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Teaching about the COVID-19 Pandemic: Perceptions and Teaching Practices of Elementary Science Teachers in Lebanon

By

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To my loving parents

Teaching about the COVID-19 Pandemic: Perceptions and Teaching Practices of Elementary Science Teachers in Lebanon

Dareen Nasr

ABSTRACT

The purpose of this research study was to investigate the perceptions and practices of elementary science teachers in Lebanon on teaching about COVID-19. The COVID-19 pandemic, with its links to science, politics, ethics and economics, can be classified as a socioscientific issue – an open-ended and controversial issue connected to science content. In the era of the COVID-19 pandemic, teaching about the current socioscientific issue has become prominent. An emerging field of research recommends that science teachers start educating students about COVID-19; however, it is not clear how teachers perceive teaching about it and what their teaching practices look like inside the science classroom. This study employed a survey design that drew upon a questionnaire and semi-structured interviews as data sources**.** The target population constituted 299 elementary science teachers. Participants were recruited using the snowball sampling technique. They completed a questionnaire comprising eighteen Likert-type questions. Next, follow-up, semi-structured interviews were conducted with a random sample of 20 participants. The questionnaire was analyzed quantitatively through the use of descriptive statistics. Pearson's correlation coefficient (r) was calculated to examine the relationship between the two variables of the study: perceptions and practices. The transcribed interview responses were analyzed using qualitative thematic analysis and triangulated with the quantitative analysis from the questionnaires. The findings of this study revealed that elementary science teachers have a strong belief in the importance of teaching about COVID-19 and in its role for enhancing scientific literacy. The results showed that teaching about COVID-19 is not part of the current teaching practices for most science teachers. Although this study is limited to elementary science teachers in Lebanon, the findings raise new questions for future research. Recommendations are provided to science educators, policy-makers and curriculum designers.

Keywords: COVID-19 pandemic; Elementary science; Science teachers; Socioscientific issue-based teaching; Teachers' perception; Teacher practices.

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CHAPTER ONE

Introduction

1.1. Background

The purpose of this research study is to explore the perceptions and teaching practices of elementary science teachers in Lebanon on teaching about COVID-19. The advancement in science and technology has created new challenges on people worldwide and has imposed on citizens the necessity to be scientifically literate in order to make informed decisions in responding to the current challenges (Evagorou et al., 2020; Yacoubian, 2018). Although scientific literacy has become a major goal for science education, it has different definitions, interpretations and perspectives (Zeidler, 2014). The perspective for scientific literacy adopted in this study is that scientifically literate citizens should be able to negotiate and make informed decisions in everyday situations that involve science (Sadler, 2011). This perspective on scientific literacy prioritizes science for all and not only for scientists, engineers and doctors. The goal should be to help students contribute to debates about important societal issues with links to science and technology (Sadler, 2011).

Socioscientific issues (SSI) have become important topics in science education and for achieving scientific literacy (Pitiporntapin & Lankford, 2015). SSI are defined as open-ended problems without clear-cut solutions; these solutions are informed by scientific theories, principles and data (Sadler, 2011). They require moral reasoning and challenge students' normative expectation (Zeidler & Sadler, 2008). SSI have been widely discussed in literature and have the following characteristics: (1) open-ended, (2)

controversial and (3) connected to science content (Hofstein et al. 2011; Kolsto 2001; Levinson 2006; Marks & Eilks 2010; Stolz et al. 2013). SSI can therefore be seen as problems that involve the use of science and are of interest to society, which also raise ethical and moral dilemmas (Morris, 2013). Examples of SSI exist in our daily lives such as stem cell research, environmental issues like climate change, genetically modified food, reproductive technologies, and nuclear power plants (Evagorou et al., 2020; Ozturk & Yilmaz-Tuzun, 2017).

One current SSI is the COVID-19 pandemic and how humans are reacting to it. The World Health Organization (WHO) states that a Severe Acute Respiratory Syndrome Coronavirus 2 (COVID-19) has plagued the world with about 500 million cumulative cases and over 6 million cumulative deaths as of April 2022 (WHO, 2022). According to Krishnan and Dasgupta (2020), the COVID-19 situation highlights the importance of combining good science with practical judgment to meet the needs of large populations. From a medical perspective, Virchow (n.d.) famously articulates, "since medicine has imperceptibly led us into the social field, it was the responsibility of physicians to provide the theoretical solution and politicians the actual solution of social problems" (Cocks, 2005: p.19). In other words, the COVID-19 pandemic has brought together scientists, policy makers, politicians, economists and educators to find practical solutions to this global crisis. Since the research on SSI suggests that SSI has multiple perspectives and COVID-19 has personal, social, environmental, political, ethical and scientific dimensions, COVID-19 can be presented as an SSI. To illustrate more, there are number of ethical issues that are raised because of the COVID-19 pandemic including, for example, health care rationing and vaccination (Reiss, 2020). Another example includes

the fact that due to the overwhelming numbers of COVID-19 patients in hospitals, ethical choices were made regarding who should have access to the limited resources available at hospitals such as health care ventilators and other medical equipment (WHO, 2020). In terms of politics, COVID-19 provides an opportunity for citizens to consider how democratic and non-democratic governments can differ in their responses to events (Reiss, 2020). In addition to the political and ethical components, Sadati et al. (2020) draw attention to one of the important consequences of the COVID-19 outbreak which is the worldwide creation of social anxiety (social component). In fact, many people felt that they are at risk and their society is vulnerable in facing the hazards. Therefore, Reiss (2020) presents COVID-19 as an SSI for it enables students to see how science, economics, society, ethics and politics inter-relate. He argues that "COVID-19 resources are beginning to be developed and it is certainly a topic that is relevant and likely to mobilise passions" (Reiss, 2020: p.13). Along the same lines, Tyrrell and Calinger (2020) argue that COVID-19 represents an SSI that has many different facets and societal impacts. On another level, the COVID-19 crisis is causing many controversies and debates inside science communities as it is considered as one of the prominent health and science controversies of our time (Nguyen & Catalan-Matamoros, 2020). For instance, in 2020, there was a debate among scientists over the effectiveness of wearing face masks on reducing the spread of COVID-19, and there was also a medical controversy about what the immunity to COVID-19 looks like (Mohammed, 2020). Therefore, since COVID-19 is scientific in nature and open-ended, causes dilemmas, and includes science, society and technology dimensions, it meets the criteria set by some researchers (e.g., Evren & Kaptan, 2014) for identifying socioscientific situations.

The rapid spread of the COVID-19 pandemic led to the release of many news reports that require citizens to have the ability to evaluate, interpret and contextualize information in order to make informed decisions. The COVID-19 related news require all citizens to have a reasonable understanding of the pandemic in order to make informed decisions based on evidence, thus the importance of preparing students to become scientifically literate citizens (Krishnan & Dasgupta, 2020). Since the development of scientifically literate citizens begins in the elementary school (Lewis, 2017), elementary science teachers are responsible for preparing students to such an emergency situation. Although most science teachers endorse the idea of teaching science in the context of everyday life, they hesitate to actualize the idea in their science teaching (Bryce, 2010; Witz & Lee, 2009). Therefore, teachers need responsiveness and flexibility to respond to new crisis (Kalloo et al., 2020) and should have the tendency to learn and teach about crucial SSIs in the twenty-first century. Given that COVID-19 is one of the crucial SSIs of current times, teachers have the responsibility to support students so that they better understand the outbreak (Hazen, 2020). Some researchers argue that in-service teachers should address the COVID-19 crisis in a wider global and historical context and take it as an opportunity for teaching all the different issues raised by this unprecedented pandemic (Daniel, 2020; Hazen, 2020). In an attempt to explore how science teachers are responding to the COVID-19 pandemic, this research study aims at investigating about the science teachers' practices as well as their perceptions towards teaching about COVID-19 in the elementary school.

1.2. Research Purpose Statement

The purpose of this research study is to explore the perceptions and teaching practices of elementary science teachers in Lebanon on teaching about COVID-19.

1.3. Research questions

1. What are the perceptions of elementary science teachers in Lebanon towards teaching about COVID-19?
2. How do elementary science teachers in Lebanon address COVID-19 in their teaching?
3. To what extent do the perceptions and practices of elementary science teachers in Lebanon involve using COVID-19 as an SSI?

1.4. Rationale

COVID-19 related research has shed the light on the impact of COVID-19 on teachers (e.g. Kim & Asbury, 2020) and has revealed some of the practices that cause anxiety among teachers (Talidong & Toquero, 2020). Along the same lines, many researchers have investigated the perceptions of teachers on online teaching experiences as well as the students' perceptions of the COVID-19 experience (cited in Flores & Swennen, 2020; Watson, 2020). However, few studies have been conducted to examine the teachers' perceptions on teaching about COVID-19.

As SSI have been part of the research agendas for the last two decades, researchers inform that many teachers are still not familiar with SSIs nor they are interested in teaching about them (Pitiporntapin & Lankford, 2015). Also, research studies have shown that there is little guidance given to science teachers on selecting SSI and on how to teach

them (Hancock et al., 2019). Previous research has addressed the factors affecting the teachers' practices for teaching SSI such as the lack of guidance and pedagogical knowledge as highlighted by Pitiporntapin and Srisakuna (2016); however, minimal research studies have highlighted how science teachers are addressing the COVID-19 pandemic in their science teaching. Since the beginning of the COVID-19 pandemic, the need to rapidly adapt to new contexts has revealed many changes that occurred in schools and among teachers. The effects and implications of COVID-19 on education are not yet well known. Many studies have emerged focusing on the implications of online teaching and learning practices during the COVID-19 crisis (e.g., Carillo & Flores, 2020; Kidd & Murray, 2020), yet little is known about how teachers are addressing COVID-19 in their classrooms.

Several published studies have shown how elementary and secondary pre-service science teachers are getting prepared to teach SSI (Evagorou, Guven, & Mugaloglu, 2014). Studies in this area of research have shed the light on the need for pre-service science teachers to experience the content and pedagogy of teaching SSI before they design their lessons (Evagorou, 2011). Further studies have explored the SSI teaching practices for middle and secondary science teachers (Hancock et al., 2019; Carson & Dawson, 2016). Therefore, despite the growing number of research studies that investigate how pre-service and in-service science teachers can teach SSI in middle and secondary schools (Genel & Topçu, 2016; Karkkainen, 2019; Lee et al., 2019), how in-service science teachers teach SSI for elementary students needs further inquiry.

Last but not least, SSI is an important context to educate citizens as scientifically literate people, and this is dependent on the teachers' perceptions on these issues. Based

on a review of the literature, there is a large number of research studies, across different countries, regarding the teachers' perceptions on SSI-based teaching (e.g. Nida et al., 2020; Lee, Abd-El-Khalick, & Choi, 2006). In Lebanon, minimum research has been conducted in the SSI field and the studies are limited to frameworks and instructions for teaching in the context of socioscientific issues (e.g. Khishfe, 2014; Yacoubian, 2015). Thus, investigating how Lebanese science teachers perceive teaching about SSI is needed. On another note, according to the results of the Programme for International Student Assessment (PISA), Lebanon's rank is almost at the lowest among all countries participating in PISA in the year of 2018, and the results show that students' scientific literacy remains among the lowest tier of teaching success (OECD, 2018). In order to promote students' scientific literacy, students should be involved actively in socio-scientific controversies (Sadler, 2004). Therefore, there is a need to study how science teachers are approaching SSI-based teaching in Lebanon.

1.5. Significance of the Study

To begin with, determining the perceptions of teachers in this study provides a response to the need for research on the factors that may hinder the teachers' implementation of SSI-based teaching at any educational stage. The dissemination of the study findings may contribute to research ways for a successful implementation of SSI-based teaching in educational contexts. The current study will build on and add to the existing research by explicitly exploring teachers' perceptions on teaching about COVID-19 issues and investigating how they address COVID-19 in their classrooms.

This research study will guide educational researchers on further exploring challenges, suggestions and practices for teaching emergency issues in the society. Since

COVID-19 related research is still emerging in the field of science education, the current study has the potential significance to begin filling in the gaps that currently exists in the literature: teachers' perceptions and practices on teaching about COVID-19 in elementary science classrooms.

Although elementary science teaching is an ongoing focus of concern for educational researchers, many research studies about SSI have not been directly associated with elementary school teachers. Therefore, in light of the findings of this study, new research studies might be conducted to determine and improve the perceptions and practices of elementary teachers who are responsible for preparing scientifically literate future citizens. Since this research study investigates the perceptions and practices of elementary science teachers on teaching about COVID-19, the findings might also encourage other researchers to explore a developmental path for SSI that starts in the elementary school and extends to the middle and secondary levels.

According to Zeidler et al. (2005), many people would value SSI in varied ways, so continued discussion of varied and different cultures is needed. Since the beginning of the COVID-19 in 2020, several researchers have shown interest in studying about the effects of COVID-19 on teaching (e.g. Kim & Asbury, 2020). In Lebanon, there is limited research that informs about the teachers' perceptions and practices related to teaching about the COVID-19 pandemic. Therefore, this research would make it possible for having cross cultural studies.

On a different level, this study has the potential significance to change the science teachers' beliefs and views on teaching about COVID-19 in their classrooms. Considering that the literature offers limited studies conducted with teachers to examine their

perceptions on teaching about COVID-19, this study might help identifying and increasing the SSI awareness of science teachers, who are the most important components of the teaching process. In addition, the teachers' perceptions on teaching any SSI topic is important for raising scientifically literate individuals as these perceptions affect the teachers' decision-making in science lessons preparation.

Determining the perceptions of elementary school teachers may help in evaluating the problems and views to affect their instructional practices. The current study has the potential of providing recommendations for: (1) encouraging science teachers to start their SSI-based teaching and (2) increasing other teachers' incorporation of SSI in their science classrooms. On another note, this study will give an insight in to what support elementary teachers need in order to start or improve their teaching practices of SSI, in general, and the COVID-19 pandemic, in particular.

Finally, the current study provides understandings about the ways by which Lebanese science teachers view and teach SSI in science classrooms. To the best of my knowledge, this is the first study in Lebanon that investigates the practices and perceptions of science teachers on teaching about COVID-19, so our results will provide compelling evidence about the target context. The study findings can help predict how Lebanese science teachers may respond to teaching about similar future emergencies. This will be helpful for teacher education programs in the country as teacher educators may benefit from the findings of this study to tailor pre-service and in-service teacher preparation programs.

CHAPTER TWO

Literature Review

The purpose of this Chapter is to provide insight review of the literature on what researchers in the field of science education have worked on with respect to socioscientific issues and scientific literacy. It also outlines the perceptions and practices of science teachers on teaching SSI. While this chapter reviews the emergent literature on the COVID-19 issue, it highlights the gaps that exist in this area of research.

2.1. Scientific Literacy (SL)

Based on a review of the literature, scientific literacy (SL) has been given many definitions and interpretations. Literature informs that SL is a construct examined from a community perspective in that individuals bring unique contributions and perspectives to solve issues in the society; when people make informed decisions on scientific matters, the community as a whole exercises scientific literacy (Barton & Roth, 2004). Many researchers in the field of science education have identified SL in terms of individual competencies and practices (e.g. Sadler & Zeidler, 2009; De Boer, 2000). Among these competencies and practices are (1) the ability to think critically about science and its nature, (2) independence in learning science, and (3) the ability to use scientific knowledge in solving problems (De Boer, 2000; Norris & Phillips, 2003; Sadler & Zeidler, 2009). Along the same lines, PISA (2006) also identifies SL in terms of individual competencies and practices; these competencies entail identifying scientific issues, explaining phenomena scientifically, and using scientific evidence. Accordingly, SL is

defined as the individual's use of scientific knowledge to identify questions and to acquire new understanding and the willingness to engage with science-related issues, and with the ideas of science, as a reflective citizen (OECD, 2007).

Besides describing the characteristics of SL, some research work has contributed to identifying a heuristic approach for understanding SL. Roberts (2007) proposed two visions for considering the range of ideas incorporated within the SL construct. While Vision I focuses on leaning about scientific content and processes, Vision II focuses on understanding the usefulness of scientific knowledge in life and society (Roberts, 2007; 2011). According to Vision I, the aim of science education is to help students develop understanding of scientific findings and formalisms; in contrast, Vision II emphasizes an approach that is broader in scope, involving personal decision-making about contextually embedded issues (Roberts, 2007). SL, as stated in Vision I, defines what scientifically literate individuals ought to know and be able to do. On the other side, Vision II SL is the situation that provides individuals with opportunities to use scientific ideas, processes, and reasoning in real life. Moreover, Vision II SL "derives its meaning from the character of situations with a scientific component, situations that students are likely to encounter as citizens. At the extreme, this vision can be called literacy about science-related situations" (Roberts, 2007, p.730). Romine et al. (2017) report that although educational effort has historically focused on improving Vision I SL, recently there has been greater emphasis to promote Vision II SL.

2.2. Scientifically Literate Citizens

In addition to the given wide range of meanings of SL, the history of science education suggests a variety of goals for teaching science; among these goals is teaching

students to be informed citizens or scientifically literate citizens (De Boer, 2000). To begin with, the term literacy, adopted by UNESCO, involves "a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society" (UNESCO, 2004, p.13). This implies a building up of capacities for being a citizen by enabling people to access, interpret and critically evaluate information and knowledge (Arnason, 2013). Drawing upon this understanding of literacy, De Boer (2000) and Arnason (2013) state that scientifically literate citizens should demonstrate the ability to evaluate the quality of scientific information on the basis of its sources and the methods used to generate it. Along the same lines, Miller (2004) describes a scientifically literate citizen as someone who has the ability to read and comprehend scientific information written at a particular educational level.

Furthermore, many researchers agree that scientifically literate citizens can contribute to the success of a democratic society (e.g. Arnason, 2013; De Boer, 2000; Leydet, 2006). In a democratic society, Bellamy (2008) and Leydet (2006) argue that every citizen is partially responsible for public policy. Using a deliberative democratic perspective, they state that scientifically literate citizens should be actively involved in the process of decision-making. The literature is rich in lists of roles that scientifically literate citizens are entitled to play, yet many researchers have only focused on the active role that these citizens have to practice in their society (e.g., Arnason, 2013; De Boer, 2000; Leydet, 2006; Rose & Novas, 2004). To illustrate more, Arnason (2013) and De Boer (2000) propose that scientifically literate citizens should be participating in conversations about matters of common concern and developing an understanding of the

way decisions regarding them are made in society. Also, Arnason (2013) hoped that when citizens are actively engaged in policy making, they can be willing to revise their individual preferences in the light of information and arguments. Consequently, based on the research findings of De Boer (2000), Leydet (2006) and Arnason (2013), actively engaged citizens will broaden their perspectives on important issues in the society, deal intelligently with science-related social issues and make informed decisions that benefit their community.

2.3. Socioscientific Issues (SSI)

Since one of the goals of SL is to prepare students to make more rational and informed decisions around issues involving scientific concepts (Sadler & Zeidler, 2005), science education for the promotion of SL should entail engaging students in socioscientific situations (Zeidler, 2014). Socioscientific issues (SSI) have become a prominent theme within the science education literature, as many researchers and scholars have been investigating and examining this field for more than a decade (e.g. Kolsto, 2001; Sadler, 2004; 2011; Sadler & Zeidler, 2005; Zeidler et al. 2005). Sadler (2004) defines SSI as controversial social issues with conceptual and/or procedural links to science and emphasizes that these issues are open-ended without clear-cut solutions (Sadler, 2011). Forbes et al. (2007, 2008) describe SSI as those that exist at the intersection between science and the broader social context in which the products and processes of science are situated. Examples of SSI include stem cell research, evolution, nuclear plants, and climate change (Evagorou et al., 2020; Forbes et al., 2007, 2008). Along the same lines, Zeidler (2014) provides several characteristics for SSIs; among these characteristics are (1) controversial and ill-structured problems that require scientific, evidence-based

reasoning to make informed decisions and (2) social ramifications for scientific topics that require students to get involved in dialogue, discussion, debate, and argumentation.

2.3.1. SSI framework

This research work in the science education field is situated within an SSI framework (Sadler & Zeidler, 2009) that builds on perspectives informed by psychological, sociological, and developmental theory (Zeidler & Keefer, 2003). In their SSI framework, Sadler and Zeidler (2005) describe the following about SL: (1) scientific literacy ought to be a goal for all students; (2) science education should provide opportunities for learners to experience science in contexts similar to the contexts that they may confront in their lived experiences outside the school experience; and (3) when educators want to use real world issues related to science, they should separate the elements of the science issues from the boundaries of traditional science. In light of this framework, Sadler and Zeidler (2005) report that students will approach socioscientific issues with diverse perspectives that integrate science and other considerations.

Scholars have further developed different structures for the SSI framework. To begin with, Fensham (2012) proposed a scheme based on *Cynefin* framework that is based on two elements: the certainty in science and the level of human risk involved. Simple case, complicated, complex and chaos are the four categories of this framework. An example from the Complicated SSI category is a heart bypass surgery since the human risk involved in this case is low to medium, and the application of established knowledge from several science disciplines is involved (cited in Hancock et al, 2019). In response to classroom-based SSI research (Sadler, 2011), Presley et al. (2013) proposed a framework for SSI-based instruction. The first core element for this SSI framework is the design

elements that contains some essential features: (1) the SSI-based instruction should be related to a social issue with some connection to science, (2) it should be grounded in real world contexts, and (3) SSI-based instruction should engage students in argumentation and decision making (Presley et al, 2013). Besides the design elements, there are learner experiences that students should be engaged in an SSI-based instruction. The second core aspect of the SSI framework requires learners to be engaged in higher order practices and to confront scientific ideas and theories related to the science issue discussed in the classroom (Presley et al, 2013). Along with the design elements and the learner experiences, the third core aspect in the framework describes some teacher's attributes. Presley et al. (2013) conclude that in order to effectively implement SSI-based instruction in the classroom all these aspects should be considered.

2.3.2. SSI Education and Socioscientific Decision Making

To begin with, SSI education is primarily affected by the teacher's knowledge and perceptions about teaching socioscientific issues in science classes (Lee et al., 2012). Since SSI is multidisciplinary in nature, Forbes et al. (2007, 2008) argue that many science teachers do not have the subject matter knowledge across disciplines. Due to the fact that subject matter knowledge is an important factor for student socioscientific decision making, Forbes et al. (2007, 2008) claim that it is relevant for teachers' interactions with curriculum materials in which they are addressed. Along the same lines, Sadler et al. (2006) describe a value neutral approach that many middle and secondary school teachers adopt. This approach has content oriented learning objectives and involves teachers teaching science facts for students. Therefore, according to Sadler et al. (2006), students will perceive science as "ready-made science" and won't be encouraged to participate in

making decisions about issues related to science and society. Based on the findings of Forbes et al. (2007, 2008) and Sadler et al. (2006), the teacher's belief on the importance of SSI education affects the way they address socioscientific issues in the classroom; hence, it shapes the students' socioscientific decision making.

Given that one of the goals of SL, in science education, is to help students make informed decisions on science related issues (Sadler & Zeidler, 2005), Sutter et al. (2018) report that SSI and structured decision-making frameworks can help students reach these goals. Research informs that the teachers' use of structured-decision making tools in a classroom will help students in understanding and analyzing complex SSIs and remaining objective when taking a stance in any controversial issues (Sutter et al., 2018). In further research on SSI education, Chung, Yoo, Kim, Lee, and Zeidler (2016) argue that the discussion of controversial socioscientific issues result in increasing the positive attitudes of students towards science and the ability to understand the ideas of others and to value their perspectives. Pelch et al. (2017) argue that students' attitude towards the relevance of socioscientific issues to their lives affect their decision making to pursue a certain career. Based on the findings reported by Pelch et al. (2017) and Sutter et al. (2018), there is a lack of literature about the relationship that exist between teaching scientific literacy, socioscientific issues, and students' interest.

2.4. Frameworks for Teaching SSI

In an attempt to design a research-based framework for SSI education, Zeidler et al. (2005) inform that as SSI education aims to promote the individual intellectual growth in moral and ethical issues and their awareness to the interdependence between science and society. It doesn't only serve as a context but rather a pedagogical strategy with clearly

defined goals. For this purpose, Zeidler et al. (2005) identified four pedagogical areas that are central to SSI teaching: (1) nature of science issues, (2) classroom discourse issues, (3) cultural issues and (4) case-based issues. To begin with, nature of science issues put an emphasis on students' epistemological understanding as they pertain to decisions regarding SSI (Bell, 2004; Bell, Lederman, & Abd-El-Khalick, 2000). Along the same lines, Yacoubian (2015) argues that developing future citizens' understandings for the nature of science is necessary for fostering scientific literacy and for making critical decisions on socioscientific issues. Besides nature of science issues, Zeidler et al. (2005) claim that classroom discourse is crucial in developing students' views about science through argumentation in the constructions of shared social knowledge via discourse about SSI. Also, the cultural aspect is a pedagogical area that highlights pluralistic and sociological aspects of science classrooms. Many researchers agree that cultural issues are important for educational experiences related to SSI as they consider the inclusion of ethics in their teaching a matter of high priority (e.g. Barett & Nieswandt, 2010). The last pedagogical area suggested in Zeidler's framework is the case-based issues that involves students with issues that contribute to fostering their critical thinking skills and moral and ethical development (Zeidler et al., 2005). Research studies, involving example cases of the construction of nuclear power plant, importation of genetically modified seeds, and legal practice on antibiotic use, strongly suggest that curricula using such issues provide an environment where students become engaged in discourse and reflection that affect cognitive and moral development (Evren-Yapicioglu,2018; Zeidler et al., 2005).

Socioscientific teaching and learning (SSI-TL) has been suggested as an effective approach for supporting SSI teaching (Sadler et al., 2017). In the SSI-TL framework,

Sadler et al. (2017) propose that students should first be introduced to a focal issue in order develop awareness of the

social issues and problems that emerge from the issue. Then they begin to be engaged with disciplinary core ideas (DCI), crosscutting concepts (CCC), and science practices (SP) that define the issue while reasoning about the societal influences that make the issue complex and difficult to resolve (Sadler et al. 2017). The final phase of the sequence calls for students to synthesize ideas and practices they have encountered and engaged with throughout the unit (Sadler et al., 2017).

2.5. Perceptions of Teachers on Teaching SSI

Since science teachers represent a considerable asset in applying SSI into authentic practices, literature has shed the light on teachers' perceptions on teaching SSI. Many researchers have investigated the perceptions of science teachers on teaching socioscientific issues in order to reveal how epistemologically science teachers understand science and its role in people's lives (e.g. Alamri, 2017; Lee at al., 2006; Ozturk & Erabdan, 2019). A study conducted by Lee et al. (2006) indicates that SSI-based teaching helps students make informed decisions. Another study by Simonneaux (2008), reveals that it helps them develop their critical thinking skills. Along the same lines, Nida et al. (2020) argue that SSI-based teaching helps students increase competency development and character formation. Based on the findings reported by Simonneaux (2008), Nida et al. (2020) and Lee et al. (2006), we can conclude that SSI-based teaching helps students make informed decisions, develop their problem-solving and critical thinking skills, and increase their competency development and character formation.

The literature shows that science teachers face difficulties when teaching SSI in science classrooms (Nida et al., 2020; Ozturk & Yilmaz-Tuzun, 2017). To begin with, research findings inform that science teachers find teaching socioscientific issues to be challenging due to the following factors: unavailability of supporting materials, lack of students' competencies and the teacher pedagogical experience, and the challenge in incorporating student-centered teaching practices (Bosser et al. 2015; Nida et al.,2020; Ozturk & Erabdan, 2019; Saunders & Rennie, 2013). As noticed by Misco and Tseng (2017), a clear lack of attention to social studies education exists as well as a clear neglect of controversial issue instruction within preservice education. Along the same lines, research reports that science teachers have been resistant to teaching socioscientific issues (Lazarowitz & Bloch, 2005; Lee & Witz, 2009; Misco & Tseng, 2017). Many reasons were proposed to explain this phenomenon including the limitations of assessment and curriculum techniques and the teachers' lack of support for the merits of SSI discussions as relevant to specific learning subjects (Aivelo & Uitto, 2019; Gray & Bryce, 2006). In addition to this, the role of high-stake exams and the seductive hold of textbooks have led to few opportunities for discussing socioscientific issues in science classrooms (Misco & Tseng, 2017). Similar research studies have also investigated the challenges that teachers face when teaching SSI; among them is the interdisciplinary nature of SSI, which puts high demands on teachers' knowledge and the challenge in promoting and assessing the quality of socioscientific argumentation (Christenson et al., 2016; 2017; Simonneaux, 2008).

In response to the above challenges mentioned in the literature, some scholars have shown interest in exploring teachers' suggestions on teaching SSI (Alamri, 2017; Ozturk

& Erabdan, 2019). Some science teachers suggest that teaching SSI should be performed outside of the classroom and that students should learn SSI with experts as they believe that learning these issues is only possible by applying them in real life (Ozturk & Erabdan, 2019). Other science teachers proposed that there should be adequate support material and sufficient in-service education on SSI-based teaching provided to them (Hancock et al.,2019; Ozturk &Erabdan, 2019). Although science teachers face challenges in teaching SSI, many of them acknowledge the important role their own perceptions and beliefs play in helping students negotiate these issues in the classroom (Forbes & Davis, 2007, 2008).

2.6. Science Teachers' Practices in SSI-based Teaching

The literature on science teachers and SSI has not only focused on teachers' perceptions but also on their practices in teaching SSI for elementary and high school levels. Regarding the teachers' practices on teaching SSI, the teacher knowledge structure such as pedagogical knowledge has been the research focus for many scholars in the field (e.g., Bausmith & Barry, 2011; Owens et al., 2019).

To begin with, some research studies suggest that science teachers should be guiding students in developing habits of mind that employ skepticism when making arguments about SSI using various forms of media, as they consider this teaching practice to be crucial to the successful enactment of SSI instruction (e.g. Owens et al., 2019). In fact, Zeidler et al. (2005) and Owens et al. (2019) agree that learning about and resolving SSI require analysis and evaluation of a variety of perspectives and resources, so students are required to question and evaluate the truthfulness of any sources of news they receive (Zeidler et al., 2005). According to the National Research Council (2000), it is generally important to employ skepticism when considering the claims that result from any

scientific issue, therefore doing so is particularly important when considering information regarding SSI (Owens et al., 2019). Owen's (2019) study suggests another teaching practice that serves to enhance students' ability to engage in the informed negotiation of argumentative issues about which they must be able to make decisions informed by an understanding of science and science practice (Owens et al., 2019). This teaching practice includes fostering a classroom community and increasing learners' participation in science practices. In the case of engagement in the negotiation of socioscientific issues, where the ill-structured nature of problem contexts introduces uncertainty and doubt, Owens et al. (2019) advise science teachers to help students enhance their understandings of scientific knowledge as new problem contexts present themselves such as those represented by SSI.

Another line of research has been exploring ways in which science teachers use mass media for addressing socioscientific issues (Hobbs & Jensen 2009). Scholars suggest that using media in science classrooms can "provide more authentic educational experiences for students when combining the educational objectives of science educators with media literacy experiences" (Hobbs & Jensen, 2009, p. 8). Studies involving researcher interventions have showed the following results: (1) teachers make use of newspaper and television news to highlight socioscientific issues, (2) teachers and students can access articles that focus on socioscientific issues, and (3) students are capable of analyzing the scientific concepts presented in media as demonstrated by their ability to identify the related scientific concepts and intended message of the media (Almqvist & Ostman, 2006; Kachan et al., 2006; Klosterman et al., 2012). In his study about science teachers' use of media to explore socioscientific issues, Klosterman (2012) advises teachers to use

mass media to help students explore SSIs. Although many teachers tried to use mass media for students to explore SSIs, Klosterman (2012) has reported that the teachers' use of frameworks that align with SSI-based teaching was limited. On the other side, Pitiporntapin (2015) suggests using social media to promote pre-service science teacher practices of SSI-based teaching. Pitiporntapin (2015) proposes some social media strategies for promoting the implementation of SSI-based instructions. These strategies include: (1) providing empirical examples for their holistic views of SSI-based teaching, and (2) providing a friendly atmosphere for increasing their reflection in order to reduce the problems about SSI-based teaching. In conclusion, based on the findings of Owens et al. (2019), there is a need to help teachers develop a full collection of teaching practices that contribute to the successful implication of SSI instruction.

As a result of many research studies piloted in the field (e.g. Sadler, 2009; Klosterman, 2012; Thoman & Jolls, 2004), it can be concluded that the teacher practices focusing on the analysis and evaluation of media that addresses socioscientific issues are limited. Therefore, teachers should start engaging students in media literacy practices such as accessing, analyzing and evaluating media relative to SSI since these practices are essential for fostering decision making that will lead in developing scientific literacy.

2.7. COVID-19

2.7.1. COVID-19 as a Socioscientific Issue

In articulating their vision for K-12 science education, the *Next Generation Science Standards (NGSS)* (NGSS Leads States, 2013) states in their opening statement that

"never before has our world been so complex and science knowledge so critical to making sense of it all. When comprehending current events, choosing and using technology, or making informed decisions about one's healthcare, science understanding is a key" (NGSS Leads States, 2013: p.1). In January 2020, WHO reported that Chinese state health authorities had determined that an outbreak caused by a novel coronavirus, produced a disease that subsequently became known as COVID-19 (WHO, 2020). By March 2020, WHO had classified the outbreaks of COVID-19 as a global pandemic (Ellis et al., 2020).

Reiss (2020) discusses that COVID-19 provides students with an opportunity to see how science, politics, ethics and economics interrelate, and broaden their understanding on the implications that COVID-19 has on different society levels. First, according to Mykhalovskiy and French (2020), COVID-19 is a crisis on the public health, so policy makers have introduced the notion of the "politics of prevention" as an attempt to reduce the likelihood of future harms. Second, as COVID-19 poses an extraordinary global health threat, so people need to take the vaccine; therefore, many ethical issues related to vaccination are raised (Mykhalovskiy & French, 2020). The arising human challenge studies that evaluate the vaccine safety and efficacy still involve risks on the participants, so Jamrozik and Selgelid (2020) warn that there is a need for a consultation with scientific experts and prospective participants in order to determine the extent to which their residual risks are acceptable and ethical. Third, COVID-19 had its negative huge impacts on the world economy; for instance, since transport was limited and even restricted among countries during the COVID outbreak, this has slowed global economic activities (Gupta et al., 2020). To sum it up, based on Zeidlar and Khan's (2014) characterization of SSI,

the complex, multidisciplinary and controversial nature of COVID-19 presents it as a socioscientific issue (Reiss, 2020; Zeidlar & Khan, 2014).

2.7.2. Teaching about COVID-19

Focusing on COVID-19, teachers can refer to the history of science for helping students better understand the emerging socioscientific issues and appreciate how science is undertaken (Reiss, 2020). As science educators have no other choice but to move curricula into a new era of contextualized science, students want to have a say in local and global issues (Zeidlar & Khan, 2014). Research suggests that teachers should help students understand the global implications of scientific decisions in terms of the economic, political, socio-logical and ethical impacts, and that they should approach teaching science in a context that is meaningful to students' lives and requires students to consider the ethical implications of their decisions (NGSS, 2013; Zeidlar & Khan, 2014). At present COVID-19 resources are beginning to be developed; therefore, science teachers should make use of the history and sociology of science to teach about COVID-19 and promote for scientific literacy (Reiss, 2020).

Overall, it seemed that the previous studies had looked into the teaching practices and perceptions of science teachers on teaching SSI, yet they didn't seek to deeply understand phenomena underlying these practices and perceptions. Also, many researchers have conducted studies on different socioscientific issues, but to date, no study has tasked to investigate how teachers (1) approach COVID-19 teaching and (2) perceive teaching about COVID-19 as a socioscientific issue.

CHAPTER THREE

Methodology

The following chapter describes the research method used to investigate the perceptions and teaching practices of elementary science teachers in Lebanon on teaching about COVID-19. The chapter sections are research design, participants, instruments, procedure, data collection and analysis, validity and reliability, and ethical considerations. This study is guided by the following three research questions:

1. What are the perceptions of elementary science teachers in Lebanon towards teaching about COVID-19?
2. How do elementary science teachers in Lebanon address COVID-19 in their teaching?
3. To what extent do the perceptions and practices of elementary science teachers in Lebanon involve using COVID-19 as an SSI?

3.1. Research Design

This study employed a survey design which aimed to investigate the perceptions and practices of elementary science teachers on teaching about COVID-19 in Lebanon. In order to elucidate the research questions, a questionnaire and semi-structured interviews were designed. The study employed a questionnaire that serves for gathering information from a sample of the target population: elementary science teachers in Lebanon. Follow-up interviews were carried out with a random sample of twenty teachers from the participants, for the purpose of gaining a deep insight into the teacher perceptions and

practices on teaching about COVID-19. Responses derived from the questionnaires were analyzed using quantitative statistical methods; whereas, interview responses were analyzed through the use of qualitative thematic analysis.

3.2. Participants

The target population for this research was elementary science teachers in Lebanon. The major criteria for selecting participants were that (a) they're elementary teachers, (b) they teach science, (c) they teach in private schools in Lebanon, (d) they teach in schools with English being used as the language of instruction of science, and (e) they are experienced teachers who spent at least three years in teaching science at the elementary level. The process of recruiting participants followed the snowball sampling method. The snowball sampling is a purposeful method of sampling and it is recommended when working with the attendees of educational programs (Ghaljaie et al.,2017). Through the use of snowball sampling method, 304 elementary science teachers in Lebanon filled the questionnaire. At first, 100 teachers were reached through personal connections, then these teachers were asked to share the questionnaire with other teachers they know or they work with. After receiving the questionnaire responses, the 5 participant responses that did not meet with the research criteria were eliminated. Therefore, the total number of elementary science teachers who participated in this study is n= 299.

The research quantitative data was collected over a period of six months starting from August 2021 and ending in January 2022. The demographic data collected was based on the following criteria: year of birth, gender, number of years of teaching experience, number of years of science teaching experience and that of science teaching experience

at the elementary level, highest educational degree attained, their major in the Bachelor's degree/License, and their district areas.

Table 1 below shows the total number of elementary science teachers who participated in this study (n=299) out of which n1 = 275 (approximately 92%) are females and n2 = 24 (approximately 8%) are males. It also shows that participants come from different age groups and have diverse educational backgrounds. Participants were recruited from all geographical locations in Lebanon as shown in Table 2.

Table 1. Demographic Characteristics of the Science Teachers.

Aspect	**Profile**	**n**	**%**
Gender	Female	275	92%
	Male	24	8%
	TOTAL	299	100%
Age	Below 25 years old	25	8 %
	26-30	69	23%
	31-35	104	35%
	36-40	58	19%
	Above 40 years old	43	15%
	TOTAL	299	100%
Highest Educational Degree	Bachelor Degree /License	180	60%
	Master's Degree	79	27%
	Bachelor Degree and Teaching Diploma	31	10.5%
	High school	4	1%
	Vocational and Technical Education	3	1%
	Other	2	< 1%

TOTAL	299	100%

Table 2. Distribution of the Science Teachers across Districts in Lebanon.

(n=number of participants)

District	N	%
South Lebanon	91	30%
Beirut	75	25%
Mount Lebanon	78	26%
Bekaa	29	10%
North Lebanon	26	9%
TOTAL	299	100%

As shown in Table 3 below, the majority of teacher participants (n=106) have 10-15 years of teaching experience. Table 3 displays that the majority of participants (n=95) have 3-5 years of science teaching experience. As for the science teaching experience at the elementary level, most teachers (n=108) have 3-5 years of experience.

Table 3. Number of Years of Teaching Experience, Science Teaching Experience, and that of Science Teaching Experience at the Elementary Level.

		N
Number of years of teaching experience	3-5 years	70
	6-9 years	82
	10-15 years	106
	Above 15 years	41

Number of years of teaching science experience	3-5 years	95
	6-9 years	87
	10-15 years	93
	Above 15 years	24
Number of years of science teaching experience at the elementary level	3-5 years	108
	6-9 years	94
	10-15 years	77
	Above 15 years	20

Of the 299 questionnaire responses, 40 volunteered to participate in the interviews yet only 20 responded to the interview invitation.

3.3. Research Instruments

3.3.1. Questionnaire

The questionnaire (see Appendix A) was divided into three sections: demographic information**,** the Likert-type items, and the teacher contact information for the interview. The main part of the questionnaire addresses the teachers' perceptions and practices toward teaching about COVID-19. The questionnaire was piloted with a randomly selected group of 9 teachers to guarantee the clarity of the instrument before the study. These teachers were not part of the main study. After piloting the questionnaire, the definition, given in the questionnaire, to the socioscientific issues term was simplified. No other changes were made to the questionnaire.

In the first section, the respondents were asked to describe their educational backgrounds, including the teaching qualifications and the science teaching experience. The second section of the questionnaire comprised 18 five-point Likert-type. The Likert-type items were adapted from extant instruments which were developed to identify science teachers' practices and perceptions on teaching SSI (e.g. Kara, 2012; Lee & Abd-El-Khalick, 2006; Owens & et al., 2019; Sadler et al., 2006; Tidemand & Nielsen, 2017). The only modification made to these items was replacing the SSI example with COVID-19. The content and emphasis of these selected items were related to some major themes and issues identified in the SSI literature (e.g., Ozturk & Erabdan, 2019; Ozturk, 2017; Nida et al., 2020; Genel & Topçu, 2016) as relevant to teaching about COVID-19. These items range on a 5-point scale (5,4,3,2,1) where "1" represents strongly disagree, "2" disagree, "3" neither agree nor disagree, "4" agree and "5" strongly agree, and "NA" represents not applicable. Participants choose the degree of agreement corresponding to each question (Welkenhuysen et al., 2003).

The Likert-type items in the questionnaire address three main areas: (1) the teachers' perceptions on teaching about COVID-19, (2) their practices in teaching about COVID-19, and (3) their perceptions and practices on teaching about COVID-19 as a socioscientific issue. Six out of the eighteen items (items 1, 2, 3, 4, 5 & 6) concern with the teachers' perceptions on teaching about COVID-19 (adapted from Lee et al., 2006; Kara, 2012; Sadler et al., 2006). In this area, teachers were asked to rate their perceptions on the following: importance of teaching about COVID-19, role of COVID-19 in enhancing scientific literacy, their readiness for teaching about COVID-19 and their belief on the readiness of elementary students in learning about COVID-19 (see Appendix A).

Another group of the Likert-type items (items 7, 8, 9, 10, 11, & 12) address the practices of elementary science teachers in teaching about COVID-19 (adapted from Ceyhan et al., 2019; Kara, 2012; Lee et al., 2006; Owens & et al., 2019; Tidemand & Nielsen, 2017). The purpose of these items is to provide an overall sense of the teachers' preferred practices for teaching about COVID-19. For instance, participants were asked to rate on the Likert-scale (a) their various teaching strategies and (b) the scientific practices they use in their COVID-19 teaching. Another area of focus in the survey is related to the teacher class time management during the COVID-19 teaching sessions. The remaining six items (items 13, 14, 15, 16, 17 & 18) are related to the teachers' perceptions and practices on teaching about COVID-19 as a socioscientific issue (adapted from Lee et al., 2006; Owens & et al., 2019; Tidemand & Nielsen, 2017). Participant teachers were asked to evaluate on the Likert-scale their practices in (a) making connections between COVID-19 and socioscientific issues and (b) focusing on teaching about COVID-19 as a socioscientific issue, compared to teaching science content. Also, this set of items address the teachers' use of the following strategies: discussion strategy and the role play strategy to help students understand the COVID-19 issue from multiple perspectives.

3.3.2. Semi-Structured Interviews

The semi-structured interviews aimed at exploring participant teachers' perceptions and practices toward teaching about COVID-19 in more depth and to provide further insight into the teachers' views. The interviews were guided by a set of questions (adapted from Lee et al., 2006). First, interviewees' views on teaching about COVID-19 was probed (See Appendix B). Interviewees were asked about their perceptions on the role of COVID-19 in enhancing scientific literacy (adapted from Sadler et al., 2006). They were

also asked about their perceptions on the readiness of elementary science teachers for teaching about COVID-19. Next, participants were invited to share their experiences with COVID-19 teaching. For instance, interviewees were asked to describe a COVID-19 teaching activity they had given before, the instructional strategies they use in teaching about COVID-19, and the practices they use for engaging students in the negotiation of the COVID-19 pandemic. Finally, participants were asked about addressing COVID-19 as an SSI in their classrooms. In this part of the interview, interviewees were requested to share their experience with SSI teaching. They were also asked to suggest challenges that hinder the teaching of COVID-19 as a socioscientific issue and come up with solutions for solving these challenges.

3.4. Procedure

The Institutional Review Board (IRB) at the Lebanese American University approved the study before data collection. Upon IRB approval, the questionnaire, created on Google forms, were sent to 304 elementary science teachers in Lebanon; however, only 299 responses were involved in the study. Then, upon analyzing the responses, the twenty teachers, who approved on participating in the interview and provided their contact information, were contacted for the interview. Only two out of 20 interviews were recorded as per the interviewees approval while the other 18 interviews responses were written down, and all twenty interviews lasted from 25-30 minutes. All the interviews were conducted online during January, 2022. The platforms used for conducting the individual interviews with teachers were Google Meet and Zoom. These platforms were chosen for they are easy to use and both include the option for recording the meeting. The

interviews were in English given that all the participants teach in schools where the language of instruction is English.

3.5. Data Analysis

To analyze the data from the questionnaires, descriptive statistics (calculating the mode and frequencies) were generated for the Likert-type items using the SPSS software (version 25). Data were further explored through correlation analysis**.** Pearson's correlation coefficient (r) was calculated to examine the relationship between the two variables of the study: perceptions and practices.

In order to investigate whether there was a difference between the responses of the teachers who participated in the beginning of the research data collection period to those who participated in the end of this period, the data collected was divided into sets: Old and New. The Old data set (n=99) represents the questionnaire responses received during the first three months of the data collection period that ranges from beginning of August 2021 till end of October 2021.However, the New data set (n=206) represents the responses received during the second three months of the data collection period that ranges from beginning of November 2021 till end of January 2022. In order to calculate the difference in results between old and new data sets, the Chi-Square Test was obtained. The Chi-Square Test determines whether there is an association between categorical variables (i.e., whether the variables are independent or related). The Sig or P-value are compared with Alpha which is the error rate, where Sig is a probability between 0 and 1, and Alpha (α) is a constant value equal to 0.05.

The interviews were analyzed through qualitative thematic analysis, that was described by Braun and Clarke (2006) as a theoretically flexible method for interpreting qualitative data. In the first phase, the interview responses were transcribed into written form in order to conduct a thematic analysis, then the researcher read the transcribed responses several times in order to inductively explore the codes that were particularly essential or revealing about the teacher practices and perceptions towards teaching about COVID-19. After generating codes (Table 4), the researcher clustered them into ideas (categories) that are related, identified patterns among them, then started coming up with candidate themes. In the fourth phase, the themes were reviewed by comparing them to their collated extracts. Fifth, candidate themes were further refined by naming and defining them in order to give the reader a sense of what the theme is about. The sixth phase involved the final analysis and write-up of the report that is presented in the results chapter of this thesis. This analysis provides sufficient evidence of the themes within the data, particularly vivid examples which capture the essence of the teacher views on the COVID-19 teaching.

Table 4. Codes Generated from the Qualitative Thematic Analysis.

Codes	Definitions
Imp	Teaching about COVID-19 is important.
Role	It is the teacher's role to teach about COVID-19.
Inc SL	Teaching about COVID-19 helps in increasing students' scientific literacy (SL).
Prep	Prepared to teach about COVID-19.
Lack	Lack of resources, pedagogical knowledge, professional training, and instructional time.
Strat	The strategies used for teaching about COVID-19 *(e.g. Inquiry-based learning and Cooperative learning).*
Yes	I teach about COVID-19.
No	I don't teach about COVID-19.
No arg	It means not engaging students in argumentations
SSI Teach	It means teaching socioscientific issues.
COVID-19 as SSI	It refers to COVID-19 as a socioscientific issue.

In short, for each research question, the researcher analyzed quantitative then qualitative data from the questionnaires and the interviews respectively. Then, the data was integrated for triangulation purposes.

3.6. Validity and Reliability

Validity and reliability are two factors which any researcher should be concerned about while designing a research study (Patton, 2002). First, validity is described as "the congruence of the researcher's claims to the reality his or her claims seek to represent"

(Eisner & Peshkin, 1990: p.97). To increase the validity of the questionnaire, a pilot study was administered with a group of teachers, then analyzed using the same quantitative data analysis method used in this research. The questionnaire was pretested in order to guarantee its comprehensibility among participants, thus ensuring the content validity. Moreover, Creswell (2007) recommends using the triangulation strategy as a validation method in order to ensure the internal validity of the study. In this research, a variety of data sources were used to answer each research question, so the codes that emerged within one data source were considered with other data sources to support or disprove the validity of the naturalistic code (Creswell, 2007).

Second, Joppe (2000) defines reliability as "the extent to which results are consistent over time and an accurate representation of the total population under study … and if the results of a study can be reproduced under a similar methodology (p.1)" (cited in Golafshani, 2003). To provide external reliability for helping other researchers decide their sample, the participants' educational backgrounds and teaching experience were described in detail: they're elementary science teachers who teach in Lebanon and have spent at least three years in teaching science at the elementary level. Since the items in the questionnaire are derived from previous literature studies, this also increases the reliability of the research. Furthermore, the internal reliability in this study is provided since the data coming from qualitative sources was presented with the direct quotes of the participants.

3.7. Ethical Considerations

Every target participant received an introductory letter and a consent form. Those who agreed to participate in the study, signed the consent form. The consent forms,

instruments, emails and other documents were approved by the Institutional Review Board (IRB) of the Lebanese American University (LAU). Confidentiality and anonymity were ensured as neither the names of participants nor names of schools were mentioned in the study.

CHAPTER FOUR

Findings

The purpose of this study was to investigate the perceptions and teaching practices of elementary science teachers in Lebanon on teaching about COVID-19. The research questionnaire and the semi structured interviews tried to investigate how those teachers view and what they do in their science classes with respect to teaching about COVID-19. Chapter 4 presents the descriptive and inferential statistical analyses of the findings obtained from the questionnaire and the findings analyzed from the qualitative interviews, in order to answer each of the three research questions. The chapter ends with an "Overall Summary".

The results showed that most teachers responded with "agree" and "strongly agree" to the questionnaire items (See Figure 1). Discussing more precisely the results, overall, teachers stated their strong belief in the need for teaching about COVID-19. Most of the teachers admitted addressing COVID-19 in their science teaching and being aware of the challenges that hinder their teaching about COVID-19. Lastly, they reported addressing COVID-19 as a socioscientific issue. It is important to note that none of the participants chose "Not Applicable" for any of the items in the questionnaire.

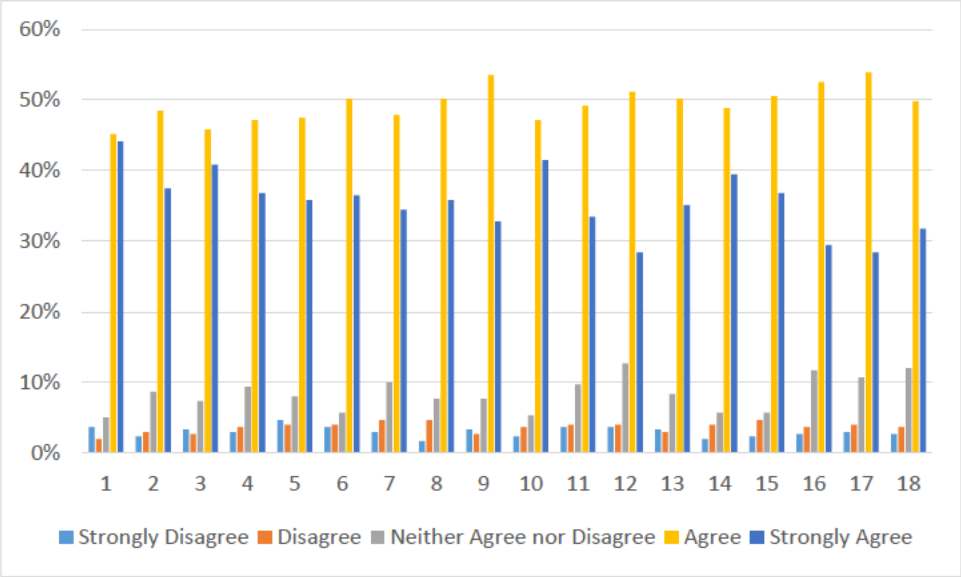

Figure 1. Science Teachers' Reponses to the 18 Items of the Questionnaire.

4.1. Correlation Between Variables

In order to study the association between the research variables: perceptions and practices, Pearson's correlation coefficient (r) was calculated. As shown in Table 5, the results reveal that there was positive and strong correlation between practices and perceptions *(Sig. = 0.000 < α, Pearson correlation= 0.890)*, also there was positive and strong correlation between the two variables: perceptions and perceptions and practices toward teaching about COVID-19 as a socioscientific issue *(Sig. = 0.000 < α, Pearson correlation= 0.863)*. Finally, the three research variables practices, perceptions and perceptions and practices toward teaching about COVID-19 as a socioscientific issue were highly and positively correlated *(Sig. = 0.000 < α, Pearson correlation= 0.884)* as shown in Table 5.

Table 5. Correlation between perceptions, practices and perceptions and practices toward teaching about COVID-19 as a socioscientific issue.

		Perceptions	Practices	Perceptions and practices toward teaching about COVID-19 as a socioscientific issue
Perceptions	Correlation	1.000	0.890**	0.863**
	Sig		0.000	0.000
Practices	Correlation		1.000	0.884**
	Sig			0.000
Perceptions and practices toward COVID-19 as a socioscientific issue	Correlation			1.000
	Sig			

*. Significant at the 0.05 level, **. Significant at the 0.01 level

4.2. Data Analysis for Research Question 1

4.2.1. Quantitative Data Analysis for Research Question 1

As mentioned in Chapter 3, the first area of the Likert-type items in the questionnaire, which includes items 1 to 6, addresses the perceptions of science teachers towards teaching about COVID-19. Table 6 summarizes the decision of participants to the questionnaire items (1 to 6). The "Agree" response in the table below represents the responses to "Agree" and "Strongly Agree" combined together. About 86% of the teachers agreed on the perceptions related items in the questionnaire, therefore, their awareness of and feelings towards teaching about COVID-19 were reflected in their stated belief in the need to address this issue. Analysis of responses to the Likert type items indicated that elementary science teachers believed that COVID-19 should be taught in

science classrooms. As evident in Table 6, elementary science teachers (approximately 90%) indicated a strong need for introducing COVID-19 into science classes. The majority of elementary science teachers (approximately 87%) believed that teaching about COVID-19 contributes to enhancing scientific literacy. Only 82% of the teachers believed that elementary students are mature enough to understand the COVID-19 pandemic. Elementary science teachers indicated that they have both the confidence in developing teaching and learning materials about the COVID-19 topic (approximately 86%) and the pedagogical knowledge for teaching elementary students about this issue (approximately 83%). Finally, as evident in Table 6, 87% of teachers agreed that addressing the COVID-19 in science classes doesn't confuse students about their own values.

Table 6. The percent data of participants' degree of agreement for the perceptions related items.

	Item	Decision	%
1	Introducing COVID-19 into science classes is definitely necessary.	Agree	89.30%
2	I have confidence in developing teaching and learning materials about the COVID-19 topic.	Agree	85.95%
3	I believe teaching about COVID-19 contributes to enhancing scientific literacy.	Agree	86.62%
4	I believe that elementary students are mature enough to understand the COVID-19 pandemic.	Agree	83.95%
5	I have the pedagogical knowledge for teaching elementary students about COVID-19.	Agree	83.28%
6	Addressing the COVID-19 in science classes doesn't confuse students about their own values.	Agree	86.62%
		AVERAGE	85.95%

4.2.2. Qualitative Data Analysis for Research Question 1

After the interviews were transcribed, the responses were analyzed using semantic thematic analysis (Braun & Clarke, 2006). The thematic analysis of the qualitative data has produced three general themes. The first theme that emerged from the teachers' responses during the interviews concerns their perceptions on teaching about COVID-19 (see Appendix C).

Theme 1: Perceptions on teaching about COVID-19		
Patterns	**Codes**	**Example Statements**
perception of the importance of teaching about COVID-19	Imp	"As this pandemic is not going to be the last one, it is very important that students learn how to deal with such pandemics. Take H1N1 as an example" (ST5). "It is necessary to teach students about COVID-19 for it will help them to understand about any new virus that they might encounter in the future" (ST14).
	Role	"As students are still living the COVID-19 pandemic, and not all parents can teach their kids about this pandemic, it is our role as elementary teachers to teach them about COVID-19" (ST3)
perception of the role of teaching about COVID-19 in enhancing scientific literacy	Inc SL	"One of the goals for teaching science is to increase students' scientific literacy. Teaching students about COVID-19 helps them to take informed decisions, thus enhancing their scientific literacy". (ST2) "Teaching about COVID-19 will help students better understand the scientific reasons (rationale) for taking precautions. Once they know the reasons, they will understand why they should protect themselves". (ST6)

perception of their readiness to teach about COVID-19	Prep	"Yes, we are prepared since we have lots of resources that are child friendly and can be used in science classrooms to teach about COVID-19. From my side, I have both the content and pedagogical knowledge to teach about... we can (not using the medical terminologies) explain the idea, teach some definitions like what is an infectious disease and how does it spread. In a way we are able and competent to teach about COVID-19 to students" (ST2). I have never attended a lecture/workshop related to teaching about COVID-19. I can do my own research but still I need support from a medical expert. Since elementary students might get confused about many issues related to COVID-19, I cannot handle debates with students (ST9).
perception on the challenges that hinder them in teaching about COVID-19	Lack	"We don't have **teaching materials** in our school that could help us in teaching about COVID-19. We cannot lecture students about this topic, it should be engaging for them…" (ST12). "There is not enough resources in the curriculum" (ST4). "Not finding the **effective pedagogy** that will make a difference in correcting students' misconceptions is also challenging" (ST9). "One challenge is not finding effective strategies to convince students with knowledge related to COVID-19"(ST5).
	COVID-19 Characteristics	"Teaching about COVID-19 is going to be stressful on me, and on my many other teachers, as it will bring trauma, it is similar to teaching about Beirut explosion" (ST16, ST9). *(Social-emotional aspect)* "Environment and culture of the school (mindset of parents) is a challenge for us'(ST15). "We do not have answers to students' questions (that are many) as this topic is controversial and our students are very curious" (ST10). "We do not have accurate information about this virus" (ST14).
perception of the need for professional training to improve the COVID-19 teaching experience	Lack	"Lack of training" (ST4). "The government, represented by the ministries of Education and Health, should step in and help schools to take precautions that will ensure students' safety in the first place. Then, they should form specialized committees and visit schools to give lectures and train teachers to teach about COVID-19. They should work on having a

	unified resource or reference among all schools in Lebanon" (ST15) "The school should provide their teachers with materials and resources and equip them with some teaching methods that will make their teaching more interactive. I also suggest that we substitute the unimportant science lessons in the curriculum with COVID-19 lessons, then we start developing teaching materials based on the students' levels" (ST10).

First, of the 20 responses, 18 in some way or other signaled that it is important to teach about COVID-19 in science "for it will help students to understand about any new virus that they might encounter in the future" (ST14, personal interview). The interviewed teachers perceive that they play a role in teaching about COVID-19, "as students are still living the COVID-19 pandemic, and not all parents can teach their kids about this pandemic, it is our role as elementary teachers to teach them about COVID-19" (ST3, personal interview). Notably, the interviewed teachers generally stressed on the importance of teaching about COVID-19.

Second, in the interviews, teachers were asked to express the ways in which teaching about COVID-19 can contribute to enhancing scientific literacy. Some teachers mentioned in this regard that "teaching about COVID-19 will help students better understand the scientific reasons (rationale) for taking precautions. Once they know the reasons, they will understand why they should protect themselves" (ST6, personal interview). Another teacher stated that "one of the goals for teaching science is to increase students' scientific literacy. Teaching students about COVID-19 helps them to take informed decisions, thus enhancing their scientific literacy" (ST2, personal interview).

Therefore, the participant teachers voiced their perceptions on the role of teaching about COVID-19 in increasing scientific literacy.

Third, of the 20 responses, 9 articulated that they are well-prepared to teach about COVID-19. The interviewed teachers argued that they are ready for COVID-19 teaching since they have "some resources [..] that are child friendly and can be used in science classrooms to teach about COVID-19". From my side, I have both the content and pedagogical knowledge to teach about it. We can (not using the medical terminologies) explain the idea, teach some definitions like what is an infectious disease and how does it spread. In a way we are able and competent to teach about COVID-19 to students" (ST2, personal interview).

On the other hand, many interviewees argued that elementary science teachers are not well-prepared to teach about COVID-19 since they don't have the pedagogical knowledge needed. Teachers explicitly stated that sometimes they can't find the effective pedagogy for teaching a lesson on COVID-19. For example, one teacher argued that …

> *"I have never attended a lecture/workshop related to teaching about COVID-19. I can do my own research but still I need support from a medical expert. Since elementary students might get confused about many issues related to COVID-19, I cannot handle debates with students." (ST9, personal interview)*

Forth, in the interviews, the teachers were asked to identify the challenges that hinder them in teaching about COVID-19. In this regard, all interviewees signaled barriers that affect their COVID-19 teaching. The first challenge concerns limit in the lack of relevant resources as teachers argued that they don't have enough teaching materials in their school that could help them in teaching about COVID-19 and cannot lecture students about this

topic (ST12, personal interview). Moreover, the lack of content and pedagogical knowledge were also identified as challenges. For instance, one teacher articulated, "not having enough content knowledge is challenging for me as a teacher. Not finding the effective pedagogy that will make a difference in correcting students' misconceptions is also challenging" (ST9, personal interview). In addition to these challenges, the interviewed teachers perceived the characteristics of the COVID-19 issue as an obstacle in teaching. For instance, ST1 and ST16 referred to the social-emotional aspect of the COVID-19 teaching. In ST16 words "teaching about COVID-19 is going to be stressful on me, and on many other teachers, as it will bring trauma, it is similar to teaching about Beirut explosion" (ST16, personal interview).

Some interviewees also stressed on the confusion that teaching about COVID-19 brings to students due to its controversial nature. In this regard ST10 said, "we do not have answers to students' questions (that are many) as this topic is controversial and our students are very curious" (ST10, personal interview). Moreover, ST14 added "we do not have accurate information about this virus, for example, some research says that it can be transmitted through objects or animals, or if you keep things outside, the virus will be killed. Also, information related to the side effects and vaccines is still not clear till now. Therefore, these challenges will prohibit (confuse) elementary students from understanding all about COVID-19" (ST14, personal interview). Two interviewees brought up the issue of the school environment and policy and the parents role. In this regards ST11 commented "my school do not agree that we replace teaching another science topic with teaching about COVID-19" (ST11, personal interview). Also, ST15 noted "many parents at my school don't believe in COVID-19 so it was reflected in

students and affected them especially the six-year-old students. They are more affected by their parents' perceptions, so they believe that COVID-19 doesn't exist" (ST15, personal interview). Hence, all the teachers discussed their perception on the challenges that hinder them in teaching about COVID-19.

Fifth, during the interviews, participants showed significant level of awareness for a need to improve their COVID-19 teaching experience. Teachers made many recommendations for improving their COVID-19 teaching. For instance, ST15 voiced that "the government, represented by the ministries of Education and Health, should step in and help schools to take precautions that will ensure students' safety in the first place. Then, they should form specialized committees and visit schools to give lectures and train teachers to teach about COVID-19. They should work on having a unified resource or reference among all schools in Lebanon" (ST15, personal interview). Moreover, ST10 suggested that "the school should provide their teachers with materials and resources and equip them with some teaching methods that will make their teaching more interactive. I also suggest that we substitute the unimportant science lessons in the curriculum with COVID-19 lessons, then we start developing teaching materials based on the students' levels" (ST10, personal interview). Therefore, the participant teachers voiced their perceptions on the need of professional training to improve teaching about COVID-19.

As described above, a substantial portion of the teacher responses during the interviews revolved around their perceptions on (1) the importance of teaching about COVID-19, (2) the role of teaching about COVID-19 in enhancing scientific literacy, (3) the readiness to teach about COVID-19, (4) the challenges that hinder teachers in teaching about COVID-19, and (5) the need of professional training to improve COVID-19

teaching experience. The thematic analysis of these responses led to extrapolate the first theme: perceptions on teaching about COVID-19.

4.2.3. Findings for Research Question 1: What are the perceptions of elementary science teachers in Lebanon towards teaching about COVID-19?

The result of associating old and new data collected for research question 1 showed that time for collecting the data doesn't have any effect on items 1, 3 and 5 in the questionnaire (Figure 2). For the other items 2,4, and 6, the results demonstrate a significant difference. Upon calculating the Chi-Square values for items 2,4, and 6, their corresponding P-values were as follows: 0.035,0.047 and 0.038 respectively (See Table 7). Since the P-value for each of these items was less than 5% ($p<5\%$), this indicated that there is a significant difference between the old and new results for items 2,4, and 6 in the questionnaire.

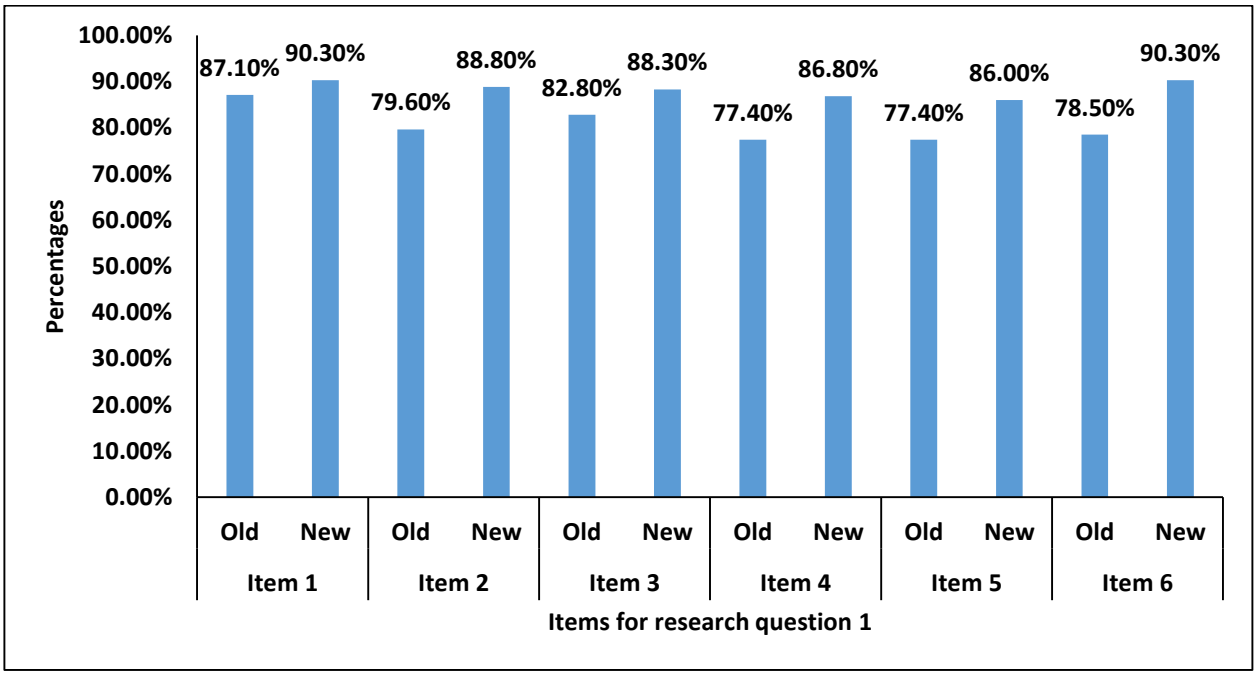

Figure 2. The Association Between Old and New Data Received for Items 1 To 6 in the Questionnaire.

Table 7 below summarizes the statistics related to the association between old and new data received on items 2,4 and 6 in the questionnaire. For item 2, 16.10% of the participants in the old data didn't specify whether they agree or not if they have confidence in developing teaching and learning materials about the COVID-19 topic, while 5.30% didn't specify in the new collected data (Table 7). Though, 31.20% of the participants in the old data strongly agreed that they have confidence in developing teaching and learning materials about the COVID-19 topic, while this percentage was equal to 40.30% for the participants in the new collected data, *Chi-square = 10.349, p<5%.*

Table 7. The association between old and new data received for items 2,4 and 6 in the questionnaire.

Items			SD	D	Neither A nor D	A	SA	Total	Chi-square	P-value
2	Old	Count	2	2	15	45	29	93	10.349	**0.035**
		Percentage	2.20%	2.20%	**16.10%**	48.40%	**31.20%**	100.00%		
	New	Count	5	7	11	100	83	206		
		Percentage	2.40%	3.40%	**5.30%**	48.50%	**40.30%**	100.00%		
4	Old	Count	3	6	12	48	24	93	9.641	**0.047**
		Percentage	3.20%	6.50%	12.90%	**51.60%**	**25.80%**	100.00%		
	New	Count	6	5	16	93	86	206		
		Percentage	2.90%	2.40%	7.80%	**45.10%**	**41.70%**	100.00%		
6	Old	Count	5	5	10	38	35	93	10.160	**0.038**
		Percentage	5.40%	5.40%	**10.80%**	**40.90%**	37.60%	100.00%		
	New	Count	6	7	7	112	74	206		
		Percentage	2.90%	3.40%	**3.40%**	**54.40%**	35.90%	100.00%		

As evident in Table 7 above, for item 4, 51.60% of the participants in the old data agreed that they believe that elementary students are mature enough to understand the COVID-19 pandemic, while 45.10% agreed in the new collected data. However, 25.80%

of the participants in the old data strongly agreed, while this percentage was equal to 41.70% for the participants in the new collected data, Chi-square = 9.641, p<5%.

For item 6, 10.80% of the participants in the old data didn't specify whether they agree or not if addressing the COVID-19 in science classes doesn't confuse students about their own values, while 3.70% didn't specify in the new collected data (Table 7). Though, 40.90% of the participants in the old data answered agree, while this percentage was equal to 54.40% for the participants in the new collected data, Chi-square = 10.160, p<5%.

The results of the quantitative data analysis for research question 1 (Table 6) reflected the participants' strong belief in the importance of teaching about COVID-19. This finding is consistent with the results of the qualitative data analysis as 90% of the participants indicated that it is important to teach about COVID-19, based on their statements in the interview. The overall opinion of elementary science teachers (approximately 89.30%) is that introducing COVID-19 into science classes is definitely necessary as it enhances students' scientific literacy, which was articulated during the interviews.

Quantitative analysis also showed that participants' lowest vote (83%) is for the perception that elementary science teachers have the pedagogical knowledge for teaching elementary students about COVID-19, which was also articulated during the interviews, when interviewees articulated their perception of their readiness to teach about COVID-19 and the challenges that hinder them in teaching about COVID-19.

In conclusion, the qualitative results confirm that participants have provided similar articulation regarding their strong perception on the importance of teaching about COVID-19.

4.3. Data Analysis for Research Question 2

4.3.1. Quantitative Data Analysis for Research Question 2

With reference to the second area of the Likert-type items in the questionnaire, *Teacher practices in teaching about COVID-19,* which includes items 7 to 12, overall the teachers agreed that they address COVID-19 in their science teaching.

Table 8. The percent data of participants' degree of agreement for the practices related items.

	Item	Decision	%
7	I use COVID-19 as a means (or aid) to motivate students to learn science content.	Agree	82.27%
8	I use various teaching strategies (e.g. role plays and group activities) when teaching about COVID-19.	Agree	85.95%
9	I use argumentation and evidence-based thinking as scientific practices for teaching about COVID-19.	Agree	86.29%
10	I can properly manage class time when teaching about COVID-19.	Agree	88.63%
11	I teach about COVID-19 not only in extra-curricular activity sessions but also during the science sessions.	Agree	82.61%
12	I challenge my students to analyze COVID-19 data from multiple perspectives.	Agree	70.00%
		AVERAGE	82.63%

Table 8 summarizes the decision of participants to the questionnaire items (7 to 12). The "Agree" response in the table above represents the responses to "Agree" and "Strongly Agree" combined together. As evident in Table 8, elementary science teachers (approximately 82%) indicated that they use COVID-19 as a means (or aid) to motivate students to learn science content. Around 86% of the participants use various teaching strategies (e.g. role plays and group activities) and argumentation and evidence-based

thinking as scientific practices for teaching about COVID-19. However, only 70% of them challenge their students to analyze COVID-19 data from multiple perspectives. While 88% of the participants can properly manage class time when teaching about COVID-19, 82% of them teach about COVID-19 not only in extra-curricular activity sessions but also during the science sessions.

4.3.2. Qualitative Data Analysis for Research Question 2

The teachers' responses to the interview protocol were coded. Then patterns were derived from these codes. Accordingly, a new theme has emerged from the corresponding patterns. The second theme that emerged from the teachers' talk-in-interaction concerns their interpretation of COVID-19 teaching (See Appendix D).

Theme 2: Interpretation of COVID-19 Teaching		
Patterns	**Codes**	**Example Statements**
Reasons behind not teaching about COVID-19	Lack	"We have no time to teach students about COVID-19. We only teach them how to take pre-cautions" (ST14). *(lack of instructional time)* "I don't teach about COVID-19, unfortunately, because it is not in the science curriculum that we should cover. Sometimes, we give it as an example when we teach about the scientific method" (ST13). *(lack of relevant instructional materials)*

Describing a COVID-19 teaching session	Class discussions-group work	"Students were asked at first about it (whole class discussion at the beginning of the science session). Then I showed students a video about COVID-19, and made a discussion with them about the severity of the disease. Then continued answering students related questions. Then we tackled their misconceptions" (ST2) "We let students watch videos, (for example videos about how the virus is transmitted), then we have class discussions. After that students work in groups on answering questions related to the lesson…If there is an update about COVID-19, we also explain it to students. We also address the vaccine issue" (ST15),
Use of instructional strategies when teaching about COVID-19	Strt	"I use inquiry-based approach. It starts with questions, then reaching a conclusion" (ST2). "We do a lot of hands-on activities when it comes to teaching about COVID-19. Students are always encouraged to work in groups and solve the lesson questions" (ST16)
Use of argumentation when teaching about COVID-19	No arg	"Not argumentation in a direct way, because in third grade we haven't started with argumentation. Sometimes in the middle of a discussion, a student starts with an argument (based on what he heard), so we do fall into a discussion about it but in a very informal way" (ST2). "One of the controversial issues about COVID-19 is whether or not to take the vaccine, but students were not engaged in argumentations. This is because we were afraid that parents won't accept this and would interpret that we have a benefit behind tackling this issue" (ST19)

First, during the interviews, teachers were asked to specify whether they teach or do not teach about COVID-19. Of the 20 responses, 15 stated that they do not teach about COVID-19. These 15 teachers generally held that one cannot teach about COVID-19 because of lack of time and lack of relevant instructional materials in the curriculum. Statements similar to the following appeared regularly: "We have no time to teach students about COVID-19. We only teach them how to take pre-cautions" (ST14, personal interview). "I don't teach about COVID-19, unfortunately, because it is not in the science curriculum that we should cover. Sometimes, we give it as an example when we teach about the scientific method" (ST13, personal interview). Generally, the teachers provided their main reasons for not teaching about COVID-19.

Second, the teachers who are currently teaching about COVID-19 were asked in the interviews to describe a COVID-19 teaching session or activity. Therefore, these interviewed teachers explained how they usually proceed with COVID-19 teaching lessons during their science classes. In this regard ST2 said, "Since the school has already added some posters related to COVID-19 and made some adjustments to keep it a safe environment, students were asked at first about it (whole class discussion at the beginning of the science session). Then I showed students a video about COVID-19, and made a discussion with them about the severity of the disease. Then continued answering students related questions. Then we tackled their misconceptions" (ST2, personal interview). Another interviewee stated, "As homeroom teachers, it is our duty to tackle this topic at least twice a week. We let students watch videos, (for example videos about how the virus is transmitted), then we have class discussions After that students work in groups on answering questions related to the lesson…If there

is an update about COVID-19, we also explain it to students. We also address the vaccine issue". ST15 added "We kept on repeating the same precautions on daily basis. We also introduced that it is a virus. We introduced the concept "mutation" that students need to know but it was very basic (for grade 1). We explained how the virus is transmitted, so we have to convince them why we shouldn't borrow items from each other, from a scientific perspective" (ST15, personal interview). Thus, the teachers' responses for having class discussions then group work activities describe their regular COVID-19 teaching session.

Third, participants who are currently teaching about COVID-19 expressed that they adopt the inquiry-based approach and the cooperative learning strategy in their COVID-19 teaching. For example, one of the teachers who said that she uses inquiry-based approach; she would start with questions, then engage students in investigations in order to reach conclusions (ST2, personal interview). Another teacher who uses the cooperative learning strategy articulated that, "We do a lot of hands-on activities when it comes to teaching about COVID-19. Students are always encouraged to work in groups and solve the lesson questions" (ST16, personal interview). Notably, teachers' responses in this regard revolved around their use of instructional strategies in the COVID-19 teaching.

Forth, it was interpreted from the participants' responses in the interviews that teachers generally avoid getting into arguments with students about the COVID-19 issue. The 5 interviewed teachers who teach about COVID-19 stated that they don't engage students in any argumentative task. One of the interviewed teachers said, "Not argumentation in a direct way, because in third grade we haven't started with

argumentation. Sometimes in the middle of a discussion, a student starts with an argument (based on what he heard), so we do fall into a discussion about it but in a very informal way" (ST2, personal interview). Another interviewee stated, "One of the controversial issues about COVID-19 is whether or not to take the vaccine, but students were not engaged in argumentations. This is because we were afraid that parents won't accept this and would interpret that we have a benefit behind tackling this issue. We informed them about the importance of taking the vaccine but we didn't try to convince students with taking the vaccine (school's policy)" (ST19, personal interview). In general, the teachers' responses indicated the absence in the use of argumentation in their COVID-19 teaching.

Notably, in the teachers' descriptions of COVID-19, there was a little attention given to the use of argumentation. Instead there was a clear focus on using a variety of instructional strategies. The thematic analysis of these responses led to extrapolate the second theme: Interpretation of COVID-19 Teaching.

4.3.3. Findings for Research Question 2: How do elementary science teachers in Lebanon address COVID-19 in their teaching?

As for the association between old and new data collected, the results for research question 2 indicated that the time for collecting the data doesn't have any effect on items 8, 9 and 10 in the questionnaire (Figure 3). However, for the other items 7, 11, and 12, the results demonstrated a significant difference. Upon calculating the Chi-Square values for items 7, 11, and 12, their corresponding P-values were as follows: 0.014,0.002 and 0.006 respectively (See Table 9). Since the P-value for each of these items was less than 5% ($p<5\%$), this indicated that there is a significant difference between the old and new results for items 7, 11, and 12 in the questionnaire.

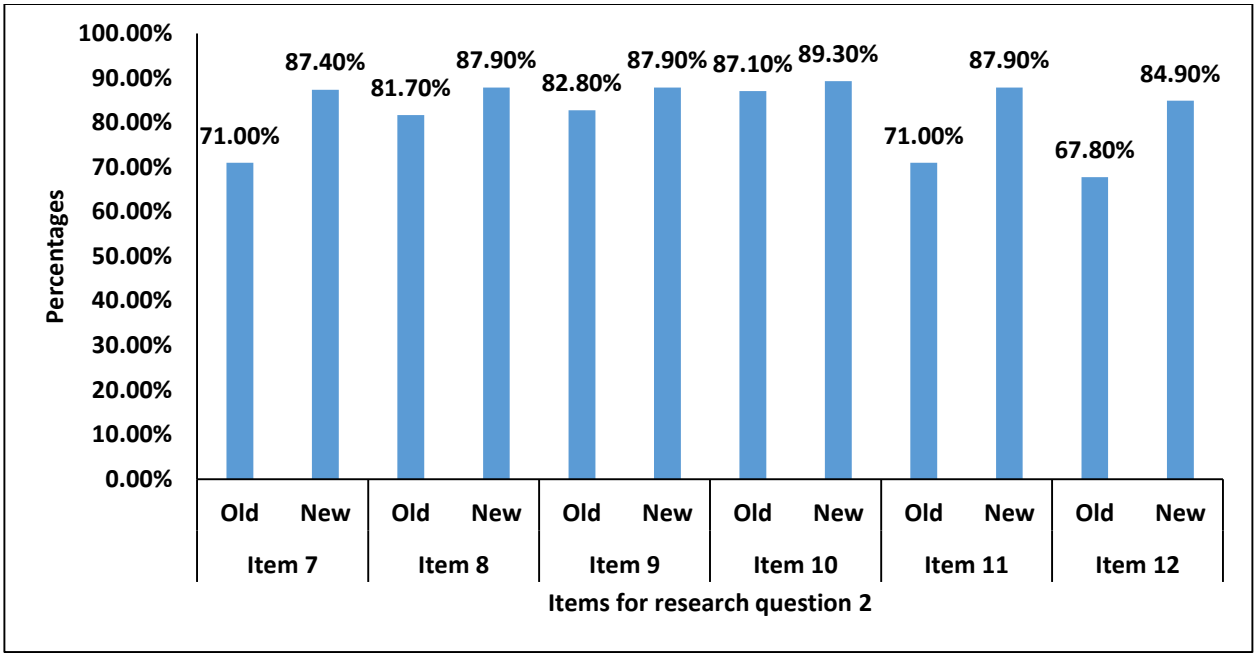

Figure 3. The association between old and new data received for items 7 to 12 in the questionnaire.

Table 9 below summarizes the statistics related to the association between old and new data received on items 7, 11 and 12 in the questionnaire. For item 7, 17.20% of the participants in the old data didn't specify whether they agree or not if they use COVID-19 as a means (or aid) to motivate students to learn science content, while 6.80% didn't specify in the new collected data. Though, 40.90% of the participants in the old data agreed that they use COVID-19 as a means (or aid) to motivate students to learn science content, while this percentage was equal to 51.00% for the participants in the new collected data, *Chi-square = 12.439, p<5%* (Table 9).

Table 9. The association between old and new data received for items 7,11 and 12 in the questionnaire.

Items			SD	D	Neither A nor D	A	SA	Total	Chi-square	P-value
7	Old	Count	5	6	16	38	28	93	12.439	**0.014**
		Percentage	5.40%	6.50%	**17.20%**	**40.90%**	**30.10%**	100.00%		
	New	Count	4	8	14	105	75	206		
		Percentage	1.90%	3.90%	**6.80%**	**51.00%**	**36.40%**	100.00%		
11	Old	Count	7	4	16	44	22	93	17.262	**0.002**
		Percentage	7.50%	4.30%	**17.20%**	47.30%	**23.70%**	100.00%		
	New	Count	4	8	13	103	78	206		
		Percentage	1.90%	3.90%	**6.30%**	50.00%	**37.90%**	100.00%		
12	Old	Count	5	6	19	46	17	93	14.356	**0.006**
		Percentage	5.40%	6.50%	**20.40%**	49.50%	**18.30%**	100.00%		
	New	Count	6	6	19	107	68	206		
		Percentage	2.90%	2.90%	**9.20%**	51.90%	**33.00%**	100.00%		

For item 11, 17.20% of the participants (Table 9) in the old data didn't specify whether they agree or not if they teach about COVID-19 not only in extra-curricular activity sessions but also during the science sessions, while 6.30% didn't specify in the new collected data. However, 23.70% of the participants in the old data strongly agreed, while this percentage was equal to 37.90% for the participants in the new collected data, Chi-square = 17.262, $p<1\%$.

For item 12, 20.40% of the participants in the old data didn't specify whether they agree or not if they challenge their students to analyze COVID-19 data from multiple perspectives, while 9.20% didn't specify in the new collected data (Table 9). Though, 18.30% of the participants in the old data answered strongly agree, while this percentage was equal to 33.00% for the participants in the new collected data, Chi-square = 14.356, $p<1\%$.

The quantitative data analysis for research question 2 (Table 8) revealed that teachers address COVID-19 in their science teaching with an average of 82.63% of the

participants (n= 247). However, the results from the qualitative data analysis was slightly different. It was inferred from the teacher interview responses that 75% of the interviewees do not teach about COVID-19 while only 25% of them teach about it.

The quantitative data analysis for research question 2 (Table 8) also showed that around 86% of the participants use various teaching strategies when teaching about COVID-19. This result was articulated in the responses of the teachers who currently teach about COVID-19 as they use various instructional strategies such as the inquiry and cooperative learning strategy. Another finding from the quantitative data analysis indicated that the least practice that participants use is challenging students to analyze COVID-19 data from multiple perspectives (Table 8) which was articulated in the interview responses, when interviewees expressed that they do not use argumentation scientific practices in their COVID-19 teaching.

In summary, qualitative results confirm that participants provided similar articulation in regard of their COVID-19 teaching practices. However, sample size in general and unequal sample size per group in particular, should be taken into consideration during data discussion.

4.4. Data Analysis for Research Question 3

4.4.1. Quantitative Data Analysis for Research Question 3

With reference to the third area of the Likert-type items in the questionnaire, the perceptions and practices of elementary science teachers in Lebanon involve using COVID-19 as an SSI, which includes items 13 to 18, overall the teachers agreed on addressing COVID-19 as a socioscientific issue.

Table 10. The percent data of participants' degree of agreement for the practices related items.

	Item	Decision	%
13	In my science teaching, I give equal attention to teaching socioscience issues, such as the COVID-19 pandemic, as well as to teaching science content.	Agree	85.28%
14	Activities related to COVID-19 provide students with opportunities to voice their opinions, and improve their judgments regarding this socioscientific issue.	Agree	88.29%
15	Socioscientific issues, such as COVID-19, expose students to ''positive and negative'' aspects of science and technology, thus, allowing them to develop deeper and unbiased understandings of science and technology.	Agree	87.29%
16	I make ongoing connections to socioscientific issues when teaching about COVID-19.	Agree	81.94%
17	Due to the ill-structured and dynamic nature of socioscientific issues, I urge students to employ skepticism when considering sources of information concerning the COVID-19.	Agree	82.27%
18	Through teaching about COVID-19, I help students to improve their ability to communicate criticism of others' positions regarding this socioscientific issue.	Agree	81.61%
		AVERAGE	84.45%

Table 10 summarizes the decision of participants to the questionnaire items (13 to 18). The "Agree" response in the table above represents their responses to "Agree" and "Strongly Agree" combined together. As evident in Table 10, elementary science teachers (approximately 85%) indicated that they give, in their science teaching, equal attention to teaching socioscience issues, such as the COVID-19 pandemic, as well as to teaching science content. Around 88% of the participants agreed that socioscientific issues, such as COVID-19, expose students to ''positive and negative'' aspects of science and technology thus, allowing them to develop deeper and unbiased understandings of science and technology, and also agreed that activities related to COVID-19 provide students with

opportunities to voice their opinions, and improve their judgments regarding this socioscientific issue. About 82% of the participants stated that they (1) make ongoing connections to socioscientific issues when teaching about COVID-19, (2) urge students to employ skepticism when considering sources of information concerning the COVID-19 due to the ill-structured and dynamic nature of socioscientific issues, and (3) help students to improve their ability to communicate criticism of others' positions regarding this socioscientific issue, through teaching about COVID-19.

4.4.2. Qualitative Data Analysis for Research Question 3

The findings of the third research question were also analyzed using semantic thematic analysis (Braun & Clarke, 2006). The third theme that emerged from the teachers' responses is: Addressing COVID-19 as a Socioscientific Issue (See Appendix E).

Theme 3: Addressing COVID-19 as a Socioscientific Issue		
Patterns	**Codes**	**Example Statements**
Teaching socioscientific issues	Yes	We teach SSI such as pollution, global warming, food technology, sustainability, food pollution, food preservation, ozone, and plastic waste (ST1, ST2, ST4, ST5, ST6, ST7, ST8, ST10, ST15, ST17, ST18)
	No	"We do not teach any socioscientific issues, students learn about it in other subjects such as geography or sociology" (ST3, ST9, ST11, ST12, ST13, ST14, ST16, ST19, ST20).
Addressing COVID-19 as a socioscientific issue.	COVID-19 as SSI	"Since COVID-19 topic is controversial in nature, this adds a challenge on the

	teacher" (ST11, personal interview). "First we need to do some research. Students ask many challenging questions, so we have to be ready. COVID-19 is a controversial topic yet we can simplify the material for students and give them simple COVID-19 lessons" (ST13, personal interview)

First, when asked to identify socioscientific issues, teachers typically explained that socioscientific issues are informed by science, controversial and have different dimensions though they didn't recognize the term "socioscientific issues". Of the 20 responses, 11 stated that they teach socioscientific issues. During the interviews, the teachers referred to socioscientific issues such as pollution (f=6), global warming (f=3), food technology (f=3), sustainability (f=2), food pollution (f=1), food preservation (f=1), ozone (f=1), and plastic waste (f=1). However, of the 20 responses, 11 indicated that they do not teach socioscientific issues. In this regard, one of the teachers argued, "We do not teach any socioscientific issues, students learn about it in other subjects such as geography-sociology" (ST11, personal interview). Thus, a good portion of the teacher responses revolved around teaching socioscientific issues.

Second, there were instances in which there were traces of characterization of COVID-19 as a socioscientific issue. In these characterizations, there was a strong focus by the teachers on the controversial and multidimensional aspects of COVID-19. Herein, I present some of interviewees' verbalizations: "Since COVID-19 topic is controversial in nature, this adds a challenge on the teacher" (ST11, personal interview). Given

that teachers are aware of the nature of COVID-19 as a socioscientific issue, they use their experience in teaching socioscientific issues to address COVID-19 in their science classes. Statements similar to the following appeared regularly: “first we need to do some research. Students ask many challenging questions, so we have to be ready. COVID-19 is a controversial topic yet we can simplify the material for students and give them simple COVID-19 lessons” (ST13, personal interview). Another teacher added, “As this pandemic is not going to be the last one, it is very important that students learn how to deal with such pandemics. Take H1N1 as an example” (ST5, personal interview). Generally, teachers learned how to handle the dilemma that the COVID-19 socioscientific issue causes in class. In this regard one teacher argued, “On the pedagogical level we teach students based on the principle that all knowledge in science is open to change” (ST10, personal interview). It is evident from the teacher responses that they effectively address COVID as a socioscientific issue.

Overall, teachers showed that they are aware of socioscientific issues in science. It was evident from their responses that they teach socioscientific issues. Also it was notable that they use effective methods to address COVID-19 as a socioscientific issue. Based on these responses the third theme was driven: Addressing COVID-19 as a Socioscientific Issue.

4.4.3. Findings for Research Question 3: To what extent do the perceptions and practices of elementary science teachers in Lebanon involve using COVID-19 as an SSI?

The results for the association between old and new data collected for research question 3 revealed that the time for collecting the data doesn’t have any effect on items 13, 14 and 15. However, for the other items 16, 17 and 18, the results showed a significant

difference in the questionnaire (Figure 4). Upon calculating the Chi-Square values for items 16, 17 and 18, their corresponding P-values were as follows: 0.001,0.004 and 0 respectively (See Table 11). Since the P-value for each of these items was less than 5% (p<5%), this indicated that there is a significant difference between the old and new results for items 16, 17 and 18 in the questionnaire.

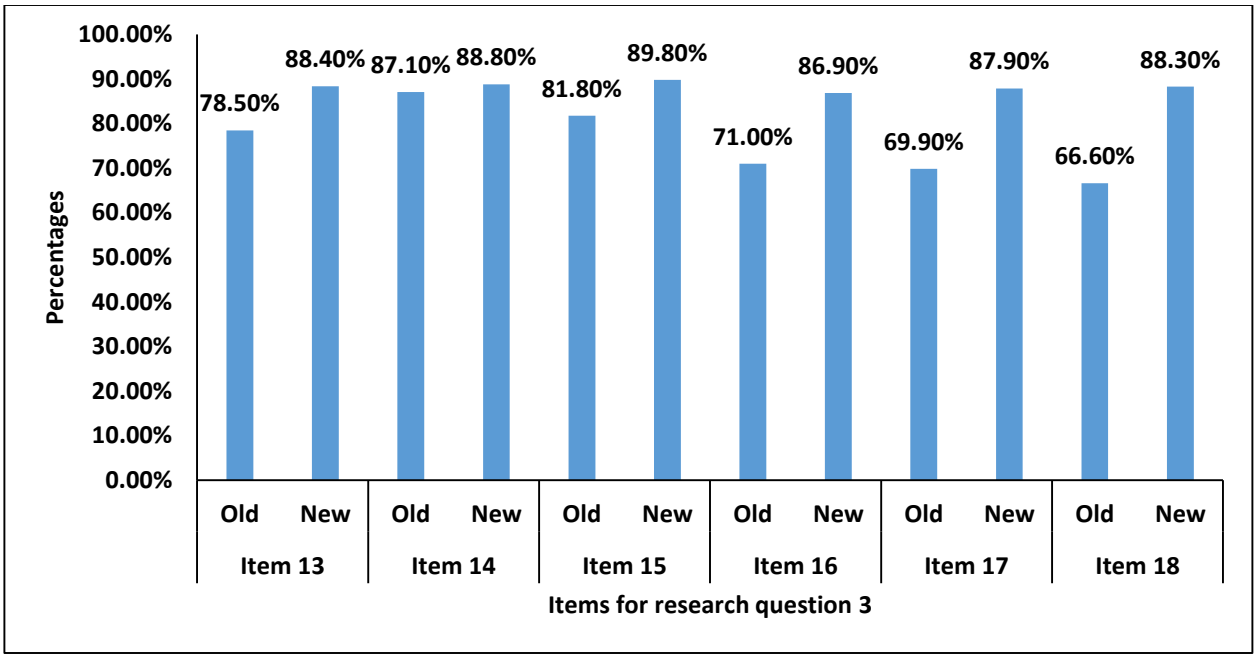

Figure 4. The association between old and new data received for items 13 to 18 in the questionnaire.

Table 11 below summarizes the statistics related to the association between old and new data received on items 16, 17 and 18 in the questionnaire. For item 16, 21.50% of the participants in the old data didn't specify whether they agree or not if they make ongoing connections to socio scientific issues when teaching about COVID-19, while 7.30% didn't specify in the new collected data. Though, 18.30% of the participants in the old data strongly agreed that they make ongoing connections to socio scientific issues when teaching about COVID-19, while this percentage was equal to 34.50% for the participants in the new collected data, *Chi-square = 18.187, p<1%.*

Table 11. The association between old and new data received for items 16,17 and 18 in the questionnaire.

Items			SD	D	Neither A nor D	A	SA	Total	Chi-square	P-value
16	Old	Count	4	3	20	49	17	93	18.187	**0.001**
		Percentage	4.30%	3.20%	21.50%	52.70%	**18.30%**	100.00%		
	New	Count	4	8	15	108	71	206		
		Percentage	1.90%	3.90%	7.30%	52.40%	**34.50%**	100.00%		
17	Old	Count	4	7	17	45	20	93	15.164	**0.004**
		Percentage	4.30%	7.50%	18.30%	48.40%	**21.50%**	100.00%		
	New	Count	5	5	15	116	65	206		
		Percentage	2.40%	2.40%	7.30%	56.30%	**31.60%**	100.00%		
18	Old	Count	3	5	23	35	27	93	23.617	**0.000**
		Percentage	3.20%	5.40%	24.70%	37.60%	**29.00%**	100.00%		
	New	Count	5	6	13	114	68	206		
		Percentage	2.40%	2.90%	6.30%	55.30%	**33.00%**	100.00%		

For item 17, 18.30% of the participants in the old data didn't specify whether they agree or not if they urge students to employ skepticism when considering sources of information concerning the COVID-19 due to the ill-structured and dynamic nature of socio scientific issues, while 7.30% didn't specify in the new collected data. However, 48.40% of the participants in the old data answered agree and 21.50% answered strongly agree, while these percentages were equal to 56.30% and 31.60% respectively for the participants in the new collected data, *Chi-square = 15.164, p<1%*.

For item 18, 24.70% of the participants in the old data didn't specify whether they agree or not if they help students to improve their ability to communicate criticism of others' positions regarding this socio scientific issue through teaching about COVID-19, while 6.30% didn't specify in the new collected data. Though, 37.60% of the participants

in the old data answered agree, while this percentage was equal to 55.30% for the participants in the new collected data, Chi-square = 23.617, p<1%.

The quantitative data analysis for research question 3 (Table 10) indicated that overall the teachers address COVID-19 as a socioscientific issue with an average of 84.45% of the participants. The overall opinion of elementary science teachers (approximately 88%) is that activities related to COVID-19 provide students with opportunities to voice their opinions, and improve their judgments regarding this socioscientific issue (Table 10), which could be interpreted that they address COVID-19 similar to how they address other socioscientific issues. This interpretation was deducted from the interviewee responses, during the interviews, as they were frequently referring to other socioscientific issues to explain their current practices in teaching about COVID-19.

The analysis of the quantitative data obtained from the questionnaire indicated that 82% of elementary science teachers (Table 10) make ongoing connections to socioscientific issues when teaching about COVID-19, which could be inferred that they have awareness about the characteristics of the COVID-19 socioscientific issue. Along the same lines, the articulations of the interviewees showed that they're aware of the characteristics of the COVID-19 socioscientific issue which was expressed during the interviews, when interviewees described the nature of COVID-19 as controversial and multidimensional.

In conclusion, the above mentioned findings from the quantitative data were confirmed with the qualitative data analysis as participants articulated that they address COVID-19 as a socioscientific issue.

4.5. Overall Summary

The previous sections include descriptive statistics analyzed from the questionnaire responses as well as direct quotes extracted from the interview answers. First, based on the above findings from quantitative data analysis, it was observed that teachers strongly believe in the importance of teaching about COVID-19 and in its importance in enhancing scientific literacy. It was also found that elementary science teachers have the pedagogical knowledge for teaching elementary students about COVID-19. Thematic analysis allowed the emergence of the first key construct: perceptions on teaching about COVID-19, and the results obtained from this analysis were aligned with the quantitative data findings.

Second, regarding the teachers' practices in teaching about COVID-19, the quantitative data analysis revealed that participant teachers address COVID-19 in their science classes. It was also found that teachers use various teaching strategies when teaching about COVID-19, yet they do not engage students in argumentation. The second theme, *interpretation of COVID-19 teaching,* that emerged from the qualitative data analysis revealed different results. Upon data triangulation, it was interpreted that most teachers do not teach about COVID-19 in their science classes.

Third, the quantitative data analysis also revealed that teachers make ongoing connections to socioscientific issues when teaching about COVID-19, and that they're aware of the characteristics of COVID-19 as a socioscientific issue. The last theme, *addressing COVID-19 as a socioscientific issue*, that emerged from the qualitative data analysis confirmed the same results. Hence, it was concluded that teachers effectively address COVID-19 as a socioscientific issue. Therefore, the three research questions were

answered after cross-verifying the results obtained through quantitative and qualitative data analysis.

CHAPTER FIVE

Discussion and Conclusions

This chapter discusses the results of the study in conformity with the three research questions and their connections to the literature. The following headings guide this chapter: "Overview of the Study", "Discussion", "Conclusions", "Limitations and Directions for Future Research", and "Recommendations".

5.1. Overview of the Study

This study aimed to answer the following research questions:

a. What are the perceptions of elementary science teachers in Lebanon towards teaching about COVID-19?
b. How do elementary science teachers in Lebanon address COVID-19 in their teaching?
c. To what extent do the perceptions and practices of elementary science teachers in Lebanon involve using COVID-19 as an SSI?

5.2. Discussion

5.2.1. Research question 1: What are the perceptions of elementary science teachers in Lebanon towards teaching about COVID-19?

The first finding indicated that 90% of the teacher participants perceived a need to teach about COVID-19 in science classes (Table 6). Based on the results, teacher participants (approximately 87%) believed that teaching about COVID-19 contributes to enhancing scientific literacy. These results are in line with several studies reported in the

literature (Lee et al., 2006; Sadler et al., 2006; Forbes et al. 2007, 2008; Simonneaux, 2008; Chung, Yoo, Kim, Lee, and Zeidler, 2016; Nida et al. 2020) and highlight the need for more attempts or strategies to improve teaching of socioscientific issues. Hence, in this research triangulation was important to verify the first finding of the descriptive analysis. The analysis of the interviews was in line with the quantitative analysis which showed that the interviewees demonstrated a strong belief in (1) the importance of teaching about COVID-19 in science classes, and (2) the importance of professional training in the COVID-19 teaching context. This could be achieved through equipping schools, specifically science teachers, with teaching materials and resources on teaching about COVID-19. Therefore, this finding implies that there should be adequate support material and sufficient in-service education on SSI-based teaching provided to science teachers as found in Hancock et al (2019) and Ozturk and Erabdan's (2019) studies. Moreover, this finding was in line with a study conducted by Lee et al. (2006) whose research results also reflect the important need for professional development especially in the context of the associated controversial, social and personal issues. Along the same lines, Kara (2012) suggested that teachers' professional development in relation to SSI should be thought of as an integral part of their general professional development. Also, this study finding is consistent with the study of Ozturk and Erabdan (2019) that suggested renewing the science curriculum and giving teachers service trainings and seminars about the adopted learning approaches.

The second finding indicated that the perception that elementary science teachers have the pedagogical knowledge for teaching elementary students about COVID-19 was the least selected item (approximately 83%) in the questionnaire (Table 6). In this regard,

triangulation with semi-structured interview was critical to confirm that most teachers do not find themselves ready to teach about COVID-19. This finding is consistent with other research findings in the field (e.g. Kara, 2012; Saunders & Rennie, 2013; Bosser et al., 2015; Ozturk & Erabdan, 2019; Nida et al., 2020) and reveal that the lack of pedagogical knowledge is one of the challenges that hinder science teachers in teaching about COVID-19. According to Nida et al. (2020), the main barriers in SSI-based teaching concern limits in a lack of teachers' knowledge and expertise. Moreover, this finding also comes in line with Ozturk and Erabdan (2019), who pointed out that science teachers do not have sufficient knowledge about the methods and techniques with which they would teach SSI.

The third finding indicated that participants (approximately 84%) believe that elementary students are mature enough to understand the COVID-19 pandemic. This finding contradicts findings of a study conducted by Ozturk and Erabdan (2019) in the Turkish context, who showed that age of elementary and secondary students is too small to understand such controversial issues and to have the skills to discuss them. A possible explanation for this could be due to the fact that the participant science teachers were not aware of SSI and they didn't have experience in teaching SSI. Also, these teachers believe that teaching SSI will put students in dilemma. Along the same lines, in the study of Nida et al. (2020), more than half of the science teachers were not aware of SSI and these teachers argued that learners lack competencies and abilities to learn socioscientific issues. This could explain why teacher participants in Ozturk and Erabdan (2019) study believe that their students are not mature enough to understand any SSI.

The results obtained regarding the first research question contribute to the existing literature in a number of ways. The first contribution is through the use of a mixed

methods approach, which according to Almeida (2018) helps in overcoming the limitations of each of the quantitative and qualitative methodologies, when conducted alone. Second, as mentioned in Chapter 1, there are few studies related to the perceptions of science teachers towards teaching about SSI, which have relied on quantitative analysis to measure the perspective of science teachers (e.g. Kara, 2012; Lee et al., 2006). Hence the findings of the present study contribute to the research gap. Third, these results contribute to developing evidence-based recommendations for empowering teachers to act on their stated beliefs and to address SSI meaningfully in their classrooms.

5.2.2. Research question 2: How do elementary science teachers in Lebanon address COVID-19 in their teaching?

The first finding based on descriptive analysis of the quantitative data obtained from the questionnaire indicated that 82.63% of the teacher participants address COVID-19 in their science teaching (Table 8). While this result suggests that participants teach about COVID-19, the triangulation with semi-structured interviews yielded different results. Based on the qualitative analysis obtained from the interviews, only 25% of the interviewed teachers teach about COVID-19 in their science classes. The difference in results between quantitative and qualitative data is due to the fact that teachers hold misconceptions regarding the concept of addressing COVID-19 in their science teaching. Interviewed teachers articulated that they address COVID-19 through explaining to students how to take preventive measures and protect themselves from getting infected by COVID-19. In this regard, teachers stated their main reasons for not teaching about COVID-19 which are the lack of instructional time and the unavailability of relevant material in the science curriculum. These results are consistent with the findings of many

research studies in the literature (e.g. Lee et al., 2006; Ozturk & Erabdan, 2019; Nida et al.,2020). Based on the findings of Ozturk and Erabdan's (2019) study in the Turkish context, teachers feel themselves inadequate regarding SSI education because there is no relevant supporting material in their curriculum. Along the same lines, Nida et al. (2020) study results revealed that the content in the Indonesian's official curriculum doesn't support the implementation of SSI based instruction.

The second finding based on descriptive analysis of the quantitative data obtained from the questionnaire indicated that 86% of the participants use various teaching strategies in their COVID-19 teaching (Table 8). The triangulation with the qualitative data findings confirmed that teachers who teach about COVID-19 use various instructional strategies such as the inquiry and cooperative learning strategy. This study finding can be related to the findings of Ozturk and Erabdan (2019). In their research study, Ozturk and Erabdan (2019) found out that teachers vary their teaching methods and techniques in SSI based instruction which include discussions, debates and case study methods. It can be interpreted from both studies that teachers rely on student-centered approach for teaching SSI. Moreover, this finding can be related to and elaborate on the finding of Day and Bryce (2011) which suggests that if science teachers are to incorporate more debate in their teaching and are to develop approaches useful for the discussion of controversial socio-scientific issues in particular, this will require them to change their lesson delivery to include approaches which foster inquiry.

The third finding based on descriptive analysis of the quantitative data obtained from the questionnaire indicated that 86% of the participants use argumentation and

evidence-based thinking as scientific practices for teaching about COVID-19 (Table 8). The triangulation with semi-structured interviews revealed that participant teachers do not engage students in any argumentative task. It was interpreted from the teachers' responses in the interviews that they engage students in discussions and debates but they don't have students construct arguments in the context of learning about COVID-19. In fact, teachers avoid getting into arguments with students regarding any COVID-19 related issue. The present research finding is similar to the finding of Ozturk and Erabdan (2019) that investigated how teachers teach SSI and found out that there was no evidence observed on engaging students in argumentation. Along the same lines, Tidemand & Nielsen (2017) presented in their study that students who are engaged in learning biological socioscientific issues present their opinions without argumentation or evidence but based on personal emotions or experiences. According to the teachers, the majority of students do not possess enough content knowledge to properly engage in discussions and argumentation about socioscientific issues (Tidemand & Nielsen, 2017).

Although the teachers perceived COVID-19 teaching positively and saw its potential in enhancing students' scientific literacy, the participants did not exhibit high levels of implementation of COVID-19 teaching in their science classrooms. Regardless, few teachers had implemented COVID-19 teaching to varying degrees in their classrooms. Therefore, our findings resonate well with trends in the literature and add a crucial layer to previous research in the field (Tidemand & Nielsen, 2017; Ozturk & Erabdan, 2019; Nida et al.,2020). It also contributes to the existing literature by informing how teachers start teaching a new socioscientific issue

in the field (COVID-19). These results call for more qualitative studies to be conducted in order to further investigate the teachers' implementation of SSI based instruction.

5.2.3. Research question 3: To what extent do the perceptions and practices of elementary science teachers in Lebanon involve using COVID-19 as an SSI?

The first finding based on descriptive analysis of the quantitative data obtained from the questionnaire indicated that 82% of the teachers make ongoing connections to socioscientific issues when teaching about COVID-19 (Table 10). In this regard, triangulation with semi-structured interviews was critical to confirm that most teachers teach different socioscientific issues in their science classes. Also, the qualitative data obtained from the interview responses indicated that teachers are aware of the characteristics of socioscientific issues but not aware of the concept socioscientific issues (SSI). The present research finding is similar in one way to the finding of Ozturk and Erabdan (2019) which determined that most of the science teachers did not know about SSI and did not hear of this concept before. Although teachers in Ozturk and Erabdan's study (2019) identified SSI as social issues only, science teachers in the present study recognized SSI as issues that are controversial and multidimensional. Also, this finding is consistent with the finding of Nida et al. (2020) which revealed that half of the teachers in the research sample were familiar with SSI-based learning, yet they teach SSIs to varying degrees in their classrooms.

The second finding based on descriptive analysis of the quantitative data obtained from the questionnaire indicated that 85% of the teachers give equal attention to teaching socioscience issues, such as the COVID-19 pandemic, as well as to teaching science content (Table 10). In this regard, triangulation with semi-structured interviews was

critical to confirm that teachers address COVID-19 as a socioscientific issue. The qualitative data analysis revealed that not only teachers are aware of the characteristics of COVID-19 as a socioscientific issue but also they address it using effective methods.

5.3. Limitations and Directions for Future Research

At the completion of this research, some limitations of the study could be identified. The explorative nature of the study does not permit us to generalize our findings beyond the particular context (Lebanese elementary science teachers). Hence, future studies need to be conducted which broaden the scope and encompass schools from different countries and that random sampling strategies.

This study didn't include public schools and didn't take a representative sample of teachers in Lebanon. Therefore, future research needs to take into consideration having a representative sample. Also, this study didn't analyze the data with respect to gender and geographical areas in Lebanon. Hence, future studies need to take this into consideration and study whether there is an impact of gender and geographical locations on the research findings. Last but not least, the findings of this study are helpful for designing similar studies on teaching about COVID-19 or other socioscientific issues.

The findings of this research confronted to new research ideas worthy of further investigations. Given that research on teaching about COVID-19 is still limited, many recommendations can be made for future studies:

a. Investigating the current status of COVID-19 education in Lebanon through classroom observations and interviews;

b. Extending the research of perceptions and practices on teaching about COVID-19 to beyond than science teachers;
c. Exploring the teachers' perceptions and practices on teaching about COVID-19 at the middle school, high school and college levels;
d. Studying the Lebanese contexts to other contexts through conducting cross-cultural comparative studies.

5.4. Conclusions

This study was the first attempt to explore the perceptions and practices of elementary science teachers on teaching about COVID-19 in Lebanon. The findings of this study showed that elementary science teachers strongly believe in the importance of teaching about COVID-19 and in its role for enhancing scientific literacy. The review of literature showed the importance of scientific literacy as one of the main goals of science education in preparing scientifically literate citizens; thus, this study results are similar to and elaborate on several previous studies reported in the literature (e.g., Lee et al., 2006; Sadler et al., 2006; Forbes et al. 2007, 2008; Simonneaux, 2008; Chung, Yoo, Kim, Lee, and Zeidler, 2016; Nida et al. 2020). At this point, it should be noted that, while some theoretical arguments have been advanced on the teachers' perceptions and practices on teaching SSI (e.g., Lee et al., 2006; Tidemand & Nielsen, 2017; Ozturk & Erabdan, 2019; Nida et al., 2020), there is little empirical evidence about how these two constructs interact. Moreover, this study encourages scholars to highlight in their research studies the need for more attempts or strategies to improve teaching of socioscientific issues in general and COVID-19 in specific.

It was observed in this study that teaching about COVID-19 is not part of the current teaching practices for all science teachers. It was also found that teachers use various teaching strategies when teaching about COVID-19, yet they do not engage students in argumentation. These findings resonate well with trends in the literature and indicate a fundamental alignment with the studies of Tidemand and Nielsen (2017) and that of Ozturk and Erabdan (2019). It was also evident in this study that some teachers still attempt teaching about COVID-19 bearing in mind the number of barriers that hinder them in their teaching. Given that teachers have positive views on teaching about COVID-19, they came up with practical suggestions for improving the COVID-19 teaching implementation and for facing challenges raised by the teachers in this study and echoed elsewhere in the field (Kara,2012; Ozturk & Erabdan,2019; Nida et al., 2020). However, more empirical work which explores the potential to embed COVID-19 content in science learning contexts is certainly needed.

Last but not least, the findings of this study indicated that teachers are aware of the nature of COVID-19 as a socioscientific issue and address the COVID-19 socioscientific issue using effective teaching methods. Obviously, there should be more attempts to improve the current practices in teaching about the COVID socioscientific issue. Since studies on teaching about COVID-19 as a socioscientific issue are still limited, many researchers can build on the results of the present study and further investigate the implementation of COVID-19 based instruction in science.

5.5. Recommendations

In light of the findings of this study, the following recommendations for policy and practice are made:

- Curriculum and resource developers should target developing resources and engaging learning materials that address COVID-19 teaching.
- Professional development initiatives should focus on teachers' beliefs about and operationalization of socioscientific issues in general and COVID-19 in specific.
- In Lebanon, a teaching model can be developed and its effectiveness can be evaluated. In this regard, a revised science curriculum, learning areas, application examples related to various COVID-19 teaching method techniques, applied in-service trainings and seminars about the adopted learning approaches can be given to the teachers.

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Appendix A

Questionnaire

Section 1- Demographic Information	
Gender:	Male
	Female
	Other
Year of birth:	
Highest educational degree attained:	High school
	Vocational and Technical Education
	Bachelor Degree /Licence
	Master's Degree
	Bachelor Degree and Teaching Diploma
	Other
Specify your major in the Bachelor's degree/Licence	
Number of years of teaching experience	
Number of years of science teaching experience	
Number of years of science teaching experience at the elementary level	

Section 2						
Definition of socioscientific issues (SSI)*:* *Socioscientific issues are controversial issues, socially relevant, real-world problems that are multidimensional, and often involve ethical, moral or legal dilemmas (Sadler et al, 2006; Walker & Zeidler, 2007).*						
Items	**1**	**2**	**3**	**4**	**5**	**NA**
1. Introducing COVID-19 into science classes is definitely necessary (adapted from Lee et al.,2006).						
2. I have confidence in developing teaching and learning materials about the COVID-19 topic.						
3. I believe teaching about COVID-19 contributes to enhancing scientific literacy.						
4. I believe that elementary students are mature enough to understand the COVID-19 pandemic						
5. I have the pedagogical knowledge for teaching elementary students about COVID-19.						
6. Addressing the COVID-19 in science classes doesn't confuse students about their own values.						
7. I use COVID-19 as a means (or aid) to motivate students to learn science content.						

8. I use various teaching strategies (e.g. role plays and group activities) when teaching about COVID-19.						
9. I use argumentation and evidence-based thinking as scientific practices for teaching about COVID-19.						
10. I can properly manage class time when teaching about COVID-19.						
11. I teach about COVID-19 not only in extra-curricular activity sessions but also during the science sessions.						
12. I challenge my students to analyze COVID-19 data from multiple perspectives.						
13. In my science teaching, I give equal attention to teaching socioscience issues, such as the COVID-19 pandemic, as well as to teaching science content.						
14. Activities related to COVID-19 provide students with opportunities to voice their opinions, and improve their judgments regarding this socioscientific issue.						
15. Socioscientific issues, such as COVID-19, expose students to ‘‘positive and negative’’						

aspects of science and technology, thus, allowing them to develop deeper and unbiased understandings of science and technology						
16. I make ongoing connections to socioscientific issues when teaching about COVID-19.						
17. Due to the ill-structured and dynamic nature of socioscientific issues, I urge students to employ skepticism when considering sources of information concerning the COVID-19.						
18. Through teaching about COVID-19, I help students to improve their ability to communicate criticism of others' positions regarding this socioscientific issue.						

Note. 1=Strongly Disagree ,2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, 5=Strongly Agree, NA= Not Applicable

Section 3	
Are you willing to participate in an online interview with the researcher?	Yes
	No
If you answered yes to the above question, please provide the following contact information:	**Your Name:**
	Your email address:

Appendix -B-

Interview Questions

1. Have you ever introduced issues related to science and society into your science classes? If yes, give examples.
2. To what extent is it important to teach elementary students about COVID-19?
3. In what ways can teaching about COVID-19 contribute to enhancing scientific literacy?
4. Do you think as elementary science teacher you are well-prepared to teach about COVID-19? Explain.

   Sub-question: Do you have the content knowledge for teaching about COVID-19? what about the pedagogical knowledge?

5. Do you teach about COVID-19 in your science classroom? (If no, why? If yes, then continue with question 5).
6. Remember the last time you taught about COVID-19 in your science classroom. Could you please describe the session/ activity?
7. What instructional strategies do you use for teaching about COVID-19?
8. How do you use argumentation to engage students in the controversial COVID-19 issue?

9. As there are many challenges that hinder teachers in implementing SSI in their teaching practices, what sorts of difficulties hinder you in teaching about COVID-19?

   Sub-question: Could teaching about COVID-19 bring teachers anxiety?

10. Would you describe how can challenges (that you discussed in question 8) be overcome?

Appendix -C-

Theme 1: Perceptions on teaching about COVID-19		
Patterns	**Codes**	**Example Statements**
perception of the importance of teaching about COVID-19	Imp	"As this pandemic is not going to be the last one, it is very important that students learn how to deal with such pandemics. Take H1N1 as an example" (ST5). "It is necessary to teach students about COVID-19 for it will help them to understand about any new virus that they might encounter in the future" (ST14).
	Role	"As students are still living the COVID-19 pandemic, and not all parents can teach their kids about this pandemic, it is our role as elementary teachers to teach them about COVID-19" (ST3)
perception of the role of teaching about COVID-19 in enhancing scientific literacy	Inc SL	"One of the goals for teaching science is to increase students' scientific literacy. Teaching students about COVID-19 helps them to take informed decisions, thus enhancing their scientific literacy". (ST2) "Teaching about COVID-19 will help students better understand the scientific reasons (rationale) for taking precautions. Once they know the reasons, they will understand why they should protect themselves". (ST6)
perception of their readiness to teach about COVID-19	Prep	"Yes, we are prepared since we have lots of resources that are child friendly and can be used in science classrooms to teach about COVID-19. From my side, I have both the content and pedagogical knowledge to teach about... we can (not using the medical terminologies) explain the idea, teach some definitions like what is an infectious disease and how does it spread. In a way we are able and competent to teach about COVID-19 to students" (ST2).
		I have never attended a lecture/workshop related to teaching about COVID-19. I can do my own research but still I need support from a medical expert. Since elementary students might get confused about many issues related to COVID-19, I cannot handle debates with students (ST9).

perception on the challenges that hinder them in teaching about COVID-19	Lack	"We don't have **teaching materials** in our school that could help us in teaching about COVID-19. We cannot lecture students about this topic, it should be engaging for them…" (ST12). "There is not enough resources in the curriculum" (ST4). "Not finding the **effective pedagogy** that will make a difference in correcting students' misconceptions is also challenging" (ST9). "One challenge is not finding effective strategies to convince students with knowledge related to COVID-19"(ST5).
	COVID-19 Characteristics	"Teaching about COVID-19 is going to be stressful on me, and on my many other teachers, as it will bring trauma, it is similar to teaching about Beirut explosion" (ST16, ST9). *(Social-emotional aspect)* "Environment and culture of the school (mindset of parents) is a challenge for us'(ST15).
		"We do not have answers to students' questions (that are many) as this topic is controversial and our students are very curious" (ST10). "We do not have accurate information about this virus" (ST14).
perception of the need for professional training to tackle COVID-19 teaching related issues	Lack	"Lack of training" (ST4). "The government, represented by the ministries of Education and Health, should step in and help schools to take precautions that will ensure students' safety in the first place. Then, they should form specialized committees and **visit schools to give lectures and train teachers to teach about COVID-19**. They should work on having a unified resource or reference among all schools in Lebanon" (ST15) "The school should provide their teachers with materials and resources and equip them with some teaching methods that will make their teaching more interactive. I also suggest that we **substitute the**

		unimportant science lessons in the curriculum with COVID-19 lessons, then we start developing teaching materials based on the students' levels" (ST10).

Appendix-D -

Theme 2: Interpretation of COVID-19 Teaching		
Patterns	**Codes**	**Example Statements**
Reasons behind not teaching about COVID-19	Lack	"We have no time to teach students about COVID-19. We only teach them how to take pre-cautions" (ST14). *(lack of instructional time)* "I don't teach about COVID-19, unfortunately, because it is not in the science curriculum that we should cover. Sometimes, we give it as an example when we teach about the scientific method" (ST13). *(lack of relevant instructional materials)*
Describing a COVID-19 teaching session	Class discussions-group work	"Students were asked at first about it (whole class discussion at the beginning of the science session). Then I showed students a video about COVID-19, and made a discussion with them about the severity of the disease. Then continued answering students related questions. Then we tackled their misconceptions" (ST2) "We let students watch videos, (for example videos about how the virus is transmitted), then we have class discussions After that students work in groups on answering questions related to the lesson…If there is an update about COVID-19, we also explain it to

		students. We also address the vaccine issue" (ST15)
Use of instructional strategies when teaching about COVID-19	Strt	"I use inquiry-based approach. It starts with questions, then reaching a conclusion" (ST2). Inquiry based using the scientific method to reach a conclusion" (ST1).
		"We do a lot of hands-on activities when it comes to teaching about COVID-19. Students are always encouraged to work in groups and solve the lesson questions" (ST16)
Use of argumentation when teaching about COVID-19	No arg	"Not argumentation in a direct way, because in third grade we haven't started with argumentation. Sometimes in the middle of a discussion, a student starts with an argument (based on what he heard), so we do fall into a discussion about it but in a very informal way" (ST2). "One of the controversial issues about COVID-19 is whether or not to take the vaccine, but students were not engaged in argumentations. This is because we were afraid that parents won't accept this and would interpret that we have a benefit behind tackling this issue" (ST19)

Appendix-E-

Theme 3: Addressing COVID-19 as a Socioscientific Issue		
Patterns	**Codes**	**Example Statements**
Teaching socioscientific issues	Yes	We teach SSI such as pollution, global warming, food technology, sustainability, food pollution, food preservation, ozone, and plastic waste (ST1, ST2, ST4, ST5, ST6, ST7, ST8, ST10, ST15, ST17, ST18)
	No	"We do not teach any socioscientific issues, students learn about it in other subjects such as geography or sociology" (ST3, ST9, ST11, ST12, ST13, ST14, ST16, ST19, ST20).
Addressing COVID-19 as a socioscientific issue.	COVID-19 as SSI	"Since COVID-19 topic is controversial in nature, this adds a challenge on the teacher" (ST11, personal interview). "First we need to do some research. Students ask many challenging questions, so we have to be ready. COVID-19 is a controversial topic yet we can simplify the material for students and give them simple COVID-19 lessons" (ST13, personal interview)