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## Research Article

### SCIENCE STORY WRITING AS AN INSTRUCTIONAL TECHNIQUE TO ENHANCE STUDENTS' LEARNING AND TEACHERS' PROFESSIONAL DEVELOPMENT

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#### ABSTRACT

This research aimed at exploring students' understanding of scientific vocabulary, concepts and information through story writing instructions in science classrooms. It also aimed to help teachers reflect on students' science story structure to generate and explore new ideas and strategies in teaching science.

This study was carried out in science classrooms of grades four and five in the context of Jerusalem, Palestine for the school year 2015-2016. Qualitative data collection methods were classroom observation, field notes, video recordings, analysis of students' stories, and analysis of teachers' reflection. Thematic analysis was used to develop themes from the data. The coding analysis was based on three main thematic categories, which were based on answering the research questions of the study. The thematic categories used in the coding of data were: (a) story structures, (b) benefits of story-based instruction, and (d) reflections of teachers.

Findings revealed that stories played a pivotal role in enhancing students' understanding and developing story writing skills. Dialogues and argumentative dialogues were the main structures of students story writing. Results also indicated that apart from fun and enjoyment of writing science stories, they were an effective tool for making students thinking visible and enhancing their imagination. Story based instruction helped students be engaged in authentic activities and had more control on their own inquiry learning process. Through reflection, teachers become more convinced of the importance of moving from a traditional classroom instruction to a more creative and powerful science classroom.

Based on the research results, several recommendations are stated. Teaching and learning through science story writing is highly recommended to enhance and consolidate students' concept understanding in addition to developing students' writing skills. It is also recommended that teachers use science story writing as a pedagogical strategy in their science classrooms so as to facilitate and enhance students' science learning. More studies are needed to further explore teachers' application of being reflective through action research and its effect on improving teachers' practices and students' learning based on inquiry approach. Furthermore, studying how writing in science classrooms impact student achievement in science is highly suggested.

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#### INTRODUCTION

Compulsory basic education in Palestine covers 10 years that starts from Grade 1 to Grade 10, divided into the preparation stage from Grade 1 to Grade 4 and the empowerment stage from Grade 5 to Grade 10. The responsibility of science teachers in compulsory basic education is very important because they are required to help students realize the significance of science learning on the development of societies. Compulsory basic education is considered the first step of the educational system in Palestine and in many other Arab worlds, where students get basic knowledge and skills that they should develop for a better future in Palestine. Unfortunately, in Palestine 24% of students enroll the scientific stream according to the information provided by the Palestinian Ministry of Education (MoE) for the year 2016. Therefore, and to encourage Palestinian students enroll the Scientific Stream, we need to develop and improve teaching and learning science

using innovative approaches. Teaching science combined with story writing is an approach that can be implemented in Palestinian schools as they can make instruction more meaningful and relevant to the real competent world of the students. Science story writing is an opportunity for students to develop other skills like reading, writing and communication. Using written and spoken language is important through which students can explore and understand scientific concepts. Teachers can use students' written stories to check students' knowledge and understanding of material taught in science classrooms and at the same time, they can be used as part of teachers' instructional technique that keep students involved and engaged in the learning process. In this research paper Palestinian science teachers in two private schools in Jerusalem used story writing as a new instructional approach to help students be actively involved and engaged in learning science. Writing in science means being familiar with scientific vocabulary and being able to use the language in a meaningful

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and creative way. In this research stories were seen as multiple representations of science vocabulary, concepts and information taught in science classrooms in the aim to improve students' science learning and help them gain deeper understanding. Writing science stories were also seen as an alternative way of assessing students' understanding as mentioned earlier.

Reading and discussing science students' stories encourage collaboration among students as they engage together in writing, rewriting, drafting and proofreading. They share their stories together, justify their ideas, modify thinking, confirm the validity of ideas and together improve and refine their stories.

In this research, teachers were asked to reflect on the new experience of science story writing as the aim was also to improve the quality of teachers' practices and help them develop their pedagogical content knowledge. In other words, the aim was exploring teaching and learning through story writing to facilitate change in teacher classroom performance and students learning.

This paper provided important insight into the adoption of story writing as a new instructional technique of teaching and learning science to help students learn better. The nature of change that occurred either on teachers' practices or on students' learning and understanding was detected. This paper also provided the type of story structures that students created to enhance their learning and at the same time helped teachers reflect on the new strategies that they needed to invest in their science classrooms.

### ***The Purpose of the Study***

This study sought to investigate the story structure that fourth and fifth grade students used to convey their understanding of science concepts and information that were taught in their science classrooms. It sought to encourage students to see writing in science classrooms as a resource of communication through which they can develop discussion, reading and writing skills as well as enhance their understanding. It also sought to help students be more involved and engaged in their learning process through displaying their knowledge and understanding in their written stories. Stories were also used as a road to develop students' interest in science learning and encourage a large number of students enroll the scientific stream in the future.

Additionally, this study attempted to assess the impact of teachers' reflections on modifying, developing and improving the quality of teaching and learning in science classrooms through encouraging students to write stories. Reflection was seen as a starting point for improving teachers' practices and enhancing their personal professional development. Teachers' reflection on students' implementation of story writing was an attempt to identify the extent to which science story writing influenced teachers' instructional practices and empowered them to adopt or adapt new strategies and methods to improve students' learning.

### ***The Significance of the Study***

This study was expected to contribute in helping students practice writing stories on science concepts to improve their science learning and to help them better understand concepts studied in their classrooms on the one hand and to develop their reading, writing and communication skills on the other hand. It helped students be active learners and be more responsible over their own learning. Apart from this, writing science stories helped students develop their communication skills through presenting and discussing their stories to - with their classmates. Similarly, this writing project aimed to empower teachers to adopt/ adapt new strategies and methods and help them develop professionally. They experienced being reflective practitioners on the new strategy of implementing story writing in science classrooms for the purpose of enhancing students' learning and developing teachers' practices.

### ***The Importance of Stories***

Stories are rooted in the Arab heritage and their charm has an impact on young and old alike. In Arab culture, stories were used, for example, in the *Maqamat* (created by [Badi Al-Zaman Hamadānī \[Abu Al-Fadl Ahmad Bin Al-Hussein\]](#), [Al-Hariri \[Abu Mohammed, Mohammed Bin Al-Qasim AL-Hariri\]](#)), ([Hamadānī, 1915](#)) to educate, entertain, inform and send moral messages to the listener. The *Maqamat* contains short stories in which rhyming dialogues occur between two or more characters: heroes who have ideal, positive and moral views and anti-heroes who succumb to the forces of evil and they often try to persuade and justify their actions to each other.

Since Palestinian children are part of the rich Arab storytelling culture and since the ancient Arab art of storytelling or "Hakawati" "Tell Me a Story" is currently reviving, it was important to consider how stories could be used as an instructional technique to enhance students' learning and understanding in science classrooms. Considering reading and writing as integral parts of science and science learning, students could use these literacy skills to help them make sense of science information and develop new ideas through story writing ([Norris & Phillips, 2003](#)). According to Wellington and Osborne's study (2001, p.12), learning science is "in many ways, as learning a new language". Story writing in science classrooms is a strategy that teachers are always encouraged to use to help students learn more meaningfully and enjoyably ([Fulwiler, 2007, 2011](#)).

The importance of stories in education continues to increase day after day, especially recent research asserts that teaching and learning through stories builds the foundation of developing reading and writing skills ([Fisher & Medvic, 2003](#)), and nurtures children's imagination, inquiry and creativity ([Schirmacher, 2006](#)). Furthermore, stories can help students retain and retrieve information better than traditional ways of learning.

[Klassen \(2009\)](#) stated that unlike stories in the humanities, science stories play different role to the reader and listener and this is because science stories aim to improve teaching and learning in science and not only entertain and send a message or a moral as in the case of a story in humanities.

## Research Questions

This research sought to answer the following questions:

1. What story structure do fourth and fifth grade students use to convey their understanding?
2. How do teachers' reflections on students' story writing influence their instructional practices?
3. How do students' story structure helped teachers develop a professional teaching knowledge and helped students understand better?

## LITERATURE REVIEW

In this section, the researcher highlighted some of the studies that discussed the importance of engaging writing in science classrooms. Interest in science is very important, and a comprehensive review of literature shows that the interest of science is declining (Schibeci, 2009; Blank, 2012) and this is what the percentages show in the Palestinian culture. Researchers always pose challenging pedagogical questions related to how can the complexity of science concepts and information be translated to everyday language (Avraamidou & Osborne, 2009).

Ritchie, Rigano & Duane (2008) qualitative research on integrating narrative into science classrooms for fourth grade students showed that students' engagement and interest in the writing task helped in developing students written and spoken fluency using accurate scientific knowledge. The practices of reading, writing and talking (i.e., the use of language) remain fundamental to communicating and coming to know and understand science (Yore, Bisanz, & Hand, 2003).

Among other, Norris and Phillips (2003) asserted that

*"Coming to know science requires competency in two senses of scientific literacy: the fundamental sense of scientific literacy (reading and writing science content) and the derived sense (being knowledgeable, learned and educated in science). They argued, 'conceptions of scientific literacy typically attend to the derived sense of literacy and not to the fundamental sense. They also made the distinction between a simple fundamental scientific literacy (i.e., decoding texts) and an expanded fundamental scientific literacy (i.e., inferring meaning from text)"* (p. 224).

Research asserts that science can be humanized by encouraging students to generate stories in science classrooms. Students generate stories in class is a powerful tool in science instruction, as they engage students and help them be active, productive learners (Fensham, 2001; Fensham, 2009; Hodson, 2009) and make their learning more enjoyable and meaningful. Writing science stories is not traditionally associated with learning science, yet it is the genre with which most students are to be familiar (Wellington & Osborne, 2001). Using a familiar genre (such as stories), Wellington and Osborne argued, 'at least begins the process of helping children express their thoughts in written language through being personally and creatively engaged' (p. 76).

If science teachers help their students see a clear purpose for carrying out their writing activity in science classrooms, students are more likely to work hard and stay on task as well as stay motivated. Stories are easier for children to remember than a "stream of facts typical in expository text" (Butzow &

Butzow, 1998, p. xi). Real learning occurs when learners are motivated and are actively engaged and involved in their own knowledge construction (Cavendish *et al.*, 2006). Research asserts that reading and writing activities can help students to comprehend, interpret, analyze, evaluate and communicate scientific ideas (Holliday *et al.*, 1994). Such activities can help engage in students' minds the complex reasoning and problem solving processes that scientists use in the course of their work. Discussing, reading and writing, all play important roles in science learning. Rivard and Straw (2000) noted:

Talk is important for sharing, clarifying, and distributing scientific ideas among peers, while asking questions, hypothesizing, explaining, and formulating ideas together all appear to be important mechanisms during discussions. The use of writing appears to be important for refining and consolidating these new ideas with prior knowledge. (p. 588) Many researchers emphasize that language should be part of science and science learning. Students use language to make sense of new information and develop new ideas (Grant, & Fisher, 2010). They use language to externalize their thoughts and their thinking processes. Therefore, reading and writing are fundamental components of scientific literacy (Hapgood & Pallincsar, 2007; Norris & Phillips, 2003). As Wellington and Osborne (2001) compare, learning science is "in many ways, like learning a new language" (p. 12). Rowell (1997) explained, "writing is a cognitive and a social act in which authors must go beyond individualistic expression for specific purposes such as building convincing arguments, effective explanations or insightful analyses" (p. 45).

To sum up, there are many benefits for integrating writing in science classrooms. Research has proved that integrating reading and writing in science classrooms can help students achieve better not only in science, but also in other subjects (Amaral *et al.*, 2002). Learning to write prepares students for writing to learn. By writing about science topics, students can discover new ideas and clarify their thinking (Butler, 1991; Holliday, 1992; Rivard, 1994; Zinsler, 1988). Writing science stories can provide the engagement and discussion context that science classrooms often lack. Studies informed educators that writing help develop students' reading and writing skills and increase conceptual understanding (Rivard, 1994).

## Research Design and Procedures

### Research Participants

The participants were forty students from fourth and fifth grades studying in the two private schools chosen for this research paper in the school year 2015-2016. Four elementary teachers from the two private schools in Jerusalem volunteered to participate in science-story writing project as a new instructional strategy to improve science teaching and learning.

## METHODS

This study utilized a case study approach to conduct an in depth examination of some of the issues that elementary teachers experienced when adopting an integrated story writing approach to science learning. The case focused on a single professional development project involving four teachers with monthly meetings over a span of approximately twelve months. The major data collection was classroom observation, field

notes, videos, and students' stories and teachers' reflection diaries.

The goal of this study was to observe 12 classes (4 classes for each teacher) and to provide detailed data of the application of writing science stories in science classrooms. To ensure the validity of this study, the researcher videotaped some of the classes and took some field notes to emphasize some points during the discussion. Field notes were also taken during the monthly meetings with teachers to validate the data. Students' story samples were collected, read, discussed with students and their teachers and then translated and analyzed by the researcher and the teachers. Teachers' reflection collected from their written diaries were also analyzed. As commonalities arose among the data sources, the researcher addressed these commonalities by comparing them with the field notes, videos and observations of teachers' instructions; teachers' and students' reflections all to provide the triangulation of the data.

### **Findings**

In this research, students were asked to write stories in their science classrooms after they were provided with explanations and some models by the science teachers. The teachers also modeled how scientific information could be integrated into narrative texts by reading aloud some stories and watching some You Tubes. Throughout the project, the researcher provided on the spot assistance to both the teachers and the students during the tasks whenever necessary. During the monthly meetings with teachers, it was agreed that writing stories might help students to construct knowledge and improve their reading and writing skills and help them better understand science concepts. The goal was to teach science within the context of writing stories. Exposure to writing science stories might allow students an opportunity to develop and enhance their understanding. In support of this, students might connect science content with the processes of science and develop a deep understanding of the science concepts, and gain better scientific knowledge, reasoning and critical thinking. Teachers, as well as, can check students' understanding of information and science concepts taught in classrooms.

The data analysis revealed that when starting the science story writing project, students and teachers had some concerns because this was their first time they experienced writing stories in science classrooms and they also had some concerns regarding the length of the curriculum to apply the story writing activity. Science teachers were also worried because they thought that they needed to exert extra effort to teach reading and writing. The researcher clarified for the teachers that this project is not about teaching another subject; on the contrary, it is about making sure that students understand what is taught to them by creating stories and helping them be more engaged and more responsible towards their own learning. It is about engaging students in a number of activities that enhance and assess their understanding and help them communicate using science vocabulary, information and concepts. Writing science stories, reading and discussing them were desirable goals to achieve in science classrooms. Students were readers and writers, and story negotiators. Teachers reflected that story writing activities assisted fourth and fifth grade students learning and improved their understanding.

In the following section, the researcher discussed the story structure that students used to express their understanding and the effect of this structure in modifying and improving teachers' instructions.

### **Story Structures**

The first research question aimed to identify the dominant story structure that students used to express their understanding as well as how this structure helped teachers develop a professional teaching knowledge and teaching strategy that helped students understand better.

After the teachers' and the researcher's analysis of students' stories, the science teachers and the researcher agreed that the dominant story structures that students used were dialoguing and argumentative dialogue.

### **Story structures and students' understanding**

Through analysis of students' stories, different story structures and narrative techniques were created to present students' understanding. The different forms that students used to communicate science were dialoguing, argumentative dialogue, description or explanation of science concepts, a sequence or series of actions arranged chronologically, a series of facts and details, and sometimes a mixture of different forms. Students also used personification and imagery as methods to create and develop their stories. For example, they gave human qualities to different objects (the tree, the stomach, the planets) in order to convey their understanding and to add some interest to the stories. Students used first person narratives in some stories and in other stories they used third person narratives. They referred to characters by names and pronouns. Students' stories ranged from presenting realistic immediate experience, to presenting imagined, fictional experiences. The language used in a large number of stories resembled the language that students use in their everyday speech.

In this research, the researcher discussed only the two dominant forms that fourth and fifth grade students used to present their understanding in their stories.

### **Dialoguing as the main narrative technique**

A large number of stories were created in a dialogue form between a specialist and a person seeking some knowledge or information. The findings of this study revealed that the dialogue form was the most salient to fourth and fifth grade students. Science details were used to fill gaps to support conversation in their stories. For example, students' understanding of the three components of the blood cell, the white cell, the red cell, and the platelets were shown through this dialogue that was held between Mira and the doctor (The Story of Blood: Pain can Teach). The doctor acted as a specialist from whom Mira was getting information about blood:

One day while Mira was peeling tomatoes, she injured her hand and bled. Her mom felt sad and took her to the doctor to heal the wounds. Mira was very frightened because of the blood. She asked the doctor, "What is blood?" The doctor replied, "Red blood is a liquid, which a tissue composed of a group of cells that become the center of viscous liquid called plasma. She asked, "What is plasma? What is its role?" He replied,

“Plasma is a transparent liquid that tends to yellow and contains proteins and other materials, and its role is to transfer the digested food into the body's cells and transport harmful materials to kidneys and lungs.(Extract from student's text)

In another story about blood, the dialogue was between the white cell and the red cell:

### ***The Function of Blood Cells***

White Cell: I'll go to the area of injury and start attacking germs.

Red Cell: and how are you going to attack germs?

White Cell: I'm going to engulf a number of these germs and destroy them.

Red Cell: Can I help?

White Cell: of course, of course, cells in the wounded area will be dividing until the wound heal and this needs energy.

Red Cell: So I will provide the cells in the wounded area with all the oxygen I carry to help them in the process of respiration and energy production needed for the division.

White Cell: Thank you dear, but please go to the lungs to get more oxygen to provide the cells with more quantities.

Red Cell: Do not panic, my body contains 250 million hemoglobin molecules and each molecule is associated with four molecules of oxygen.

White Cell: This means that you can transfer billion molecule of oxygen.

Red Cell: Yes ... Yes, Don't you hear God's words: "And in yourselves, do you not see. (Extract from student's text)

In another story entitled scientific nightmare, the student dialogued his story with his mom by saying:

Majd: Two years ago at my childhood stage. I've seen that weird dreadful nightmare!

Mom: Dreadful nightmare?

Majd: Yes, Mom. My tiny brain was overloaded with facts of how and why and where?! I've seen the cells digging epidermis, growing platelets watering with blood! At midnight blossomed their trachea tree; photosynthesis sprayed a urinary flood!(Extract from student's text)

Students used dialogues to convey scientific information. They also tried to reveal characters' voices in the dialogues and to keep the conversation going in order to represent key events in their stories. The characters often discussed science vocabulary, knowledge and concepts. Dialoguing stories in this research led to other activities like role play and dramatization, and this emphasized that stories can be used as a stimulus to other interesting activities in the elementary stages.

### ***Argumentative dialogue as a narrative technique***

The other most prominent structure that students used in their science story writing was argumentative dialogue. In students' stories, argumentative dialogue was used whereby two or more individuals or objects try to reach to consensus through a debate. In one of the examples, an argumentative dialogue took place amongst different parts of a tree. The student used personification to describe the different parts of the tree. For example, in the story *The Tree Dialogue: We are All Unique, We are All Important* the parts of the tree are dialoguing in order to identify their importance. The conclusions reveal that

all given claims are true for the different parts of the tree. The student wrote:

Once upon a time, the tree leaves started to boast in a loud voice. We are the most powerful of all parts of the trees. We provide trees with all the food that they need. The roots looked at the leaves scornfully, but we are the ones who absorb water and minerals. The stems protested and said, we are the most important part and we are the most powerful. The plant stems include leaves and flowers and stems transport water and food within the plant.

The leaves interrupted and said, we are the most important and the most powerful. We provide the oxygen for the process of photosynthesis and thus we manufacture the nutrients to all parts of the plant. The flowers then assure that they are the most important part. They provide people with food they need. Some flowers become fruit, some become vegetables and because of the seeds people get more plants and flowers. Suddenly, as the quarrel among the parts of the trees arise, a wise man passed and asked, "Why are you quarrelling? You are all important. You all complement each other. All trees include roots, stems, leaves, and flowers that are important to our life. You are all important and essential to beautify our world.

Argumentative dialogue also appeared in a story which addressed the concepts "elements, compounds and mixtures". The student used evidence to support the struggle among these in the story: *Things Happen Around Us, Things Happened to Us*:

The element and the compound continued their struggle till the mixture came. The mixture said, "I am your mother, stop it and tell me why you are arguing." You are both crucial to life." The element and the compound yelled together. "How come?" "Yes, you the element, is considered the secret of the existence of life because oxygen is part of you and life cannot exist without oxygen. While you the compound, "O" the compound, you have a composite of water, and again living things can't live without water." The element and the compound were surprised to hear that they are both important. They apologized to each other and they lived happily ever after. Don't forget the importance of your mom, the mixture. Mixtures are two or more substances that are mixed together, but not chemically joined. A good example of a mixture is a salad. There are tomatoes, lettuce, cucumbers, and salad dressing all mixed together. (Extract from student's text)

Students' argumentative dialogues did not only contain argumentation, but they also included some explanations to refine knowledge, science vocabulary and concepts related to the issue/s they wanted to present.

### ***The Second and the Third Research Question***

This research aimed to help teachers reflect on the new implementation and practice of story writing and see how this experience helped them change and develop their work. In the following section, the researcher discussed the major points that were reported through teachers' reflection and discussion through the monthly meetings.



### **Writing as an instructional technique that makes students' thinking visible**

Through their reflection, science teachers revealed that the story writing experience positively influenced their instructional practices. They stated in their reflection that writing was an instructional technique that makes students' thinking visible for both the teachers and the students.

They reported that with their traditional teaching methods, students' thinking processes were often invisible; however, in story writing, students recorded their thinking processes and externalized their thoughts. Stories provided opportunities to enhance classroom discussions and thus enhance students' understanding or misunderstanding. Students' understanding was further revealed when they read their stories to their classmates and answered oral questions raised either by teachers or students. Teachers were able to identify students' knowledge and understanding of some scientific concepts mentioned in their science textbooks and explained by the teacher.

Teachers explained that stories had provided valuable opportunities for them to check their students' understanding. Students' stories helped teachers identify students' misconceptions or misunderstandings. For example, in one of the dialogues that occurred between one of the students and the science teacher, the dialogue goes like this:

The Teacher: When do plants breathe?

Ali: At night.

The teacher: Why do you think plants breathe at night?

Ali: You said that we should not sleep in a room full of plants because they breathe in the oxygen and breathe out the carbon dioxide?

The teachers: Students, do you think plants breathe at day time?

Ali: I don't think so.

The teacher: Do human breathe day and night?

Ali: Yes, or they die. (Extract from classroom dialogue)

Fostering students' thinking was important in this research. Therefore, helping students visualize their thinking was achieved through discussion of students' stories. Students not only explained their thoughts aloud, but they also listened to other students explaining, interpreting, elaborating and justifying their thinking. Generally, students were able to explain and interpret their ideas and justify the way they present the science concept in their stories. In Ritchhart and Perkins (2008) study "*Making Thinking Visible*", they emphasize that, "When learners speak, write, or draw their ideas, they deepen their cognition" (p. 57). They also argue that, "Fostering thinking requires making thinking visible" (p. 58). In this project, writing made students' thinking visible and available for questioning, reviewing, modifying and finally publishing on their classroom walls. Writing provided immediate and long term feedback because the written product was visible and available for reviewing, modifying and revealing students' understanding.

### **Stories and authenticity for developing skills (including Reading and Writing skills)**

Teachers illustrated in their reflections that although writing is a difficult and complex skill, it is one of the most powerful and effective skills that students need to support their development and advancement in the current context. From the early stages of school, the Palestinian curriculum emphasizes the mechanics of writing: handwriting, spelling, sentence construction, and then move to building a paragraph. The curriculum moves from controlled writing activities, to guided and in very later stages to free writing. However, students need more opportunities to write during school time in order to develop their writing skills. In other words, students need dedicated instructional time to learn the skills and the strategies essential to become good writers (Graham & Sandmel, 2011; Tracy, Reid & Graham, 2009).

In Palestinian schools, cross curricular writing instruction is currently not implemented. Teachers believe that developing writing skills is the responsibility of language teachers, though it should be seen as a shared responsibility with teachers in other curriculum areas. Lately, the MoEHE has emphasized the importance of incorporating writing in all subject areas to improve and develop students' writing skills.

At this elementary stage, teachers emphasize oral skills and the mechanics of writing rather than creative writing. As a result, students do not have enough experience in writing creative stories. However, teachers pointed out that science story writing contributed to developing a variety of skills, including reading and writing skills. To some extent, students showed good skills in organizing their ideas and conveying their intended meaning through their written stories. Many students arranged their thoughts logically and effectively. The writing was structured with a beginning, middle and end. Students were aware that they were writing for an audience (their teachers, classmates and sometimes their parents). In some of the stories, students were not only writing to convey scientific information and concepts, but also to express feelings, points of views and beliefs. For example, one student wrote:

Patient: I have a severe pain in my stomach and I cannot sleep at all.

The doctor examines the patient and says: you are suffering from severe stomach ulcer and an urgent operation must be done.

Patient: I will do the operation to get rid of the severe pain.

The doctor opens the membrane of the stomach and what surrounds from the infected parts of the digestive system  
Pharynx: Do not be afraid wounded stomach you will be healed!

Stomach, crying: what kind of healing with this greedy man who eats tons of food and soft drinks....

The stomach always reminds people with these precious words: We are in your hands humankind, so don't bother us with a lot of food you eat and with your laziness. Eat balanced diet and play sport. Remember God's words:

(Eat and drink, but do not exceed or waste. God does not love the wasters)." (Extract from student's text)

Many skills were enhanced during the project as students were required to read stories, listen to stories on You Tube, to plan,

draft, share, revise, edit and then write and publish their stories through presentations. Questioning skills were also improved as a result of the project. Stories fostered inquiry skills. This was revealed because students have since raised further questions which were included in some of their stories. In the story Nature Speaks its Power the student finished his story by writing, "Instead of quarrelling my dear, think of why is the earth's outer core is liquid while its inner core is solid? Can you explain this?" The crust and the mantle felt ashamed and decided to think about the answer instead of quarrelling."

The data showed that Meaningful learning happened through reading, writing, and questioning. Students were engaged in authentic activities and had more control on their own learning processes. The data also showed that writing was an effective, powerful approach to develop students' skills as writing about science concepts not only helped students take an active role and be involved in the learning process. Story writing allowed students to express themselves in an unlimited way. Stories let students' minds be more creative and imaginative. Students came up with some surprising connections and ideas as revealed by their science teachers. For example, the process of digestion was explained by imagining the unseen processes of food digestion. The student described this journey that started from the mouth and ended in the waste factory (the kidney). The story goes like this:

### **The Story**

"Ahmed is a very simple man and he lives a very simple life. He usually eats from the popular Arabian cuisine like Maqlouba, Mojadarah, Mosakhan, etc. One day Ahmed desired to eat pizza, so he went to Samir's Kiosk. Samir sells pizza in the street near his home. The body wondered: What would I do with the pizza? The brain (the king) heard what had been said, and immediately shouted, I'm sending my orders to the teeth to cut the pizza and to the saliva to soften the food to help in swallowing it and to start its journey. In the mouth, food is physically changed when it is chewed by our teeth; it is also chemically changed by the chemicals in our saliva. The food then travels from the mouth to the stomach by the food tube known as esophagus. For two or three hours, food stays in stomach, where digestive juices further change it.

The pizza went to the stomach and there the pizza was a prey for the city's population (cells). A quick meeting was held and the brain (the king) sent his orders to the army (the blood) who transported the food to the city's population (cells). The cells started to analyze the food. It realized that unfortunately inside the food there were toxins. The cells still wanted to distribute the food to the residents, but residents objected, saying: How come! our enemies (toxins) enter our cities? So they held another meeting. And the result was not to allow the enemy to enter. A guard called plasma membrane stood bravely to allow the useful material to enter and prevent toxins from entering. When the useful materials entered, those who were specialized in digestion (called Lysosomes) discovered that inside it was an important source of energy and after identifying its identity, they discovered that it was called glucose sugar, which was then transferred to the power station (called mitochondrion). The mitochondria issued enzymes that interact with this sugar in the presence of an important element named oxygen. Water and carbon dioxide were released and energy necessary to the

city's population cells was provided. Finally the army, which is called (blood), transferred the toxins to the waste factories (kidneys)."

It could be concluded that science story writing was an opportunity for fourth and fifth grade students to develop many important skills in addition to enhancing and consolidating their understanding of science vocabulary, concept and information. This research also helped teachers reflect and think of the importance of implementing new effective strategies in their science classrooms.

## **DISCUSSION**

The findings indicated that students were able to comprehend and remember scientific vocabulary, concepts and knowledge better because of the effort they put in writing their own stories. Students who wrote stories about scientific vocabulary/concepts refer to their previously learned science knowledge (background knowledge) and also constructed new understandings. The constructed new understandings were more meaningful and more memorable for students as they worked and reworked their stories. When students produced their stories, they chose different vocabulary, worked on grammar, including the mechanics of writing (spelling, punctuation), and they organized their thoughts in dialoguing and argumentative form. These structures encouraged teachers to reflect and start promoting dialogic teaching in their science classrooms.

Promoting Productive Dialogic Teaching in Science Classrooms. Students' story structure encouraged teachers to think of how to promote productive dialogues in their science classrooms. Teachers were always encouraged to think about the authoritative approach as stated by (Mortimer & Scott, 2003) they used in their science classrooms. Palestinian teachers were also advised to think about their classroom practices as most of Palestinian science classrooms are oriented towards the teacher and not the learner (Khaldi & Wahbeh, 2002). Teachers reflected that their science classroom interactions could appear dialogic and interactive through teachers' questions and students' answers, but unfortunately, teachers are always under pressure of finishing the curriculum and getting the right answers from students. They never thought of the convergent or divergent use of their questions or the quality of the dialogues they used. They never thought of the tools for enriching communication in their science classrooms. Teachers recognized that dialogues should always support different points of views, different perspectives that lead students to be inquisitors as stated by many other researchers (Mercer, Dawes, & Staarmann, 2009). Teachers commented in their reflection. "We never thought of the importance of questions we ask and their roles in helping our students understand the science content,". McNeill & Pimentel (2010) indicate that teacher's questions are crucial to make science classes more dialogic and more interactive. Teachers in this research started to work on questioning skills and they started to ask questions that triggered students' minds. Questions like "Do the names of the planets have meaning? Do you think Earth is a good name for our planet? What other names would you like to suggest?" Why do people have different skin color? were asked.

As does Mercer and Dawes (2008), they also emphasize teacher's comments to the students' answers and responses as this allows the continuity of discourse and reconstruction of knowledge and thus help students get better understanding.

Teachers reflected that they need more practice on how to use effective dialogues and discussions to support students' understanding since the Palestinian textbooks do not provide tools for teachers on how to move from students' ideas to abstract scientific concepts. The results of the study support research indication for the increased number of advocates of the importance of dialogic teaching and learning (Alozie, Moje & Krajcik, 2010; Ford & Wargo, 2012).

According to Wells and Ball (2008), "When students pursue investigations, they develop ideas and acquire information that they want to share and debate; at the same time, the problems they encounter call for the joint consideration of alternative possible solutions. In these circumstances, students have reasons to learn the skills necessary for engaging in productive dialogue and, over time, they also develop the disposition to approach problem solving of all kinds in this way" (p. 270).

Promoting Productive Dialogic Activities (Role Play-Drama). Dialoguing stories helped both teachers and students recognize the variety of activities that could be implemented through these dialogues, i.e., working in groups, role playing, dramatization and drawing. In other words, dialoguing stories were stimulus to other interesting activities that acted as optional repertoire for teaching and as an additional means for consolidating students learning.

For example, in the story "Journey into the Depths", Ibrahim and Mahmoud, who were in fifth grade, worked together in creating their story and then dramatized to the class. They wrote and said:

"Ibrahim is a computer scientist. He used to sit alone and think. He always wonders about the huge amount of money that people spend for space exploration while many people are starving to death. "What can I do by myself to discover the depths of the earth instead of spending a lot of money to discover space ...." (Extract from student's text)

Several authors (Hardman, 2008; Mercer & Dawes, 2008; Pimentel & McNeill, 2016) emphasize that when students try out ideas together and use dialogue language to think together, they are more likely to interact and be more productive. Working in pairs or in groups reduces the amount of teachers' interventions and assign more responsibilities for students autonomy in processing information (Walcyn, 2002). Dunne (2006) emphasized that teachers can bring the story alive through the various activities that could be implemented.

Writing helped teachers diagnose students knowledge gaps and misconceptions or misunderstanding, especially when they read their stories to their peers and to their teachers. Some misconceptions and misunderstanding appeared when students wrote about the digestive system. Some students thought that stomach is the only body part that is responsible for digesting food. Some students did not understand that digestion starts in the mouth, where the salivary amylase, the digestive enzyme, acts on the starch in food. Proteins are digested in the stomach

while water and minerals are absorbed into the bloodstream in the large intestine. Some students thought that the digestive system has two outlets, one for the feces and one for urine. This is a misconception since the digestive system has one outlet - the anus through which the undigested food is discharged from the body.

Writing enabled students to express their intellectual and emotional reactions to science topics in different ways. Incorporating science writing in science classrooms yielded enormous benefits for both students and teachers. Writing was not a passive skill for students, and the class was not a teacher-centered. When students wrote their stories, they were to think hard, to read and search more, to ask for more clarification and thus forcing them to be active learners who were able to develop their literacy skills. Writing about newly acquired content strengthens understanding, and allow students to make connection with prior learning. The writing process forced students to face and seek help with concepts that cause confusion. Writing enhanced retention, and enhanced development of science vocabulary. This was revealed through teachers' oral discussion and the results of students' tests. Teachers' feedback and interaction with students helped students improve their writing skills in addition to the increase in science knowledge and understanding.

Like any instructional intervention, not all students benefited to the same degree from this experience of writing in science classrooms. This was affected by students past experience, enthusiasm, motivation, and disposition toward using writing as a mode of learning and consolidation of scientific vocabulary/ concepts. However, teachers asserted that the use of writing as to improve the reading and writing skills encouraged students to make connections between the conceptual framework and the supporting content knowledge. In Palestine, we always need to focus on challenges facing Palestinian teachers in changing instructional practices, adopting a focus that is much more on the concepts of the topic, rather than only the content of the unit in the science textbook. It could be argued that reading and writing to learn science took place effectively in this project as revealed by teachers' reflection.

Reading and writing activities helped students cover science content in greater depth and thus supporting active, constructive learning, inquiry, and problem solving. This is supported by (Klassen, 2009; Muth., *et al.* 1988) who emphasize that the skills of reading and writing can serve as dynamic vehicles for learning science meaningfully and purposefully.

Data revealed that teachers developed and improved their instructional practices in science classrooms in this research to improve teaching in a supportive environment. Teachers' participation in critical reflection activities helped teachers view themselves as continuously learning and professionally growing. They realized the importance of adopting new strategies and teaching instructions in their science classrooms. They became more committed to students learning and understanding. One of the teachers commented in her diary by writing,



“I think writing science stories have greatly improved my students’ writing. It has given me the support to provide my students with story writing that both strengthen their scientific understandings and their reading and writing skills.” She continued,

“I see real growth in my students’ abilities. They were able to put their thoughts down on paper with some imagination and connection with their real life situations. I would never have thought that I would love and enjoy teaching science as this year. I feel that reading students’ science stories aloud in a classroom allow me to teach the concepts more efficiently.”

Reading and writing are important skills that should be developed in different means and science could be an opportunity to develop these skills that are essential to cope with the development of the twenty first century.

### ***Implications for Palestinian Early Childhood and Elementary Education***

Teachers identified the implications of this project on Palestinian early childhood education and elementary teachers’ professional growth by linking teacher reflection with understanding science education. Science teachers believe that they should start applying reading and writing science stories from earlier stages as this might help students be more creative and productive as stories could be used as a process of inquiry based learning. Students at the very early stages in Palestinian schools should therefore listen to a large number of stories, read by their teachers and parents. Younger learners could be asked to draw stories related to science concepts using their imagination, because at the earlier stages they may not be able to write.

Palestinian students in the elementary stages should be more engaged in learning to view the world more scientifically. Students at this stage are curious to discover and learn about their world. They need to observe, collect, organize and have more chance for hands-on activities. Discovering everything by direct experience is a real challenge in Palestinian schools because of the lack of resources, but at the same time, teachers could use stories about people making discoveries and inventions. Teachers can introduce science stories that help students understand scientific vocabulary/ concepts and at the same time encourage them to create their own. These created stories can be used to illustrate students’ understanding and their different kinds of views about the world.

### **Recommendations**

The following recommendations are based on science teachers’ reflection on the implementation of story writing and its impact on their students’ understanding and their own professional development. The recommendations address the following sectors, Palestinian Schools, the Palestinian Curriculum Development Center (PCDC), the Ministry of Education and Higher Education (MoEHE) and the National Institute for Educational Training (NIET), the teachers’ instructions, and researchers.

#### ***Palestinian schools***

Science teachers showed their positive attitudes towards the implementation of science story writing to the extent that they have the willingness to recommend it to other colleagues.

Therefore, it is recommended that the two private schools, where the research was implemented, hold several workshops for other schools in Palestine to spread the results of using “science story writing as a pedagogical strategy in the science classrooms”.

#### ***The Palestinian Curriculum Development Center (PCDC)***

Part of the PCDC is to upgrade the Palestinian educational system. Thus, it is recommended that the PCDC develop an early childhood and elementary science curriculum. The Palestinian science syllabus needs to be modified in a way that suits the inquiry nature of young and elementary learners. The activities should be presented in new, creative ways to help students process their understanding of science concepts and thus better understand the world around them.

#### ***The Ministry of Education and Higher Education (MoEHE) and***

It is recommended that the MoEHE support pre-service and in-service Palestinian teachers to help them develop their instructional practices through action research and reflection on how to enhance and reinforce students’ understanding. Teachers need some freedom and supervisory support to design activities that lead students to induce the importance of science and to create positive attitudes towards science learning. Such activities would aim to help students see how science is connected to their near environment and to their real world.

#### ***The National Institute for Educational Training (NIET)***

Since NIET is seeking excellence in training to build the capacities of all in-service Palestinian teachers, and since they are involved in the Leadership and Teacher Development Program (LTD), it is recommended they invite the two teachers with some students to talk about their experiences and its impact on students’ understanding and teachers’ professional development

NIET is recommended to develop a pre-service training programs in cooperation with schools and universities to embrace inquiry-based instructional approaches in science classrooms in the future.

#### ***Instructional recommendations***

It is recommended that teachers choose appropriate stories written by students in teaching particular science concepts. They can combine written with asking students to create comics using pictures and bubble dialogue boxes. It is recommended that teachers publish students’ stories on a website, Facebook page, blog, etc. to provide reference materials for other students.

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