Term Paper

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Addressing the STSE Issues in the Lebanese National Science Curriculum and Textbooks

Abstract

The purpose of this study is to identify the kinds of STSE issues that are addressed in the K1-6 Lebanese national science curriculum and textbooks. It also aims to investigate the variation of the STSE issues across cycles one and two of the curriculum and textbooks, as well as their alignment. The curriculum objectives and the unit introductions, instructions, and texts of the textbooks were analyzed and categorized using a framework synthesized for this study. The results indicate that the K1-6 Lebanese national science curriculum and textbooks highly emphasize the inter-relationships between science, technology, society, and environmental issues. Besides, there is a strong relationship between the STSE issues addressed in the curriculum and textbooks, as well as the coverage of STSE issues increases as grade level increases. The recommendation of this study is to work on updating the curriculum and textbooks to add new kinds of STSE issues. It is also suggested that further studies can be conducted to explore how teachers deliver the STSE issues in classrooms.

1. Introduction

The emphasis on science and technology has increased, and it is getting more attention in today's world. It has been agreed globally by education and political leaders that science and technology are the stimulants for progress in modern society (BouJaoude, 2002). However, many people, especially the teaching staff, do not have the required knowledge of science and technology. Besides, a plethora of research has shown that many people in developed countries lack the essential science and technology knowledge and skills to perform in the developed

world (AAAS 1989; Eisenhart et al. 1996; ETS 1988; Halloun 1993; Miller 1989; Ogawa 1998; Shamos 1995). Subsequently, this world that is highly shaped by science and technology requires an essential development of scientific and technological literacy (UNESCO, 1994). According to Chiapetta et al. (1991, 1993), scientific literacy has four major aspects that are the knowledge of science, the investigative nature of science, science as a way of thinking, and the interaction of science, technology, and society (STS). The STS aspect shows the inter-relationships between science, society, and technology, and the effect of science on society (AAAS 1989; Chiapetta et al. 1991; Hurd 1994; Lederman & Niess 1998; NSTA 1982). There are different movements other than the STS such as SSI and STSE.

Socio-scientific issues (SSI), science-technology-society (STS), and science-technology-society-environment (STSE) are three different movements. They have a common point which is making a relation between science and the social aspect of students' lives. According to Chowdhury, Holbrook, and Rannikmäe (2020), socio-scientific issues are scientifically contextualized topics that address the social surroundings. SSI tackles the cultural background of students and their moral and ethical values. The main purpose of SSI is to enhance students' scientific literacy that helps them create projects to help their communities (Chowdhury et al., 2020). However, science, technology, and society (STS) education aims to interpret the new technological advancements on society and scientific knowledge (Primastuti & Atun, 2018). According to Aikenhead (1994), STS focuses on the interaction between the social contexts to the technological inventions or to what scientific information students learn in their classrooms. Predictably, STS helps students understand the different aspects of science and relate them to their circumstances (Yager, 2001). Besides, science, technology, society, environment (STSE) is to a certain extent similar to STS, but it sheds the light on the environmental aspect. The

National Science Teachers Association (NSTA) (1990) defines STSE as teaching and learning science in the context of students' experiences in their community. STSE movement has mainly tried to bridge the gap between the scientific knowledge inside the classroom and its effects on students' lives outside their learning environment (Sadler, 2004). Additionally, research has shown that there are advantages of STSE on the level of career planning, decision making, scientific knowledge, and citizen responsibility (Evagorou, 2011; Gresch et al., 2017; Klosterman & Sadler, 2010; Oulton et al., 2004; Yörük et al., 2009). Even though this paper includes research on SSI and STS, its major focus is on STSE.

1.1 Purpose

Helping students to keep pace with scientific and technological development in the world is one of the goals presented by the National Educational Plan adopted by the Council of Ministers in 1994 in Lebanon (CERD, 1994). Consequently, this goal is expected to be highlighted in the Lebanese national science curriculum and textbooks. Thus, our research is concerned with identifying the kinds of science, technology, society, and environment (STSE) issues that are addressed in the K1-6 Lebanese national science curriculum and textbooks. It also aims to investigate the variation of those STSE issues across cycles one and two of the elementary level as well as the alignment between the curriculum and textbooks with respect to the issues. The proposed research questions of this study are:

1- What kinds of STSE issues are addressed in the K1-6 Lebanese national science curriculum?
2- What kinds of STSE issues are addressed in the K1-6 Lebanese national science textbooks?

3- How do the STSE issues vary across cycles one and two of the Lebanese national science curriculum and textbooks?
4- To what extent are the K1-6 Lebanese national science curriculum and textbooks aligned with respect to STSE issues?

1.2 Rationale

Different research has studied the kinds and the variation of SSI, STS, and STSE issues in science curriculums and/or textbooks (BouJaoude, 2002; Calado et al., 2015; Calado et al., 2016; Calado et al., 2018; Chiappetta et al., 1991, 1993). Instead of identifying the kinds of STSE issues, BouJaoude (2002) investigated the balance of scientific literacy themes wherein STS is part of them. The similarity between our study and BouJaoude's (2002) research is the focus on the Lebanese national science curriculum. Other studies conducted by Chiappetta et al., (1991, 1993) also explored the balance of scientific literacy aspects in science textbooks wherein it focused on STS rather than STSE. A major difference between our study and BouJaoude's (2002) and Chiappetta et al., (1991, 1993) is that it investigates both Lebanese national science curriculum and textbooks. Additionally, other research analyzed biology textbooks to identify the kinds of STSE issues in Germany and Portuguese (Calado et al., 2015, 2016, 2018). Their focus was only on chapters related to genetics, but our study shed light on all the chapters of the K1-6 Lebanese national science textbooks. All of that makes our study unique especially that it will be carried out in Lebanon.

1.3 Significance

In addition to the uniqueness of our study, it is significant because it tackles the kinds of STSE issues addressed in the K1-6 Lebanese national science curriculum and textbooks. It also investigates the alignment between the curriculum and textbooks along with the variation of the

STSE issues across cycles one and two. This will help curriculum and textbook developers to identify the STSE issues found in the curriculum and textbooks to check if they are enough or need modifications to achieve the goals behind them. Also, teachers will be able to explore the STSE issues and their kinds, so that they plan their units/lessons accordingly. When teachers do so, it will be easier for them to teach these issues. Thus, students will understand better the STSE issues and improve their decision-making skills, critical thinking, and much more. Besides, teachers can modify the number of STSE issues addressed in the textbooks when they find out if the number of those issues increases or decreases as the grade level increases.

2. Literature Review

Science, technology, and society (STS) is a very significant aspect of scientific literacy. According to BouJaoude (2002), STS is the scientific literacy aspect that shows the importance of applying science in everyday life. Thus, its presence in the science curriculum and textbooks is essential. Similarly, the same applies to STSE which is the major focus of our study. Hence, the K1-6 Lebanese national science curriculum and textbooks were analyzed. Many researchers conducted different studies to analyze science curriculums and/or textbooks of different domains and grade levels (Berlin & Kumar, 1998; BouJaoude, 2002; Chiappetta et al., 1991; Phillips & Chiappetta, 2007).

2.1 STSE in Science Curriculum

Science curriculums might address many different kinds of STSE issues that are essential for scientific literacy. According to Amirshokoohi (2010), the main goal of developing the STSE curriculum is to prepare students to have the willingness to make wise decisions. In this research, the researchers analyzed the K1-6 Lebanese science curriculum to look at the different kinds of addressed STSE issues. The interaction of the science curriculum with technology, society, and

environment (TSE) is a fundamental part of the STSE curriculum (Surata, et al., 2018). For instance, in the Netherlands, the physics curriculum is STSE-based as it develops the context according to students' real world (Kortland, 2005). In this research, the authors will explore if the K1-6 Lebanese science curriculum, and textbooks as well, address STSE issues.

Additionally, contextualizing the content environmentally enhances students' understanding of the environmental issues (Taptamat, 2011) which makes them propose some possible solutions to the environmental problems. For example, in Bali, students show high-critical thinking abilities while reflecting on their local environmental issues. Other than the environmental gains after following the STSE curriculum, students proved to become technologically literate (Ozaktas, 2013). There are some reasons that make it important to analyze the Lebanese textbooks and curriculum in order to find out if students gain such the needed skills and experiences.

Science educationalists have a similar opinion regarding the importance of the STSE curriculum (MacLeod, 2013). Their perspective is opposite to textbook-centered classrooms that highly emphasize textbook content (DeBoer, 2006). This indicates that they prefer to help students relate the content of science textbooks to the context (Lederman & Stefanich, 2006). Providing students with a wider and more relevant context can be achieved by using STSE (Bybee, 2006). This is related to our research that will investigate the issues that link the content to students' real experiences regarding science, technology, society, and environment domains.

2.1.1 STS/STSE in Science Curricula of Different Countries

In 2004, the ministry of national education in Turkey integrated STSE into the science curriculum (Yetisir & Kaptan, 2008). This was noticed as the science course changed to become "science and technology." According to MEB (2004), 36 STSE goals were included, and sample

activities were provided for each unit. However, in Lebanon, the Lebanese national science curriculum has not been updated since 1998 (CERD, 1998). Thus, BouJaoude (2002) conducted a research to analyze the balance of scientific literacy themes in the Lebanese national science curriculum, which is our focus, and it showed that it includes STS issues.

In the same context, Kumar and Berlin (1998) carried out a study to analyze the STS themes in the United States science curriculum. Some goals of the U.S. curriculum boost students' levels in mathematics and science, help teachers design and choose materials, and improve classroom activities (Blank & Pechman, 1995). The researchers reported that 88% of the 25 state curriculums included STS goals. This high percentage reflects the importance of integrating the STSE issues in the curriculum. About 50% of the content emphasized three main standards which are: environmental quality, science as a human endeavor, and nature of science and scientific knowledge. The relation between science and technology empathized in 40% of the analyzed materials. The findings also showed less than 40% emphasis on environmental changes and the science-technology and societal issues relationship. All those results were based on specific criteria, and in this research, the kinds of STSE issues will be classified according to similar criteria and much more. The STSE issues will be analyzed in both the K1-6 Lebanese national science curriculum and textbooks.

2.2 STSE in Science Textbooks

2.2.1 The Use of Science Textbooks

Science teachers agree that science textbooks are significant resources that express the concept of the "social context of science" (Green & Naidoo, 2008; Ramnarain & Chanetsa, 2016). They are also expected to align with the official syllabi and guidelines; however, they may contradict the official curricula (Gericke et. al., 2014).

Chiappetta et al. (1991) claimed that many science teachers highly depend on textbooks, which might give learners negative impressions about the nature of science. Those teachers are content-oriented, so they do not devote enough time to science-technology-society issues (Gottfried & Kyle, 1992). Additionally, what makes science textbooks of good quality is not just the content and illustrations they include but also their balanced reflection on the four scientific literacy themes (Chiappetta et al. 1993). The four themes are "science as a body of knowledge, science as a way of investigating, science as a way of thinking, and the interaction among science, technology, and society (STS)." However, there are still textbooks that fail to integrate accurate views on STS (Calado et al., 2016; Morris, 2014). This shows that there are still textbooks that do not reflect a balance of all the scientific literacy themes.

2.2.2 The Kinds of STSE Issues in Science Textbooks

Several science textbooks of different countries contain various kinds of STSE issues. In their work, Calado et al. (2015) analyzed two German 11th grade biology textbooks (A&B) from two different publishers. They aimed to identify the STSE issues presented in the textbooks. The findings revealed that both textbooks differ from each other with respect to the STSE issues (Calado et al., 2015). Although both textbooks dealt with science and technology relationships, textbook A focused more on the social dimension, and textbook B on the environmental dimension.

In the same vein, the same researchers, Calado et al. (2016), conducted the same study, but on four Portuguese natural sciences and biology textbooks, two for grade 9 and two for grade 12. The results showed that 12th grade textbooks include more STSE issues than 9th grade textbooks. 12th grade textbooks emphasized social impacts more than 9th grade textbooks, but all textbooks failed to refer properly to the environmental dimension (Calado et. al., 2016).

One common gap in the two studies of Calado et. al., (2015, 2016) is the selection of a small sample of related textbook chapters. Besides, both studies indicated that some science textbooks give attention to STSE issues, but to a certain extent. However, our study's focus is on analyzing all the chapters of K1-6 Lebanese national science textbooks to identify the STSE issues kinds.

2.2.3 The Effect of Socio-Cultural Context on STSE Issues

Moreover, STSE issues do not only differ between textbooks of the same country, but they also differ among different socio-cultural contexts. De Carvalho et al., (2008) claimed that international comparisons in education are beneficial because they shed light on alternatives and may lead to new science education program designs. To illustrate, Calado et al. (2018) carried out a third study to compare how German and Portuguese biology textbooks handle STSE issues. Calado et al. (2018) showed that their hypothesis was confirmed wherein German and Portuguese textbooks differ at the nationality level with respect to STSE issues. Similarly, another study compared biology textbooks of eight countries, and it reported that the interaction of "social, cultural, economic, and ethical dimensions" was rarely present (Selmaoui et al., 2012). If this interaction is absent, STS issues will be different in the biology textbooks of eight countries. Thus, sociocultural contexts influence handling STS and STSE issues in science textbooks.

Additionally, it is important to analyze science textbooks of the same country because they also might differ in the social, cultural, economic, and ethical issues that they address. As indicated in Calado et al., (2015, 1016), biology textbooks of the same country differ in their focus on STSE issues. This study will also analyze 6 Lebanese national science textbooks to highlight the kinds of STSE issues that have the most emphasis.

2.2.4 The Variation of STS and Social Issues in Textbooks

It is worth mentioning that our research's focus is on STSE, and not STS, but both movements share some common goals. As STS and STSE issues differ according to the socio-cultural context, their number differ from year to year and among grade levels. Rosenthal (1984) analyzed the most frequently used high school biology textbooks in the United States published between 1963 and 1983. Their aim was to identify how biology textbooks handle social issues. As shown in the previous studies, science textbooks differ in handling STS issues, so it might be predicted that they differ in handling social issues.

Likewise, a second study conducted by Chiang-Soong and Yager (1993) aimed to identify the STS topics in 11 science textbooks of different grade levels in the United States too. The researchers implemented two different frameworks for content analysis in their studies. Despite using different frameworks, both studies shared common results. For instance, Rosenthal (1984) indicated that the focus on social issues in science textbooks declined between 1963 and 1983. Similarly, Chiang-Soong and Yager (1993) showed that as grade level increases, the space devoted to STS issues decreases. This shows that STS and social issues vary across grade levels and years. Besides, this is one of the aims of our study which is to explore the variation of STSE issues, instead of STS, across cycles one and two of the Lebanese national science curriculum and textbooks.

2.2.5 STS Issues Within the Context of Scientific Literacy Themes

A plethora of research was conducted to investigate the balance of scientific literacy themes in science textbooks of different grade levels (Cakici, 2012; Chiappetta et al., 1991, 1993; Chiappetta & Fillman, 2007). One of the scientific literacy themes is science, technology, and society which is related to science, technology, society, and environment. STS was also

analyzed in those studies and many others under the umbrella of scientific literacy (Cakici, 2012; Chiappetta et al., 1991, 1993; Chiappetta & Fillman, 2007). Thus, the authors referred to the part related to STS in the latter studies.

2.2.5.1 Little Space Devoted to STS Issues in Science Textbooks

STS issues include several kinds that are addressed differently in science textbooks. On one hand, Chiappetta et al. (1991) investigated the content of seven high school chemistry textbooks listed by Texas State to explore the curriculum and scientific literacy aspects balance. They chose to analyze scientific literacy themes to highlight the kinds of themes that chemistry textbooks focus on. On the other hand, another study done by the same researchers, Chiappetta et al. (1993), aimed to analyze middle school life science textbooks used in Texas State based on scientific literacy themes. In both studies, they used the same textbook analysis method which they had done in their 1988a study (Chiappetta et al., 1991; Chiappetta et al., 1993). Regarding the STS theme, Chiappetta et al. (1991, 1993) describe it as content that demonstrates science's impact on society, social issues, and careers. Also, this scientific literacy theme involves application and technology's role in facilitating or hindering people's life. This shows the kinds of STS issues that textbooks' content might be divided into. In Chiappetta et al. (1991), the results indicated different percentages of STS issues among the seven textbooks. For instance, some books devoted only 4% and 8% of their texts to STS, and on average, all books include around 1% of STS issues. Similarly, in Chiappetta et al. (1993), the findings showed that an average of 0% to 9% is devoted to STS material among the chapters related to the nature of science. Among the five percent random sample, an average of 3% to 11% is devoted to STS material. Therefore, both studies' results are aligned wherein STS material has little space in high school chemistry textbooks and middle school life science textbooks.

Similar studies have been done by different researchers using the same method described by Chiappetta et al. (1991). For instance, Lumpe and Beck (1996) conducted a study to explore the presence of scientific literacy themes in U.S. biology textbooks. They reported that all biology textbooks cover a minimal amount of STS themes. Another similar study was done by Phillips and Chiappetta (2007) where they analyzed 12 middle school science textbooks and indicated that little space is devoted to STS material. Despite the importance of STS issues, many science textbooks still do not include them effectively among the other scientific literacy themes.

2.2.5.2 More Space Devoted to STS Issues in Science Textbooks

Although many science textbooks did not devote enough space for STS issues, other textbooks showed a little increase in focusing on STS. Chiappetta and Fillman (2007) analyzed five high school biology textbooks in the United States. They used the same method stated in Chiappetta et al., 1991 and Chiappetta et al., 1993 to analyze the same six chapters of the five textbooks. Despite using the same framework as in Chiappetta et al. (1991, 1993), this study reported different findings. The five new biology textbooks revealed more balance in the four scientific literacy themes. Consequently, the STS theme had been given more attention in textbooks (Chiappetta & Fillman, 2007). Similarly, Cakici (2012) carried out a study in Turkey to explore the presence of the four scientific literacy themes in the upper primary level science textbooks. They also implemented Chiappetta et al. (1991a) framework in content analysis. Their results show alignment with Chiappetta & Fillman,(2007) where one-fifth of the content was dedicated to STS themes (Cakici, 2012). This reveals that more attention and emphasis have been given to STS themes in science textbooks.

Therefore, STS issues vary in different science textbooks wherein some textbooks devote more space for them and others not. The same applies to STSE issues wherein their presence in science textbooks also varies. This will be investigated in our study to explore the different kinds of STSE issues and their percentage of distribution in the K1-6 Lebanese national science curriculum and textbooks.

3. Theoretical Framework

Textbook analysis should be done based on a specific framework that aligns with the purpose of the analysis. Many researchers used several frameworks to investigate STSE issues. For instance, the "Science and Technology Education Promoting Wellbeing for Individuals," (STEPWISE) framework is developed by Larry Bencze (Bencze, 2017). The purpose of this framework is to create a curriculum and instruction that emphasize science and technology so learners can apply their literacy to reach a better world. This framework is very effective, but the researchers found that it does not have suitable criteria that can be applied to textbooks. Another framework that grabbed the authors' attention is the STSE model by Pedretti (1996). This framework focuses on the decision-making, action, and sustainability aspects of STSE only. Similarly, one use of Pedretti's (1996) framework is like the STEPWISE framework which is to develop curriculum and instruction. Also, Pedretti's (1996) model is used as a reflective tool and to explore STSE issues in the curriculum. This model was not chosen in this study because it focuses only on two aspects of STSE that are decision-making, action, and sustainability; thus, this would limit our analysis.

In other research, some frameworks highlight more aspects of STS and STSE. For instance, BouJaoude (2002) implemented the framework used in Chiappetta et al. (1991, 1993), but with some adaptations. He used this framework to identify the balance of scientific literacy

themes in the Lebanese science curriculum. STS is one of the scientific literacy themes, and the categories of it are, “impact of science on society, inter-relationships between science, society, and technology, careers, science-related social issues, personal use of science to make everyday decisions, solve everyday problems, and improve one’s life, and finally, science-related moral and ethical issues” (BouJaoude, 2002). This part of the framework is more suitable for our study than Pedretti (1996) and Bencze (2017) because it can be applied for content analysis and includes several aspects of STS. However, BouJaoude’s (2002) framework does not include the environment dimension, thus it needs adaptation to fit our study. Additionally, Calado et al. (2015) proposed six criteria and 26 sub-criteria to analyze STSE issues in biology textbooks. They used this framework in two other studies, and this indicated the usefulness of this criteria. The criteria include, “science and technology events and their social contextualization; the interplay between science and technology; science and technology as a means to solve problems; risks and impacts of science and technology; controversial issues; decision-making process” (Calado et al., 2015). Furthermore, under each category, there are subcategories, and the environmental dimension is one of them. This made us recognize the overlap in BouJaoude’s (2002) and Calado’s et al. (2015) frameworks. Both frameworks share some common aspects of STS and STSE. Hence, for BouJaoude’s (2002) framework to fit with our study, we decided to adapt it by integrating Calado et al. (2015) framework with it. Both frameworks with the definition of the criteria and sub-criteria are presented in Appendix A.

The adapted framework that we will use in our study includes criteria and sub-criteria from BouJaoude (2002) and Calado et al., (2015) frameworks (Table 1). First, we took the common criteria in both frameworks, and then we added the un-mutual criteria to them. We included some of the STS aspects in BouJaoude’s (2002) framework in the sub-criteria of Calado

et al. (2015) framework. Therefore, the criteria of the adapted framework are, "Inter-relationships between science, society, and technology; personal use of science to make everyday decisions, solve everyday problems, and improve one's life; risks and impacts of science and technology; controversial issues; science-related social, moral, and ethical issues. In addition, under each criterion, there are several sub-criteria (Table 1), and the environmental dimension is one of them.

Criteria	Inter-relationships between science, society, and technology	Personal use of science and/or technology to make everyday decisions, solve everyday problems, and improve one's life	Risks and/or impacts of science and technology	Controversial issues	Science related moral and ethical issues
Sub-criteria	Distinction	Legislation	Risks	Different perspectives	Science and moral issues
	Technology towards science	International comparison	Social impact	Conflict values	Science and ethical issues
	Science towards technology	Agents	Local environmental impact	Involved interests	
	Society towards science and technology	Citizen participation and decision making	Global environmental impact	Different source of information	
	Science and applied science	Problem-solving			
	Society towards environment				
	Environment towards society				

Table 1. Criteria and sub-criterion of the adapted framework that will be used in this study.

All in all, it is very important to address STSE issues in science curriculum and textbooks, which will be our focus in this study. Science education needs to actively integrate meaningful issues that are relevant to students' everyday life.

4. Methodology

This study aims to identify the kinds of STSE issues addressed in the K1-6 Lebanese national science curriculum and textbooks. It also aims to explore the variation of the addressed STSE issues across the lower and upper elementary levels in the curriculum and textbooks, in addition to the level of their alignment. To achieve this purpose, we looked at the curriculum and textbooks and read them to identify how we will analyze them. The Lebanese national science curriculum has not been updated since 1998 (CERD, 1998). In this study, the focus is on the K1-6 curriculum that is under the title "Elementary Level" that starts with an introduction and is divided into two cycles: cycle one for grades one, two, and three, and cycle two for grades four, five, and six. Regarding the K1-6 science textbooks, they were published between 1998 and 2000. It is worth noting that there is no need for IRB permission. Also, there are no restrictions for using the Lebanese national science curriculum and textbooks.

The introduction and objectives of the K1-6 Lebanese national science curriculum were analyzed. Besides, the unit introduction, instructions, and texts were analyzed in the K1-6 science textbooks. The distribution of the kinds of STSE issues found in the K1-6 science curriculum and textbooks was carried out in two steps. The first step is the distribution of STSE issues according to the criteria of the framework. The five framework's criteria are: inter-relationships between science, technology, society, and environment (CR1), personal use of science to make everyday decisions, solve everyday problems, and improve one's life (CR2), risks and/or impacts of science and technology (CR3), controversial issues (CR4), science-related moral and ethical issues (CR5). The second step is classifying them according to the sub-criteria of the framework. The analyzed information was categorized using the synthesized framework on excel sheets.

The authors first prepared seven excel sheets, one for the curriculum, and the other six for the six science textbooks. The excel sheet of the K1-6 science curriculum included two tables of the framework. The first table was designed for cycle one objectives and the second table for cycle two objectives (Appendix B). For the other six excel sheets of the textbooks, each one included three tables of the framework. The first table was for the unit introduction, the second table for the instructions, and the third one was for the texts (Appendix B). This procedure that we followed is adopted from BouJaoude's (2002) study, but we did some adaptations wherein we used a different framework and applied it on both the K1-6 curriculum and textbooks.

Then, the analysis and categorization processes were done in two steps. First, each author analyzed and categorized the STSE issues in the curriculum and six textbooks alone. For instance, while reading the grade one science textbook, the unit introduction, instructions, and texts were analyzed to explore if they include STSE issues. If a text highlights an STSE issue, it was classified as belonging to one of the five criteria or more, and under one sub-criteria or more. Second, each author discussed their findings, and the similarity between both of them was 70.17%. Whenever there were discrepancies in the categorization of the STSE issues, they were discussed to change their category, add them as new STSE issues, or remove them at all. After discussing all the contradicted STSE issues, we agreed on all the results. These two steps were done to ensure the validity and credibility of the final results.

After categorizing all the STSE issues according to the criteria and sub-criteria, the total number of STSE issues was calculated in the K1-6 Lebanese national science curriculum, then in the six science textbooks. Subsequently, the percentages of each criterion and sub-criterion in the STSE framework were computed. Regarding the data collected from the six textbooks, the STSE issues in the unit introduction, instructions, and texts were computed as one whole. For instance,

to find the percentage of each criterion, the STSE issues related to this criterion in the unit introduction, instructions, and texts were computed together. The percentage of the kinds of STSE issues was computed for cycles 1 and 2 of the curriculum separately; then, it was computed as a total for cycles 1 and 2 together. The same was applied to the textbooks. The percentage of STSE issues kinds was computed for grade levels one, two, and three textbooks (cycle 1), and then, for grade levels four, five, and six (cycle 2) separately. Then, the percentage of total kinds of STSE issues were computed for cycles 1 and 2 textbooks together. The final results of this categorization are presented in tables 2, 3, and 4, and in figures 1-6. It is worth stating that some STSE issues were classified as belonging to more than one criteria or sub-criteria. Thus, the total number of STSE issues is not always equal to the number of K1-6 curriculum objectives and the unit introduction, instructions, and texts of the six science textbooks. Besides, the linear correlation coefficient method and the guide for interpreting the strength of correlation were used to find the alignment between the science curriculum and textbooks with respect to the STSE issues. The authors followed this procedure to find all the results in an organized way.

5. Results

The analysis of the results is done in several steps to achieve the purpose of this study. The introduction of the elementary level curriculum (Cycles 1 & 2) shows that the K1-6 Lebanese national science curriculum addresses STSE issues. For instance, it is mentioned that the elementary level curriculum was updated to meet the modern development in science-technology-society and the new educational development in Lebanon (CERD, 1997).

5.1 The STSE Issues Addressed in the K1-6 Lebanese National Science Curriculum

The introduction and the objectives of the K1-6 Lebanese science curriculum were first analyzed according to the criteria. The introduction shows that the curriculum addresses STSE issues. For instance, it is mentioned that the elementary level curriculum was updated to meet the modern development in science-technology-society and the new educational development in Lebanon (CERD, 1997).

Additionally, the percentages of the STSE issues in the K1-6 Lebanese national science curriculum are presented in figures 1, 2, and 3. Figure 1 shows the percentage of distribution of the STSE issues in cycle 1 curriculum objectives according to the framework's criteria. The results indicate that there is presence of the first two criteria (CR1 and CR2) only, 50% for each. However, there is no presence for any of the last three criteria (CR3, CR4, and CR5). Regarding cycle 2 curriculum objectives, figure 2 presents the percentage of distribution of STSE issues according to the criteria. 57.14% of cycle 2 curriculum objectives is devoted to CR1, 28.57% for CR2, and 14.28% for CR3. An example of criterion one is, "explain, with simple examples, the relation of science to industry and agriculture, and summarize the importance of sustainable development of resources and energy in Lebanon." Another example for criterion 2 is, "name simple machines and explain their characteristics and everyday uses." As for CR4 and CR5, there is no presence for them in the cycle 2 curriculum objectives. Therefore, figures 1 and 2 reveal that the inter-relationships between science, technology, society, and environment (CR1), and the personal use of science to make everyday decisions, solve everyday problems, and improve one's life (CR2) have the highest emphasis among the five criteria in cycles 1 and 2 curriculum objectives.

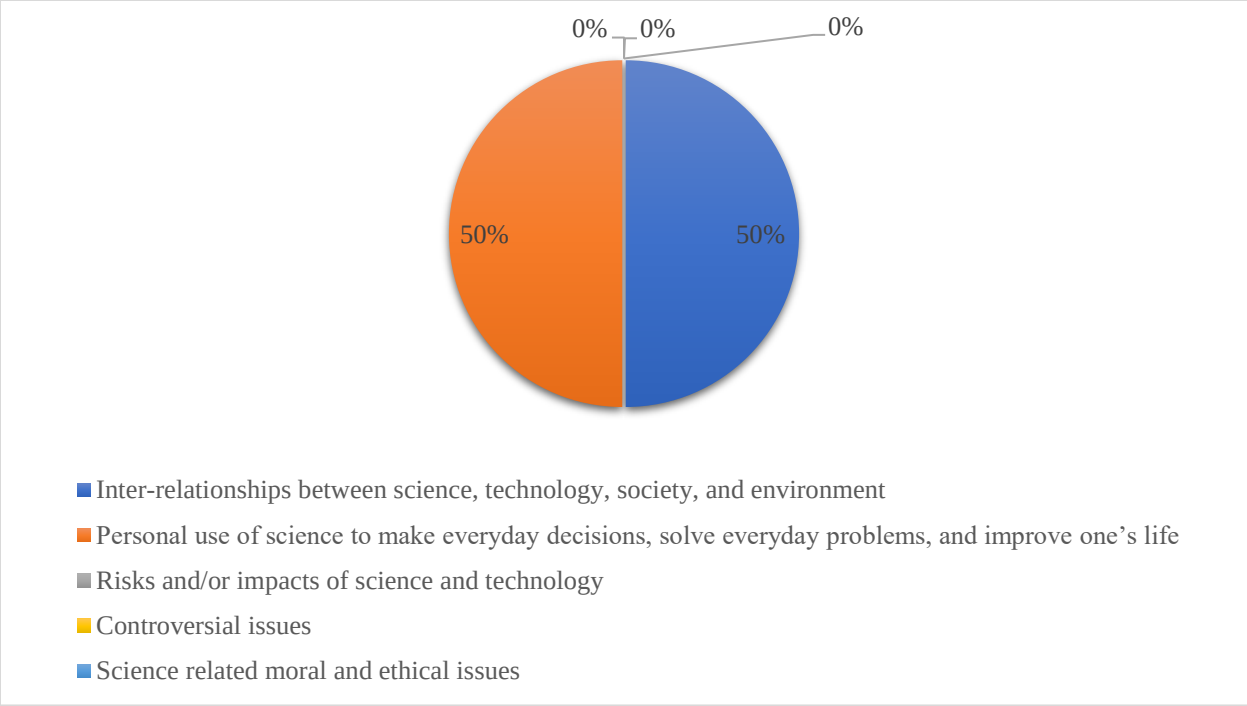

Figure 1: Distribution of STSE Issues in Cycle 1 Science Curriculum Objectives according to the Criteria

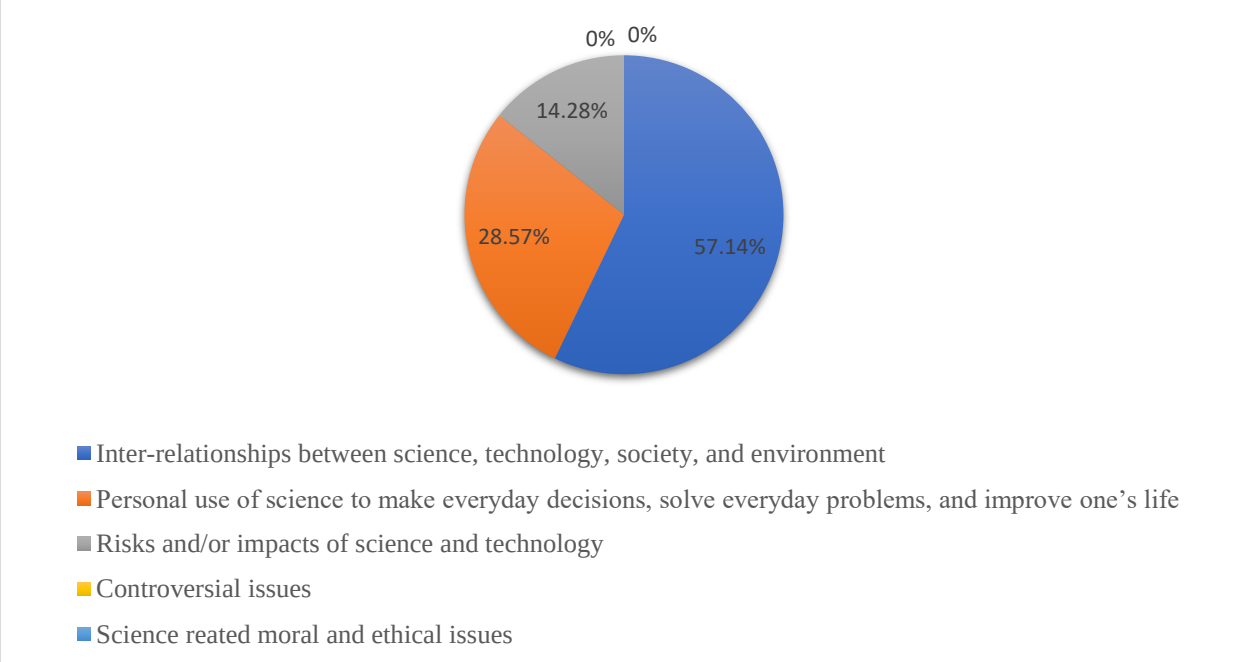

Figure 2: Distribution of STSE Issues in Cycle 2 Science Curriculum Objectives according to the Criteria

The percentage of the STSE issues in the K1-6 Lebanese national science curriculum, cycles 1 and 2, was also computed together. Figure 3 shows the percentage of their distribution according to the criteria. The findings indicate that 54.54% of the STSE issues are presented in CR1. Besides, 36.36% of the STSE issues are presented in CR2, and 9.09% in CR3. There is also no presence of controversial issues (CR4), and science-related moral and ethical issues (CR5). This shows that the emphasis of the K1-6 Lebanese national science curriculum objectives is on three kinds of STSE issues presented under CR1, CR2, and CR3.

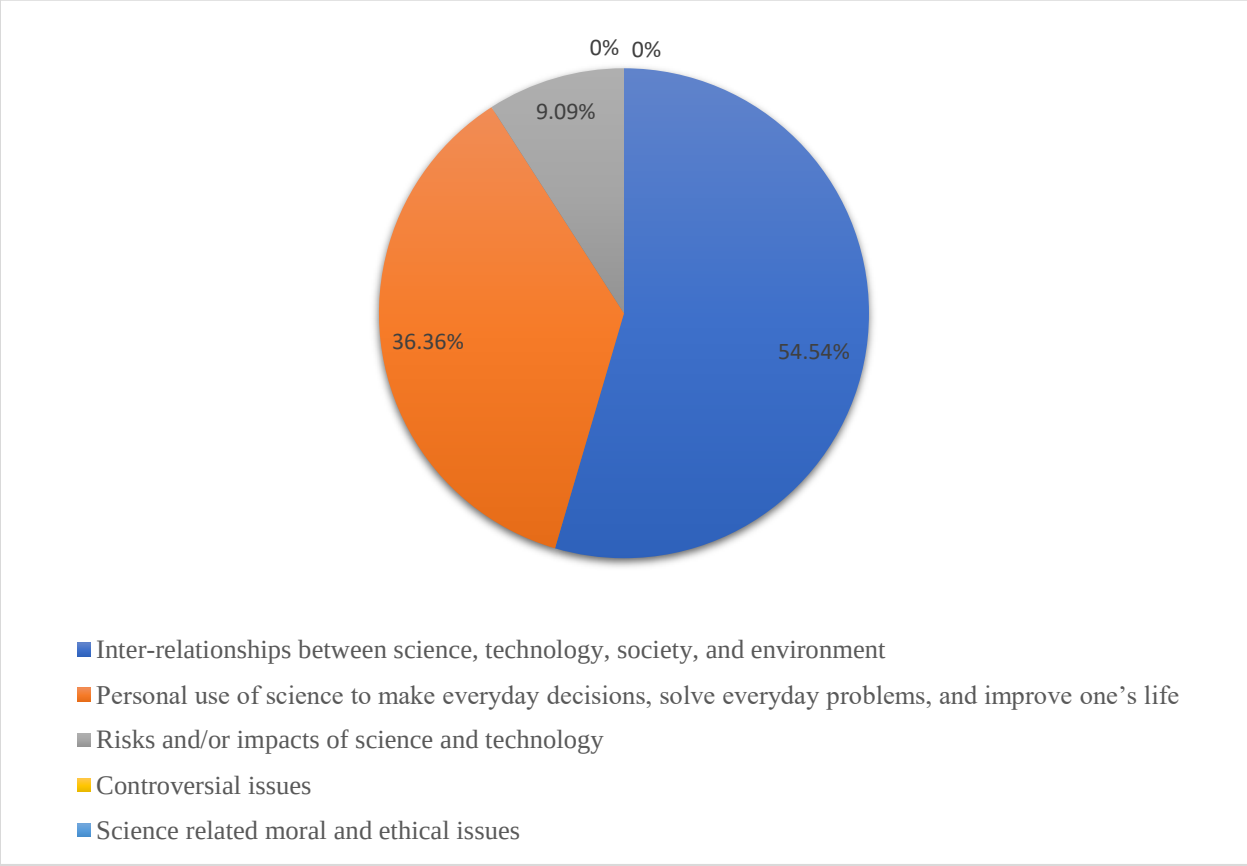

Figure 3: Distribution of STSE Issues in the K1-6 Lebanese National Science Curriculum Objectives according to the Criteria

The second step in analyzing the kinds of STSE issues in the K1-6 Lebanese national science curriculum is classifying them according to the sub-criteria of the framework. Table 2 shows the percentages of distribution of the STSE issues according to the sub-criteria of the curriculum objectives of cycle 1 and cycle 2 each separately, and both cycles together. The results of cycle 1 curriculum objectives indicate that 50% of the STSE issues are under the society towards environment sub-criterion, 25% for citizen participation and decision making, and 25% for problem-solving. However, there is no presence of the other sub-criteria in the objectives of cycle 1. Thus, the major focus is on issues related to society towards the environment. Table 3 shows different results between cycle 1 and 2 curriculum objectives. 28.57% of the STSE issues are under the society towards environment sub-criterion. Each of the following sub-criteria: science towards technology, society towards science and technology, citizen participation and decision making, problem-solving, and local environmental impact has 14.28% of the STSE issues. The major emphasis of cycle 2 curriculum objectives is the same as in cycle 1, which is society towards the environment. However, cycle 2 has more different STSE issues of different sub-criteria than cycle 1.

The last column of Table 2 shows the percentage of distribution of the STSE issues in the curriculum objectives of both cycles 1 and 2 together. The findings reveal that the major STSE issues are related to society towards the environment (36.36%). Each of the citizen participation and decision making, and problem-solving sub-criteria has 18.18%. The other issues that cycle 1 and 2 curriculum objectives include are science towards technology, society towards science and technology, and local environmental impact; each sub-criterion devotes 9.09% of the issues. Besides, the K1-6 Lebanese national science curriculum objectives emphasize the stated six sub-criteria with 0% focus on the other 16 sub-criteria.

Sub-Criteria	Curriculum – Cycle 1	Curriculum – Cycle 2	Curriculum – Cycles 1 & 2
Distinction	0	0	0
Technology towards science	0	0	0
Science towards technology	0	14.28 %	9.09 %
Society towards science and technology	0	14.28 %	9.09 %
Science and applied science	0	0	0
Society towards environment	50 %	28.57 %	36.36 %
Environment towards society	0	0	0
Legislation	0	0	0
International comparison	0	0	0
Agents	0	0	0
Citizen participation and decision making	25 %	14.28 %	18.18 %
Problem-solving	25 %	14.28 %	18.18 %
Risks	0	0	0
Social impact	0	0	0
Local environmental impact	0	14.28 %	9.09 %
Global environmental impact	0	0	0
Different perspectives	0	0	0
Conflict values	0	0	0
Involved interests	0	0	0
Different source of information	0	0	0
Science and moral issues	0	0	0
Science and ethical issues	0	0	0

Table 2. Distribution of STSE issues in the Lebanese national science curriculum objectives of cycle 1, cycle 2, and cycles 1 and 2 together.

5.2 The STSE Issues Addressed in the K1-6 Lebanese National Science Textbooks

The same data collection methods were applied to the STSE issues in the K1-6 science textbooks. Figure 4 reflects the percentage of distribution of STSE issues in the cycle 1 science textbooks according to the criteria. It demonstrates that 51.92% of the STSE issues are under CR1, and 36.53% under CR2. The other STSE issues are distributed as 7.69% of CR3, and 3.84% of CR4, with 0% of CR5. This highlights the focus of cycle 1 science textbooks on the inter-relationships between science, technology, society, and environment (CR1), and the personal use of science to make everyday decisions, solve everyday problems, and improve one's life (CR2). Moreover, figure 5 presents the percentage of distribution of STSE issues in cycle 2 science textbooks according to the criteria. 68.68% of the STSE issues are under CR1, 6.06% under CR2, and 25.25% under CR3. As for the last two criteria, CR4 and CR5, no STSE issues were detected. This shows that the emphasis of cycle 2 textbooks is on the inter-relationships between science, technology, society, and environment (CR1), and risks and/or impacts of science and technology (CR3). Both science textbooks of cycles 1 and 2 highly emphasize CR1, but with different emphasis on CR2 and CR3.

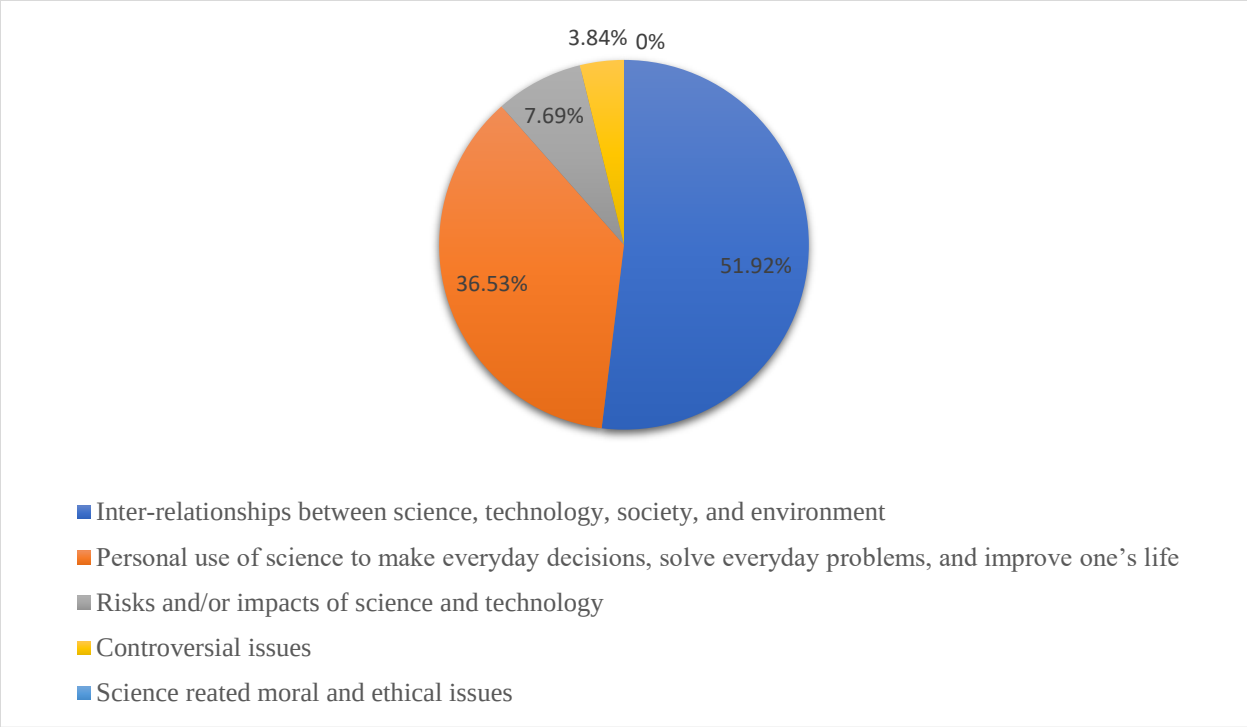

Figure 4: Distribution of STSE Issues in Cycle 1 Science Textbooks according to the Criteria

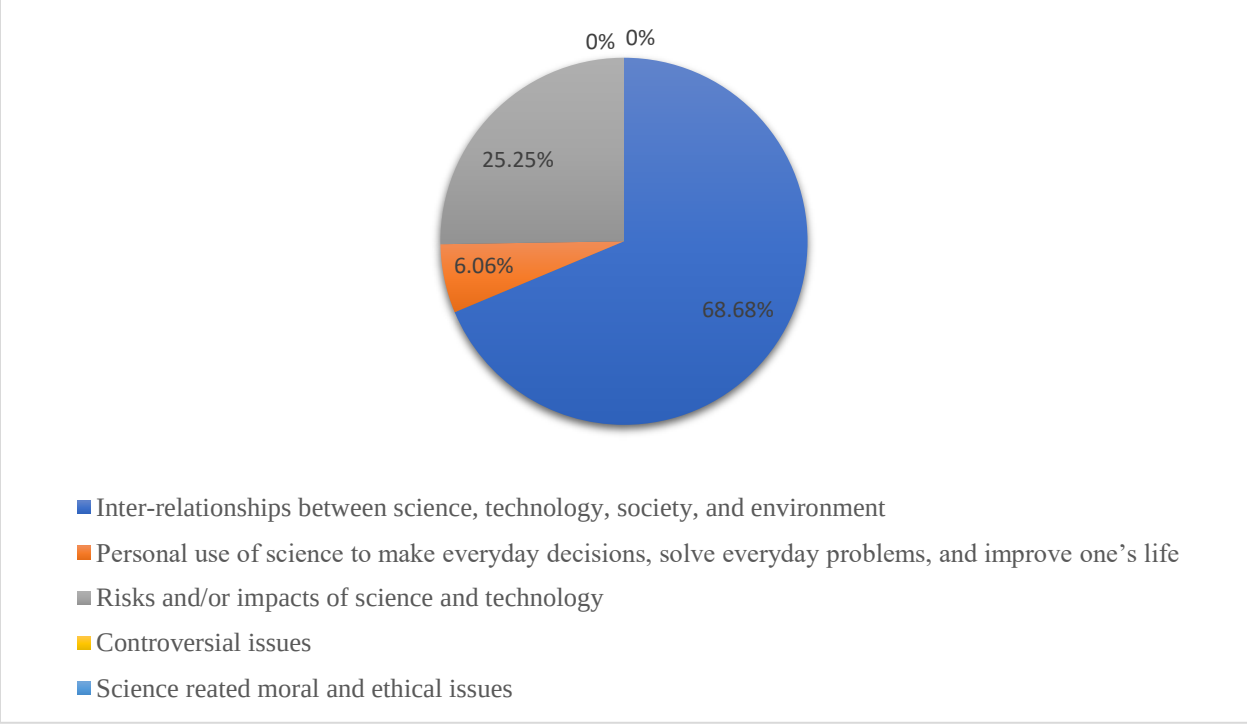

Figure 5: Distribution of STSE Issues in the Cycle 2 Science Textbooks according to the Criteria

The percentage of the STSE issues in the K1-6 Lebanese national science textbooks, cycles 1 and 2, was also computed together. Figure 6 shows the percentage of their distribution according to the criteria. It indicates that 62.91% of the issues are devoted to CR1, 16.55% to CR2, 19.2% to CR3, and 1.32% to CR4. Regarding the last criterion, CR5, there is no presence of STSE issues under it. According to figure 6, the major emphasis of cycles 1 and 2 science textbooks is on the inter-relationships between science, technology, society, and environment criterion (CR1).

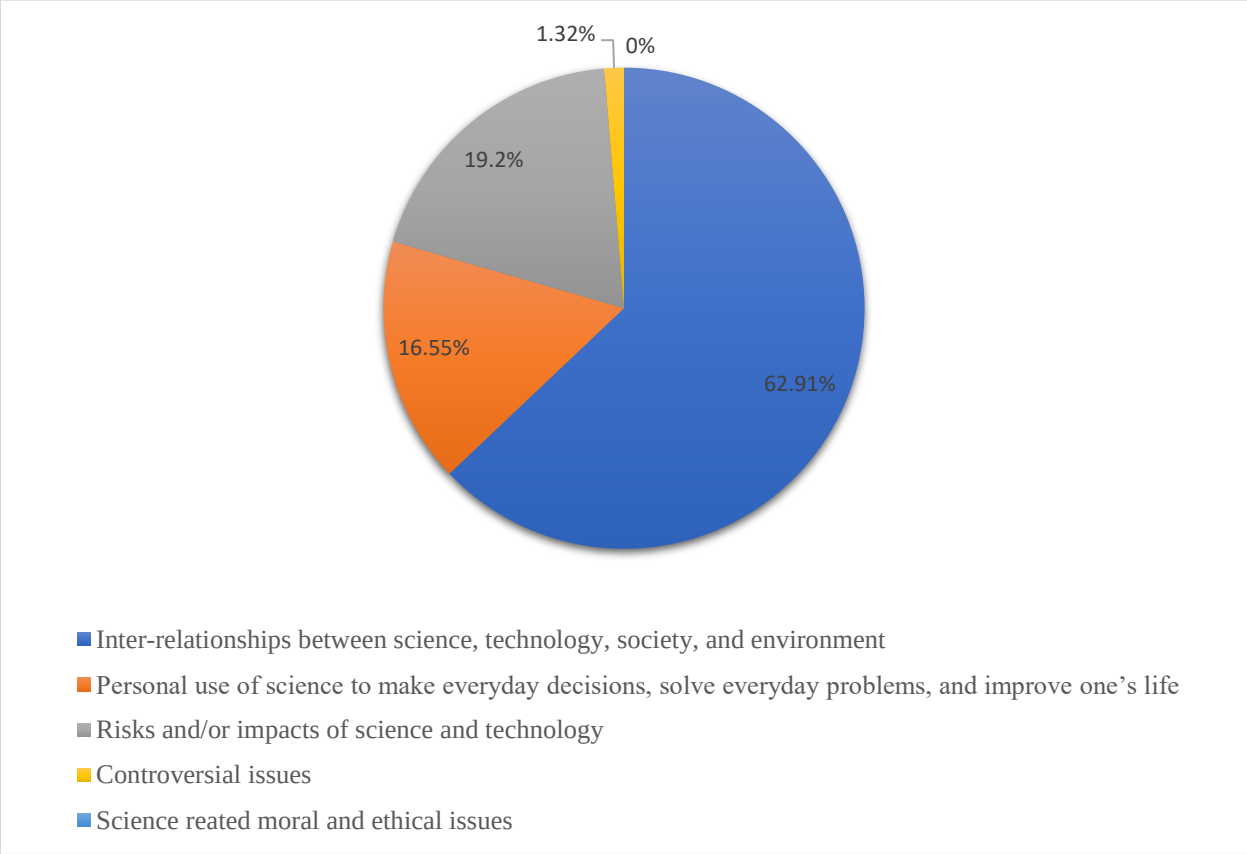

Figure 6: Distribution of STSE Issues in Cycles 1 & 2 Science Textbooks according to the Criteria

The same procedure was done to analyze the kinds of STSE issues in the K1-6 Lebanese national science textbooks according to the sub-criteria. Table 3 presents the percentages of distribution of the STSE issues according to the sub-criteria of the science textbooks of cycle 1 and cycle 2 each separately, and both cycles together. To start with the textbooks of cycle 1, the highest emphasis is on society towards the environment (32.69%). Some other STSE issues fall under citizen participation and decision making (19.23%), problem-solving (17.3%), and environment towards society (13.46%). There is also an equal emphasis on science and applied science, global environmental impact, and different perspectives with 3.84% each. In addition to the equal focus on technology towards science, social impact, and local environmental impact with 1.92% each. Nevertheless, some sub-criteria have no emphasis in cycle 1 science textbooks such as distinction, science towards technology, society towards science and technology, legislation, international comparison, agents, risks, conflict values, involved interests, different sources of information, science and moral issues, and science and ethical issues.

Moreover, Table 3 shows that there are some discrepancies between the results of cycle 1 and cycle 2 science textbooks. For instance, the sub-criteria that have 0% of STSE issues in cycle 1 textbooks have slightly increased to become 5.05% in science towards technology, and 3.03% in society towards science and technology sub-criteria in cycle 2 textbooks. Other percentages of other STSE issues in cycle 1 increased in cycle 2 also. For illustration purposes, the percentages of technology towards science, science and applied science, social impact, local environmental impact, and global environmental impact increased to become 15.15%, 13.13%, 16.16%, 2.02%, and 7.07% respectively. An example of a technology towards science sub-criterion from grade six is “The invention of the microscope allows us to see such living things and learn about them.” However, some percentages of STSE issues presented in cycle 1 decreased in cycle 2.

For example, the percentages of environment towards society, citizen participation, and decision making, problem-solving, and different perspectives decreased to become 7.07%, 4.04%, 2.02%, and 0% respectively. Even though the percentage of STSE issues related to society towards the environment decreased in cycle 2, it still has the highest emphasis in cycles 1 and 2. The remaining sub-criteria that do not have any emphasis in cycle 2 science textbooks are presented in Table 3 with 0%.

As in Table 2, the last column of Table 3 presents the percentages of distribution of STSE issues according to the sub-criteria in the science textbooks of both cycles 1 and 2 together. The major focus is on society towards environmental issues (27.81%). Then, the percentages are distributed among the following sub-criteria: social impact (11.25%), technology towards science (10.59%), science and applied science (9.93%), problem-solving (7.28%), global environmental impact (5.96%), science towards technology (3.31%), and different perspectives (1.32%). In addition, both the environment towards society and citizen participation and decision making have the same percentage of STSE issues which is 9.27%. Similarly, society towards science and technology, and local environmental impact have the same percentage of STSE issues which is 1.98%. As the curriculum objectives of cycles 1 and 2, the science textbooks of these two cycles have no emphasis on STSE issues in some different sub-criteria. For example, distinction, legislation, international comparison, agents, risks, conflict values, involved interests, different sources of information, science and moral issues, and science and ethical issues sub-criteria. Finally, the science textbooks of cycles 1 and 2 include STSE issues of different 12 sub-criteria.

Sub-Criteria	Textbooks of Cycle 1	Textbooks of Cycle 2	Textbooks of Cycles 1 & 2
Distinction	0	0	0
Technology towards science	1.92 %	15.15 %	10.59%
Science towards technology	0	5.05 %	3.31 %
Society towards science and technology	0	3.03 %	1.98 %
Science and applied science	3.84 %	13.13 %	9.93 %
Society towards environment	32.69 %	25.25 %	27.81 %
Environment towards society	13.46 %	7.07 %	9.27 %
Legislation	0	0	0
International comparison	0	0	0
Agents	0	0	0
Citizen participation and decision making	19.23 %	4.04 %	9.27 %
Problem-solving	17.3 %	2.02 %	7.28 %
Risks	0	0	0
Social impact	1.92 %	16.16 %	11.25 %
Local environmental impact	1.92 %	2.02%	1.98 %
Global environmental impact	3.84 %	7.07 %	5.96 %
Different perspectives	3.84 %	0	1.32 %
Conflict values	0	0	0
Involved interests	0	0	0
Different sources of information	0	0	0
Science and moral issues	0	0	0
Science and ethical issues	0	0	0

Table 3. Distribution of STSE issues in the Lebanese national science textbooks of cycle 1, cycle 2, and cycles 1 and 2 together.

5.3 The Variation of STSE Issues across cycles 1 and 2 of the Lebanese National Science Curriculum and Textbooks

The percentage distribution of the STSE issues in cycles 1 and 2 of the curriculum objectives and textbooks is presented in the table . As table 4 shows, 36.36% of cycle 1 curriculum objectives are STSE issues. This percentage increases to 63.63% in cycle 2 curriculum objectives. As for the K1-6 science textbooks, the percentage of STSE issues in cycle 1 textbooks is 34.43%. In cycle 2 textbooks, the STSE issues percentage increases to 65.56%. Thus, in both the science curriculum and textbooks, as grade level increases, the number of STSE issues increases.

Distribution of STSE Issues (%)			
Curriculum – Cycle 1	Curriculum – Cycle 2	Textbooks – Cycle 1	Textbooks – Cycle 2
36.36%	63.63%	34.43%	65.56%

Table 4. Distribution of STSE issues (%) in cycles 1 and 2 of the Lebanese national science curriculum and textbooks.

5.4 The Alignment of the K1-6 Lebanese National Science Curriculum Objectives and Textbooks with respect to the STSE issues

After finding the distribution percentages of the kinds of STSE issues in the science curriculum objectives and textbooks, the researchers used them to find the alignment between them. In order to find the alignment between the kinds of STSE issues categorized according to the criteria figures 3 and 6 were used. The authors applied the linear correlation method to calculate the linear correlation coefficient (r) that is equal to 0.8873. According to the guide for interpreting the strength of correlation, any linear correlation coefficient (r) between 0.75 and 1

shows a strong relationship. Thus, r=0.8873 is between 0.75 and 1, so there is a strong relationship and alignment between the K1-6 Lebanese national science curriculum objectives and textbooks with respect to the STSE issues according to the criteria.

Furthermore, to find the alignment between the kinds of STSE issues categorized according to the sub-criteria, the authors used column 3 of tables 2 and 3. The linear correlation coefficient (r) was calculated, and it is equal to 0.857 which is also between 0.75 and 1. Therefore, there is a strong relationship and alignment between the science curriculum objectives and textbooks with respect to the STSE issues according to the sub-criteria.

To summarize, the following conclusions are inferred from the analysis of the collected data of the K1-6 Lebanese science curriculum objectives and textbooks. First, the major emphasis of the science curriculum objectives and textbooks of cycles 1 and 2 is on the inter-relationships between science, technology, society, and environmental criterion. Second, the sub-criterion that has the highest focus in both science curriculum objectives and textbooks of cycles 1 and 2 is society towards the environment. Third, the percentage of STSE issues increases from cycle 1 to cycle 2 in the curriculum objectives, as well as in the science textbooks. Fourth, there is alignment between the science curriculum objectives and textbooks of cycles 1 and 2 with respect to the criteria and sub-criteria that show the kinds of STSE issues.

6. Discussion

We present the results of each research question under a specific sub-heading. For each sub-heading, we start with concluding the results, then discussing them in relation to other literature.

6.1 The Kinds of STSE Issues Addressed in the K1-6 Lebanese National Science Curriculum Objectives

One of the major purposes of this study is to identify the kinds of STSE issues addressed in the K1-6 Lebanese national science curriculum. The results show that the major kinds of STSE addressed in cycle 1 of the curriculum are under the inter-relationships between science, technology, society, and environment (CR1), and the personal use of science to make everyday decisions, solve everyday problems, and improve one's life (CR2) criteria. However, for cycle 2, the STSE issues are under the inter-relationships between science, technology, society, and environment (CR1), personal use of science to make everyday decisions, solve everyday problems, and improve one's life (CR2), and risks and/or impacts of science and technology (CR3) criteria. Thus, the kinds of STSE issues that are addressed in both cycles 1 and 2 of the Lebanese national science curriculum are related to the inter-relationships between science, technology, society, and environment (CR1), personal use of science to make everyday decisions, solve everyday problems, and improve one's life (CR2), and risks and/or impacts of science and technology (CR3). Regarding the sub-criteria, the results indicate that the major focus is on STSE issues related to "society towards the environment" sub-criteria in cycles 1 and 2 of the curriculum. In contrast, the minimal focus is given to the issues under the science towards technology, society towards science and technology, citizen participation and decision making, problem solving, and local environmental impact sub-criteria.

There is a clear presence of STSE issues in the K1-6 Lebanese science curriculum which is significant. The addressed STSE issues are related to specific criteria and sub-criteria, thus, the kinds of the issues are limited. The main focus is on the inter-relationships between science, technology, society, and the environment. Those results are aligned with BouJaoude's (2002)

results wherein the curriculum emphasizes the interactions of science, technology, and society. In his study (BouJaoude, 2002), the STS issues were classified according to a specific framework that was adapted, and part of it was used in our study. Thus, common sub-criteria were used such as the impact of science on society, inter-relationships between science, technology, and society, and personal use of science to make everyday decisions, solve everyday problems, and improve one's life. Furthermore, the K1-6 curriculum objectives show different kinds of STSE issues other than the inter-relationships between science, technology, society, and the environment. For instance, there are issues related to the personal use of science to make everyday decisions, solve everyday problems, and improve one's life. Similarly, the findings in BouJaoude's (2002) study indicate that the partial emphasis in the elementary level objectives is on STS. Therefore, there is a strong alignment between BouJaoude's (2002) results and this study's results regarding the kinds of STS/STSE issues addressed in cycles one and two.

Additionally, the results derived from the K1-6 Lebanese science curriculum are also aligned to a certain extent with Berlin and Kumar's (1998) results. In other words, both focus on environmental issues in relation to society. However, they contradict the percentage of distribution of the issues related to science and technology. To clarify, Berlin and Kumar (1998) indicated that the U.S. curriculum put less than 40% emphasis on the science-technology and societal issues relationship; in contrast to 54.54% of this issue addressed in the K1-6 Lebanese science curriculum. An added value of our study is that it includes an analysis of both the science curriculum and textbooks.

6.2 The Kinds of STSE Issues Addressed in the K1-6 Lebanese National Science Textbooks

The second major purpose of this study is to identify the kinds of STSE issues addressed in the K1-6 Lebanese national science textbooks. The findings indicate that the major kinds of

STSE issues in cycle 1 textbooks are distributed among the inter-relationships between science, technology, society, and environment (CR1), and personal use of science to make everyday decisions, solve everyday problems, and improve one's life (CR2) criteria. However, for cycle 2 textbooks, the major addressed STSE issues are distributed among the inter-relationships between science, technology, society, and environment (CR1), and risks and/or impacts of science and technology (CR3) criteria. Therefore, cycles 1 and 2 textbooks include STSE issues related to the inter-relationships between science, technology, society, and environment (CR1), personal use of science to make everyday decisions, solve everyday problems, and improve one's life (CR2), and risks and/or impacts of science and technology (CR3) criteria. Regarding the distribution of the STSE issues according to the sub-criteria, the highest emphasis is on the "society towards environment" sub-criteria.

The K1-6 science textbooks also reflect a clear presence of different kinds of STSE issues. This presence is addressed in different percentages among the unit introduction, instructions, and texts of the six textbooks. Besides, the emphasis is on issues related to "society towards the environment." Those issues show the learners how they should behave and act towards the environment, either locally or globally. This can be related to the two German 11th grade biology textbooks' analysis results (Calado et al., 2015). For instance, their results showed that textbook A emphasizes the social dimension, and textbook B emphasizes the environmental dimension (Calado et al., 2015). As for the six Lebanese national science textbooks, they emphasize both the social and environmental dimensions. However, in Calado et al. (2016), the findings indicated that the four Portuguese biology textbooks of grade levels 9 and 12 did not include the environmental dimension adequately. This shows that some science textbooks give more emphasis on some STSE issues without shedding light on other issues.

Additionally, the K1-6 Lebanese national science textbooks include STSE issues other than “society towards environment” issues. For instance, there is 19.2% devoted to the “risks and impacts” criteria wherein this percentage is dedicated to the impacts sub-criteria only. This contradicts the results indicated in Calado et al. (2016) that showed that the textbooks they analyzed approached risks frequently with seldom presence of the impacts. Risks and/or impacts of science and technology are significant STSE issues that are preferable to be both included in science textbooks. Regarding the “controversial issues” criterion, 1.32% of the K1-6 Lebanese science textbooks are devoted to it. This percentage is very low, and it contradicts the percentage of the controversial issues in the Portuguese textbooks (Calado et al., 2016). “Citizens need to possess skepticism, open-mindedness, critical thinking, inquiry, ambiguity or even skills in the interpretation of data-driven knowledge” (Calado et al., 2016). Thus, including controversial issues in science textbooks is a must.

Having different kinds of STSE issues in science textbooks helps in highlighting more issues that improve students’ decision-making skills and much more. The addressed STSE issues in the K1-6 Lebanese national science textbooks differ between textbooks of cycles 1 and 2. This is in alignment with Cakici’s (2021) results that revealed that the analyzed upper primary level science textbooks displayed significant differences in terms of their coverage of the interaction among science, technology, and society. The difference among the kinds of STSE issues is essential because it shows all the dimensions of STSE. This difference is not only in the kinds of STSE issues, but it is also in the number of the STSE issues addressed among science textbooks of different levels.

6.3 The Variation of the STSE Issues Across Cycles One and Two of the Lebanese National Science Curriculum and Textbooks

The third aim of this study is to investigate the variation of the STSE issues across cycles 1 and 2 of the Lebanese national science curriculum and textbooks. The results reveal that as the grade level increases, the number of STSE issues increases also in both the curriculum and textbooks. The percentage of STSE issues increases from cycle 1 to cycle 2 by 27.27% in the curriculum objectives. Similarly, this percentage increases from cycle 1 to cycle 2 by 31.13% in the science textbooks. However, this contradicts the results of the study done by Chiang-Soong and Yager (1993) that aimed to analyze 11 secondary science textbooks to determine the space devoted to STS issues. Their results indicated that as grade level increases, the coverage of STS issues decreases (Chiang-Soong & Yager, 1993). This study is outdated; thus another updated study's results were compared to this study's results.

According to Calado et al. (2016), biology textbooks of grade 12 included two and a half times more STSE issues than biology grade 9 textbooks. This shows that as the grade level increases from grade 9 to grade 12, the number of STSE issues also increases. Those results are aligned with the variation of the STSE issues from cycle 1 to cycle 2 of the Lebanese national science textbooks and curriculum objectives. As learners get older, they are expected to be more aware of the issues related to the interaction of science-technology-society-environment. Thus, this explains the increase in the number of STSE issues as the grade level increases.

6.4 The Alignment between the K1-6 Lebanese Science Curriculum Objectives and Textbooks with Respect to the Addressed STSE Issues

The last purpose of this study is to find out if the K1-6 science curriculum objectives and textbooks align with respect to the STSE issues addressed in them. The findings indicate that

there is a strong relationship between the STSE issues addressed in the curriculum objectives and textbooks. Thus, there is alignment between the K1-6 Lebanese science curriculum objectives and textbooks. Another study conducted by Waddington and Imbriglio (2011) aimed to investigate if the available textbooks convey the STSE curriculum goals. The results showed that textbooks address the general STSE goals to a certain extent, but they neglect the critical STSE perspectives (Waddington & Imbriglio, 2011). Waddington and Imbriglio's (2011) study's results are aligned with the results of this study to a certain extent because they both show alignment between the curriculum objectives and textbooks. The presence of this alignment is very critical because the curriculum objectives should be conveyed in the textbooks that are used in the classrooms.

7. Conclusion

The presence of different kinds of STSE issues in the K1-6 Lebanese national science curriculum and textbooks is very significant. Besides, the strong relationship between the curriculum and textbooks, as well as the increase of STSE issues as the grade level increases show that there is room for improvement in the curriculum and textbooks. Thus, according to this research results and BouJaoude's (2002) results, this curriculum that has not been updated since 1998 provides an opportunity to change. Hence, it is recommended to work more on updating the science curriculum, as well as the science textbooks to add new updated STSE issues. The curriculum should be updated regularly to keep pace with the local and global changes that might happen. For example, issues related to environmental problems in Lebanon, effects of science on society, and effects of science and technology on society. Additionally, not only the kinds of addressed STSE issues matter but also the way they are being taught matters.

Therefore, it is also suggested to conduct further studies to explore how teachers deliver the STSE issues in science classrooms.

8. Limitations

Despite the clear results found in this research, some limitations are acknowledged. Analyzing the K1-6 Lebanese national science curriculum introduction and general objectives is one of the limitations. The specific objectives of each grade level and the curriculum activities were not analyzed. Thus, we did not have much data to analyze. Additionally, analyzing only science textbooks of cycles one and two was another limitation. This is due to the minimal emphasis on written texts in cycle one textbooks wherein they include a lot of visuals that they were not analyzed. Also, textbooks of cycles one and two are considered as a small sample to draw a more generalized conclusion based on them.

9. Action Plan

This study helped us know more about the importance of including STSE issues in the curriculum and textbooks. Besides, the synthesized framework made us more aware of the different kinds of STSE issues that might be addressed in science curriculums and textbooks. This framework helped us know the kinds of addressed STSE issues in the K1-6 Lebanese national science curriculum and textbooks. Thus, this will help us in our teaching because we can differentiate more between the STSE issues and other scientific literacy themes.

Moreover, the indicated results grabbed our attention to the idea that the way teachers teach the STSE issues has a critical impact on the purpose of those issues. Also, after analyzing the K1-6 textbooks, we realized that some visuals can be related to STSE issues. That is why they can be analyzed by the teacher to teach the addressed STSE issue in that specific picture.

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Appendices

Appendix A:

BouJaoude (2002) Framework:

4. Interaction of science, technology, and society (Aspect 4):
   —Impact of science on society
   —Inter-relationships between science, society, and technology
   —Careers
   —Science-related social issues
   —Personal use of science to make everyday decisions, solve everyday problems, and improve one's life
   —Science related moral and ethical issues

Calado et al (2015) Framework:

Table 2. Definitions, textbook examples and textbook frequencies of all sub-criteria (sub-criteria headed by the criterion, keywords in textbook statements in *italics*).

Sub-Criterion	Definition	Textbook Example	Textbook	Frequencies
	Science and technology events and their social contextualization		A[a]	B[b]
	Mentioning and/or suggesting			
Event per se	a scientific or a technological event	*chromosome theory of inheritance* of Boveri and Sutton (A, p. 98)	78	40

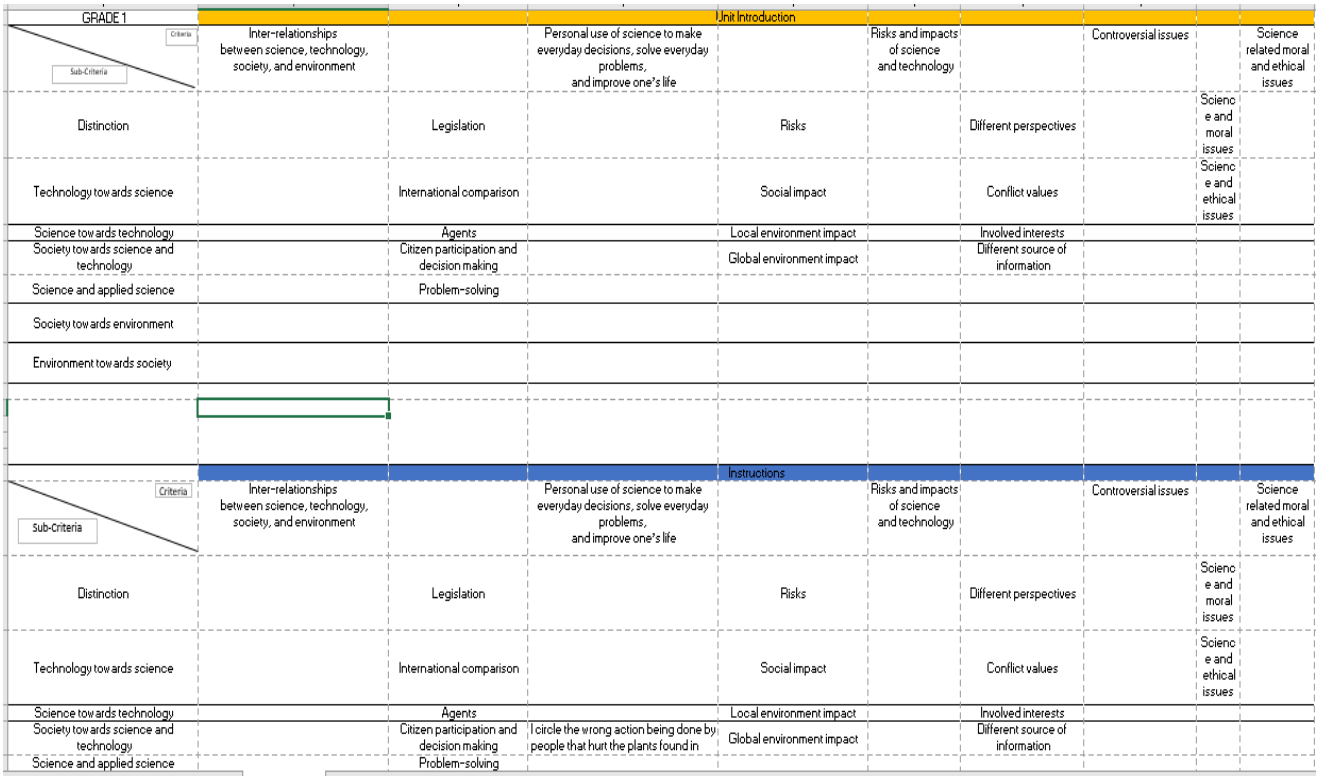
Sub-Criterion	Definition	Textbook Example	Textbook	Frequencies
Event time	the time the event took place	*during the National Socialist regime* (A, p. 111)	70	20
Event place	the place the event occurred	Johann G. Mendel was a science teacher *in Brünn* (B, p. 98)	6	2
Underlying problem	the social problem that motivated research regarding the event	The *aim* is to *develop new possibilities for diagnoses and therapies for genetic diseases or cancer*. (A, p. 83)	11	7
Favourable factors	factors favourable for the event	The reason for that [advancement] were other *improvements in microscopes and staining techniques* (B, p. 102)	1	3
Obstacles	factors representing obstacles	had to fight, *as a woman*, against strong *prejudices of their colleagues* (A, p. 62)	1	1
	Interplay between science and technology			
Distinction	Science and technology are distinguished.	*Genetics* is *defined* as and *gene technology* is *defined* as (B, p. 58)	6	6
Technology towards science	A technology device or process is useful for achieving scientific knowledge.	These *enzymes* are *used* to *determine which genes are active* in a tissue (B, p. 131)	19	26
Science towards technology	Scientific knowledge is useful or even indispensable for technology advancements.	The *discovery* of enzymes was the *decisive condition for* the development of modern genetic *methods* (B, p. 128)	9	6
Science and applied science	Technology is seen as applied science	the *development of therapeutic possibilities*. In addition, *this branch of genetics* is (B, p. 112)	1	1

	Science and Technology as means to solve societal problems			
	Mentioning and/or suggesting of			
Potential applicability	potential applicability of science and technology in the future	In cancer patients, we *attempted* to *make* cancer genes *ineffective*." (A, p. 121)	19	7
Applicability	real benefits of science and technology processes or devices	Bacteria *can* now *produce* the *desired* *insulin* (A, p. 113)	42	63
Costs	costs of science and technology processes or devices	The *1 million-Dollar*, two-month *project* (A, pg. 83)	6	3
Limitations	limitations of science and/or technology	Nevertheless, it *isn't possible* to gain every desired medicament from bacteria cells (B, p. 135)	13	9
	Risks and impacts of Science and Technology			
	Mentioning and/or suggesting of			
Risks	risks of science and technology	The development of Bt-toxin resistant corn borers represents a *further risk* (B, p. 138)	22	19
Social impact	an potential and/or real science and technology impact on society	The introduction of pre-implantation diagnostics *might lead to a dam crack in the direction* of Brave New World (A, p. 111)	13	6
Local environmental impact	a local potential and/or real science and technology environmental impact	*Protection* of the *environment* remains primary *objective* of the [German] *gene technology law* (A, p. 125)	1	1

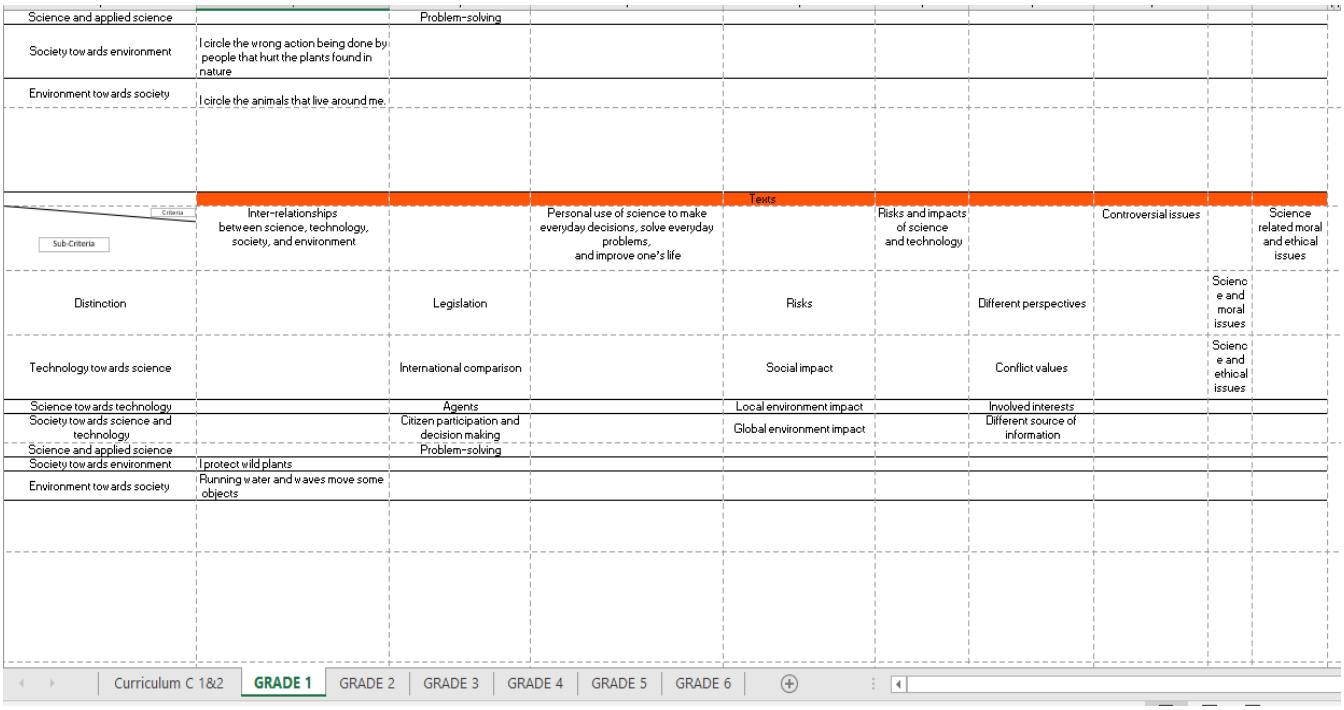
Sub-Criterion	**Definition**	**Textbook Example**	**Textbook**	**Frequencies**
Global environmental impact	a global potential and/or real science and technology environmental impact	Once accepted, Bt-maize would *in the future worldwide* and *almost exclusively* grow and the dimension of *damages* would be *enormous* (B, p. 138)	0	7
	Controversial issues			
	Mentioning and/or suggesting of controversial issues			
Different perspectives	given with different perspectives	Nevertheless, the *pros and cons* of cultivating [genetically modified plants] are still hotly debated in society (B, p. 138)	17	8
Conflict values	by referring to values interfering with decisions	The *human dignity* is inviolable (A, p. 111)	25	14
Involved interests	given with potentially involved interests (e.g., social, individual, political and/or economic ones).	Discuss *reasons* why *private companies invest millions of Dollars* to sequence human genes (A, p. 83)	10	4
Different sources of information	presented with different information sources conveyed by media	This year's 50th anniversary of the discovery of the structure of DNA has kindled many debates (*Guardian, 2003*) (A, p. 124)	11	0
	Decision making process			
	Mentioning and/or suggesting of			
Legislation	legislation processes and/or results	According to an *EU directive of 1998*, DNA sequences can be patented (A, p. 83)	26	7
International comparison	decisions by comparing international realities concerning legislation	but it is *not forbidden in other countries*, such as U.S.A. (B, p. 137)	4	1
Agents	the agents involved in decision making	In Germany, every treatment requires the *approval* of the *Ethics Committee* and of the *German Medical Association* (A, p. 121)	18	3
Citizen participation	the citizens as participants in decisions (e.g., as consumers, as voters, as informed human beings)	To the question "Would you eat genetically modified food?" *answer* 70% of *respondents* with "no" (A, p. 125)	23	2

Appendix B: Data Collection Sample:

Grade One Textbook:



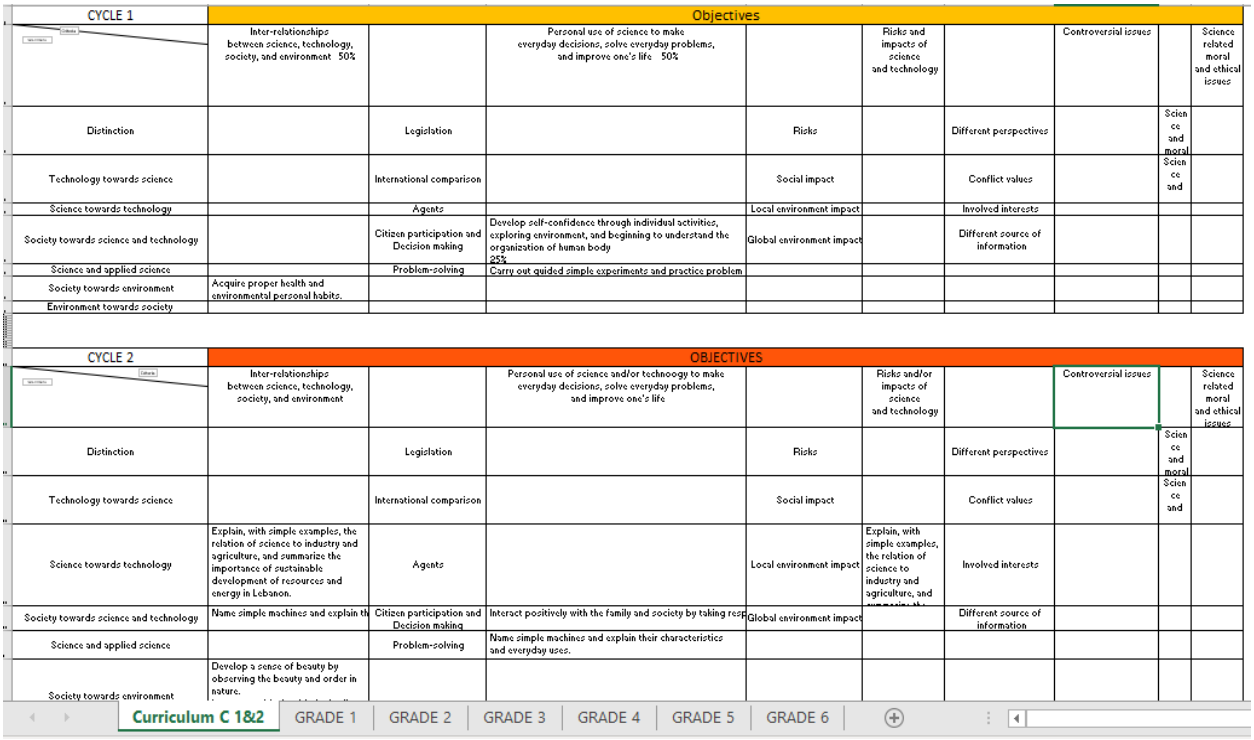
GRADE 1	Unit Introduction								
Criteria / Sub-Criteria	Inter-relationships between science, technology, society, and environment		Personal use of science to make everyday decisions, solve everyday problems, and improve one's life		Risks and impacts of science and technology		Controversial issues		Science related moral and ethical issues
Distinction		Legislation		Risks		Different perspectives		Science and moral issues	
Technology towards science		International comparison		Social impact		Conflict values		Science and ethical issues	
Science towards technology		Agents		Local environment impact		Involved interests			
Society towards science and technology		Citizen participation and decision making		Global environment impact		Different source of information			
Science and applied science		Problem-solving							
Society towards environment									
Environment towards society									
	Instructions								
Criteria / Sub-Criteria	Inter-relationships between science, technology, society, and environment		Personal use of science to make everyday decisions, solve everyday problems, and improve one's life		Risks and impacts of science and technology		Controversial issues		Science related moral and ethical issues
Distinction		Legislation		Risks		Different perspectives		Science and moral issues	
Technology towards science		International comparison		Social impact		Conflict values		Science and ethical issues	
Science towards technology		Agents		Local environment impact		Involved interests			
Society towards science and technology		Citizen participation and decision making	I circle the wrong action being done by people that hurt the plants found in	Global environment impact		Different source of information			
Science and applied science		Problem-solving							



Science and applied science		Problem-solving							
Society towards environment	I circle the wrong action being done by people that hurt the plants found in nature								
Environment towards society	I circle the animals that live around me.								
	Texts								
Criteria / Sub-Criteria	Inter-relationships between science, technology, society, and environment		Personal use of science to make everyday decisions, solve everyday problems, and improve one's life		Risks and impacts of science and technology		Controversial issues		Science related moral and ethical issues
Distinction		Legislation		Risks		Different perspectives		Science and moral issues	
Technology towards science		International comparison		Social impact		Conflict values		Science and ethical issues	
Science towards technology		Agents		Local environment impact		Involved interests			
Society towards science and technology		Citizen participation and decision making		Global environment impact		Different source of information			
Science and applied science		Problem-solving							
Society towards environment	I protect wild plants								
Environment towards society	Running water and waves move some objects								

Curriculum C 1&2 | GRADE 1 | GRADE 2 | GRADE 3 | GRADE 4 | GRADE 5 | GRADE 6

Cycles One and Two of the Curriculum:



CYCLE 1	Objectives								
	Inter-relationships between science, technology, society, and environment 50%		Personal use of science to make everyday decisions, solve everyday problems, and improve one's life 50%		Risks and impacts of science and technology		Controversial issues		Science related moral and ethical issues
Distinction		Legislation		Risks		Different perspectives		Science and moral	
Technology towards science		International comparison		Social impact		Conflict values		Science and	
Science towards technology		Agents		Local environment impact		Involved interests			
Society towards science and technology		Citizen participation and Decision making	Develop self-confidence through individual activities, exploring environment, and beginning to understand the organization of human body 25%	Global environment impact		Different source of information			
Science and applied science		Problem-solving	Carry out guided simple experiments and practice problem						
Society towards environment	Acquire proper health and environmental personal habits.								
Environment towards society									

CYCLE 2	OBJECTIVES								
	Inter-relationships between science, technology, society, and environment		Personal use of science and/or technoogy to make everyday decisions, solve everyday problems, and improve one's life		Risks and/or impacts of science and technology		Controversial issues		Science related moral and ethical issues
Distinction		Legislation		Risks		Different perspectives		Science and moral	
Technology towards science		International comparison		Social impact		Conflict values		Science and	
Science towards technology	Explain, with simple examples, the relation of science to industry and agriculture, and summarize the importance of sustainable development of resources and energy in Lebanon.	Agents		Local environment impact	Explain, with simple examples, the relation of science to industry and agriculture, and	Involved interests			
Society towards science and technology	Name simple machines and explain th	Citizen participation and Decision making	Interact positively with the family and society by taking resp	Global environment impact		Different source of information			
Science and applied science		Problem-solving	Name simple machines and explain their characteristics and everyday uses.						
Society towards environment	Develop a sense of beauty by observing the beauty and order in nature.								

Curriculum C 1&2 | GRADE 1 | GRADE 2 | GRADE 3 | GRADE 4 | GRADE 5 | GRADE 6