Arab science novice teachers seem to use up-to-date instructional practices, such as Investigating an Investigation, Data Collection and Analysis Critique, Explanation, and Argumentation, and Modelling more than traditional non-NGSS one. This finding was attributed to the fact that the novice teachers finished their science teacher preparation programs recently, and it is probably that they exposure to the new NGSS-oriented science teaching practices rather that the expert teachers that they finished their science teacher preparation programs before more than ten years and at that time they gained science teaching practices that are more non-NGSS oriented.

From the above two findings it could be highly recommended that Arab science teachers in Israel, mainly those the experts, need to participate in and undergo professional development programs in order to gain the new era up-to-date NGSS oriented science instructional practices such as Investigating an Investigation, Data Collection and Analysis Critique, Explanation, and Argumentation, and Modelling in order to implement them during their science teaching, and thus bring their students to such a level that they obtain these 21th century skills (NRC, 2013) and the *Next Generation Science Standards* (NGSS Lead States, 2013).

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