SAUDI SCIENCE TEACHERS’ VIEWS AND TEACHING STRATEGIES OF
SOCIOScientIFIC ISSUES

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Scientific developments such as cloning and nuclear energy have generated many controversial issues pertain to many political, social, environmental, ethical and cultural values in different societies around the globe. These controversies delimited and encircled the potential of including and teaching some important aspects of science in schools and therefore caused less consideration to the influence of these issues on enhancing the scientific literacy of people in general. The purpose of this study was to investigate how Saudi science teachers in the city of Tabuk in Saudi Arabia view and teach SSI in Saudi Arabia. This study employed semi-structured interviews with Saudi science teachers. Methodologically, this study used a constructivist grounded theory as a method for analysis to generate in depth descriptive data about Saudi science teachers’ views and teaching strategies of socio scientific issues. Some direct and indirect benefits pertain to teaching science, understanding the relationship between science, religion, and society and some other topics are discussed in this study.

*Keywords:* Socio Scientific issues, Saudi science teachers, Science and religion, Teaching strategies.
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CHAPTER I
INTRODUCTION

The growing interest in how science influences and get influenced by other aspects like society and technology has gotten a greater momentum in the recent years. For example, issues like evolution, cloning, genetic engineering, and many others have caused different interpretations of how such issues should be experienced and addressed with the complexity involved in many of them. Different scholars have discussed this aspect of science education and provided varied views of how teaching such issues should be conducted in ways where teachers can meet the complexities involved in them. (Mansour 2008; Sadler & Zeidler, 2009; Zeidler & Keefer, 2003; Zeidler, Sadler, Simmons & Howes, 2005).

Moreover, different western scholars and science organizations have called for reforms in science education that consider more relevant science teaching practices to include these interactions between science, technology, and society (STS) (American Association for the Advancement of Science, 2009; 2013; Aikenhead, 2006; 2007; Achieve, 2013). For example, the American National Research Council (NRC) (2012) called for teaching practices that open ways where pupils “come to understand these interactions and at increasing levels of sophistication as they mature. Their appreciation of the interface of science, engineering, and society should give them deeper insights into local, national, and global issues” (p. 203). However, the lack of recognition of these interactions have caused much criticism to the strict teaching practices of dealing with and teaching science in schools, which do not take into consideration the
interrelationships within science, technology, and society intercreative aspects (STS) and therefore neglects the importance of its relevance in the domain of science education. In this respect, Aikenhead (2007) distinguished between two types of science curriculum, traditional versus humanistic science curriculum. He asserted, “probably the most pervasive alternative to the traditional science curriculum has been a humanistic approach to school science that is intended to prepare future citizens to critically and rationally assess science and technology” (Aikenhead, 2007, p. 881). Thus, mere characterization of science education as an intellectual discipline would not represent the growing interaction within science, technology, and society.

However, the interactions among science, technology, and society are not easily grasped through a mere STS approach. Some researchers called for explicit attention to socio-scientific issues (SSI) that have the added moral dimension when dealing with these interactive entities. On this point, Zeidler et al., (2005, p. 360) asserted,

Whereas the overarching purpose of the STS approach is to increase student interest in science by placing science content learning in a societal context, SSI education aims to stimulate and promote individual intellectual development in morality and ethics as well as awareness of the interdependence between science and society. SSI therefore does not simply serve as a context for learning science, but rather as a pedagogical strategy with clearly defined goals

Thus, any discussion of the interaction between science, technology and society should include the moral and ethical aspects that emerge from such interactions.
Science curriculum, however, needs to be designed innovatively to include ways where science teachers discuss and deal with these issues effectively. For example, Hodson (2014, p.941) emphasized, “Much of the information needed to address SSI is of the science-in-the-making kind rather than a well-established science.” A well-established science curriculum, however, requires real attempts where these issues are organized and included in ways that assist science teachers in dealing with them contextually, including preparations, tools, and materials to understand the relationships between these issues and the everyday lives of students. However, “Teachers’ access to well-developed, standards-based, innovative curriculum materials designed around SSI is limited” (Forbes & Davis, 2008, P. 831). Therefore, investigating how science teachers view and deal with these issues is necessary, especially with the lack of curriculum support in many places around the world.

Moreover, due to the controversies embedded in many of these issues, many science curriculum reforms avoided such explicit attention to these issues; which caused “the science content encountered in the culture of conventional school science” to be “invariably academically abstract and decontextualized” (Sadler, 2011, p. Viii). Therefore, “Teachers only deal with the socio-scientific domain within limited contexts, such as genetics, personal health, or environment related issues” (Kara, 2012, p. 112). Therefore, such explicit attention to teaching SSI need to incorporate a contextual consideration including ethical, societal, religious and other aspects for better addressing humanistic dimensions of science related to many SSI effectively.
Therefore, many authors and researchers have emphasized that any curriculum reforms that take into consideration SSI should investigate teachers’ views, such as their ethical, cultural, social values related to these issues and their teaching practices of them (Albe, Barrué, Bencze, Byhring, Carter, Grace & Sperling, 2014; Kara, 2012; Lee, Abd-El-Khalick, & Choi, 2006; Oulton & Dillon and Grace, 2004; Sadler, Amirshokoohi, Kazempour, & Allspaw, 2006). Based on this premise, science teachers represent a considerable asset in transforming and applying any reforms regarding SSI into real and genuine practices. Without real investigation to their views and teaching strategies on these issues, no real curriculum reforms designed around SSI effectively would succeed.

In this respect, many research studies have reported different views and teaching practices of SSI among science teachers (Albe, Barrué, Bencze, Byhring, Carter, Grace & Sperling, 2014; Asghar, 2013 Boujaoude, Asghar, Wiles, Jaber, Sarieddine & Alters, 2011; Deniz, Donnelly & Yilmaz, 2008; Kara, 2012; Oulton & Dillon and Grace, 2004; Lee et al. 2006; Mansour, 2007; Sadler et al., 2006). These studies and others revealed several directions that exemplified different teachers’ views and teaching practices of these issues. However, in this study, there is a focus on some main aspects; including a general understanding of Saudi science teachers’ views of these issues and the factors influencing such views. In addition, this study also investigated Saudi science teachers’ views of some issues that were reported in the literature and by some teachers. In addition, there is a discussion of some teaching strategies used by science teachers when teaching some of these issues.

Science teachers’ views of SSI are varied and included different interpretations
and directions. This study focused more on the reasons behind science teachers’ views of some of the SSI. For example, different studies from different and varied settings revealed different and varied views about these issues and the reasons behind such views. Therefore, in this study, there is a review of some studies that provided some reasons for science teachers’ views and teaching strategies of SSI in different contexts (Boujaoude, Asghar, Wiles, Jaber, Sarieddine & Alters, 2011; Hestness, Morgenstern, Reis & Galvão, 2004; Reis & Galvão, 2009; Khalid, 2003; Mansour, 2007; Riedinger & Marbach-Ad, 2011). These studies and others are discussed in detail to reveal what factors influence science teachers’ views and teaching of many SSI.

For example, some of the reasons that influence science teachers’ views of many SSI is related to their perceptions of nature as well as understandings of the validity, and the importance of many SSI in science education. Some authors called for more emphasis on such perceptions and understandings as they help to understand how science teachers value and regard many SSI in the science classroom (Deniz et al., 2008; Hestness et al., 2011; Khalid, 2003; Crawford, Zembal-Saul, Munford, & Friedrichsen, 2005; Asghar, 2013; Wise, 2010; Moore, 2008). Such investigation to these perceptions is important, especially to reveal how epistemologically science teachers understand science and its role in people’s lives. It also gives a considerable understanding to evaluate science teachers’ scientific strategies in a more constructed manner.

Additionally, other reasons that influenced science teachers’ views of many SSI are related to their worldviews including their religious, cultural, and societal worldviews. In their discussion of the influence of people’s worldviews, Kawagley,
Norris-Tull, & Norris-Tull, (1998) identified people’s worldviews as a combination of principles and beliefs that people acquire to understand their surrounding world. In addition, research on teachers’ worldviews has uncovered that people’s cultural beliefs, values, and religiosity contribute to their views of science as a human endeavor (Aikenhead, 2001; Dzama & Osborne, 1999; Lemke, 2001; Osborne, Simon & Collins, 2003). Hence, science teachers’ worldviews represent a considerable aspect to their views of many SSI. Especially, one of the main problems embedded in many SSI is that they tend to be “open-ended problems without clear-cut solutions” (Sadler, 2011, p. 4) as well as present and provide different associations to varied interests and beliefs (Zeidler, Sadler, Simmons & Howes, 2005).

Therefore, when faced with such indeterminate situations, science teachers’ exposure to religious conflicts, for example, would threaten their acceptance of many of SSI in both their inclination and their willingness to teach them. Particularly, for fear of threatening their students’ beliefs or because they do not themselves believe in the validity of many of these issues (Asghar, 2013; Asghar, Hameed & Farahani, 2014; Barrett & Nieswandt, 2010; Boujaoude et al., 2011; Deniz, Donnelly & Yilmaz, 2008; Mansour, 2011; Sadler et al., 2006). For example, Trani (2004) emphasized that the main reason to reject evolution is teachers’ religious beliefs. On another hand, Moore (2008) found that 80% of high school teachers in his study presented biblical stories of creationism even though there are numerous sources of creationism stories. Similarly, Muslim teachers either rejected evolution because of its contradiction to their Islamic instructions (Mansour, 2007) or selectively accepted the aspects of evolution that do not
contradict their religious beliefs, therefore only accepted non-human evolution (Asghar, 2013).

Therefore, many scholars have emphasized that science teachers prefer to teach value-free science to avoid such contradictions that are embedded in many SSI. For example, Mueller & Zeidler (2010) found that science teachers in their study preferred to teach value-free science because of the moral dilemmas involved in some of the SSI. The authors argued that such inclinations on teaching value-free science oppose “the aspects of SSI that make it an appropriate and significant context for developing moral–ethical character and functional scientific literacy” (p. 115). In this context, they emphasized that a science teacher needs to aid as a cultural-mediator (Mueller & Zeidler, 2010). Based on this assumption, science teachers as cultural-mediators represent a considerable role in promoting moral sensitivity to many of these issues in science education. Investigating science teachers’ moral reasoning, thus, is important to denote their willingness to embrace more flexible cultural, social, and political stances that many of these issues require.

Several other studies have investigated science teachers’ worldviews with respect to SSI (Lee & Witz, 2009; Mansour, 2011; Reis & Galvão, 2004; 2009). Despite some teachers’ emphasis on the need to address science ethically to cope with many SSI (Lee & Witz, 2009), others argued that such emphasis would not be amenable because of the ways science is presented in the science classroom (Reis & Galvão, 2009; Mansour, 2011). Thus, investigating science teachers’ worldviews is important to reveal how such views would help them to address the moral and ethical dilemmas embedded in many
Investigating science teachers’ views and the reasons for such views is not only important to reveal their decisions relevant to SSI including their acceptance or rejection to them but also to reveal how they view teaching these issues in the science classroom. Science teachers’ teaching strategies have been reported by different scholars in different contexts around the world. Even though different studies revealed different teaching strategies about these issues, many studies emphasized the importance of student-centered approaches when dealing with these issues (Oliveira, Cook & Buck, 2011; Mork, 2012; Oulton, Day, Dillon & Grace, 2004; Oulton, Day, Dillon & Grace, 2004; Oliveira, Cook & Buck, 2011; Mork, 2012; Goldston & Kyzer, 2009).

For example, some researchers emphasized that teaching these issues requires science teachers to avoid imposing their views on their students and be neutral as much as they can (Oliveira, Cook & Buck, 2011; Mork, 2012; Oulton, Day, Dillon & Grace, 2004). On the same hand, some other studies emphasized the importance of having adequate argumentation teaching strategies among science teachers to be able to deal with the dilemmas involved in many of these issues (Goldston & Kyzer, 2009; Cook & Buck, 2011; Oulton, Day, Dillon & Grace, 2004; Oliveira; Mork, 2012; Taylor, 2013). Other studies reported using role play strategies (Oulton, Day, Dillon & Grace, 2004; Mork, 2012), as well as resource-based strategies (the internet, videos, and other materials) to help students investigate these issues individually. Similarly, some teachers benefited from students’ real-life examples while discussing these issues (Forbes & Davis, 2008). Some other studies reported using chalk talk or post in strategies for more
engagement and for going based on what is appropriate and respectful for students (Oliveira, Cook & Buck, 2011). Some other teachers reported using discussion strategies (Mork, 2012). These studies reveal one most important theme that combines these different strategies, which pertain to the importance of students-centered approach.

**Significance**

Much of the discussion of SSI includes a western framework (Sadler, 2011). Still, there is a need for more discussion of these issues in different contexts for better understanding to how science teachers from different contexts and cultures view and teach these issues (Mansur, 2007; 2008; Sadler, 2011). Different studies have been conducted in a Muslim context that revealed some insights on how Muslim science teachers conceive and address some of these issues in their science classrooms (Asghar, 2013; Deniz, Donnelly & Yilmaz, 2008; Mansour, 2007, 2010, 2011; Kilinç, Et al., 2013; Topçu, Yilmaz-Tüzün & Sadler, 2011). For example, some researchers suggested that teaching *evolution* requires constructivist means for effectively teaching this controversial issue in Turkey (Deniz, Donnelly & Yilmaz, 2008). Others called for a need to understand Turkish science teachers’ NOS understandings, especially in the context of SSI along with their strategies for using such understandings in the context of teaching these issues (Topçu, Yilmaz-Tüzün & Sadler, 2011). Kilinç, Kartal, Eroğlu, Demiral, Afacan, Polat and Görgülü (2013) in another Turkish context, called for shifting the direction into managing and enhancing teachers’ worldviews to be able to address such issues. Similarly, Mansour (2007) in an Egyptian context suggested that Muslim science teachers’ worldviews restricted them from teaching some issues such as
evolution. Even though these studies revealed significant outcomes and suggestions, especially in how science teachers view and teach some of these issues in Muslim countries, these suggestions and outcomes need more exhaustive framework to explain science teachers’ willingness and adaptations that requires deep analysis to science teachers’ reasons behind such views and teaching practices specially with Muslim science teachers.

In addition, up to the researcher’s knowledge, there is no single study addresses the role of SSI in science education in Saudi Arabia. Even though many studies that have been conducted on Muslim contexts inform many questions about how Saudi science teachers’ views and teach SSI (Asghar, 2013; Deniz, Donnelly & Yilmaz, 2008; Mansour, 2007, 2010, 2011; Kilinç, et al., 2013; Topçu, Yılmaz-Tüzün & Sadler, 2011), there is a need for more studies that address the role of these issues in a Saudi Arabian context for a broader cultural view of SSI. First, Saudi Arabia is the heart of Muslim countries and religion is the basic element for jurisdiction. Second, there are several energy-related SSI surfacing in the Saudi society including the government willingness to build several nuclear plants around the country and the growing interest in alternative energy, especially that oil has been and still is the main source for energy in Saudi Arabia (king Abdullah City for Atomic and Renewable Energy, 2013). However, neither energy-related nor many other important SSI is represented properly in the national curriculum in Saudi Arabia (Tatweer, 2008).

Therefore, since different people would value these issues in varied ways (Ziedler et al., 2005), continued discussion of varied and different cultures is needed.
Specifically, in a Saudi science teachers’ context, this study may add a considerable asset in facilitating the ways by which Saudi science teachers view and teach such issues in the Saudi science classroom. Firstly, understanding Saudi science teachers’ views of these issues reveals significant outcomes relevant to the reasons behind their views, which would give a considerable understanding to their ontological perceptions that base and support investigating how Saudi science teachers think and experience science as a discipline. Therefore, it helps to reveal how epistemologically those teachers understand science’s role in the Saudi society, which helped to evaluate their scientific strategies in a more constructed manner. Secondly, a study of this type is important as it widens Saudi science teachers’ views of science from not only focusing on the content part of science, as is the case with the Saudi science curriculum, but rather to investigate their reactions toward some of the SSI, which might help them widen their views of science to include the societal, cultural and religious aspects that inform thinking of science as a discipline. Thirdly, using a constructivist grounded theory for investigating Saudi science views and teaching practices revealed in-depth and significant insights on how Saudi science teachers understand and deal with such issues in their science classrooms.

**Purpose**

The purpose of this qualitative study was to investigate how and in what ways Saudi science teachers view and teach SSI by conducting a constructivist grounded theory in the city of Tabuk in Saudi Arabia. Investigating Saudi science teachers’ views of SSI should be conducted using profound and intensive interviews to gain in-depth
views of how to describe their views and teaching strategies of SSI, having in mind that science teachers’ views of SSI include their decisions to accept or reject some of the SSI and the reasons behind such decisions. Those teaching strategies also include a discussion of the reasons those teachers use to justify teaching specific issues over others.

A theoretical sampling procedure was used during data collection to generate the study’s participants. The analysis was conducted using a constructivist grounded theory (Charmaz, 2000, 2006, 2014). The implications and outcomes of this study are discussed.

**Theoretical Framework**

This study used a constructivist approach method as it gives in-depth views and understanding of how Saudi science teachers experience, view and teach SSI within their unique cultural, and societal understandings. This approach is very important as it helped to situate their perceptions more objectively, having in mind the subjective influence of the researcher that may influence the findings of such deep analysis to these different influences that inform thinking of these diverse issues. My understanding of these issues, that is based on my understanding of reality surrounding me and of teaching science for nine years in different Saudi elementary schools, will have fewer influences on the findings as the main sources of these findings are their interpretations, illustrations, and worldviews of these issues. Moreover, understanding that one’s social and cultural life differs substantially from others, even if they live in the same societal and cultural underpinnings, is very important to reveal more in-depth and comprehensive picture of
these issues among participants. Such depth helped to facilitate and situate more accurate understanding of these issues among the Saudi science teachers’ society. Given the fact that constructivist grounded theory is focusing more on experiences, interpretations, sense making, and perceptions of the participants gave more credibility to constructing more comprehensive views of these issues among Saudi teachers (Charamz, 2014). (more discussion of this section is in chapter 4).
CHAPTER II

OVERVIEW OF THE SAUDI EDUCATION SYSTEM

Introduction

Education in Saudi Arabia is attributed as one of the most important dimensions of the Saudi government policy. The Saudi government spends almost 25% of its yearly income to improve and develop the education system (Saudi Ministry of Finance, 2015). In this chapter, there will be a discussion of the different aspects that inform thinking about how education is practiced in Saudi Arabia including the influence of Islam and some other societal aspects. There will be also a discussion of the historical developments that have occurred to improve and develop education in Saudi Arabia. Finally, there will be a discussion of teacher education different programs to situate their inclusion within the education system in Saudi Arabia.

Aspects Inform Thinking about Education in Saudi Arabia

There are different religious, cultural, societal, geographical and historical features that influence education in Saudi Arabia. These different features have developed a unique understanding of education and how should it be practiced in this country. Geographically and historically speaking, Saudi Arabia is in the heart of the Islamic world. Particularly, because it controls the two most visited Islamic sites in the Muslim world, the Holy Mosque in Makkah and the Prophet Muhammad’s mosque in the city of Al Madinah Al Munawarah. These sites have special values among Muslims all over the world. Some other religious, cultural, and societal influences also inform
thinking about the education system in Saudi Arabia. Some of these influences will be discussed in this section.

**Islam and Education**

The relationship between Islam as a faith and education, or seeking knowledge, is solid and hard to be detached throughout the history of Islam. This lively relationship between Islam and education has been endorsed greatly through urging people to look for knowledge for their benefits that should include the better understanding of the surrounding world; hence, to God who is the creator of the world. To many Muslims, this understanding is stable and justifiable in the Islamic faith as it is consistent with God who wants us to think and contemplate about how the world is created and the greatness that surrounds human beings (Ibrahim, 2015; The Holy Qur’an, Surat Fussilat 41:53). Moreover, the first verse that was received by Prophet Muhammad, peace be upon him, was “Read, in the name of Thy Lord and Cherisher who created. Who taught you the use of pen” (The Holy Quran, Surat Al-Alaq 96:1). There are also different spots in the Holy Quran emphasize the important of education and seeking knowledge. Moreover, the word (*ilm*), which could be translated to the English word knowledge, has been mentioned several times in the Holy Quran as a sign of the importance of this essential component of human civilization (Sabki & Hardaker, 2013). Attention to learning and the importance of education also was given directly by prophet Muhammad, Peace be upon him, himself through Hadith and Sunnah, which include his sayings and behaviors, during his lifetime. Therefore, education and seeking knowledge could be envisaged as
one solid foundation and one of the biggest influences on Islamic civilization (Kadi, 2006). Education as well as seeking knowledge; therefore, is highly considered and intentionally reflected in Islam as a faith.

However, from an Islamic worldview, that is based on the Islamic understanding of *Tawhid or divine unity*, knowledge is comprehensive and holistic, therefore there are no such divisions of knowledge or categorization of knowledge into religious versus secular (Sabki & Hardaker, 2013). Based on this understanding, education in the Islamic faith has specific features that are strictly shaped by the traditions and instructions of Islam including Quran and other related beliefs of sacred knowledge; like Sunnah and Hadith. Therefore, it is justifiable to say that the Islamic educational policy developed its fundamentals from mutual relationships with religious guidelines (Henzell-Thomas, 2002). This mutual understanding between Islam and education as well as seeking knowledge is hard to be distinguished and caused different interpretations to how Muslims should adopt and understand the world surrounding them. Hence, it is important to investigate how Muslims understand these different interpretations, especially in regards to science, which is the main emphasis of this study.

**Islam and Science**

The relationship between science as a discipline and Islam as a faith is well established and understood as an important dimension that Muslims should seek for better understanding to the world surrounding them. However, the understanding of the unity of knowledge has influenced Muslims’ understandings of science at the beginning
of the Islamic history due to epistemological and ontological grounds, which emphasize that the purpose of human beings on this earth is to worship God and be a caliph on it (Ibrahim, 2015; Setia, 2005). The definition of being a caliph has a specific purpose that fosters the features of thinking, reflection, and observing how God has created the world (The Holy Qur’an, Surat al-Dhariyyat 51: 56; al-Baqarah 2: 30). Moreover, in the Islamic understanding of knowledge, science, or understanding the surrounding nature, is only one sort of knowledge that is strictly connected with other branches of knowledge where these sorts of knowledge are linked to the concept of Tawhid (Iqbal, 2007).

Furthermore, science as a discipline should strengthen an individual’s belief in God, which is a synonym word to (Iman) (Ibrahim, 2015; Saliba, 2007). Being a believer in the Islamic faith; therefore, could be a consequent result of humans’ seeking to understand the world, to implement what Allah asked believers to do that is to be caliphs on the earth (The Holy Qur’an, Surat Al-Baqarah 2: 30). However, one strong interpretation and influence of being a caliph, that involves the responsibility of preserving and understanding the surrounding nature, is the influence of understanding the term causality; the relationship between cause and effect. Causality has triggered a lot of discussion throughout the history of Islam (Ali, 2009; Saliba, 2007; Ibrahim, 2015). Even though there is a consensus among different scholars throughout the history of Islam that God is the cause for everything (Ibrahim, 2015; Iqbal, 2007); still there is some discussion of how this process works (Abrahamov, 1988; Ali, 2009; Ibrahim, 2015; Setia, 2005). For example, Islam does not conceive the surrounding world or nature “as a self-subsisting entity that can be studied in isolation from its all-embracing view of God,
humanity, and cosmological setting in which human history is unfolding” (Iqbal, 2007, p. Xvii). Such understanding of causality influences the way by which Muslims understand their surrounding world; therefore, how to understand the science behind it.

**The Saudi Society (Culture, Principles, and Population)**

Being at the heart of the Islamic nation, as Islam emerged from what is called now Saudi Arabia, as well as the possession of the two holy sites, The Holy Mosque in Makkah and the Prophet Muhammad’s Mosque in Al-Madinah Al-Munwarah that bring millions of pilgrims each year from all over the world to perform Hajj. Furthermore, Arabian Peninsula, or the so-called Saudi Arabia now, is the place where Prophet Muhammad started his Prophetic mission. These characteristics gave Saudi Arabia as a country and Saudis as people special treatment among Muslims. The Saudi king himself is called the Custodian of the two Holy Mosques. Saudis, therefore, see themselves in a position of being obligated to reflect integrally these historical and geographical connections to Islam.

Such integrity to Islam shaped Saudis with a rich and huge heritage of cultures, traditions, thoughts and values that formed the Saudi society. Furthermore, Saudi Arabia is an Arabic state. As all Saudis have one religion, they also have Arabic as their main language. The Arabic language was and is at the core of the Arabian Peninsula thousands of years ago even with the different dialects and idioms. Arabic also got a greater momentum after the emergence of Islam; since it is the language of The Holy Qur’an, which is the main source of Islamic jurisdictions and instructions.
The Saudi population is almost thirty-one million people with almost twelve million of them are under 19 years old (General Authority for Statistics, 2016). Therefore, Saudi Arabia has one of the largest youth ratios in the world in comparison to the national population (Al-Mulhim, 2013). However, the education system has been criticized heavily, especially in its deficiency of preparing Saudis for the job market (Al-Mulhim, 2013; Murphy, 2011). Particularly, the number of expatriates is increasing yearly to fill up the gap in the job market that could not be filled with unskilled Saudis (Al-Mulhim, 2013). Different reforms have been conducted by the Saudi government, represented by the ministry of education and some other governmental offices, to fix this issue and improve the education system to indeed reflect Saudis’ needs. However, it seems like none of these efforts have made a considerable effect (Ali Sallam & Hunter, 2013). Some of these reforms will be discussed later in this chapter.

**Education System in Saudi Arabia (an Overview)**

The Saudi education system is substantial and highly centralized. All educational policies are subject to government control and supervision. That include providing uniform curricula, textbooks throughout the Kingdom of Saudi Arabia. Educational administration and policy are conducted solely through the ministry of education. Recently, the ministry of higher education was canceled in 2015 by a decree from the government where the tasks of higher education were combined and controlled by the ministry of education to constitute one centralized agency that provide and control education from kindergarten to the university level.
The education system in Saudi Arabia has five divisions. These divisions include the years of kindergarten from 3-6, elementary education from 6 to 12 that involves six-year levels, three-year intermediate levels from 12 to 15 years old, three-year secondary school levels from 15 to 18 years old and finally different university levels and years depending on the subject being conducted by students.

Different developmental stages of education in Saudi Arabia have stated clear weight on the importance of education in this country. Specifically, throughout the history of the third Saudi state that started on 1932, there is a clear emphasis on reforming and developing education in Saudi Arabia. Different stages have emphasized this interest to educate Saudi people and transform and increase the huge illiteracy rate that was significant at the beginning of the state. It seems like Saudi education system emphasizes heavily on religious and Arabic classes. Little have been approached to increase science and math classes among Saudis, especially at the beginning of institutionalizing education in Saudi Arabia. This section will discuss in detail the different stages that shaped the Saudi education system since the beginning of the department of education in 1925 until project Tatweer that will last until 2025 A.D. Some discussions also will focus on how these different stages tried to present and improve science courses in the Saudi schools. Initially, there will be a discussion of historical overview of the Saudi education system since its beginning in 1925

**Historical Overview of the Saudi Education System**
Historically speaking, the Saudi education system was developed several times during the last 90 years, even before the country was founded in 1932. These developments include; first, the initial phase dated from 1925 until establishing the ministry of education in 1953. Second, the phase of establishing the ministry of education until 2008. Third, the phase of Tatweer project from 2008 that aims to last develop education in Saudi Arabia until 2025 (Al-Uqail, 2013).

**The department of education 1925.** The real beginning of education in Saudi Arabia dates to 1925, even before the establishment of the country that occurred 1932, when the Saudi government established the department of education, which formally took the lead to initiate the first formal Saudi schools. Before this date, there were some individual and private attempts to initiate different forms of schooling but they did not get enough momentum to be able to spread in more than the big cities or even provide adequate schooling at the time (Al-Uqail, 2013). Initially, in 1926, the department of education decided to begin its mission with four preparatory schools (Hakeem, 2012) with the first curriculum that was imported and applied as is from Egypt. This move changed the education system from the only one-teacher approach of Halaqah or Kuttab, where only one teacher teaches students religion and Arabic arts to more modernized curricula and school systems that were imported from nearby countries like Egypt (Khalil, & Karim, 2016). However, due to the nature of this curriculum and due to the lacking number of Saudi teachers, the department of Education hired many Egyptian teachers to teach this curriculum. Those teachers represented many teachers from the beginning of the formal education system until the end of the sixties of the 20th century.
These schools initiated a new era of schooling and education taking the system into more formal ways of teaching.

The first curriculum was mainly concerned with religious and Arabic studies. However, it included some other studies such as art, geography, and foreign languages (Hakeem, 2012). Many dilemmas faced applying this curriculum, especially due to the high illiteracy rate among Saudi citizens at that period (Hakeem, 2012). For example, in 1927 people protested a lesson in geography that states that the earth rotates around the sun. Many families came from different regions around the country to Makkah asking for omitting this lesson from the geography curriculum because they felt insulted especially to their beliefs (Hakeem, 2012). Other dilemmas included lack of prepared teachers, school buildings, economic dilemmas and inadequate schooling environments (Hakeem, 2012; Al-Uqail, 2013).

Establishing the Ministry of Education 1953. The department of education continued its mission to building the emerging education system until the Ministry of Education was established in 1953, which took the lead and established the first Saudi curriculum at that time. For this task, in 1964, the ministry of education established the department of curricula to revise the curricula that were applied in the education system since 1926. Later, the department of curricula designated a specific delegation to improve and revise the elementary education curricula. However, it was not until 1969 when the new curricula were applied (Al-Uqail, 2013).

The new curriculum though did not meet science and mathematics demands, particularly in providing more rigorous science practices and teaching strategies. Therefore,
in 1970, the ministry of education through its department of curricula appointed the science and mathematics department at the American University in Beirut to design science curricula especially for secondary schools (Al-Uqail, 2013). Moreover, in 1974, the ministry of education established new centers for science and mathematics to help science teachers deal with and use appropriate teaching strategies for teaching science in all grades (Hakeem, 2012).

However, these recommendations and efforts did not get significant outcomes until 1997 when a new plan was submitted to the elementary school (Ministry of Education, 1997). In this plan, there was more emphasis on science studies where science occupied almost 7% to 10% of the elementary curriculum (Al-Uqail, 2013). In addition, the emphasis on religious and Arabic studies occupied significantly the rest of students’ times in the elementary school. However, this plan was submitted to meet some new goals. For example, it emphasized that curriculum should connect students to their society. It also emphasized that students should keep consistent with the growing technological demands around them. Moreover, this plan also encouraged teachers to use behavioral objectives to measure their students’ progress and to make the teaching profession more organized (Al-Uqail, 2013), which was a considerable shift at the time.

The history of including science in the middle and secondary schools involves many shifts. As stated earlier the focus was on reading and writing especially in the first half of the 20th century. Therefore, the attention was given to elementary education for the most part. The first appearance of formal middle school was on 1958 (Al-Uqail, 2013), which grew from only 20 schools in 1958 to 4326 schools by the end of 2012 (Al-
Uqail, 2013). This enormous growth did not correspond with more attention to the middle school curriculum. The domination of religion and Arabic studies still occupies a huge number of students’ times in schools with no more than 12% of a general science course with no real significant shifts to change the curriculum throughout these years except for minor changes (Al-Uqail, 2013). However, Tatweer project, as will be shown later did change significantly the understanding of science in the middle school and at all other levels.

The history of the secondary school is not so old in Saudi Arabia. First, the real beginning of secondary schools is dated on 1955 with 12 formal secondary schools around the country. The number grew to almost 2914 secondary schools by the year 2012 (Al-Uqail, 2013). Due to the scientific demands, a specific type of secondary schools was named the natural science secondary school. This version of schooling emphasized heavily on pure sciences such as physics, chemistry, biology, and earth sciences. These subjects almost occupy 37% of the whole time of students in schools, especially in the second and third years of the secondary school. However, many dilemmas still exist especially the lack of labs and unqualified science teachers (Al-Uqail, 2013). Such dilemma continued to influence the education system in Saudi Arabia for years to come, especially at the first years.

The 1970 document. In 1970, the Saudi ministry of education issued a revised version of its educational policy. This policy contained 232 principles under nine different aspects. This document also emphasized some principles that took into consideration the value system of Saudis, increasing Saudis humanistic aspects,
emphasizing justice and equivalency of opportunities among Saudi students, and increasing scientific and educational principles (Al-Murshid, 1999). Even though this policy document was launched almost 45 years ago, it is still acting as the constitution or base for education in Saudi Arabia where all goals of improving and developing education should adhere to the principles that are mentioned in this document.

This policy document stressed heavily on some aspects including; the importance of Arabic language and Arabic arts in principles (46-45-44-24), education in Saudi Arabia is obligatory (156-155-154-153-10-9), education should serve societal needs and issues, development plans of the country, and the interests of the Islamic nation (48-41-37-35-34-33-22-21-19-18-16-15-8). This document also emphasized the importance of critical thinking, love of discovery and increasing the love of observing the whole universe with all diversities (58-52-50-49-43-42-41-39-37-16-14-13) and taking care of special needs and talented students (58-57-56-55-54-53) (Al-Murshid, 1999). However, one of the biggest emphases of this policy is the focus of Islam. For example, in this document, there was great emphasis on how Islam and its instructions should be the main source for legislations of Saudi Arabia as a country that should be transferred to Saudi Arabian people strictly as a way of life where this strong emphasis was mentioned more than one hundred times in this document. This emphasis would give a hint to the importance of religion in the Saudi education system.

**Tatweer Project 2008.** The previous phases with the different dilemmas involved in many levels and in all grade levels, pushed Saudi Arabia to issue a new plan called Tatweer Project. The government issued this project to improve the education
system in general as well as some major shifts to improve and develop science studies. One of the main reasons for this project was the failure that Saudi students showed when competing internationally in exams such as TIMSS (Jieffry, 2013). In its website, Tatweer initiative highlighted some goals that aimed at developing science and math along with improving other disciplines education practices in the country including increasing the competencies of students to compete in international exams and to provide explicit attention to Science Technology Engineering and Math issues (STEM). Other goals of this project included; improving teachers’ abilities to teach science, technology, math, engineering aspects through professional developments sessions around how to teach, help science teachers to use formative and summative assessment strategies, and help science teachers to use traditional and simulation labs. This project also emphasized that science should occupy more time in the student’s day through providing extracurricular activities dedicated for this purpose (Tatweer Project, 2008).

**Science subject and Tatweer project.** The development that science subjects got in the recent years were significant and included new topics that ethically triggered some argumentation within the Saudi society. In the science text books of the new science and math projects, a considerable part of Tatweer project, different issues were discussed, even slightly. These issues are introduced using different angles like the importance of teaching them because of their scientific literacy value. These issues included genetic engineering, cloning, nuclear energy, global warming, the consumption of fossil oil fuel, genetically modified food, and mercy killing. These secondary science text books addressed these issues considering how they influence Saudi citizens’ religious and
societal principles. Some other issues like evolution is not discussed in these text books. However, even though the new science curriculum discussed many SSI, still it addresses these topics in a very shallow way.

**Obstacles to implementing Tatweer project.** Even though Tatweer project has captured a significant interest in Saudi Arabia with the goal of developing the Saudi education system, many dilemmas decelerated and delayed implementing many plans of this project. For example, the initial plan was on conducting a system of modeling of smart schools. However, in 2011 and due to financial reasons, the ministry of education has shifted to another phase that was called school development model (Alyami, 2014). To meet this new development, the ministry of education conferred more authorities to schools’ principals to promote decentralization, which is an important step to apply and employ many plans of the new project. However, school principals seem to have limited ability and lack of support to use the new authorities (Meemar, 2014). Different other reasons seem to delay and slow this project such as the teachers’ lack of training, and the need to replace rented public schools, which represented more than 35% of Saudi public schools by the end of 2014 (Aljasser, 2014). Many other shortages of implementing this project were also reported by many principals, teachers, and other educators, especially in providing the needed sources and materials required for implementing this project, which caused a gap between what is expected of this project and the real nature surrounding it (Khalil, & Karim, 2016). The ministry of education, therefore, redesigned the projected plan of the Tatweer and asked for the government help, which in turn supported a revised plan of the project and allocated 21.3 billion dollars to meet many of the previous
deficiencies and to accelerate the project (Tatweer project, 2014). However, there are still some delays especially after combining the two ministries of education and of higher education together for more consistent educational policies in Saudi Arabia.

Discussion

Throughout the different historical developments and initiatives including Tatweer project, it is clear to see how essential the relationship between Islam as a faith of one hand and education on the other hand is in Saudi system. It is important to mention the role of the supreme council of sheiks, which is a council of senior scholars that serves as the religious body of the Saudi government that is appointed by the king to verify that all the actions of the government are compatible with the instructions of Islam. One of the main tasks of this council is to issue Fatwas for the new issues and concerns that need to be discussed to be compatible with the Islamic understanding (The general presidency of scholarly research and Ifta, 2016). The job of this council is especially important to clarify the new issues that concern of the Saudi society, which is shaped by the importance of the perceptions of Islam on how they act with the new things in life. Particularly, the social, cultural, historical understandings of the relationship between Islam as a faith and education as a social enterprise controlled almost every aspect of the education process starting from designing and applying Curricula for all subjects to all the remaining processes of the education system (Al Uqail, 2005). Understanding these ties and the reasons behind them gave a clear hint of the basics and principles that shape education in Saudi Arabia. The educational policy of the Saudi government; therefore,
focuses uniquely on religious studies in an unquestionable way that transform and control all subjects in schools to be compatible with this understanding of Islam and education.

However, the intent to improve and develop education is clear and significant throughout the history of Saudi Arabia. With spending that exceeds twenty-five percent of the yearly income of Saudi Arabia, which is huge having in mind the fact that Saudi Arabia is ranked amongst the 20 countries that have the highest GDP in the world (Soldatkin and Astrasheuskaya 2011), the Saudi government is considering education seriously. Nevertheless, even with Saudi government generous spending and the different attempts and initiatives to improve the Saudi education system, still, no significant gains are approachable. For example, the Saudi education system is still struggling with different obstacles that are hindering the real development of this important sector particularly in subjects like math and science. Nationally, many stakeholders, officials, and other people from all levels in the Saudi society called for real reforms that take into consideration the new era nationally and internationally to be able to compete with the world. Internationally speaking, Saudi Arabia is ranked very low in international educational testing including TIMSS where Saudi students ranked below international average in both science and mathematics (Martin, Mullis, Foy, & Stanco, 2012; Mullis, I. V., Martin, Foy, & Arora, 2012; Khalil, & Karim, 2016). Some Saudi scholars called for reforms that take into consideration how other countries implemented their policies and strategies for transitioning and reforming their educational systems (Abdul-Ghafour 2009; Khalil, & Karim, 2016).
The desire to develop teacher education in Saudi Arabia was and is of a great concern of the Saudi government. For example, in 1926 almost months after establishing the department of education or the Saudi Directorate, the first Saudi official agency for education, the Saudi Elmi Institute for teachers was established in the city of Makkah. This institute aimed at increasing the number of Saudi teachers in the established education system at the time (Al-Murshid, 1999). Before this institute, teachers who could just read and write were eligible to be recruited as teachers regardless of their teaching capacities (Al-Harbi, 2011). Later, some attempts have been made to establish a university level for preparing teachers. In 1945, the first Shariah College, a religious college, was established to start the first institution of higher education in Saudi Arabia (Al-Hugail, 2003). This institution was the first to prepare teachers for a university level. However, it was mainly interested in providing Islamic and Arabic studies without a real focus on teaching as a vocation. However, some graduates from this college attended the teaching profession. Afterward, the Saudi Elmi Institute spread its focus to cover similar institutes that were distributed along the country to reach 37 institutes by 1961. Students who have primary schools certificate were eligible to enter these institutes and spend three years before they graduate as primary school teachers (Al-Hugail, 2003).

The Period of Higher Education and Teacher Education

Even though Shariah college was the first attempt to establish a collegial level of preparing teachers in Saudi Arabia, the real dreams to provide higher education, after the
Shariah college, were approachable after establishing King Saud University in Riyadh city, which was established in 1957 (Khalil, & Karim, 2016). Other universities were established later to reach a total number of six universities by 1980. The first education college was not affiliated to King Saudi University; rather it was affiliated to Um Al-Qura University in Makkah city in 1961. By 1980 there were six colleges of education throughout the country (Al-Harbi, 2011). These colleges could fill the gap in providing enough teachers in the growing Saudi society in both elementary and secondary schools at the 70s, 80s, and 90s. The requirement to be admitted into these colleges included a secondary school certificate and passing a designed interview (Al-Hugail, 2003). This policy was almost the same for these different colleges (Al-Harbi, 2011).

**Different forms of teacher education.** Some other colleges were established by different government agencies like the ministry of education, which built several teachers colleges around the country to be specialized for preparing elementary school teachers. In addition, the General Presidency of Girls education, before canceling this agency in 2002 (Asharq Alawsat, 2002), provided higher education through several education colleges that were specialized to preparing Saudi female teachers. These different forms of teacher education were later joined to the nearest universities to their locations. Nowadays, it is estimated that there are more than 27 public universities within each at least one college of education. By 2011 there were more two hundred thousand students studying in education colleges around the country (Al-Issa, 2011).

**Teacher education programs.** Preparing teachers before service got different forms throughout the history of teacher education in Saudi Arabia. For example, the
Saudi Elmi Institute was only looking and preparing for that teacher who can read and write to be recruited as teachers. After the development of education and comparing Saudi education to different forms of education around the world, the process of preparing teachers is far deeper and more complex in different colleges of education throughout Saudi Arabia. Even though many colleges, that are now affiliated to different universities in Saudi Arabia, that prepare teachers in Saudi Arabia are called education colleges, some of these colleges were affiliated to the ministry of education and were called teachers colleges. Those colleges were established to prepare Saudi elementary schools teachers. Even though many these colleges were joined to the nearest college of education or transferred to be colleges of education themselves, still tens of thousands of in-service teachers graduated from these forms of higher education and therefore it is important to discuss how they got prepared for deeper view of the nature of teacher education in Saudi Arabia. Later, there will be a discussion of how teachers are getting prepared through different forms of higher education specifically, throughout education colleges.

*Teachers colleges.* Preparing teachers in teacher colleges used to be for four years including one semester of in-field training. Throughout these four years, and using an integrative program, teachers must take obligatory courses including education, psychology, dedicated courses in the subject being chosen like math, science, or literacy (Al-Thuainy, 2010). At the final year, students- teachers are required to take a whole semester of in-field training that should be conducted cooperatively between a supervisor from the college and the teacher that is assigned to help that student-teacher in schools.
After successfully completing these requirements students-teachers graduate from teacher colleges with a bachelor degree in teaching for elementary school. No licenses for teaching is required by those teachers. These sorts of education are no longer exist except for few places around the country, specifically two colleges in the cities of Riyadh and Makkah.

*Education colleges.* Students enroll to these sorts of higher education are required to get in-depth knowledge of specific subjects like applied sciences, in-depth literary arts, or in-depth course of mathematics depending on the academic path they chose before entering the college of education (Al-Hugail, 2003). Some other courses in some other subjects should be taken by those student teachers including history, geography arts, and some other general ones. After four years and after finishing the required courses, students-teachers can graduate from these colleges with a bachelor degree of those specified fields that they chose when getting enrolled to the college. However, they will be able to practice teaching before finishing a high diploma in education that could last for one or two years depending on the program assigned by the college of education. After successfully completing these requirements, student teachers will be able to teach in all K-12 schools in Saudi Arabia. No licenses for teaching is required by those teachers as well.

**Challenges Facing Teachers in Saudi Arabia**

Different challenges are facing the development of teacher education in Saudi Arabia. For Example, the number of students in K-12 education increased from 6682730 in 2013 to 6798442 in 2014. The latest statistics is estimating the number to be 7450319
students in 2015 (General Authority for Statistics, 2016). This growing number of
students is taking a lot of the ministry of education efforts to modernize and improve
education in Saudi Arabia. Having in mind the need for building new schools each year
with all needed resources and tools that are very hard to keep up with even with the
generous government spending. For example, to fix the lack of school buildings, the
ministry of education has a system of renting buildings and transforming them into
school. Those residence-designed buildings would lack a lot of resources and tools
necessary for teachers including no science labs for instance. Therefore, providing the
adequate environment for the teachers to practice their profession is not easy in such an
environment. Being in such an environment with lack of supported resources forced
many teachers to leave the teaching profession and look for other jobs (Al-Harbi, 2011).

Increasing the number of teachers is necessary for a better teacher-students rate
that is estimated around 14 students for each teacher (the ministry of education, 2016).
Having in mind that fact that the latest estimate of the number of teachers in Saudi Arabia
reaches almost 543158 teachers in the K-12 education by the end of the 2015-2016
school year who are responsible for teaching more than 7 million students (Ministry of
Education, 2016). Even though this number seems moderate, a lot of non-teaching
positions take away a lot of teachers from the real nature of teaching into some other
administrative positions that they may not be even prepared for. For example, almost
seventy thousands of employees, among which thousands of teachers work in almost 44
departments of educations across the country without teaching positions. Real
consideration to modifying these distorted figures need real consideration to many aspects including better techniques for teachers and teaching in general.

**Conclusion**

It is estimated that the number of teachers in Saudi Arabia reaches almost 543158 teachers in the K-12 education by the end of the 2015-2016 school year (Ministry of Education, 2016). Even though this number seems huge, especially in a country of almost 30 million people, it is important to understand that this number is misleading as almost 70 thousands of employees, among which thousands of teachers work in almost 44 departments of educations across the country without teaching positions. Moreover, the challenges that face teaching as a profession in Saudi Arabia are deep-rooted with very deep and complex backgrounds that are hard to be fixed without a comprehensive plan to deal with such complexity. Some of these challenges are well reported in different countries like low attitudes towards teaching as a profession (Darling-Hammond, 2005; Su, 1992), and teaching environment (Andersen, Dragsted, Evans, & Sørensen, 2004). However, in the case of Saudi Arabia, it is important to investigate the ways and the reasons behind these complexities before proceeding to fix them.

For example, to improve the quality of teaching practices, as resulted from *Tatweer* initiative, the Ministry of Education is focusing on improving teachers’ preparations, standards, curricula, tools and resources for schools. However, some criticism is still facing those efforts to improve teachers, for example, as the ministry of education is still focusing on the quantity over quality of teachers (Al-Issa, 2011).
Having in mind the growing number of students and high mortality rate of the Saudi population, 266184 new babies were born in 2015 (General Authority for Statistics, 2016), enough qualified Saudi teachers would be hard; yet very important.
CHAPTER III
LITERATURE REVIEW

The literature review of this study will be organized around distinct but related themes. First, there will be a review of empirical studies about science teachers’ views of SSI including a discussion of their views on issues like cloning, the theory of evolution, genetic engineering and others. This section will also investigate science teachers’ views of the teaching of some SSI. This section also aims to reveal some possible thrusts for such views to reveal the main possible causes for science teachers’ views of these issues. The following sections will be organized to investigate science teachers’ reasons behind their views of SSI including a discussion of what science teachers’ understandings and perceptions of some issues and their worldviews - societal and religious – that influenced their SSI views. Moreover, there is an investigation to science teachers’ teaching strategies of teaching many SSI that include views of teaching some SSI as well as actual teaching practices used for teaching some issues. These different themes are tied together and selected for their connection to each other. For example, teachers’ views of SSI would likely illustrate their views of the teaching and their actual teaching practices of these issues. Investigating these different themes, therefore, would likely frame an understanding of the different factors that inform and describe science teachers’ views and teaching strategies of SSI in the science classroom.

Criteria for Conducting Literature Review
Some criteria will be applied when choosing the literature review for this study. First, this literature review focuses on studies within the past 15 years for a more accurate picture of the recent trends in viewing and teaching these issues. However, most of the studies reviewed in this literature review will be less than 10 years old. Second, since teachers represent the main factor of delivering and teaching SSI (Sadler, 2011; Ziedler et al., 2005), the focus of this literature review will be on science teachers’ views and their teaching practices alone excluding students’ views. Third, the main procedure for analyzing these studies will be through an in-depth analysis of some major studies in each section along with a further discussion of some other studies related to each section.

**Different Views of SSI and of Teaching SSI**

Several studies have reported different views of science teachers hold regarding different SSI and how they view the teaching of these issues in the science classroom. In this section, there will be a review of studies about science teachers’ views and teaching strategies (Boujaoude, Asghar, Wiles, Jaber, Sarieddine & Alters, 2011; Hestness, Meginnis, Reis & Galvão, 2004; Reis & Galvao, 2009; Khalid, 2003; Mansour, 2007; Riedinger & Marbach-AD, 2011). Some of these studies will be discussed in detail to reveal what factors influence science teachers’ views and teaching on these issues.

**Science Teachers’ Views of SSI**

Reis & Galvao (2009) investigated factors that influence the teaching of controversial SSI of one protégées teacher in Portugal. They studied these factors using a case study procedure that lasted for a whole year. This teacher was selected from a group
of teachers who worked with the researchers in previous studies because of her experiences in teaching and managing her science classroom. The researchers observed the teacher in 14 class sessions. Each class lasted for 50 minutes and intended to teach preprogrammed controversial topics. They also interviewed the teachers several times throughout the year.

Christina, the participant in this study, revealed many views in respect to these issues. For example, she emphasized that these issues are too complex and require adequate knowledge from the part of the teachers that includes the nature of these issues and how to teach them using not only technical procedures. She revealed and emphasized that science should be taught in a human way where issues such as hierarchies of values, social aspects, and personal perceptions should be addressed. She also emphasized that participating in decision-making processes especially with respect to technology and science requires an adequate understanding of these issues and how such issues influence the society. Additionally, she showed distinct views of science when she believed that scientists do not pay attention to peoples’ values and morals when they conduct science, as their ambition sometimes becomes a priority to them more than ethics. The authors concluded that Christina’s strong positions and knowledge of these issues along with her NOS understanding and belief of the importance of articulating and teaching these issues in the science classroom helped her to overcome many obstacles in her pursuit to teaching these issues.

This study has some weaknesses and strengths. One of its weaknesses is that it recruited only one teacher, which would not reveal more justifiable and generalizable
findings. The authors also did not try to investigate what aspects of the NOS contributed the most to Christina’s positive conceptions of the importance of these issues in the science curriculum. However, one of the most valuable strengths of this study is the methodology that employed a case study and the long period that allowed more depth in discussing the teachers’ views of these issues. Boujaoude et al., (2011) investigated 20 Lebanese secondary teachers’ and university biology professors’ worldviews regarding evolution. They attempted to address: (1) Lebanese secondary school (Grade 9–12) biology teachers’ and university biology professors’ worldviews regarding biological evolution (2) how participants’ religious affiliations pertain to their worldviews about evolutionary science, and (3) participants’ worldviews regarding evolution education. They used semi-structured interviews to investigate these three aspects of the participants. Additionally, they used codes developed by Dagher and Boujaoude (1997) to incorporate categorical descriptions based on Scott’s (2009) study to categorize the participants’ responses in these interviews. They also used constant comparative analysis method to refine and compare the categories they developed and grouped them under three main sections “What is taught about evolution, how it is taught, and whether or not it should be taught” (p. 985).

The results revealed varied conceptions of evolutionary theory however many Muslim teachers rejected this theory. These authors categorized participants who rejected the evolutionary theory into three types. There were those who rejected this theory because of their religiosity. Others revealed some conceptual difficulties. The third type rejected this theory because of their lack understanding of the NOS. The
authors concluded that religion plays an important role especially to Muslim teachers among other teachers and professors in this study.

There are some strengths and weaknesses in this study. One of the strengths is that the authors recruited Muslim and Christian participants, which gave this study more depth, especially to investigate the role of religion in accepting the evolutionary theory. On the other hand, this study has some weaknesses. For example, despite the authors’ emphasis that some science teachers revealed some misconceptions with respect to the NOS, they did not provide a clear explanation to how they investigated these misconceptions, nor did they reveal what misconception contributed the most to rejecting the evolutionary theory.

Reis & Galvao (2004) conducted a study to investigate the influence of SSI in Portuguese natural science teachers’ views and practices. To conduct this study, they focused on assessing secondary science teachers’ conceptions of the nature, teaching, and learning of science. In addition, they studied the possible influence of recent controversies surrounding scientific and technological issues on their conceptions and teaching practices. The sample of this study consisted of five secondary teachers in different five secondary schools. Those teachers had worked with the researcher in previous research, which gave more familiarity and flexibility in collecting data for this study. Those teachers had a wide range of experiences (3, 8, 25, 33, and 39 years of experiences in teaching science). The study has been conducted over a course of a whole school year using classroom observations, interviews, open-ended questionnaire and analysis of classroom plans and materials.
Many factors influenced science teachers’ views of SSI. For example, the authors emphasized that some teachers in this study associated science with honesty, objectivity, and rigor while they associated technology with rigor, efficacy, and adaptability. Therefore, the authors emphasized that the image and the conceptions of the controversies embedded in some SSI did not correspond with their conceptions of science as objective and value-free. However, when some of those teachers have more understanding of the NOS especially to its tentativeness, complexity, dynamic activity and differences in opinions, they seem to accept the controversies embedded in this issues. The authors concluded that even though many teachers emphasized the importance of these issues, they also considered them as difficult, and hard to be taught in the existing school curriculum. Therefore, they called for developments in the science curriculum that could help to address these issues in the science classroom.

This study has some advantages and disadvantages. For example, one of the advantages in this study is the wide range of experiences of participants, which should be considered when investigating such wide and varied views of these issues. This study also emphasized the influence of science teachers’ conceptions of the NOS on their views of SSI especially the aspects of science as tentative, involves complexity, dynamic activity, and differences in opinions. Another strength in this study is the different methods used for collecting data that involved, class observation, interviews, and analysis of teachers’ plans. However, one of the weaknesses in this study is the limited number of participants that would threaten its generalizability.

Mansour (2007) investigated 162 pre-service Egyptian teachers’ views of STS
issues. He focused his study on investigating their views of the constraints that influence the teaching of these issues. He also focused on investigating how such views influence their teaching practices. Finally, he focused on how science teachers see the relationships among these constraints. He used a mixed method technique that included a questionnaire followed by open-ended interviews, field notes, and classroom observation to conduct his study. The questionnaire involved 18 points to assess participants’ views of the STS. He conducted a pilot study with 126 to investigate the validity of this questionnaire. The interviews were piloted to some teachers before conducting the final version to assure more accuracy of its questions that focused mainly on teachers’ worldviews to implement STS lessons. These interviews lasted between 30-45 minutes for each participant. They were transcribed immediately and returned to each participant for more validity, confirmation, and scrutiny. Every participant was observed and interviewed four to five times.

This study revealed many results that identified Egyptian science teachers’ views of teaching these issues in the science classroom. The author organized participants’ worldviews to these issues into two main categories. External constraints included examination system, constraints related to time and lack of resources, education policy and materials needed for teaching these issues. In addition, there were internal constraints included teachers’ backgrounds and experiences with STS, teachers’ religious beliefs especially the relationship between science and religion, and teachers’ professional capabilities. The authors concluded that these factors emphasized a negative view of these issues and of their importance in science education and called for more
attention to these internal and external factors that influence science teachers’ willingness and abilities to teaching these issues in the science classroom.

This study has some weaknesses and strengths. One of its strengths is the big number of participants who were recruited. This study also was conducted in a Muslim country, which would be considered more related to the Saudi context in many ways, especially to investigate the religious worldview of those teachers to some SSI. Another strength of this study is the methodology used, which employed both quantitative and qualitative methods to strengthen its results. However, one of the weaknesses of this study is the lack of context especially in how the researcher conducted observation and the value of this procedure in the data collection and analysis phases.

**Summary and discussion.** The review of these studies along with many other studies revealed different and varied views of SSI among science teachers in different settings and contexts. First, even though some science teachers accepted some SSI like evolution, many Muslim science teachers do not feel empowered or encouraged to teaching this theory (Asghar, 2013; Trani, 2004; Mansour, 2007, 2010, 2011). However, when science teachers combine good understanding and content knowledge of evolution, they would see this theory positively (Asghar, 2013; Moore, 2008). Second, some other science teachers rejected some SSI because of their worldviews (Boujaoude, Asghar, Wiles, Jaber, Sarieddine & Alters, 2011), especially religiosity (Asghar, 2013; Boujaoude, Asghar, Wiles, Jaber, Sarieddine & Alters, 2011). These different constructs were seen heavily in many previous studies, particularly the religious and knowledge about many SSI and their influence on science teachers’ views of many SSI.
Science Teachers’ Views of the Teaching of these Issues

One of the important dimensions that have been investigated in respect to studying science teachers’ views of teaching these issues focused on the influence of such views on science teachers’ views of teaching them. Even though there is compelling evidence emphasizes a relationship between these two constructs (Sadler et al., 2006; Sadler, 2011; Ziedler et al., 2005; Hestness et al., 2011; Kara, 2012; Mansour, 2007, 2008, 2011; Asghar, 2013; Boujaoude et al., 2011), still there are many difficulties contributed to a limited picture of the value of teaching these issues in the science classroom.

For example, Mansour’s (2007) study is important to focus more on internal and external factors that influence science teachers’ views of teaching these issues. First, many science teachers in different settings and contexts have reported different internal factors that influenced their views of teaching SSI in the science classroom. For example, many science teachers reported that many of these issues are difficult to teach (Barrué & Albe, 2011; Aroua, S., Coquide, M., & Abbes, 2009; Trani, 2004; Sadler et al., 2006; Reis & Galvao, 2009). Other teachers reported that their religious beliefs contribute as a barrier toward teaching issues such as evolution (Asghar, 2013; Trani, 2004; Boujaoude et al., 2011, Mansour, 2007), and cloning (Mansour, 2008, 2011). Moreover, teachers’ political stance or their lack understanding of the political background of some of these issues represents another barrier toward their willingness to teaching issues such as climate change (Hestness et al., 2011). Other researchers reported some other internal factors that reduced teachers’ willingness to teaching these issues.
especially teachers’ abilities to manage the legal dilemmas associated with some of these issues, especially to evolution (Moore, 2004). Even though these internal factors may seem invisible, they influence science teachers’ willingness to teaching these issues. It is important therefore to investigate these hidden factors.

Second, some other teachers reported external dimensions that reduced their inclination toward teaching SSI in the science classroom. For example, the length of the science program was reported as one of these factors that diminished science teachers’ abilities to teach these issues (Reis & Galvao, 2004; Mansour, 2007). Others reported the large class size as another factor (Mansour, 2007). The facts that science programs do not include explicit attention and appropriate topics around SSI in the science curriculum were other factors that reduced teachers’ abilities to teach these issues (Reis & Galvao, 2004). Other teachers reported time constraints, especially to teaching and preparing activities to teach these issues in the science classroom (Sadler et al., 2006; Hestness et al., 2011; Boujoaoude et al., 2011; Mansour, 2007). Other teachers reported constraints related to the national exams (Reis & Galvao, 2004; Mansour, 2007), which focuses “almost entirely on memorization and very little on critical analysis” (Reis & Galvao, 2004, p. 168). Students, in this case, would be less interested in these issues because they are not part of the final exam (Mansour, 2007). Teachers also reported that these issues are hard to be taught due to the conceptual framework needed for teaching them (Hestness, 2011). Therefore, science teachers would highlight these activities as merely “informal extra-curricular conversations” (Reis & Galvao, 2004, p 168). Other teachers reported a lack of the needed materials and curriculum resources for effective teaching to
these issues in the science classroom (Forbes & Davis, 2008). Mostly, these external factors can be reduced if the science school favored more progressive ways of addressing science that favor the usefulness of knowledge not mere accumulating facts that have less to do with students’ surrounding.

**Summary and discussion.** These studies of science teachers’ teaching strategies of SSI reveal different directions. First, there are external factors influenced teaching these issues. These factors included examination system (Mansour, 2007; Reis & Galvao, 2004), Lack of time as many of SSI require deep discussion and preparing the required activities (Boujoaoude et al., 2011; Sadler et al., 2006; Hestness et al., 2011; Mansour, 2007), and lack of the needed materials and curriculum resources for effective teaching of these issues in the science classroom (Forbes & Davis, 2008). Second, there are internal factors influenced teaching these issues. These factors included teachers’ backgrounds and experiences with SSI, teachers’ religious beliefs especially the relationship between science and religion, and teachers’ professional capabilities (Hestness et al., 2011; Mansour, 2007; Sadler et al., 2006).

The previous studies along with many other different studies in different settings and contexts revealed varied views of SSI among science teachers (Tekkaya, Akyol & Sungur, 2012; Deniz et al., 2008; Kara, 2012; Nehm & Kim, 2009; Trani, 2004; Barrué & Albe, 2011; Ekborg, Ottander, Silfver & Simon, 2012; Saunders, 2009; Hodson, 2014). However, there are still gaps in how such factors influence science teachers’ views of these issues. For example, some studies revealed that science teachers’ knowledge of these issues contributed significantly to science teachers’ views of them (Boujaoude,
Asghar, Wiles, Jaber, Sarieddine & Alters, 2011; Hestness et al., 2011; Khalid, 2003; Reis & Galvao, 2004; Reis & Galvão, 2009). However, such knowledge rarely “expanded on how facts or content knowledge could be used for purposes such as ethical decision-making or countering opinions” (Levinson, 2006, p. 253), which should be considered as the main interest when discussing these issues worldwide.

Many of the previous studies also revealed clear evidence that teachers’ views of teaching these issues are relatively influenced by their worldviews of them (Mansour, 2007, 2011; Sullivan, Ledley, Lynds & Gold, 2014; Trani, 2004). For example, teachers who have negative views of evolution would not teach it at all (Asghar, 2013; Mansour, 2007, 2010, 2011; Moore, 2008; Trani, 2004), selectively teach the parts that do not oppose their religious beliefs (Asghar, 2013; Mansour, 2007), or teach creationism along with evolutionary theory (Asghar, 2013; Berkman, Pacheco, & Plutzer, 2008; Boujaoaoued et al., 2011; Moore, 2008; Plutzer & Berkman, 2008). Moreover, some other factors would foster teachers’ views of teaching these issues such as: explicitly including these issues in the science curriculum standards (Donnelly & Boone, 2007; Wise, 2010) and teachers’ own worldviews of the importance of these issues (Reis & Galvao, 2004). A deep analysis, therefore, is required to clarify what factors would influence science teachers’ views of SSI.

**Constructs Inform Science Teachers’ Views of SSI**

In the following two sections, there will be a discussion of two main factors that have been reported by previous studies and others as main reasons for science teachers’
views of SSI. First, there is clear evidence that science teachers’ content knowledge of many SSI influenced their views of these different SSI (Walker & Zeidler, 2007; Sadler et al., 2006; Zeidler, Sadler, Simmons, & Howes, 2005). Second, science teachers’ worldviews including their societal and religious views influenced also their views significantly (Sadler et al., 2006; Hodson, 2014; Zeidler, Sadler, Applebaum, & Callahan, 2009). The following sections will investigate how and in what ways these different dimensions influenced science teachers’ views of SSI.

Science Teachers’ Perceptions and Understandings of SSI

Many studies will be investigated in this section to report the influence of science teachers’ knowledge, content knowledge, and understanding, of SSI on their views of these issues. Some of these studies investigated pre-service science teachers (Khalid, 2003; Crawford, Zembal-Saul, Munford, & Friedrichsen, 2005; Deniz, Donnelly & Yilmaz, 2008). The other studies investigated in-service science teachers (Asghar, 2013; Wise, 2010; Moore, 2008). Some of these studies will be investigated in depth.

For example, Deniz, Donnelly & Yilmaz (2008) investigated the factors related to acceptance of evolutionary theory among Turkish preservice teachers. The sample of this study consisted of 132 Turkish pre-service biology teachers. Those participants were enrolled in a biology education program at a western Turkish university. The authors aimed to understand the extent to which the variance in acceptance of evolutionary theory can be determined by an understanding of evolutionary theory, epistemological beliefs, thinking dispositions, and parents’ educational level. They collected data using four main methods. First, they investigated participants’ understandings of the evolutionary theory
using a modified version of a scale consisted of 21 multiple-choice questions that were used in Rutledge and Warden (2000) and developed originally by Johnson (1985). Second, they investigated participants’ acceptance of the evolutionary theory using the measure of acceptance of the theory of evolution (MATE). Third, they investigated participants’ epistemological beliefs using a scale developed by Wood and Kardash (2002), which consisted of 38 items. Finally, they used (AOT), which is a scale consisted of 41 items selected from different scales to assess participants’ thinking dispositions.

This study revealed different results. First, the authors discovered a positive correlation between pre-service knowledge of the nature of evolution and accepting it. Second, there was another positive correlation between pre-service teachers’ parents’ educational level and accepting evolution. Third, the researchers also found a positive correlation between pre-service teachers’ cognitive flexibility and openness to belief change to their acceptance of evolution. Even though the authors emphasized the influence of science teachers’ cognitive ability on their views and teaching of this theory, they emphasized that other factors would influence their willingness to teaching this theory, which should be considered in future research. This conclusion supports the need for a more comprehensive understanding of the factors that influence science teachers’ views of these issues.

This study has some advantages and disadvantages. One of its advantages is the attempt to investigate different factors that influence participants’ views of the evolutionary theory. Such emphasis on these different factors gave a more comprehensive picture of how science teachers’ perceptions of the evolutionary theory
could be influenced by multiple factors at once. Another significant strength of this study is how it showed to some extent a positive correlation between the knowledge of the evolutionary theory and accepting it, especially in a Muslim country. It is important therefore to investigate this important aspect in other contexts such as the Saudi Arabian context to investigate how such factors especially teachers’ knowledge of evolution or any other SSI would influence their views of these issue in the Saudi science education domain. However, one of the disadvantages of this study is the more focus on the quantitative methods to collect data. It will be more helpful if more focus was given to qualitative methods to have more power in analyzing the data, especially with this very controversial issue.

On the other hand, Khalid (2003) investigated pre-service teachers’ views and perceptions of some environmental issues. These issues included the greenhouse effect, the ozone depletion, and acid rain. He recruited 27 pre-service teachers who were in their fourth year taking a science teaching methods course at a large American Midwestern university. The study focused on investigating science teachers’ knowledge and perceptions of these three environmental topics. To investigate these perceptions, the author used a questionnaire with open-ended questions. This questionnaire consisted of 30 statements that were designed to investigate participants’ views on these three topics. The participants responded to the statements on a Likert scale and were encouraged to further explain their responses in a space provided under each question.

This study revealed significant findings. For example, many participants tend to have some misconceptions about these issues especially in combining one issue with
others. The author concluded that such misconceptions came from other sources such as media for example. Therefore, he called for new ways of preparing science teachers that take into consideration the knowledge needed for teaching and addressing these issues in their future careers.

This study has some strengths and weaknesses. One of the strengths of this study is the focus on different SSI such as the acid rain and greenhouse effect. This study also revealed the influence of participants’ understandings and knowledge of these issues on their views of them. However, the author did not seem to investigate in-depth the reasons for such misconceptions other than that of media.

**Science Teachers’ Worldviews and SSI**

One major source for science teachers’ negative views of many SSI is their worldviews and willingness to accept them. Specifically, this section will focus more on science teachers’ religious beliefs and the influence of such beliefs on their views of these issues. Therefore, there will be a discussion of how such beliefs influenced science teachers’ views of these issues. There will also be a focus on different contexts to develop a robust understanding of how religion and science interact and influence each other. Some of these studies focus on Muslim contexts (Asghar, 2013; Boujaoude, Asghar, Wiles, Jaber, Sarieddine & Alters, 2011; Edis, 2009; Mansour, 2011), other studies focus on Christian and Judaism contexts (Barbour, 2000; Dodick, Dayan & Orion, 2010; Hsu, 2010; Martin-Hansen, 2008; Reiss, 2010; Roth, 2010; Sadler et al., 2006; Staver, 2010; Moore, 2008). Another study investigates the role of religion within a Hinduism context (Upadhyay, 2010). The goal of this section is investigating in general
views of how religion and science are viewed within these varied contexts.

Initially, there will be a discussion of some studies from several contexts before discussing and summarizing the remaining studies pertaining to this section to be able to describe the interactions that occur between science and religion within these varied contexts. For example, Mansour (2008) designed a study to investigate experiences and personal religious beliefs of ten Muslim Egyptian science teachers pertaining to SSI. He began his sample with six participants then increased the number to ten participants to gain more informed views of these influences. The sample was chosen based on their responses to another questionnaire that had been conducted by the author in another study. This questionnaire investigated their beliefs and practices in a Likert-type design. The sample represented a variety of experiences and gender (5 males and 5 females) and a variety of ages (the 30s – 50s years old) and a variety of teaching expertise (10 to 23 years of teaching). All those teachers were Sunni Muslims. He designed his study to investigate three main aspects. First, he focused on investigating the variety of experiences the influence science teachers’ beliefs and practices. He also investigated the role of experiences in shaping teachers’ beliefs and practices. Finally, he investigated the role of the Islamic contexts in shaping teachers’ experiences, beliefs, and practices. To conduct his study, he used a grounded theory approach based on Charmaz (2006). He also designed interview protocol to collect data. Each interview lasted 30-45 minutes. Each interview was audiotaped and transcribed before the following ones. For more scrutiny, the author sent those transcripts to the science teachers for review. The author also performed a classroom observation for those teachers. Classroom observation aimed
to investigate how science teachers’ practices are influenced by their beliefs. Data analysis was conducted in two stages. First, the author used four steps that meet the requirement of grounded theory. These steps included: inductive coding, conceptual and critical reflection, constructing the emerging categories, and framing the theory. Second, the author tried to match the emerging theory with already existing theories related to this study.

Mansour found that Egyptian science teachers’ views of SSI and of the controversies embedded in some issues like cloning, for example, were influenced by their religious beliefs. He also found that science teachers’ personal beliefs controlled their conceptions of science, especially in issues like; what science is and what issues should be taught and in the science classroom. The author also emphasized that teachers’ personal beliefs acted as an organizer for what experiences should be taught in schools. This study also revealed that mush of the teachers’ understandings of these issues come from informal sources such as newspapers and other media sources.

This study has some strengths and weaknesses. The researcher himself mentioned one of the weaknesses when he emphasized that this study did not reveal how teachers’ conceptions of life and professional contexts informed their views of science and religion. However, this study investigated deeply the influence of science teachers’ beliefs on their views and conceptions of many SSI, which would help to investigate Muslim science teachers’ conceptions more easily. For example, all participants were Sunni Muslims. Such similarity would inform the discussion of how Saudi science teachers perceive the role of their Islamic conceptions on their views of what science is
and of teaching and viewing science education. The methodology used in this also was one of the strength; as grounded theory helped the researcher to investigate more in-depth the role of religion in teachers’ views of SSI.

Asghar (2013) investigated 25 Canadian and Pakistani science teachers’ perceptions of evolutionary science and evolutionary education. In his study, he tried to investigate the influence of Muslim science teachers’ religious beliefs on their perceptions of biological evolution. In addition, he tried to investigate the ways by which Muslim science teachers negotiate any conflict between science and their Islamic beliefs. He also investigated their perceptions of teaching evolution in their classrooms. Finally, he aimed to investigate the differences, if any, exist between Muslim science teachers situated in secular versus religious contexts. He conducted this study in six Canadian and Pakistani high schools. All schools were contacted through local professional contacts. The author collected data using an interview protocol that he developed for this study. He conducted individual interviews. They lasted between 35-60 minutes with seven Canadian and twelve Pakistani teachers. He also conducted a focus group discussion with six more Pakistani teachers.

The author reported many results in this study. He discovered that both Canadian and Pakistani teachers accepted the evolution of living beings but not for human beings. One main reason for such views was mainly related to their beliefs except for three Canadian teachers who selectively accepted the parts of human evolution that did not contradict their religious beliefs. The researcher also reported a lack understanding of biological evolution. The author concluded that even though those teachers were in
different contexts, they showed similarities in their views of evolution. He emphasized that Muslim science teachers have a theological framework that shapes their perceptions of science specially to accepting and teaching the evolutionary theory.

There are some weaknesses and strengths in this study. For example, the author mentioned that he used a focused group interview procedure with six Pakistani teachers but he did not justify why he did choose this way of interviewing, nor did he reveal how this procedure influenced the outcomes of this study. On the other hand, this study also reveals how Muslim science teachers’ religious views are considered as a barrier toward accepting evolution. In this context, it is important to compare this result with Deniz et al., (2008) which emphasized a positive view of evolution among Muslim Turkish science teachers. The main difference between these two contexts is that Turkish science teachers showed more knowledge of the evolutionary theory unlike the participants in Asghar (2013) who showed misconceptions in their views of this theory. This finding supports the claim that science teachers’ views of these issues are influenced by a conceptual scheme that includes multiple factors.

In addition, some studies were investigated in other western contexts. For example, Sadler et al., (2006) investigated pre-service science teachers’ worldviews and significance of ethics in science education. They used a purposeful sampling procedure to generate 22 teachers represented the sample of their study. They also employed semi-structured interview protocol around two main inquiries. First, they tried to investigate how teachers would conceptualize the place of ethics in science and science education. They also tried to investigate teachers’ abilities to handle topics with ethical implications
and expression of their own values in their classrooms. The interviews lasted between 30 and 90 minutes and were audiotaped and recorded. The data analysis in this study was conducted using inductive data analysis adopted from (Perakyla, 2005) and constant comparative method adopted from (Straus & Corbin, 1998). The authors engaged in an iterative process where they developed tentative analytical models and discussed individual analyses. To assure trustworthiness they used purposeful sampling however they emphasized that generalizability was not a goal for this study, which is the case with qualitative methods. They also organized the responses of the study into five profiles. Each profile has specific features. For example, profile A contains teachers who clearly showed an inclination to teaching SSI and cited clear examples of controversial issues in their classes. Profile B included teachers who supported SSI but did not teach it because of some constraints. Profile C involved teachers who did not consider SSI as important. Profile D was about teachers who saw science as value-free. The final profile E was for teachers who emphasized that all education should contribute to the ethical development of their students.

The authors found that science teachers showed a significant understanding of the role of values and ethics in science. They also found that many teachers stated that they kept themselves away from sharing their personal beliefs with students for fear of forcing their individual motives on students. The teachers in this study also reported lack of supporting materials to help them scrutinize some ethical and moral dilemmas when teaching SSI in the science classroom.

There are some weaknesses and strengths in this study. One of these weaknesses
is organizing participants’ responses into separate profiles. Even though such profiles helped to differentiate teachers’ responses and organize their views of SSI, such emphasis on clear-cut views of these issues is hard to be achieved. They could have improved the results if they generated themes instead of such profiles. However, this study has some advantages. One of these advantages is the qualitative method used; as such views and values are hard to be captured using only quantitative methods. In this respect, it should be mentioned that their emphasis of a methodological shift that is based on the results of this study would not be appropriate; as the wide range of views with respect to these issues is subjective and hard to be gained using a survey for example as they suggested, especially with their emphasis that the results of this study are hard to be generalized. However, the results and the questions that have been asked in the interview protocol are significantly important when it comes to investigating Saudi science teachers’ own worldviews and values when teaching these issues in their science classrooms.

**Summary and discussion.** In the context of Saudi science teachers, it is important to take into consideration these different results in the previous studies especially in how these two constructs, science teachers’ knowledge of these issues, and their religious worldviews inform teachers’ thinking and views about many SSI. For example, previous studies have emphasized that science teachers’ knowledge of many SSI influenced their views of many SSI (e.g. Asghar, 2013; Mansour, 2007, 2011; Deniz et al., 2008). It seems like teachers who know more about some SSI were more willing to teach them even if they do not personally believe in them (e.g. Asghar, 2013; Mansour, 2011). However, it is important to investigate not only teachers’ knowledge but also their
worldviews; as misconceptions about many scientific issues is not only related to lack of knowledge about these issues but also to a conflicted non-scientific worldview that people may possess (Martin-Hansen, 2008).

In addition, when it comes to investigating Saudi science worldviews of different SSI, it is important to investigate and take into consideration how teachers from different contexts view such parallels between science and religion. The main reason that justifies such discussion of these varied contexts is that the theological framework used for those studies may be used to some extent with investigating Saudi science teachers’ views of these issues to justify their experiences, especially those related to their religious frameworks. For example, Mansour (2011) believes that one reason for rejecting the theory of evolution in his study, that included Sunni Muslims, was due to the “teleological clash between Darwinian evolution and the Qur’anic verses regarding creation” (p. 296). One Muslim science teacher in his study, Ahmed, criticized the exclusive focus on the scientific aspect of science by saying “These scientists do not believe in the existence of God. That is why there are a lot of contradictions between these discoveries and religion; for example, issues or theories involving cloning and evolution” (Mansour, 2011, p. 296).

These views revealed the authority of Muslim science teachers’ personal Islamic beliefs that “controlled the gaining of new knowledge and experiences” as well as “embraced their beliefs about what science is, what science should be for, what STS they should and should not teach, and how STS should be taught” (Mansour, 2011, pp.1624-1625). Even though some scholars believe that scientific knowledge is a subset of
religious knowledge (Reiss, 2010), it is important to note that science teachers’ views of
science are multifaceted and included various directions especially when it comes to the
influence of their beliefs (Barbour, 2000), which is the case with Saudi science teachers.
Therefore, investigating the reasons that support such views of these issues and the
interrelationship between science teachers’ religious views and their understandings of
some issues may reveal a considerate approach of how aspects influences and interact
within science teachers frame of reference that they use when they teach these
complicated issues.

Moreover, theologically speaking, in his discussion of the interrelationships
between science and religion Barbour, (2000) discussed in detail different models that he
believes explain such relationship. He believes that science and religion are getting in
touch and interact within areas like, genetics, neuroscience, God and nature, evolution
and creationism, astronomy and creation among many other disciplines. Barbour also
believes that the relationship between science and religion occurs through four models:
conflict; where people persist that either science or religion is correct when it comes to
some scientific issues. Such position of the priority of one discipline over the other puts
one of either science or religion in a false position, Barbour thinks. Secondly, Barbour
believes that there is a model of independence where he believes that people may think
that both disciplines are true if each one of them respect the other’s limits and boundaries
that distinguish both disciplines. Barbour thinks that this model would give a space for
those religious people who try to accommodate the new discoveries in science like the
issue of evolution for instance.
The third model is *dialogue* where Barbour thinks that science and religion can reach in common acceptance through continuous dialogue and conversation. Knowledge in this case, Barbour believes, is holistic and both science and religion should interact in such conversations to be able to comprehensively discover it. The fourth and final model is *integrity* where Barbour believes that science and religion reach a position of integration into a wholeness or fullness. The model of integration therefore is the continuous development that follow the model of dialogue, according to Barbour. Even though this model seems promising in resolving some philosophical tensions that occur with some issues, people usually tend to stick to their position of either accepting the religious or the scientific explanation to some issues, which may trigger a conflict between these two disciplines particularly in controversial issues like evolution (Dodick, Dayan, & Orion, 2010).

In fact, Barbour’s four models of the interaction between science and religion seem approachable and easy to understand. However, the depth that lays within some SSI may seem to be hard to be discussed using these straightforward models. For example, talking about the model of integration that Barbour believes, it is important to take into consideration that most sciences in this era are westernized that may constrain or even coerce people from other cultural backgrounds to ignore such sciences. Therefore, Muslims may think that “their beliefs marginalized by such a well-respected institution as modern science” (Edis, 2009, p. 901). In addition, the status quo of modern science that is socially and culturally formulated within a western context may add another conflict to how religiously addressing different issues would be in varied cultures.
around the globe having in mind the fact that science is socially and culturally embedded with the culture of science that is applied in each society (Aikenhead, 2001). For example, Upadhyay, (2010, p. 46) believe that “modern science has no special claims to truth because it is a cultural construct of the west.” Therefore, it is ok to state that certain people have religious worldviews that cannot be reconciled within some SSI understandings (Hanleya, Bennettb & Ratcliffe, 2014).

Therefore, understanding how science and religion are integrating should take into the consideration the lens by which each society consider such relationship. In addition, having in mind that knowledge is constructive, it is not the goal of science nor religion to ignore the influence of humans and the ways by which they come to describe reality surrounding them to explain such integrity between both disciplines (Staver, 2010). Science, therefore, may benefit and need other non-scientific voices, religious voices for instance, to enrich science education practices. (Hsu, 2010).

Moreover, taking into consideration the previous literature, what matters is not only the dialogue that explains how science and religion are integrated or even conflicted but rather is how people come to understand the different aspects that formulate such integration or confliction. For example, Roth (2010, p. 16) believe that dialogue in this case should be understood as a way of overcoming the “inner contradictions that exist in the fullness of life.” Instead, it should help to shrink the distance that prevent people from understanding the common interactions between science and religion (Barbour, 2000)

Therefore, in the case of Saudi science teachers, the previous literature is very
important to reveal how such issues will be viewed within a Saudi science teachers’
context where religion plays a concrete role in people’s lives. Such ideas of the
relationship between science and religion may explain why some Saudi science teachers
stick some views of different SSI. Such investigation, however, requires qualitative
methods for an in-depth understanding to reveal how these different religious and
scientific views regarding many SSI influence and get influenced by Saudi science
teachers’ experiences of addressing many SSI, especially in a Saudi science education
context where these issues are rarely investigated.

**How Teachers Teach SSI?**

The following section contains some teaching strategies that have been used by
science teachers in respect to SSI. Different strategies have been reported and used for
teaching these issues, however, the most common strategies were centered on students’
abilities to articulate and address the issues with less authoritative intervention from the
part of teachers. Such strategies emphasize the need to prepare science teachers to handle
and manage more student-centered teaching strategies in the science classroom.

**Students-Centered Teaching Strategies**

Focusing on students’ abilities to grasp and understand many SSI was one of the
fundamental strategies used to teaching many SSI throughout different research studies.
For example, Oulton et al., (2004) have conducted a study to explore the teachers’
readiness to address controversial issues. In this study, they used a mixed methodology
design including focus groups and a questionnaire. The focused groups comprised of
four groups of teachers. Two primary groups 8 and 7 participants in each, secondary science group with six science teachers from suburban secondary schools, and five secondary geography teachers comprised the last focus group. The authors used an interview protocol and a questionnaire to collect data. First, they designed an interview protocol from the literature based on five constructs: the topic taught, teaching strategies used, principles behind such strategies, progression, and constraints. To analyze the data obtained, they developed an initial analysis based on teachers’ responses and memos. Then they developed a first draft that presented the main themes of the interviews. Two of the researcher read the draft and discussed the final findings.

They discovered that teachers identified multiple controversial topics and used three strategies more often than others. First, they used discussion strategies where they emphasized the central role of students when discussing these issues. They also used role-play to help students investigate issues from multiple perspectives and different angles. Some teachers also saw role-play to help them overcome the controversies embedded in these controversial issues. Other teachers used resource-based strategies where several resources such as videos, the Internet, and other materials were provided to help students investigate the issues individually. Many teachers in this study reported some difficulties especially in managing values of the teacher, class, school and community. They also reported difficulties related to their abilities to stick to the facts of issues. Finally, they reported difficulties in keeping a balance between the materials that should be taught and the different opinions and values of students. The questionnaire later was used to determine how the views presented by the focus groups could be
addressed to a wider population. The authors distributed six hundred copies of the questionnaire to British schools and received 205 copies. The findings of this questionnaire indicated a larger number of secondary school teachers who regularly teach controversial issues more than middle and elementary teachers. Many the teachers in this questionnaire reported role-playing as the main strategy used for teaching these issues. They also reported some difficulties related to the national curriculum and the preparation needed for teaching these issues.

This study revealed many strategies that were used to teaching different controversial issues such as environmental issues. Since these issues involve a lot of controversies, science teachers in this study tended to give more authority to their students by using strategies such as discussion, role-play and resources-based. Another advantage of this study is the wide range of participants who were investigated in the study and the follow-up questionnaire that was used to further emphasizes some of the points mentioned by those participants in the interviews. However, even though the study sample was helpful to get a wide range of views, the authors did not investigate which strategies were used most by each group. This study also would benefit a lot if qualitative methods such as grounded theory or phenomenology were used to investigate those wide and varied views with that varied and wide range of participants.

**Discussion and Argumentation Strategies**

Given the importance of enhancing students’ abilities to understand and clarify their concerns regarding many SSI, different research studies emphasized the importance of teaching SSI using discussion and argumentation strategies that can touch on the
points that concern students the most when it comes to teaching some SSI. For example, Mork (2012) investigated the role of argumentation in science lessons, especially the teacher’s role. He developed his study to investigate two main inquiries: the reasons for teacher intervention in managing the debate and the types of interventions used by science teachers to manage debate. He was the main participant of this study with his class that was comprised of 23 Norwegian middle school students at the age of (14-15 years) in Norway. The author asked students to work through an online information base and two lessons on offline role-play debates around SSI. The role-play was conducted in the shape of TV debates between politicians. Three debated lessons were conducted during each class with 10 to 15 minutes for each debate session. The teacher acted as a moderator where students who did not involve had roles as audiences and can ask and engage in the debate. The teacher in these debates also tried not to intervene in the discussion unless there were some incidents including; a wrong use of concepts, a wrong range of topic, going off track, keeping the order or when the discussion comes to a stop. The teacher in this study emphasized the role of discussion using role-plays procedure to teaching SSI. Moreover, he emphasized that the less frequent use of argumentation in science classes is due to the teachers’ lack strategies of handling debate among students.

Even though the same teacher conducted this study, it was helpful to show the importance of teaching SSI using role-play and discussions. Like Oulton et al., (2004), this study also emphasized the importance of students-centered approaches, especially when addressing controversial issues. However, this study could have been conducted better if it was conducted with another teacher instead of the researcher himself for more
objective analysis to the results of this study.

**Summary and discussion.** The previous studies along with many other studies in different settings and contexts revealed many strategies that have been used to teaching and addressing the science classroom. For example, some teachers used journals to help the student reflect on and discuss such issues in the classroom (Forbes & Davis, 2008). Moreover, Oliveira, Cook & Buck (2011) reported, “Writing anonymous responses using post in or chalk talk regarding these issues would foster more engagement in the discussion without hostile reference to the student behind the idea” It also helps teachers to frame “discussion in terms of respectful and polite student participation” (p. 266). They also emphasized that teachers should take “less authoritative social structure” within the discussion especially when it comes to the most controversial parts of an issue (Oliveira et al., 2011, p. 268).

However, due to the dialectic nature of many of these issues, many science teachers reported that argumentation strategies were successful and worthwhile (Goldston & Kyzer, 2009; Mork, 2012; Oliveira, Cook & Buck, 2011; Oulton, Day, Dillon & Grace, 2004; Taylor, 2013) to facilitate and approach many of the ethical, social, and belief problems embedded within many of these issues. Therefore, there is an emphasis that for a meaningful discussion strategy, science teachers should develop the students’ abilities to be able to take parts in the discussions (Oulton, Day, Dillon & Grace, 2004). For example, Forbes & Davis (2008) found that teachers benefit from students’ real-life examples while discussing these issues.

Additionally, some other researchers emphasized that using argumentation to
teaching SSI, especially the most controversial ones such as evolution and climate change, require teachers to consider two important aspects: 1) the cognitive parts of these issues and 2) the NOS dimension. First. Sullivan et al., (2014) argued that for any strategy to successfully address controversial issues it should “promote learning about the NOS, evidence, and data” (p. 555). Some researchers, therefore, emphasized that using conceptual change models within sessions is suggested as a successful strategy to teaching these issues (Sullivan et al., 2014; Sinatra et al., 2008) as they directly target misconceptions about many of these issues. Teachers, in this context, should have in mind that their students have enough knowledge about the most agreeable aspects of an issue, evolution, for example, then they could go further to discuss the least agreeable ones on informative bases (Oliveira, Cook & Buck, 2011).

Second, providing adequate environment is suggested as another important strategy especially when teaching through argumentation (Mork, 2012; Oliveira, Cook & Buck, 2011). Adequate environment includes giving more attention to the time needed for organizing deep discussion and for preparing the required activities around SSI (Boujoaoude et al., 2011; Hestness et al., 2011; Mansour, 2007; Sadler et al., 2006), in addition to providing the needed materials and curriculum resources for effective teaching to these issues in the science classroom (Forbes & Davis, 2008). Science teachers, in this context, should train and prepare their students for roles to do argumentation sessions such as training students in how to behave in debates, respect each other’s ideas and thoughts, and giving them permission to speak on turn (Mork, 2012; Oliveira, Cook & Buck, 2011).
Due to the controversy embedded in these issues, some teachers showed a need for a frame of reference that is used to justify their discussions of many of these issues. For example, Goldston & Kyzer (2009) reported that teachers in their study used the required textbook for legitimacy and for avoiding the conflict; some others used the curriculum standards to support such teaching (Deniz et al., 2008). Moreover, some other teachers used a list of principle such as: sticking to the facts and discussing the value of the teachers, schools, communities and students from different angles (Oulton, Day, Dillon & Grace, 2004). These strategies were helpful to some extent especially when the discussion of an issue reaches some dilemmas.

Some other teachers reported that they teach the different perspectives of an issue to make a space to the different interpretation available for such an issue. For example, in teaching climate change, some science teachers reported that they have their students “purposely research claims from all voices in the climate dialogue” as it helps students to get and practice critical thinking skill (Sullivan et al., 2014, p. 556). Teaching all voices in respect to these issues seem helpful in getting students ideas and thoughts practiced and valued, but for many reasons, not all teachers seem to be willing to teach in such a way. Yet, this strategy would be helpful to overcome some dilemmas embedded in many of these issues, such as evolution (Asghar, 2013; Moore, 2008).

Therefore, many researchers emphasized that science teachers need to be neutral to be willing to teach both sides of an issue (Asghar, 2013; Oliveira, Cook & Buck, 2011; Sullivan et al., 2014). One of the best ways to describe a science teacher neutral role in teaching these issue is to be “a facilitator” who knows the topic and have enough
knowledge about it but at the same time not “imposing regarding its acceptance by the
novices” (Oliveira, Cook & Buck, 2011, p. 268). Therefore, science teachers should pay
attention to the different interpretations that are involved in many of these issues.

Conclusion

The discussion of science teachers’ views and strategies of teaching SSI is
multifaceted and includes multiple directions. First, there is a clear relationship between
science teachers’ views of these issues and their actual teaching practices of these issues.
For example, many science teachers reported that they would selectively teach the
aspects of evolution that do not contradict their religious beliefs (Asghar, 2013).
Moreover, given the complicated nature of many of these issues, many science teachers
emphasized students-centered strategies (Mork, 2012; Oulton et al., 2004). Moreover,
many researchers reported science teachers’ use of argumentation as one of the most
important strategies for teaching and handling the controversies embedded in many of
these issues (Goldston & Kyzer, 2009; Mork, 2012; Oulton, Day, Dillon & Grace, 2004;
Oliveira, Cook & Buck, 2011). However, such emphasis on argumentation requires more
focus on science teachers’ cognitive, and ability to design the needed environment for
teaching with this such strategy (Mork, 2012; Oliveira, Cook & Buck, 2011; Sullivan et
al., 2014). Therefore, teaching these issues is not only a matter of choosing the
appropriate strategy but also is a matter of preparing science teachers’ cognition
including their societal and religious views, knowledge, and understanding to address
these issues meaningfully.
This literature review would help to investigate the Saudi science teachers’ views of multiple ways. For example, much of the discussion in this literature review focused on secondary school science curriculum and secondary school students where many of these issues are presented and discussed. A thorough discussion of science teachers’ views, therefore, should focus on secondary school teachers. Moreover, the methodology that should be used to investigate science teachers’ views of these issues should not only reveal their views or the connection between such views and other factors but also the reasons behind those views. The domain of very complicated and sometimes involves social, political, and economical dimensions. Therefore, using grounded theory for example to investigate the reasons behind such views would construct a more comprehensive picture when discussing SSI, especially in Saudi Arabia where little has been done about this important dimension of science.

Contextually, the discussion of science teachers’ views of this literature review revealed several dimensions that influenced their views of these issues. These dimensions include; science teachers’ knowledge of SSI (e.g. Sadler et al., 2006; Zeidler, Sadler, Simmons, & Howes, 2005). Another dimension was related to science teachers’ worldviews and values (Hodson, 2014; Sadler et al., 2006; Zeidler, Sadler, Applebaum, & Callahan, 2009). To investigate these dimensions, there was a clear emphasis on some other aspects including science teachers’ views of science as a discipline (Bell and Lederman, 2003; Hodson, 2014; Sadler, Chambers, & Zeidler, 2004; Walker and Zeidler, 2007; Zeidler et al., 2005). However, such emphases seem to lack coherence and depth. For example, rare studies mentioned and highlighted the interrelationships between
science teachers’ views of many SSI and their understanding of these issues or their religious or societal views on their views and teaching of these issues, especially in Muslim contexts. Moreover, understanding how these important constructs influence science teachers’ views should be conducted using in-depth strategies to reveal more accurate views of these interrelationships within Muslim science teachers, which also seems to be missing from the literature and needs to be explored for more deep picture of how Muslim science teachers view different SSI within their contextual understanding of science as a discipline of knowledge.

In addition, even though much of the previous research emphasized a lively relationship between science teachers’ views of the NOS and their views of many SSI, this study will focus mainly on the interrelationship of science teacher’s perceptions and worldviews and the influence of such interrelationships on their views of SSI for a first step. The section of the implications of future studies will explain in detail the importance of understanding and investigating Saudi science teachers’ views of the NOS on their views of many SSI.
CHAPTER IV
METHODOLOGY

The previous literature identified gaps pertaining to the discussion of science teachers’ views and teaching on both the aspects that influence such views and the interrelationships between such aspects on science teachers' views and teaching on these issues. Moreover, there is a clear trend in the literature emphasizing the importance of investigating these issues qualitatively and the need for more qualitative studies to discuss these issues (Mansour, 2008; Boujaoude, Asghar, Wiles, Jaber, Sarieddine & Alters, 2011). There is also an emphasis focused on secondary school teachers as the main participants for most research studies reviewed in the literature review section due to their exposure to real experiences of teaching these issues in the science classroom (Rise & Galvano, 2004; Boujaoude, Asghar, Wiles, Jaber, Sarieddine & Alters, 2011; Asghar, 2013). There is also no single study that was found explain or discuss these issues on a Saudi context. Some of the studies reviewed earlier also revealed the importance of recruiting experienced teachers as they may gain more in-depth experiences and understandings of many SSI (Reis & Galcao, 2004; Mansour, 2007).

Therefore, this study is guided by three questions that take into consideration these different findings from the literature review.

1. In what ways, if any, do Saudi secondary school science teachers view SSI in the Saudi science curriculum?
2. How would Saudi secondary school science teachers describe their views of teaching particular SSI (e.g. Cloning, Evolution, genetic engineering, …)
3. In what ways do Saudi secondary school science teachers describe their strategies of teaching SSI?

Setting and Participants

The population for this research is Saudi Science teachers in the City of Tabuk on the northwestern side of Saudi Arabia. All teachers are Middle Eastern males and Sunni Muslims. No females are sampled due to cultural and social reasons. For example, in Saudi Arabia, it is not acceptable to meet or phone the other gender without a direct relationship. Secondary school teachers were chosen for this study because many SSI appear considerably at the secondary school level (Evagorou, Sadler & Tal, 2011).

Context and Sample Selection

There are 28 secondary school in the city of Tabuk with almost one hundred eighty science teachers who teach different subjects including biology, chemistry, physics, and geology. Initially, twenty-five teachers agreed to participate in this study, however, the final sample included 17 who finished the interviews and helped to saturate the codes of the study. There are some demographic details about the participants in the following table with their pseudonym names.

Table 1:

List of participants with selected demographic data
<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Teaching</th>
<th>Experience</th>
<th>Highest Degree</th>
<th>Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wesam</td>
<td>Biology</td>
<td>6</td>
<td>Bachelor + Education diploma</td>
<td>Microbiology</td>
</tr>
<tr>
<td>Ahmad</td>
<td>Biology</td>
<td>3</td>
<td>Bachelor + Education diploma</td>
<td>General Biology</td>
</tr>
<tr>
<td>Ali</td>
<td>Biology</td>
<td>5</td>
<td>Bachelor + Education diploma</td>
<td>General Biology</td>
</tr>
<tr>
<td>Aid</td>
<td>Biology</td>
<td>3</td>
<td>Bachelor + Education diploma</td>
<td>General Biology</td>
</tr>
<tr>
<td>Salih</td>
<td>Biology</td>
<td>14</td>
<td>Bachelor + Master’s in C&amp;I Science Education</td>
<td>General Biology</td>
</tr>
<tr>
<td>Majed</td>
<td>Biology</td>
<td>7</td>
<td>Bachelor + Education diploma</td>
<td>General Biology</td>
</tr>
<tr>
<td>Hamad</td>
<td>Biology</td>
<td>9</td>
<td>Bachelor + Education diploma</td>
<td>Microbiology</td>
</tr>
<tr>
<td>Muhamnad</td>
<td>Biology</td>
<td>5</td>
<td>Bachelor + Education diploma</td>
<td>General Biology</td>
</tr>
<tr>
<td>Fouad</td>
<td>Physics</td>
<td>6</td>
<td>Bachelor + Education diploma</td>
<td>General Physics</td>
</tr>
<tr>
<td>Saeed</td>
<td>Biology</td>
<td>6</td>
<td>Bachelor + Education diploma</td>
<td>General Biology</td>
</tr>
</tbody>
</table>
In addition, with almost one million residents in the city of Tabuk, where this study was conducted, there are more than 86% live in suburban districts and less than 14% in rural districts (Amanah of Tabuk, 2016). The participants represented different secondary schools in varied districts in the city of Tabuk. Nine schools are considered suburban schools because they are inside the suburban arena of the city of Tabuk (Aamanh of Tabuk, 2016). In addition, one of these suburban schools was private school which was represented by Salih who is a biology teacher with a master’s degree in curriculum and instruction.
The remaining schools were public schools. Some of these schools included more than one teacher like secondary school A that was represented by two physics teachers: Jawad and Saqr, as well as two biology teachers Aaty and Aid. School B was represented by a chemistry teacher (Habbeb) and two biology teachers Saeed and Wesam. Secondary school C also was represented by two teachers: Ahmad as a biology teacher and Fuad who is a physics teacher. School D was represented by two biology teachers: Freed and Malik.

The remaining participants were the only participants representing their schools. For example, Shaher, a biology teacher, represented School E. Ali, another biology teacher, represented secondary school F. Majed, a biology teacher, represented secondary school G. Muhannad who was also a biology teacher represented school H. Finally, Hamad, a biology teacher, represented the only rural school in this study, which is secondary school I.

In addition, the researcher tried to get more statistic data from different sources for more contextual understanding of these schools. For example, he tried to get information through the General Authority for Statistics of the Kingdom of Saudi Arabia; a department responsible for all statistical data of the Saudi government, the center of suburban development in the city of Tabuk, and the department of education in the city of Tabuk. However, no source was found to explain in more detail the contextual background for each school setting and teachers’ preparation and training programs for the participants in this study.

Process of Recruiting
The process of recruiting participants included several stages. First, this study recruited teachers who spent at least two years in teaching science courses because I believed that two years would give science teachers more experiences in dealing with and teaching different SSI. Second, a written request with detailed information about the goals, purpose and the requirements needed for this study was sent to the department of education in the city of Tabuk. This study excluded some science teachers who do not actually teach science courses, for example, those who do other work in schools such as working as principals or as other staff members. The department of education sent the request to the division of planning and education for validating the needed details about this study. This validation process includes everything relevant to this study like; the time framework, potential and needed number of participants, the purpose of the study, how to collect and analyze data and the methods used for this purpose. Later, after validating these details, the division of planning and education sent this request to the division of science education in the department of education.

Once this request was received by the division of science education, they contacted me for discussing the participants’ recruitment. The participants were then given notice by the division of science, through three science supervisors, as well as through individual requests that were designed to recruit them. These requests included details about the study like the title, purpose, and the goals of conducting this study, as well as the time framework needed to finish the interviews and the potential for follow-up interviews with some participants. After getting these requests back, several phone calls were arranged with some participants who agreed to participate in this study. Throughout
these phone calls, there was a clear explanation of the points that were mentioned in the written requests for much assurance that those teachers understand the nature of this study. These phone calls also included further details about this study and inform the participants of the different phases of data collection that include the first round of interviews to generally understand their views about these issues and some follow-up interviews with some participants to elaborate more on their views and teaching strategies of some issues. (see Appendix H for more demographic information about the participants)

**Data Sources & Collection**

This study was conducted through the department of education in the city of Tabuk at the northwestern part of Saudi Arabia in the summer of 2016. Some major points were considered before conducting the study. For example, the participants were reminded that their responses were the most important dimension and the given questions are not testing their knowledge about some issues. In addition, since some questions of this protocol are open-ended, respondents were asked and encouraged to provide as complete and as clear answers as possible. Moreover, respondents were reminded that there is no wrong or right answer to these questions and all is needed is their thoughts and points of views of the issues being discussed in each question.

In this research, an interview protocol was designed to investigate Saudi science teachers’ views and teaching strategies of SSI. Specifically, this protocol aimed at (a) discovering participants’ experiences and understandings of their views of SSI as science
teachers in Saudi Arabia, (b) understanding reasons that contributed to their views and teaching of these issues. To address these two aspects, this protocol was divided into two sections. First, this protocol included general ideas about how those teachers view the Saudi science curriculum, the discipline of SSI within science education, and some other aspects they believe influence their views of these issues including religion and society. The questions that were included in this section included general ideas about how they would see themselves as science teachers, how they would view the controversy embedded in some issues, as well as some ideas about the most important issues they used to teach. The second section of the protocol was designed to investigate in-depth some issues with some teachers to reveal how those teachers would view and teach them. All teachers finished these two sections except Saqr who preferred to finish only the first section.

The process of recruiting participants was conducted using purposeful interviews with some science teachers (Charmaz, 2014), to investigate how would they view these issues in general. The interviews lasted between 60 to 90 minutes however based on the nature of this study, that allows some freedom of the part of participants to respond as they feel ready using WhatsApp chat service, some extra time was given to some respondents to cover the depth of some questions in the interview protocol. Additionally, conducting the interviews was done in Arabic, the first language of the researcher and of the participants. These interviews were conducted using phone calls and some applications like WhatsApp. Through WhatsApp, respondents were given the choice to respond to the questions given to them through safe and secure measures using
WhatsApp end to end encryption that means neither WhatsApp nor any third party can read or listen to the discussion between the individuals, which assured security, safe and free chatting during the interviewing process. During the interviews, some techniques were used like memo writing as a source of data to capture some potential themes and directions. In this context, there was a memo bank throughout the interviewing process that has been used excessively during data analysis as a framework for better analytical understanding during the data collection phase (Charmaz, 2014). Moreover, during each interview session some specific procedures, that were suggested by Charmaz (2014), were applied to ensure more engagement and full understanding of the responses. For example, there was no interruption during interviews especially when they send their responses. Being a good listener helped the respondents to express their views openly and candidly. However, there was some interruption during some interview, especially when the direction of the responses shifted from the paths designed or when there was a need for more explanations to some points that needed more clarity. There was not any intention to correct their responses or take an authoritative standpoint over their responses but to have a more understanding of their views. Interviews were flexible to allow for space when some unanticipated issues come up.

**WhatsApp Chat Service**

Using WhatsApp chat service as the main procedure to collect data helped to structure a needed space efficiently for those teachers to express their ideas and thoughts freely. Specifically, it allowed teachers to (a) respond to the questions raised in their
comfortable time during day or night (b) obtain more in-depth ideas and information from teachers as they respond when they feel like they are ready. Moreover, in some interviews, not all the questions were asked as some participants already answered those questions during previous responses.

Clearly, using WhatsApp oral service provided the appropriate way to conduct the interviews freely and properly. For example, after receiving the first participant’s reply, that was profound and heavy, it was important to allocate a few days to discuss the different points that were mentioned by that participant. Explicitly, that time was important to better understand the memos and the potential codes and themes that were emerging and for better understanding of how to conduct and proceed with the following interviews with the rest of participants. There was a great emphasis during the interviewing process to focus on how would a participant “acts on ideas, practices, and worldview from the larger and local cultures of which he is a part” (Charmaz, 2014, p. 54) to clearly understand how does he situate himself within these different understandings in respect to science education. Using WhatsApp provided such an environment that allowed for more profundity and depth to be freely received from all the participants, which was very important for this type of study.

The Interview Protocol

The interview protocol was designed around three main constructs that are based on three questions of this study. Initially, the first construct investigated how and in what ways Saudi science teachers’ view the nature of these issues in the Saudi science
education system. However, before proceeding to this section there were some initial questions to understand how would Saudi science teachers situate themselves within the large spectrum of science education. After this round of questions, there were other questions that aimed to integrate those teachers to the nature of this study. investigating these aspects of Saudi science teachers was important to understand how those teachers understand some other dimensions that influence the understanding of science as a discipline and how would they situate themselves around such understandings.

The following sections of the interview protocol focused more on Saudi science teachers’ views of some SSI. Different questions were asked to generate participants’ responses about this aspect. The main goal of these questions was to have Saudi science teacher tell their ideas about SSI in general. This section of the first round of the interviews was important to initiate an understanding to the second and third rounds of the interviews that got those responses and built on them the proceeding questions around the main issues that have been mentioned by some of the participants.

Therefore, the second section was used to understand how Saudi science viewed the teaching of some specific SSI. These issues included Cloning and genetic engineering among many others. Some questions were asked during the interviewing process to investigate this dimension. Finally, the third construct investigated how Saudi science teachers teach these issues. (See appendix L for the full list of questions).

Moreover, due to the complexity involved in these issues, an intensive interviewing approach has been used (Charmaz, 2014). Charmaz (2014) recommends intensive interviewing in grounded theory because, “both grounded theory and intensive
interviewing are open-ended yet directed, shaped yet emergent, and paced yet unrestricted” (p. 85). Charmaz (2014, p. 56) provided some considerable points to prepare for intensive interviews:

1. Selection of research participants who have first-hand experience that fits the research topic.
2. In-depth exploration of participants’ experiences and situations.
3. Reliance on open-ended questions.
4. Emphasis on understanding the research participants’ perspectives, meanings, and experiences.
5. Practice of following up on unanticipated areas of inquiry, hints, and implicit views and accounts of actions.

Intensive interviewing, therefore, was conducted at the beginning of the research due to the need to generating an initial understanding of the directions that may emerge from the first interviews. Especially with more focus on responses from participants like Salih, Muhannad, Hamad, Jawad. These four participants provided thorough views of most questions in this interview protocol. For example, Salih’s transcripts exceeded 30 pages. These five points, however, were considered substantially, especially as the investigation itself proceeded and kept changing (Charmaz, 2014). After getting a sense of some emergent themes, a constructivist-interviewing practices were applied to build up in some directions that may emerge from these first intensive interviews. In this respect, Charmaz (2014) sees interviews as, “sites of exploration, emergent understandings, legitimation of identity, and validation of experience” (p. 91). For this purpose, and to
get more sense of the data that have been gathered, collecting notes and analyzing them were conducted simultaneously. Based on Charmaz’s experience she emphasized that the researcher should make sure that using only notes is not proper because it would lead the researcher to move quickly to the abstract theoretical concepts and lose the power of rich details that would expand and enliven the abstraction (Charmaz, 2014). Therefore, it was important to keep a balance between these two important constructs through using real examples from data to support the emerging notes and memos. In this context, I may have a better chance to back up these initial notes with a rich description of Saudi science teachers’ experiences of SSI in science education. This method helped to get instant views of how and where the data is leading the emerging themes.

Table 2:

Planning matrix for phases of data collection

<table>
<thead>
<tr>
<th>Construct</th>
<th>Research Question</th>
<th>Why Is It Necessary To Know This?</th>
<th>Kind of Data</th>
<th>What Is the Source of Data?</th>
<th>Timelines For Acquisition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Views of SSI</td>
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<td>To investigate Saudi science teachers’ views including their acceptance, perspectives and their opinions of the importance of these issues.</td>
<td>Interview protocol</td>
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**Data Analysis**

Using constructive grounded theory as a method for this study was important to reveal in-depth views and teaching strategies of SSI among Saudi science teachers.

Analyzing this study using this method included specific understandings and procedures. For example, the analysis part of this study was not separated from other sections of this study as in grounded theory the analysis is neither preconceived nor discovered but rather is constructively “inductive, comparative, interactive, and iterative and later deductive” (Charmaz, 2012, p. 4). Therefore, this study tried to connect all the aspects and the different stages of this study together for more accuracy to the themes and findings that emerged.

**Grounded Theory Processes**

Conducting this study using grounded theory as a method of analysis requires
some specific processes that need to be addressed for better application to this method. For example, data collection and data analysis were one entity; where analyzing data is simultaneously connected to the data being collected. Charamaz (2014, p. 120) stressed, “grounded theorists aim to code for possibilities suggested by the data rather than ensuring complete accuracy of the data.” In this study, therefore, it was important to look for reasons and potential shifts that supported participants’ thoughts and ideas that constitute participants’ views to be able to choose the appropriate codes that fulfill the emergent themes.

**Coding processes.** Coding represents one of the main procedures in grounded theory. Charmaz (2014) stressed that coding helps the researcher “to think about the material in new ways that may differ from … the research participants’ interpretations” (p. 133). Three sorts of coding were used in this analysis including; initial, focused, and theoretical coding. First, initial coding was important guidance towards the analytical directions of grounded theory research (Chramaz, 2014). This method helped the analysis to look for how Saudi science teachers in this study conceive these issues in science education and the influences that may direct such conceptions to organize their responses accordingly. It also assisted the investigate to focus on some specific directions in the coding phase; for example, the influence of Saudi science teachers’ Islamic conceptions, on their understanding of science and therefore their acceptance of teaching some controversial issues in their classrooms. Generating some insights at the beginning of this research helped to reveal specific directions to possible developments of analysis in this study.
**Focused coding.** Focused coding is the phase that follows initial coding. In this phase, there was a greater emphasis on understanding and investigate deeply the initial directions that emerged from the initial coding. These initial guidelines helped the analysis to focus future interviews on investigating these specific directions through a theoretical sampling procedure (Charmaz, 2014). For this purpose, this study used some questions that were suggested by (Charmaz, 2014) and applied them to decide which codes could serve as focused codes:

- What do you see when you compare your initial codes with data?
- In which ways your initial codes reveal patterns?
- What does your comparison between codes indicate?
- Do your codes reveal gaps in the data?

Using these questions as guidelines helped also the study to assure the commonality and harmony among the codes under construction.

**Theoretical coding.** The third phase of coding was theoretical coding, which is the phase of coding that follows focused coding. This stage of coding was important to define the relationships among the categories that emerged from focused coding. Even though the coding procedures seem consecutive, Charmaz (2014) emphasized that coding procedures are connected constructively. These procedures interact as a process by which all sorts of coding steps assist the researcher to reach a sort of theoretical sensitivity to the data being gathered.

In this direction, grounded theory as a method for analysis considers theoretical sensitivity a major procedure in this methodology (Charmaz, 2006, 2014; Holton, 2007;
Hood, 2007), which is “the ability to understand and define phenomena in abstract terms and to demonstrate abstract relationships between studied phenomena” (Charmaz, 2014, p. 161). This procedure supported the investigator to turn himself into the data being studied. For example, it helped to avoid some of the investigator’s subjective influences by trying to turn himself into the participants’ worldviews using more abstract language. To do so, the investigator applied Charmaz’s (2014) understanding to this point through looking “at studied life from multiple vantage points, make comparisons, follow leads, and build on ideas” (p. 244). To gain this level of neutrality, the investigator used some strategies included: investigating the relationships between incidents, reconstructing these relationships and accepting different directions with data and be open-minded to the directions of the categories (Charmaz, 2014). For example, Salih shared his ideas about how science is poorly conceived in Saudi Arabia, which made the inclusion of different SSI even harder. He described how hard was it to convince people of the validity of many SSI as they are still conceiving literacy and religious studies and considered them essential for the growth of their children. Similarly, Jawad, Muhannad and other participants shared similar ideas about this important societal aspect when addressing SSI in the Saudi science curriculum. Even though these ideas were not similar, I could interrelate these experiences of teaching some SSI together and focus more on many societal aspects and how were then essential to understand the nature of SSI in the Saudi science curriculum in both how teachers view and teach many of them in SSI. Using these procedures helped the study so much, especially in using more accurate language when analyzing the participants’ interviews.
**Theoretical sampling.** Theoretical sampling is another term in the phase of data analysis. In theoretical sampling, I have a space to reevaluate the directions of the data analysis. In this respect, Charamz (2012) recommends seeing where the initial coding drives the researcher because “they may spark new ideas and may make connections that had been implicit or invisible” (p. 8). She also stressed, “theoretical sampling means seeking pertinent data to develop your emerging theory. Thus, the main purpose of theoretical sampling is to elaborate and refine the categories constituting your theory” (Charmaz, 2014, p. 197). In this sense, theoretical sampling is the power that governs the direction and the flow of the initial coding. In this context, I used the initial coding as a starting point to control the direction of the investigation until I get to a point of saturation to that direction.

**Saturation.** Saturation is the third aspect of data analysis and it is the point where more data make no difference in the emergent themes. Charmaz (2014) emphasized, “categories are saturated when gathering fresh data no longer sparks new theoretical insights, nor reveal new properties of these core theoretical categories” (p. 213). In this respect, I made sure that I use theoretical sampling to fill out the emergent concepts of, not look for commonalities or shared experiences among individuals. Charmaz (2014, p. 214) provides some questions that may help me apply saturation more accurately:

1. Which comparisons do you make between data within and between categories?
2. What sense do you make of these comparisons?
3. Where do they lead you?
4. How do your comparisons illuminate your theoretical categories?

5. In what other directions, if any, do they take you?

6. What new conceptual relationships, if any, might you see?

Grounded theory is best conceived as an interconnected process where every part influences and get influenced by others simultaneously. Therefore, I used some strategies to assure more accuracy of data analysis. For example, memo writing represented an important task that revealed some insights on the directions of the concepts being investigated. Charmaz (2014) stressed, “Memo-writing encourages ‘the researcher’ to stop, focus, take codes and data apart, compare them, and define the link between them” (p. 164). Taking memos, therefore, was crucial especially in grounded theory as the emergent data were so vast and included many directions. Charmaz (2014, p. 170) identified some memos strategies that would help a grounded theorist organize his memos:

1. Trace and categorize data subsumed by your topic.

2. Describe how your category emerges and changes.

3. Identify the beliefs and assumptions that support it.

4. Place the category or categories within an argument.

5. Sharpen your comparisons.

I, therefore, used these questions to look for emergent themes that could illustrate how Saudi science teachers’ knowledge of these issues, and their worldviews describe their views and teaching strategies of SSI in the Saudi science classroom.
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<td>Views of Teaching Particular SSI</td>
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Why Constructivist Grounded Theory?

Using constructive grounded theory is significant to reveal how Saudi science teachers elaborate on their views and teaching strategies of SSI in science education. On the one hand, due to the superiority of their Islamic religious beliefs, Saudi science teachers would understand science as inferior comparing to religion and to their Qur’anic instructions (Mansour, 2011). This understanding may “create a false contradiction between Islam and science” (Mansour, 2010, p. 138); which may lead to different conceptions influenced by their ontological understandings. Therefore, some Saudi science teachers, who hold such views, would create a gap between their interpretations and epistemologies related to religion and their epistemologies and understandings of science as a discipline. Moreover, science teachers’ knowledge of SSI would not be enough to support positive views of these issues as those teachers may adhere the aspects of science that do not contradict their beliefs (Mansour, 2007; Asghar, 2013; Moore, 2008). Therefore, since it is very hard to teach value free science instruction (Zeidler & Nicholas, 2009), Saudi science teachers would experience and practice these religious beliefs differently where some teachers might internalize and practice stronger beliefs than others (Sadler et al., 2006; Asghar, 2013). It is important, therefore, to study their views in context where Saudi science teachers have space to freely share their beliefs and discuss the influence of these beliefs on their practices of teaching their science classrooms.

On the other hand, in constructivist grounded theory, grounded theorists deal with phenomenon in context (Charmaz, 2000, 2006, 2014) that assumes “multiple realities”, as
well as “mutual construction of data through interaction” (Morse, Stern, Corbin, Bowers & Clarke, 2009, p. 141). Therefore, Constructivist grounded theory would help to contextualize and illustrate these different sorts of interpretations and interactions between science teachers’ ontological and epistemological understandings on one hand to their views and teaching practices of SSI on the other. In addition, constructivist grounded theory would help to contextually inform more accurate picture for such interaction between these constructs. In this point, Charmaz (2014) stressed, “constructivist grounded theory places priority on the studied phenomenon and sees both data and analysis as created from shared experiences and relationships with participants” (p. 239). Thus, studying these complicated interactions between what Saudi Science teachers believe ontologically and their actual epistemological ways of understanding life and therefore science surrounding them and connecting such understandings to their views and teaching practices of SSI needs thorough and comprehensive methodology, which is the case with constructive grounded theory.

Moreover, Science curriculum applies specific understandings of science that emerge from certain realities and understandings of the role of science in the education system. In such a situation, Saudi science teachers would develop normative behaviors that should be compatible with these requirements of the science curriculum. Analyzing their teaching strategies of SSI thus requires understanding to how science curriculum infused such views of science on them. Based on this premise, “the respective theories seeking to capture this reality need to convey not just a state of being, but the process of its evolution as well” (Strubing, 2007, p. 10). In addition, constructivist grounded theory
adheres to mutual, iterative and constructivist means of collecting and analyzing data (Charmaz, 2006, 2014); which may help to construct more accurate pictures of science teaching practices based on their experiences and understandings of science to capture this reality. These ways of investigation are important to explain and develop an understanding that takes in consideration Saudi science teachers’ epistemic justifications and explains why they adhere to some realities of science over others. In doing this comprehensive understanding of how Saudi science teachers teach in certain ways, grounded theorists analyze these practices holistically and comprehensively to reveal what aspects contributed to their views and teaching practices of science education.

The Saudi science teachers’ internal dispositions to teaching science along with the objective conditions applied by the Saudi science curriculum from a specific environment of teaching science in Saudi Arabia. However, as Bourdieu (1984, 2008) claims, this relationship between peoples’ dispositions and these objective conditions of a field is not static but rather is changing and revising to include new perspectives and points of views. One important aspect of enlarging the scope of accepting new views of the field of science curriculum is via investigating what factors influenced science teachers’ knowledge of science. Cultural capital in this respect, or science teachers’ sources of scientific knowledge, like newspapers, media, books, or other sources of information would enhance different directions regarding these issues. Therefore, cultural capital represents another considerable asset to inform the researcher of the framework that supports science teachers’ understanding of these issues and their importance in the domain of science especially if there is no such support for these issues.
especially in the Saudi science curriculum (Burton, 2010).

Therefore, an understanding of Saudi science teachers’ views of their teaching strategies, requires contextual and comprehensive methodologies, which is the case with constructivist grounded theory. The nature of grounded theory supports such deep analysis to individuals’ contextual understanding of the phenomenon under investigation because, in grounded theory, the creation of a theory “necessitates that an idea is explored fully and considered from many different angles or perspectives” (Corbin & Staruss, 2008, p. 57). This contextual understanding set the boundaries that help to define the factors that explain and develop an understanding of science teachers’ views and practices when dealing with these controversial issues in the Saudi science education field.

Moreover, teaching such issues in the science curriculum requires deep analysis to the powers that construct and control science curriculum in Saudi Arabia. On the one hand, understanding Saudi science teachers’ views of the powers that control the school science in Saudi Arabia would reveal significant insights, especially in why, if any, do not they include and talk about these issues in their classrooms? In this aspect, constructivist grounded theory analyzes powers that control the construction of meanings in a social space from different angles. For example, individuals have their own understanding of how power in such a society is practiced and applied. Each science teacher should situate himself in a position where he adapts positively to the norms of the power matrix in the science curriculum. Some of these positions developed unconsciously as taken for granted way (Bourdieu, 1977). However, in constructivist
grounded theory the researcher examines these worldviews within science teachers in a more constructivist way through a *conceptual abstraction* (Holton, 2007) to conceptualize science teachers’ understandings not only describe them. Holton (2007) argues, “A grounded theory must offer a conceptually abstract explanation for a latent pattern or behavior (an issue or concern) in the social setting. It must explain, not merely describe, what is happening in a social study” (p. 272). Therefore, conceptual abstraction helps to see the society as scripts (Holton, 2007); which helps to investigate how power is practiced on science teachers and the ways by which they deal with such powers in their teaching practices.

Therefore, using constructivist grounded theory to investigate Saudi science teachers’ views of science and on selected SSI seems well matched. First, this method would reveal significant insights on how science curriculum, for instance, influenced science teachers’ objective views of science and therefore influenced such relative understanding of teaching science. Second, constructivist grounded theory would develop such a considerable analysis to science teachers’ views of teaching these issues, especially with the complexities and controversies involved in them. Therefore, using a constructivist grounded theory to investigate Saudi science teachers’ views and teaching strategies of significant insights that may reveal how Saudi science teachers’ views of science explain their understanding of it as a human endeavor, and the importance of enhancing the scientific literacy of people in Saudi Arabia, that is not only content knowledge is delivered to their students.
Trustworthiness and Limitations

The researcher has nine years of experience in teaching science in different schools in Saudi Arabia. This experience gave him insights into the nature of teaching science in the Saudi science classroom. The researcher also holds strong views of how science should function in the Saudi society. For example, throughout his nine years of teaching, the researcher was only required to deliver the content knowledge to his students and nothing else. This confined freedom of teaching science delimited the potential of understanding science as a human endeavor. These views of the researcher would influence the emergent theory of this research. However, the researcher used some strategies to help assure the trustworthiness of this study.

For example, a considerable part of constructivist grounded theory is that the emergence of the theory is through mutual, co-construction of data (Charmaz, 2014). Therefore, procedures like member checking (Creswell, 2014) was used to assure genuine representation of participants’ views during the interviews and analysis of their views. This procedure helped to assure the validity and credibility of this research by asking some participants to read their responses to the transcripts of their interviews to assure more accurate representation of their thoughts. Moreover, through the analysis phase, I shared emerging categories and codes with some participants to ask for their opinions about these categories to come up with a consensus of these emergent categories.

Additionally, comparative analysis procedure was used to assure more validity of this methodology (Charmaz, 2014). In this procedure, I compared emerging themes with
raw data to make sure that these emerging themes can make considerable theoretical explanations to different incidents in the data. To assure reliability, I used peer reviews for more triangulation views (Creswell, 2014; Thurmond, 2001) where I asked for the help of a colleague of mine that speaks both languages (Arabic, the first language of the researcher and of the participants, and English) during the phase of data collection.

Specifically, this colleague revised four transcripts at the beginning of data collection. These transcripts were already coded and the colleague was asked to make sure that what I coded was reflecting the ideas that are generated by the participants. This colleague helped me to focus more on some prompts during questioning for more accurate views about emerging codes and themes. He also helped to assure that the questions are clear enough and easy to understand. He also helped me to assure that the codes that I am gathering and focusing on are appropriate and represent the transcripts and participants’ ideas. Other reflexive strategies were used, especially through going back and forth through the data, notes, and memos that I gathered to assure more accuracy of the data being gathered.

One of the major threats of this study was mortality or withdrawing from the study, especially that some teachers did not finish the questions or even answered only one or two questions and then asked for quitting, having in mind that WhatsApp chatting service was used during data collection where some participants did not finish their questions or took so much time to respond to the questions that I asked. To solve this, I tried to make sure that I discuss the process and nature of the study clearly with each participant. I informed the teachers that we need to find the most appropriate times for
interviews if needed. However, I understood their decision of withdrawing from the study when they told me. To make sure that Instrumentation is not making any threat to the internal validity I spent considerable time explaining the questions that might be ambiguous or not clear enough individually and with the reviewer who helped me to add some prompts to some questions. Such prompts helped so much to assure full understanding of each question.
CHAPTER V

FINDINGS

Introduction

The purpose of this qualitative study was to investigate how and in what ways Saudi science teachers view and teach SSI. Research questions and the follow semi-structured interviews tried to investigate how those teachers view these issues as within the Saudi science education system. They expressed different views on some issues including cloning, stem cells, evolution and genetic engineering. They also reported different teaching strategies of teaching these issues. To address these dimensions a constructivist grounded theory method was used. In this chapter, there will be a discussion of emergent themes that were based on the data gathered from Saudi science teachers.

Question 1. In What Ways, if any, Do Saudi Secondary School Science Teachers View SSI in the Saudi Science Curriculum?

The findings of the first question will be organized into themes that were generated from teachers’ responses to the interview protocol. The analysis of the data has produced themes that include: SSI and Saudi science teachers, growing views of SSI. These themes formed a foundation to understand how and in what ways Saudi science teachers view and teach these issues in their science classrooms.

SSI and Saudi Science Teachers

Saudi teachers in this study revealed varied and different views of how they see
themselves as science teachers. Many teachers expressed their happiness to deliver sciences to their students and be the reason for expanding students’ views of science. During the interviews, there were some questions that aimed to investigate this dimension including, how do you see yourself as a science teacher? Why? What is science to you as a person? How do you see science as a way of knowing, within the different domains and dimensions that influence it? What is your frame of reference of teaching science? Why? Answers to these questions revealed different views of how Saudi science teachers situate themselves within the domain of science. Especially, to understand how Saudi science teachers view other aspects of science like the humane, how science is situated within people's perceptions and needs, part that is very important to situate their understanding of the value of some SSI.

Science is attractive. Many teachers expressed how science is a lovely and engaging topic. With all different new discoveries in science that supported and modified peoples’ lives in all direction, Saudi teachers felt the need for this subject and the importance of their role as teachers of this important subject, which supported their appreciation of being in such a position. Some of their appreciation and love of science was also delivered to their students as many teachers emphasized the important of changing the current negative view of science among their students and helping them to understand science in different and varied ways.

Science is a renewed and important topic. Several teachers described how science is an attractive and lovely topic. For example, Hamad, who is a taught biology for nine years, said, “I honestly find myself in science and particularly in biology due to
my love of science in general and biology in particular, … I continued to develop myself and improve my abilities through taking specific courses for that purpose.” This teacher is an example of how love to science leads to more interest in this subject. Similarly, Jawad, a physics teacher, saw science enjoyable topic that gives teachers more enthusiasm to learn and enjoy learning the new things and discoveries of science. He said, “I see myself as a student who still learns, science is much fun and we have, as teachers, to enjoy this subject.” Many Saudi teachers emphasized the importance of this topic to the development of their country. Majed, who taught biology courses for 7 years, also expressed his excitement and enjoyment of being a science teacher. He said, “I find joy and fun in teaching my subject… biology… I enjoy teaching biology and connecting it to students’ religious aspect… it is really fun.” Such passion for science was one of the pushes that increased many teachers’ love and interest of this discipline, especially in the Saudi society where there is more focus on religious and literacy subjects as will be seen later in this analysis of the findings.

Moreover, throughout their teaching experiences, many teachers expressed how science textbooks in all secondary school grades do not provide enough information and details about the topics being discussed. For example, Freed, who is a biology teacher for 10 years, highlighted how he is so passionate about science topics and love to know more about the new topics in science. He believes that science is among those topics that encourage teachers to look for new things all the time. He said, “I love science… I love to know more about science… even though I can say that I have a lot of information and I feel that I am well prepared as a science teacher, still I read a lot and try to connect what I
read to our society.” Freed is one example of many teachers who felt like such passion and love to know more about different science topics, among which were many SSI, gave more in-depth knowledge about the different topics they discuss in their actual teaching practices.

Another reason highlighted and supported this lovely relationship between science teachers and science as a discipline was apparent with most of the teachers who were proud to be in a position of delivering and teaching a topic of this era. They mentioned how science is almost connected to every aspect of people’s lives. Science was a topic where teachers find and prove themselves, especially delivering a renewed and important topic to their students. Shaher, another biology teacher who taught this subject for 4 years, said, “as a science teacher I feel proud as science is among those topics that gives you extent and breadth … and I am very proud to be a science teacher as I find myself obligated to read more and be versed in, knowledgeable, renewed and open minded with up to date developments in science to be an effective science teacher.” To Shaher, science is a renewed topic, which requires teachers to be knowledgeable with up to date science information to be considered a capable science teacher. In addition, like Freed, Shaher believes that his love of science as a topic was a great stimulus to read more and be more interested in learning more about science.

_Have students to be connected to science._ In addition to the love of science as a discipline, many teachers expressed how important it is to make students love science. They criticized how science is poorly introduced in the science curriculum and felt that there is a need to change these views through supporting and helping students see science
in different ways. Muhannad, another biology teacher, said:

As a science teacher, I find myself obligated to make students love science through clarifying how science has improved the lives of people… as a science teacher I feel like my task is not only delivering the subject matter as is but rather trying to connect what students learn to their actual lives to show them that we do not study abstract knowledge but the knowledge that is practiced and applied most of the time.

Muhannad emphasis on the applicable parts of science and the benefits of science on students’ lives was one of the drives that make students love science and be more connected to it.

Some other teachers emphasized that science should be introduced and treated differently to help students see the value of this discipline on their lives and therefore be more enthusiastic to learn and love science. Those teachers emphasized that dimension to help students get this enthusiasm and love to science as well as realize the importance of the new developments in science there is a need to introduce it in an amusing and enjoyable way. For example, Aid, who taught biology for 3 years, thinks that students can view science differently if science is introduced productively to them. He emphasized, “Our students love to learn anything… but when they love it… Science is still conceived unwell and in a very dense approach… We are not introducing science in a funny and enjoyable way to help students get more connected to science and increase their willingness to learn it.” Aid thinks that science is still introduced in a very solid and stable state. He believes that is one of the reasons that may decrease students’
willingness to study and focus on science studies.

Comparably, Salih, who earned his master’s degree in curriculum and instruction and taught biology subjects for 14 years as well as teaches in a private school, which is the only private school in this study, emphasized the importance of making students love science by saying, “As a science teacher I find myself obligated to reflect this importance to my students … I think science has to be practiced differently in all directions, especially to emphasize scientific method as a pattern of thinking among students and within the society.” Salih is stressing how it is important to understand that science should not be just knowledge passed to students, like any other discipline, but rather he highlights the importance of understanding science as to be a way of living through applying science and its ways of knowing into people’s lives. Many teachers think that such transformation to how students perceive science would make them more connected to this discipline and its ways of knowing and reflect more scientific understanding into their own lives. Similarly, Shaher, a biology teacher, highlighted that students need to see the value of science in their own lives. He criticized the way by which science teachers deliver their teaching by saying:

Teachers are the main reason for not making students appreciate science… they only deliver their lessons and go away without even trying to understand if students accept or reject these issues being discussed. Students’ own opinions are not a priority for those teachers. You know students in this age would find it hard to understand and connect some scientific topics… teachers need to fill this role and try not to force students to learn things hardly.
Shaher believes that teachers need to have students love science through focusing on how science is connected to students’ own lives. However, he believes that many science teachers do not understand their role as main figures for constructing this passion into students own understanding of science and its value to their lives.

**Science connections and contributions.** Many teachers saw different connections and contributions of science to different disciplines and aspects of peoples’ lives. They expressed how science is deeply rooted into people’s lives in different and varied ways. Although the connection to life was mostly mentioned by teachers, some other connections to other disciplines like religion, math and within different sciences were heavily mentioned as well. These connections supported Saudi science teachers’ views of how they see themselves as science teachers in different ways.

**Science connections.** Almost all teachers in this study reported that science cannot be excluded from other disciplines like religion, math, and social studies. Connections with other disciplines were seen essential for contextually understand science within society. For example, Habbeb, who taught chemistry for 8 years, emphasized how science understanding is influenced by different subjects. He said, “Personally I believe that science is usually versed with different subjects like physics, chemistry, biology, geology, math, and English… in addition, you can say that everything we study in science is connected to life in a way or another.” Habbeb’s emphasis on how science is connected to other disciplines like math and English signifies how important a contextual understanding of science is. Habbeb who continued to discuss his understanding of the connections of science to other disciplines throughout his interview
had taken to heart a contextual understanding of science that should benefit the Saudi society and solve the problems that Saudis face, however with good attention to people’s values and ethics. Embracing this understanding was also significant throughout different interviews with many teachers. For example, like Shaher who reported that he is proud to be a science teacher, Malik, a teacher of biology for 8 years, emphasized this honor and added, “As a biology teacher I see myself in the most priority position… I am so proud of being a biology teacher… It is a purely scientific subject that has either a very destructive or constructive influence on people’s lives.” Part of Malik’s perception of biology is his belief that science may destruct people’s lives and at the same time may contribute to the advancement of them, which signifies his understanding of a mutational relationship between people and science.

Many other teachers from different disciplines like Salih, Wesam who are biology teachers, Saqr a physics teacher, Habbeb a chemistry teacher and others highlighted the importance of situating science within its contextual understanding that includes emphasizing the connection between science and people’s lives. For example, Aaty, a biology teacher, highlighted how science should be situated and understood within humans’ needs. Based on this understanding, Aaty thinks that science helps us to see the different connections around us as humans. He said, “If you think closely, science is situated within humanity even indirectly sometimes… learning about animals, plants, and everything is for our benefit. They all connect us to this earth more and more and help us to understand it.” Aaty believes that science is one of the ways that help us to understand our relationship with our surrounding to be able to better understand it. On the same
hand, Hamad believes that science has a very important influence on the development of humanity. Even though emphasizing this important humanistic aspect was also reported by many teachers, to Hamad, a teacher of biology for 9 years who also teaches in a rural secondary school, science is a message that changed and developed humanity in all directions. He thinks that science is very connected to the advancement of humanity in multiple ways. He said:

Science is a message… look around us… think about vaccines, diseases like cholera, pesticides and many other examples… science is very humanistic and should be understood as only humanistic by scientists and also teachers. We need to focus on this aspect of science and see how science has benefited us on this earth.

Hamad believes that science is very connected to the advancement of humanity on this earth. He also thinks that science as a discipline should be seen in a very high status for its benefits to humanity. He also emphasized that teaching science is very appreciated as to connect students to these important subjects.

Science should be linked to the advancement of Saudi Arabia. Another code of this category pertains to science teachers’ emphasis on the value of science to the development of Saudi Arabia as a country. Many teachers expressed feelings of how the ministry of education should contribute to the development of Saudi Arabia through more focusing on science subjects over religious and literacy. To those teachers, science is the discipline of this time. It is something that Saudi people should spend and allocate a lot of efforts to improve and develop it to get involved in the modernized world. For
example, Salih said:

As you know, science is not treated as it should be … specially comparing to many western countries… In Saudi Arabia, we tried to focus more on science but unfortunately until this moment these attempts are just ideas… however, in the recent years, you can say that there is more interest in science, especially with the new curriculum, which is good but we need huge efforts to improve sciences in Saudi Arabia and in the Arabian world in general.

Salih’s interest in changing the status quo of science disciplines in Saudi Arabia to be a drive for the development of the country was clear in his statement. Many other teachers expressed similar feelings of how improving the country should include more focus on science subjects. Some other teachers like Freed, a biology teacher for 10 years, also expressed feelings that science is the main reason for the development of the country. He thinks that science should be an essential component of students’ educated, cultured, informative and enlightened character. He believes that it is important to prepare those students to be able to enlighten Saudi Arabia in these important scientific aspects. He added, “Consider that we did construct a generation that is thirsty to science and happy to develop its scientific understanding… if we work hard to achieve it we will find that they will change many things in the Kingdom of Saudi Arabia… they may make a difference in many scientific aspects in Saudi Arabia.” Freed emphasized that science studies are very important to change the face of Saudi Arabia and develop the country. He believes that to do so it is important to focus on enlightening students’ scientific understandings and make them more interested in science to be able to add to lead this scientific
development as he thinks.

Many other teachers like Hamad, Shaher, Fouad who is a physics teacher for 6 years, Ali who is a teacher of biology for 5 years, and others emphasized this constructive relationship between the development of Saudi Arabia and science studies. They believe that it is time to give more attention to science over some other disciplines like religion and literacy in the Saudi curriculum. They also called for new and advanced means to introduce it to students to be able to reflect the importance of science for the advancement of Saudi Arabia.

**Meaningful career.** Along with teachers’ views of how science is divergent with many other disciplines and with different societal and life aspects, more than half of teachers expressed feelings of inspiration and empowerment to be agents of change. Some teachers emphasized that teachers should focus more on other aspects of teaching not only subject matter. They emphasized that their role should be to form connections between the surrounding life of students and how should students situate themselves within such surroundings. Along with this emphasis, some other teachers called for more awareness and knowledge of science to be able to form meaningful teaching practices and critiqued their lack of knowledge to some SSI. These two codes will be discussed under this category.

**Teachers should not only focus on subject matter.** Many teachers showed feelings of the need to be leaders in their classrooms. For example, Saeed who taught biology for 6 years, focused on the importance of having good personality and confidence that is based on enough knowledge about science along with having appropriate and
approachable plans and goals when teaching science. He also added, “Science teachers should be looking for the new things in science and be up to date with the new discoveries in their scientific interest as well as look for answers to some issues that may be asked during their teaching experiences.” Saeed thinks that teaching is not only delivering the subject matter but also is a more complex and hard job that requires keeping pace with the new in science. Speaking of himself and how he describes himself as a teacher, he said, “I have clear plans and goals, knowledgeable to all new things in biology, looking for questions and answers, encourage students to do research, and try to bring different perspectives about some argumentative issues together.” Saeed believes that it is the very task of science teachers to be ready for addressing science topics in profundity and depth to be able to handle students’ questions that may direct attention to different viewpoints and perspectives of science and its connections.

On the same hand, even though Jawad has only 4 years of experience as a physics teacher, he was so immersed into developing the ways by which Saudi science teachers experience and address science studies. He emphasized that science teachers in Saudi Arabia need to look at the curriculum in different ways. He asserted, “We need to look at the curriculum in an open mind and we will find that it is changing and different every time… I dislike it when some teachers say that they are bored because they teach the same material each year… NO… it is not the same material.” Jawad emphasized that being a science teacher is not an easy thing to do. Science, as he saw it, is changing and required teachers to renew their knowledge and work hard to cover the new developments in science. He thinks that science teachers do not only need to understand
that science is renewed and evolve over time but also to develop themselves to be able to see this renewed subject effectively. He said, “Teachers should not only rely on their textbooks. Rather, they need to obtain knowledge from all possible scientific sources they find either in the library or through google.” Jawad sees science not only as subject matter or knowledge to be delivered. Rather, he mentioned how important it is to have enough knowledge and get renewed to be able to see science efficiently and effectively, which emphasized his interest and love to expand students’ views of science. Similarly, when asked about how he sees himself as a biology teacher Freed said, “I usually read a lot, and attend conferences as well as meetings. These efforts help me to understand how to connect the subject matter that we deliver in the science classroom into real and genuine practices.” Habbeb described himself as, “A well-read person and I usually pay attention to the contemporary developments of our time that have an influence on our daily life in a way or another.” Similarly, Freed expressed how important it is to have enough knowledge to be able to handle science classes and be more confident. Especially, with the potential of receiving a lot of questions from students in varied and different topics related not only to the subjects being discussed in the curriculum but to different societal and religious issues related to many SSI.

Some teachers indicated that being science teachers forced them to form and serve as a link between students and the new sciences. Ahmad, who is a biology teacher for 3 years, said:

Honestly, I can describe myself as a connection figure between students and the new sciences surrounding them, and between students and the outside world. My
task is to make the definitions and issues easier for them and to correct their
definitions of many terminologies that we face in science like climate change,
cloning, genetic engineering. I also find myself obligated to clarify a lot of
ambiguity related to these issues in different directions including religion and
society. Students face and experience these issues but they cannot absorb and
understand them without schools. In school, I feel like I am the person
responsible for forming this connection between students and these new sciences
and issues they face in their lives.

Moreover, Hamad emphasized that teachers’ responsibilities are not only related
to learning but rather they should focus more attention on students’ educational, values
and principles. He said, “There are different criteria for teaching and definitely learning
is one important part of it. However, there are different educational, and directive aspects
that include our traditions, habits, and Islamic understandings, which are important parts
of our tasks as teachers.” Hamad emphasized that highlighting these parts of students
should be a priority of teachers and as he mentioned, “we have to deal with all these
aspects like the Cook when he puts spices on the food, where learning is the food and
those parts are important aspects making the food more suitable.” The emphasis on
redefining teaching to include more than the aspect of learning was reported and
highlighted by many teachers. Hamad added, “In my view and based on my field, which
is biology, I apply the saying that states: when specializes be creative.” Hamad showed
how important it is to have enough knowledge about one subject, biology in this case,
and being creative as well as able to handle the different aspects pertain to situating
biology within students’ needs and understandings.

**Critiquing the lack of self-confidence.** Many teachers expressed how science is huge and involve different interpretations. They expressed how hard for them it is to keep up with up to date the new developments and discoveries in science. Some other teachers emphasized that they are not able to comprehend science as a subject. Aaty, who has 5 years of teaching biology, for example, was concerned about the depth and wide ranging of science subjects. In this context, when asked about how would he see himself as a science teacher, Aaty said as:

As a science teacher, I see myself not versed in science as a discipline because of the variety and fast changing science subjects… Science is like a huge sea where information is too multifaceted and complex. You just start absorbing some information but new information keeps coming and expanding. I may need 10 years to be able to only handle knowledge pertains to 60% or 70% of some science topics.

Lack of self-confidence was also correlated to teaching some subject-matter materials in the Saudi curriculum. Some teachers removed and did not teach some of these topics because they did not feel they are ready to teach them. Hamad said, “Some of my colleagues omit some topics from the curriculum and prefer not to teach them. For example, I had a friend of mine who does not teach sexual topics in humans.” Whether it is because of the controversy involved in them or the lack of self-confidence, Hamad disagreed with those teachers he felt like there is a need to support them and show how important those topics are, especially that they are coming from the official curriculum
approved by the ministry of education.

**Growing Views of SSI**

One of the major interview questions of this study pertains to science teachers’ views of SSI. Early in the interviews, participants showed different initial views of some SSI. These views were typically influenced by different societal, religious and initial understandings of many of these issues. The impact of these aspects appeared to have a large influence on teachers’ views of these issues and of science as a humane endeavor in general. However, those initial views transferred and changed with time and with more understanding of many SSI. Particularly, Saudi science teachers’ views of these issues showed greater connection to two main categories: (a) understanding of science as a humane endeavor, (b), and initial views of some SSI.

**Understanding of science as a human endeavor.** One of the ways to understand and situate science teachers’ views of SSI is through investigating how they understand science contextually. Specifically, understanding the humanistic aspect of science would illustrate how those teachers understand the influence of this discipline on people’s lives. Therefore, expanding the understanding of science to include not only the scientific approach of science but also the humanistic part of it. Understanding these aspects would help to contextually understand how those teachers view and base their understanding of some issues that are more related to them. Specifically, Saudi science teachers showed varied views of how they see the humanistic dimension of science with many of them expressing how important it is to focus science on people’s needs and necessities.
**Science should be situated within human needs.** Some teachers believed that there should not be any contradiction between science and the humanistic part of it, or how science influence humanity. Many teachers showed greater understanding that science should be based on what people need like Muhannad, who is a biology teacher for 5 years, said, “Science should be situated within human needs.” He also added, “When I think of some issues like abortion and its research, intracytoplasmic sperm injection, human fertilization, and others you may see a contradiction to some values and religious understandings but in reality, they benefit humans.” Muhannad emphasized that the most important dimension is humans and their affairs before anything else. In fact, situating science around peoples’ needs and the understanding of how science should benefit humans was clear through the whole interview with Muhannad. Similarly, Aaty emphasized that science should be and is situated around humans even if there is no apparent influence. Likewise, Ahmad, another biology teacher who taught only for 3 years, emphasized how important it is to focus on the needs of people when conducting science. He said, “Personally speaking… I believe that God created the earth and the whole universe for humanity. All sciences in this world have either direct or indirect influence on humans.” Ahmad’s understanding of how science influence humanity, even indirectly, emphasizes his understanding of the great connection between science and humanity. In respect to how humanity get influenced by science, Shaher emphasized, “Science, particularly scientific procedures and investigations, may contradict our humanity. However, I would prefer to see the picture comprehensively to determine the validity of science on humanity.” Shaher prefers a balance based on how science is
beneficial of humanity even though some science investigations and issues may partly contradict humanity. This emphasis signifies Shaher’s interest to situate science around peoples’ needs and for the benefit of humanity.

On the other hand, even though Majed, a biology teacher for 7 years, thinks that teaching issues like genetic engineering are hard because he believes it requires a lot of knowledge and comprehension from the part of both teachers and students, he emphasized that there is need to focus on this issues because of “The increasing number of diabetic people in Saudi Arabia.” He sees values of this issue in solving Saudis’ health problems, which signifies a humanistic understanding of teaching those issues within Saudis. On the same direction, Ahmad believes:

We all know that science focuses on a very important humanistic dimension including the invention of vaccines, fighting agriculture diseases, fighting bacteria and viruses, and fighting a lot of diseases that hit humanity. If you look, scientists from all over the world with so different backgrounds and interests look at these problems that we face in our world. That shows a very important humanistic dimension of science in my view… I believe the source of science is humanity as science is based on pure humanistic values.

Similarly, even though Hamad believe that science is connected to humanity and should serve humanity, he understood that science is purely based on humanistic values. Even though such understanding may not portray a good picture and understanding of science, such emphasis signifies how important the humanist dimension of science is when thinking of science as a discipline. Like Hamad, Aid, a biology teacher for 3 years, also
emphasized, “Even though science focuses more on the scientific method, I do not believe there is any contradiction to humanity.”

**A balance between the scientific and humanistic approaches.** Salih showed a more in-depth view of the humanistic dimension of science. He said, “In my perspective, we need to situate the humanistic dimension of science as a goal that should be sought by people of science. If we ignore this aspect, humans will suffer and a lot of damage will occur.” He provided some examples that included some SSI like nuclear reactions, and weapons. However, he emphasized that he does not call for limiting research in science because of a potential harm to humanity. Instead, he emphasized, “scientific findings and results should be released and approached regardless of anything but employing and utilizing them should be humanistic.” Even though Salih is more concerned with the value of science and the importance of value-free science practices, he did not ignore the influence of science on the lives of humans. Salih’s understanding of the importance of the scientific aspect of science signifies his understanding that science has its own ways of knowing that should be set apart from other ways of knowledge.

Similarly, some other teachers agreed that science should be conducted freely but with more focus on the humanistic dimension. They emphasized that conducting science should be side by side with the benefit or influence on humans. Habbeb, a chemistry teacher, said, “Since we believe that science is for the benefit of people, it is important not to let scientists search whatever they want without clear understanding to the influence of their research on humanity. I rather prefer that the scientific and humanistic dimensions of science work together to prove that science is for the benefit of people.”
Like this understanding, Muhannad, another biology teacher, believed that there is no contradiction between these two aspects, the humanistic and scientific dimension of science having in mind that science is rapidly changing and therefore what is against humanity today may be different tomorrow.


Findings of this questions revealed varied themes that were situated around initial and existing views of SSI and influences that impacted Saudi science teachers’ views of many issues.

**Initial Views of Some SSI**

Some of the questions in this study tried to investigate first impressions of those teachers when they first learned and experienced some SSI. Several participants described their experiences in varied ways. For example, Freed, a biology teacher, emphasized that the first things he did when he heard about some issues are reading and expanding knowledge about them. He emphasized that he needs to understand more about these issues before taking any decision. Being knowledgeable about these issues was stimulating for some teachers to look for and research more about the new developments and studies of these issues worldwide. It gave them a helping hand of these issues and helped them to be more confident when discussing and negotiating them. The discussion of the first impression of these issues among Saudi science teachers was varied, especially these issues are different and include different backgrounds and bases.
However, it can be said that Saudi science teachers' first impressions about these issues include three main codes: acceptance with skepticism, excitement and enjoyment, and rejection and criticism.

**Acceptance with skepticism (hesitancy versus certainty).** Some teachers expressed feelings of hesitation and skepticism when they first learned about these issues. For example, Malik, a biology teacher for 8 years, said:

> The first impression that I got when I first heard about these issues was confusion and uncertainty. I was thinking a lot of these issues. For example, what is the story behind these issues? What are steps that formulated the understanding of some of these issues?

Moreover, Malik tried hard to understand these issues. He mentioned how he started looking at these issues when he was in high school, “I was looking for some answers to my questions through the small library that was in my high school. There were few scientific magazines that included some discussions about some issues which was very important to me.” Later in his interview, Malik emphasized that his ideas about these issues changed and considered them very exciting and appealing issues. He said, “As I learned more about some of these issues as I liked them so much.” Hamad, another biology teacher who taught this subject for 9 years, has similar thoughts about these issues like cloning and genetic engineering when he first heard and learned them. However, he was more skeptical and hesitated before delving deep into some of them. He said, “I remember my feeling. I was very hesitated. How do they work? Do they benefit our society? Do we need them?” Hamad’s suspicion about these issues vanished
partly as he studied and expanded knowledge about them as is shown later in this analysis.

However, initial acceptance to some SSI was also reported by many other teachers. Aid, a teacher of biology for 3 years, for example, emphasized that he saw these issues normal at the beginning like any new science. He emphasized, “Later when I started to see the connections of these issues with other aspects of Islam, I started to focus on these religious opinions and see how they are influencing them.” Similarly, Wesam, a biology teacher for 6 years, reported that his first impression was thinking of the goal of such science. He said, “When I learned some of these issues… the first thing came to my mind is what is the end? Where are we heading with this science? I also remembered that I was asking myself, how can we offer this science to our society?” Moreover, Ahmad understood many of these issues initially but later some questions started to pop up. He said, “Personally I recognized these issues but I felt like it is important to revise them and understand their background. It is very wrong to ignore the background and understand everything related to these issues to be able to say we accept them.” Even though those teachers accepted and started to learn more these SSI, at the same time they had some questions in mind about different aspects related to these issues, which made them more skeptical to fully accepting them, at least when the first learned some SSI

**Excitement and enjoyment.** Experiencing some contemporary discussions that trigger some thoughts about these issues worldwide was exciting for other teachers. They expressed how lovely some topics were when they learned them. For example, Salih expressed his feelings when he first learned about cloning. He said:
You may like that. When I first heard about cloning I was in Scotland on a scholarship. The topic was so close to me. I was so excited as everybody was talking about what happened and how the sheep Dolly was born… I never forget that experience. I remember that I went to the library and tried to find some materials and books that could answer some of the many questions that I had in mind at the time.

Salih’s unique experience with cloning showed how learning and experiencing a new issue is a trigger for excitement and more interest about it. Similarly, Muhannad was also excited when he first learned about these issues. He expressed,

Certainly, lovely and beautiful feelings. It is enough to know that you discovered something new that many people are talking about where they see it as a complicated subject when you see it differently because you know and did some research about it. They were very beautiful feelings.

Muhannad emphasized how knowing and delving deep into some issues gave him an upper hand when discussing these issues with others. He also showed how confident he was when he learned more about these issues. On the same hand was very excited when he first knew about some SSI. He said, “I remember that the first thing I tried to do was looking for a religious explanation behind some issues as they were my concern at the time.” Ali thought that the issue of cloning was not fully appreciated by Muslims and tried to find out the reasons behind these negative views of this issue.

Likewise, Saeed, another biology teacher, emphasized that even though he completely refused issues like cloning at the beginning, however, he expresses how
excited he was to know more about it. He said, “when I knew more about cloning I started to understand more about the nature of this issue and how could it benefit humanity. It really changed my mind about it.” Saeed also expressed how excited he was to know more about some other issues like genetic engineering. Similarly, Shaher expressed excitement and feelings of empowerment when he first learned about these issues. He said:

It is good that you said initially because my feelings at the beginning were combinations of excitements and enthusiasm. It drove my attention to look at these things in different ways. You feel like you swim in a huge sea of science. You want to dive deep into it to understand it and learn more about it.

Shaher emphasized that his excitement for these issues drove him also to look for and expand his knowledge about some issues. Similarly, Aaty shared his excitement with some issues. However, he wished that he has enough time to understand some issues. He emphasized, “the fun thing about science is that you look for and discover new things all the time. I wish that I have enough time to understand some issue more deeply.” It seems like teachers’ enthusiasm and excitement about these issues served as a huge impulse for their dedication to understanding and accepting some of these issues.

**Rejection and criticism.** Other teachers expressed feelings of rejection and elimination. They did not see a value of these issues because of different societal and religious reasons, especially at the beginning of knowing many SSI. For example, Habbeb, who is a chemistry teacher, expressed his feelings when he first learned about the theory of evolution and cloning. He said,” Darwin theory and cloning made me so
upset the first time I learned about them. I disliked the idea of Darwin’s theory that states that humans emerged from monkeys. Similarly cloning, I hated the idea behind it too. Honestly, I am strongly against these issues and will not accept them.” Throughout his interview, Habbeb emphasized that we must respect our special characteristics and traditions and stick so hard to them. Similarly, Jawad, a physics teacher for 4 years, had a more in-depth view of this aspect. He emphasized:

Personally, I love to look for new things and issues in science but I refused and still those ideas that say that humans emerged from monkeys and later those monkeys converted to be humans. However, I was so happy to see new ideas and issues in science. I like the idea but applying it is something different.

Similarly, Ahmad, who is a biology teacher, emphasized the influence of his professor on him to refuse the evolutionary theory. He said, “The first time I learned about the theory of evolution was during my university years where the professor convinced me of the flaws of this theory and later I refuse to accept this theory.” Ahmad’s strong position against the theory of evolution was due to other influences, his professors in this case. Even though some of these views changed later, still the influence of teachers’ first views was strong and to be changed later as will be seen later in this analysis discussion.

Existing Views of Some SSI

Saudi science teachers’ views of SSI were varied and included different interpretations and understandings. These views ranged from instant rejection going through partial inclusion and discussion of some of these issues to full acceptance and
understanding of others. These views are very compatible with teachers in Sadler’s et al., (2006) specially profiles A and B with some teacher fell in profile C. Generally, many Saudi science teachers understood the value of teaching and handling these issues in the Saudi science curriculum and saw many of them important for the advancement of science studies in Saudi Arabia.

One of the drives of accepting and positively viewing SSI is Saudi science teachers’ understanding that there is a need for remodeling and keeping pace with the new developments in science education worldwide. Especially, with the innovative and advanced understandings of science in different western countries. Some teachers emphasized that the Saudi society is changing and we should keep pace with this change, especially in science. Jawad, a physics teacher, said, “Society nowadays is more open and more developed. People started to get more connected to the new things in science and technology, particularly the new thoughts and ideas that have innovation and thinking out of the box.” Jawad and other teachers emphasized that teaching and handling many SSI is very important to keep up with those developments in different countries around the world. Similarly, some teachers focused on Saudi students and emphasized that students should be knowledgeable enough to be able to compete or at least respond to questions about these issues from students of other countries, especially that the Saudi government is giving scholarships to thousands of students each year to study abroad. Other teachers focused on the benefits that might be achieved through focusing on some of these issues that may cure some diseases among which Saudi Arabian ones like genetic engineering and Coronavirus for example. The categories that
will be discussed in this section include; a) SSI are valuable, b) rejection to some issues

**Some SSI are valuable.** It appears that many teachers in this study accepted many SSI and supported their inclusion in the Saudi curriculum. Some teachers, like Ahmad, who is a biology teacher for 3 years, saw many SSI important. For example, when talking about stem cells he thinks that this science opened a huge door that may solve a lot of people’s problems. He added, “Having in mind that we need to situate our understanding of stem cells to be compatible with our values and understandings as a Saudi Arabian Muslim society, I encourage more depth of this science in the Saudi curriculum” In addition to Ahmad’s belief that the science of stem cells is important he also thinks that Saudis need to understand and focus on SSI independently through purifying and refining them from any religious or societal distorts that do not go with Saudis’ religion, costumes and traditions in order to accept them.

Moreover, teachers’ positive views of many of these issues seem to be due to the benefits and values those teachers saw on many of them. For example, Habbeb saw many values in addressing many SSI in the Saudi curriculum because he thinks, “We need to keep pace with the world… Even though these issues are argumentative and carry a lot of criticism, the world is approaching and studying them. We need to know what is happening in the world.” Many issues were emphasized and discussed during interviews. genetic engineering, for example, was one of clearest examples of how science could serve humanity in an important way. Muhannad, for instance, said that this issue is for the benefit of humanity and he emphasized that there is no problem with it at all. In this section, there will be a discussion of some codes and reasons that supported science
teachers’ positive views of these issues.

One of the reasons of positively viewing many SSI is how these issues are beneficial to humanity. For example, in his discussion of genetic engineering, Muhannad disagreed with the idea that this discipline changes the original nature of things and humans, that has been created by God. He emphasized, “personally, I think genetic engineering should be emphasized in the curriculum… If we look closer to this issue, we find that we solved a lot of problems just because we controlled a lot of diseases that killed people in the past but now they disappeared.” Similarly, Majed, a biology teacher, expressed how genetic engineering is a lively topic. He said, “It is the science that forces you to look for knowledge in books and the internet.” Majed saw a great value of genetic engineering to the point of making him more interested and positively see how valuable this science is to him. Muhannad also emphasized this positivity of seeing genetic and called for teachers focus on it and for expanding the teaching of this issues. He disagreed with those who say that we change the nature of things and creatures when we do this science. Commenting on this point he said, “These issues are considerable parts of science. It is inappropriate to stitch some sciences that you think fit your society and ignore some important parts for no real reasons. At the end, we will be illiterate.” Muhannad emphasized that many of important parts of science worldwide. Any ideas of removing or slightly including them in the science curriculum should not be the case with science curriculum in Saudi Arabia.

Similarly, Aaty emphasized this importance of including these issues in the science curriculum. He said:
I highly support including these issues in the curriculum… It is better that our students and teachers get appropriate and valid knowledge about these issues inside the school or from the curriculum. Otherwise, students would look for these issues through other means like the internet, which could lead to misconceptions as we do not know the validity of the sources that informed their thinking.

Hamad also shared similar thoughts with Aaty as he reinforced including these issues in the science curriculum but he gave different reasons. He criticized science curriculum in Saudi Arabia and saw it inferior to what it should be. He emphasized that curriculum is not modifying enough to prepare Saudi students for new topics and scientific developments. He said, “When I look at our curriculum, I do not see new topics that stimulate students’ thinking… I almost teach the same topics for all three high school grades.” He highlighted that Saudi students need to realize the development of science around them and in the whole world. He added, “We should not be so static but rather move fast to realize the real nature of scientific developments in different countries around the world.” Such enthusiasm to include and positively viewing these issues was very clear throughout the whole interview with Hamad. For example, he criticized how these issues are treated in the Saudi science curriculum and called for real reforms that take into consideration teaching these issues immediately. He added:

We need to study these issues not for our current days but for our future as a country. Students should learn, read, and research about these aspects. Some countries have research centers that are dedicated only to one of these issues like
cloning or genetic engineering and we still argue for their validity… for example, why do not we do research to understand cloning on animals and other creatures like mice or hamsters? I do not see any valid reason why. We should not limit our views of science.

Hamad’s understanding of the importance and validity of these issues was clear. Such understandings were shared by other teachers like Salih who saw issues like cloning as opening gates for serving the humanity in large. He emphasized that cloning could “waive or omit a lot of unnecessary things in our days.” He gave examples including helping people to plant and grow a liver for instance and remove the necessity of donors. He added, “We do not have to focus on cloning in humans and consider it a barrier, instead, this very argumentative, instead we can focus on the benefits that we might get from it.” Salih highlights that there is a possibility of a religious conflict of cloning did not fully change his mind about the value of this issue in science.

**Rejection of some issues.** Even though some teachers accepted some of these issues, at least theoretically, they did not embrace them and view them positively.

Science teachers mentioned some issues like cloning, the theory of evolution, genetic engineering. However, there were some minor issues that were reported by teachers including; the law of conservation of energy, nuclear weapons, nuclear energy, chemical weapons, sex education, organs planting. Different reasons were reported for their rejection.

For example, many science teachers in this study emphasized that many SSI are argumentative in different levels, especially in the Saudi society. For example, when
asked about whether he would recommend other teachers to teaching these issues, Majed, a biology teacher for 7 years, did not positively think that would work. He said, “I would not recommend that… it is hard… many arguments embedded in them.” Majed thinks it is hard for teachers to avoid the controversy embedded in different SSI.

Some of these arguments were reported by Salih who discussed the theory of evolution. He explained how this issue is argumentative from his perspective. He emphasized, “This theory has been proven wrong from Darwin’s students in the first place. I do not know why we still consider this theory in our countries.” However, even with Salih’s instant rejecting to the theory of evolution, he emphasized that even if this theory is a mistake, as he thinks, he believes that we can use and benefit from “The efforts that have been dedicated to it and the benefits related to classification studies.” Even though Salih emphasized the importance of focusing on the scientific aspect pertain to the theory of evolution, he believes that this theory is wrong regardless of the wide range of using it worldwide.

Some of these controversies were related to religion and how Islam, or some understandings of Islam, is prohibiting people from seeing the whole picture about some issues. Some of these controversies were due to lack of knowledge of some participants and how such aspect influenced science teachers’ understandings and therefore clarification of some issues. These two aspects will be discussed in this section considering how they increased the argumentative nature of some of these issues.

Religion plays a concrete role in the Saudi society. Even though this role will be discussed in-depth later in this analysis, a little discussion here for why Islam has been
seen the main reason for rejecting many SSI. For example, throughout his interview, Salih emphasized, “The red line is when these issues touch religion, I cannot tolerate that. The reference should be a religion, not science.” However, later in his interview, Salih distinguished between the scientific understanding of science that is derived from the *indisputably of the scientific method*, as he thinks, and the other influences that influence such scientific understanding of these issues in Saudi Arabia. For example, even though he emphasized that the theory of evolution is not compatible with his religious understandings, which served as convincing reasons for why he sees this theory argumentative, he provided different other reasons for these negative views of the theory of evolution and of other SSI.

More specifically, there were some reasons justified Salih’s and other teachers’ negative views of issues like the theory of evolution and cloning. For example, when discussing his ideas about cloning, Aid, a biology teacher for 5 years, emphasized that cloning is ok if it does not violate Islam. Similarly, Hamad emphasized, “I welcome cloning if it is beneficial to humanity, but if there is any harm I disagree with it.” Aid and Hamad emphasized that the rubric is their connection to Islam and the benefits those issues have on humanity. Salih gave two more reasons about why some would disagree with some of these issues. He said:

In my view, unfortunately, I think much of our society prefer to talk about these issues without proper knowledge and enough knowledge about them. Discussing these issues should be made through specialists. The other reason is I believe that our society does not adhere to science and the scientific thinking as a way of
living. They do not believe in cause and effect and that made some people to lean toward non-scientific explanations of things… that established a lot of confusion among people and even among religious sheiks who are influenced mentally about these forms of ideas and therefore mix both the scientific and religious understandings, which even make accepting these issues hard.

Salih thinks that the Saudi society is not interested in adhering to the scientific method and the scientific ways of understanding the surrounding nature. Later, he criticized Saudi education system that emphasizes the lack of adhering to the scientific method among Saudis. He considers Saudis’ lack understanding of the value of the scientific method is the main reason for their rejection to many SSI, not only their religious background. Muhannad supported this idea when he answered a question about how would he see these issues in the Saudi science curriculum. For example, he talked about organs transplant and mentioned, “I remember reading a comment that has been released by one Sheik who said that our bodies are deposits or trusts from God. He gave us this body to protect it and therefore we have no right to donate anything from it.” Muhannad was confused as he agreed with what the sheik said and at the same time with how organs transplant is helpful and saving lives for others, which is a concrete religious understanding of his. He described how such confusion did not help him to avoid the argument embedded in this issue. Islamic explanation, not Islam itself was a huge step that may trigger controversy among students.

Malik, a biology teacher for 8 years, who discussed how religion is a priority to his students said, “The first question that I get from my students when I discuss some of
these issues is: is this issue compatible with Islam or not? … even though the answer is not easy… I know that I will start a conversation that is very argumentative with students when such concern is approached.” Malik believes that religion is very important in the Saudi society but he does mention how seeing religion in this position among Saudis is making these issues even more argumentative. Similarly, Wesam thinks that teaching cloning should be just for knowledge sake. He emphasized, “God created us and he knows how to deal with us. Therefore, when I teach cloning, I teach it to inform students of a science that is practiced in the world but I mention that we do not need it.” Wesam believes that cloning is a considerable science worldwide but he does not see a value of its application because he believes that Islam does not consider it a valid science, especially in humans. He wants his students to be aware of this issue but also reminds them that this issue is religiously not ok. Wesam justified his position against cloning by saying, “Of course the main reason is my religiosity, if I ignore this part and say it is ok to conduct science free from any values then what science we are expecting to get?” Wesam thinks that his religion is the main principle that forces him to think this way with respect to this issue.

Habbeb, a chemistry teacher for 8 years, took a stronger position against the theory of evolution. He stressed that this theory is, “False in both theory and practice.” He also emphasized that believing in this theory is against our religion, Islam, and is considered disbelieving in God. He justified his stronger position against the theory of evolution and said:

I believe that the theory of evolution is controversial, particularly the part that
states that we were monkeys very long time ago. I know that some scientists believed and some others reject this theory. Of course, I am with those who reject it. In my view, God created us in the best of shape, as it is stated in the Quran. He described who Adam was created at the beginning of humanity. On the part the theory that states that we evolve, develop, and other theoretical frameworks of this theory, I think if that true then why single cells creatures so did not evolve over millions of years ago or why invertebrates did not evolve into vertebrates… I believe this is not possible.

In this statement, it is clear how controversial the theory of evolution is to Habbeb. On another hand, when Majed, a biology teacher, was expressing his feelings about cloning emphasized, “I think this issue is HARAM.” He highlighted that we need to clarify why cloning is not compatible with Islam before we proceed and focus on it in our curriculum. Similarly, Shaher underlined issues like cloning and justified why it is not accepted in Saudi Arabia. He said, “cloning is religiously forbidden… therefore it is controversial….when sheiks intervene in cloning and give a religious opinion statement of how it violates Islam, people will not accept it.” Shaher emphasis on the religious understanding of issues like cloning is clear indication of how religion plays a concrete role in making some issues even more controversial. Similarly, Ahmad discussed stem cells and saw some arguments in this issue. For example, he said, “Even though we know that stem cells are beneficial to cure some diseases. The question is who benefit from these cells, is it the fetus himself or somebody else? How do we get them?” Later in his interview, he added, “stem cells is a huge step in biology and medicine. However,
we need to limit the use of this science if it is against humanity.” Ahmad emphasized that this research is new and we still need the religious understanding and how Islam controls and defines the appropriate procedures that we need to follow to conduct this research.

Influences

The views of some SSI emphasized different influences that shaped Saudi science teachers’ understandings of different SSI. Specifically, those teachers showed a greater influence of religion and society on how they view different SSI. The role of Islam in the Saudi society was very clear in those teachers. It was very essential component of Saudi science teachers’ understanding structure to justify different views of these issues. On the other hand, these different religious and societal aspects and codes will be analyzed in this section. The culture of Saudi Arabia, traditions, and some societal influences also form a specific understanding of how those teachers view and realize the interactive influence of different SSI on the people of Saudi Arabia. These different influences will be discussed under two categories: Religious influences and societal influences.

**Religious influences.** They showed how Islam and its instructions are very basic for Saudi people. Precisely, many teachers focused on different religious aspects that form a specific understanding of how religion influences their views of these SSI. These aspects include: how Islam should treat science, the priority of Islam in the lives of Saudis, contradiction between Islam and some issues, and many other codes and aspects that formed how religion influence viewing these issues. These different codes will be discussed in detail in this section.
Religion is essential component of Saudis. The emphasis on the priority of religion in the lives of Saudi people was clear in many participants, with many science teachers in this study talking about the importance of following Islam instructions in all aspects of their lives. For example, Wesam, a biology teacher, said, “Our religion forces us to be introduced into our lives… the religious aspect in any scientific domain should be introduced, highlighted and considered very seriously… this is our sharia law.” Wesam believes that Saudis are strictly applied their religious understanding into their lives. He does not see any exception even for science studies not to be included into this rubric. Salih underlined this lively importance considering the relationship between science specifically biology and the Saudi society. He said:

My frame of reference in teaching science in general and biology, in particular, cannot avoid and be separated from religion under any circumstances. No matter we agree or disagree with this fact… the real reference is Islam…Any other reference will be thrown into trash.

Salih justifies this strong correlation with Islam within Saudis and thinks that the main reason is people’s thinking that Islam instruction is stable, correct and cannot be wrong. Comparably, science “Is tentative, changeable and evolve over time and with new evidence”. He added, “As a domain of knowledge, religious understanding is celestial because it came from God but natural science is humanistic and is based on humans thinking.” Salih thinks that religion is more accepted among Saudis because it came from a higher being, which is God. Therefore, he thinks that such comparison between science and religion is not appropriate as there is not enough in common ontological and
epistemological grounds. Freed on the same hand also emphasized that Saudis value their religious ideas more than anything else. He commented on how he sees the potential of considering different SSI within the Saudi curriculum and said, “First, we have to acknowledge that people’s religious awareness is among the most influential features that affect the inclusion of many SSI… usually Saudis connect anything to religion… therefore these issues will have barriers pertain to strict values and principles of those people.” Freed does not only think that religion plays role in constructing Saudis frame of reference when dealing with these issues but also believes that Saudis consider these religious influences standards and common sense that is deeply rooted in their decision of studying many SSI.

*Science should follow religion.* One of the major codes that exemplify the category of religious influence on the science teachers understanding of how science is a higher status comparing to science. Many teachers emphasized that science should be a way to understand and discover religion not more. For example, Muhannad added, “I believe the main thing about science is that it helps us to understand religion.” Muhannad expressed how religion is perfect in his mind and science is only one way to discover this perfection. Similarly, Jawad said, “As a teacher, I usually look for those questions from my students that are religiously deep because I know that our religion has the superiority in explaining these questions under investigation.” Jawad also emphasized that Islam has all the answers about everything and our jobs is to look for those answers and science is one way to find them.

Science was also following Islam but in a different way to some other teachers.
For those teachers, science should not touch the aspects that are already prohibited by some religious instruction. Shaher, for example, explains this idea by saying, “If there is “Fatwa”, *(the legal opinion concerning Islamic law)*, that something is prohibited or forbidden, then we need to stop.” Shaher believes that religion is a priority among Saudis and for some issues to be taught there is a need to go over this obstacle.

**Science does not contradict religion.** Another code that exemplified a clear example of how Saudi teachers understood the influence of science on their religious understandings. Some teachers confirmed that there should not be religious reason prohibit including different the Saudi science curriculum. On this aspect, Habbeb said, “I believe that science and religion are all related and connected very strongly. As we delve deep into science we see and realize the powers of God.” Habbeb emphasized that science is not only a domain of knowledge that is separate from Islam. Instead, he emphasized that science is connected to Islam through discovering how God creates and manages the whole universe. He understands science is a way to strengthen his belief in God. Saqr, a physics teacher, on a similar thinking said, “Quran has explained some science before science itself discovers them.” Aaty explained how science and Islam are connected to him by saying, “I believe that if Quran was illustrated correctly we will find that all science exists including new sciences.” Aaty does not only thinks science is connected to religion rather he thinks that Quran is the source of science if it is explained in an appropriate way, which would give a hint of how religion is an essential to Aaty.

Comparably, in his talking about the importance of research and seeking knowledge in science Jawad emphasized that research in science “increases our
understanding and connection to God and of Islam.” He added, “To me, I think science and religion are two faces of one coin.” Other teachers emphasized that a religious idea is not different from a scientific one if the latter is correct, which gives the religious understanding a higher position over science, at least among people. Salih emphasized, “The scientific idea takes its strength from being constant and correct. This is the fine line between science and religion. Therefore, I believe the scientific idea is not different at all from a religious idea if the first is correct.” Salih emphasized the higher status of religion over science. He thinks that science is changing and able to be corrected and reformed where religion is stable and constant. Therefore, he thinks this is one of the reasons that situate religion in a higher position comparing to other disciplines including science among people in Saudi Arabia.

Some teachers also emphasized how important the scientific part of these issues is and called for avoiding the controversy that may result in misunderstanding Islam instructions. For example, Hamad said, “We are Muslims but we need to use mind and wisdom along with religion at the same time when we judge these issues. Ignoring or putting these issues on the margin because of some religious instructions should not happen.” Hamad added that what we need is to find approachable connections between science and religion regarding these issues. He emphasized that science encourages and stimulates science and there is a need to clarify this aspect with students and when we teach science in general. Moreover, Aaty thinks that mixing science with Islamic understandings would help to make students enjoy and be more interested in science. He said, “I remember many lessons that I tried to connect science and religion together. It
was more fun for students and they felt like science is more connected to their lives.”

Aaty also believed that mixing science and religion would also help students to understand scientific facts better.

Malik, a biology teacher, mentioned how Quran and science are connected heavily. When asked about how he would describe the relationship between science and religion he said:

The relationship between them is very strong. A lot of new scientific discoveries have been mentioned in Quran one thousand and four hundred years ago. The new science also discovered a lot of things that have been mentioned by prophet Muhammad (peace be upon him).

Similarly, Shaher emphasized that science has already discovered a lot of things that we knew since prophet Muhammad, but he thinks that the relationship between them is “intrusive.” He thinks that science is intrusive on religion where religion has superior status and science is only a way to discover some things that Islam already explained. On the same direction, Saqr said, “Quran follows science. We know that the first verse in Quran is Read, which means learn. The intention here is not only learning how to read and write but it is open to all sciences without exception.” Saqr’s understanding on this aspect reveals how science and religion are connected to him.

**Islam is a priority.** Even though Saudi science teacher understood that science and Islam are not different and very connected. Some science teachers preferred to stick to their religious beliefs if there was any controversy involving to some SSI. When talking about cloning and tube babies’ procedures, Shaher said, “When the supreme
council of sheiks, an official council meeting that discusses how new and different things are compatible with the instructions of Islam, say that an issue is not ok, then a lot of argument, controversy, and confusion happen within people but, at the end, they will refuse them.” Shaher emphasis on how peoples’ religious understanding concerning these issues is very important and reveal how difficult it is to go around Islamic instructions when discussing these issues. Moreover, he revealed how science and religion are connected to him. He said, “I believe that every scientific explanation is enclosed by a traditional Islamic cover.” Shaher emphasized that Islam instructions have a higher status with Saudis, which will be a crucial component of evaluating these issues and the aspects that influence them. To Shaher, “Islam is always the regulator for science, it shows us how to seek knowledge and reach it.” This belief of Shaher would justify why he sees this higher status of Islam over science.

Even though Hamad emphasized similar thoughts regarding how religion precedes the importance of science within Saudis, he expressed different feelings about this aspect. Specifically, when talking about cloning, Hamad emphasized that religion influences science deeply but it does not reflect the reality by which society adapts to their religious beliefs. He said:

Saudi are religious but within specific features and with different characteristics.

When introducing cloning to such a society, you may not know the consequences as you may see that they mix both their religious and societal values together and you may end up in nowhere as a teacher.

Hamad thinks that Saudis with their different cultural understandings may apply and
situate their religious understandings in ways that are far from the meaning meant by Sheiks, which would make introducing these issues even more complicated.

**Religious understanding develops as science itself develops.** Even though many teachers expressed how religious the Saudi society is, they said that religious understandings develop as science itself develops and changes. This understanding of the changing nature of both science and how Islam understands the change and adopt it came across different incident during interviews. For example, Jawad said, “I think the scientific ideas behind some issues did not come to us correctly to provide the appropriate religious explanation.” Jawad believes that the scientific aspect behind these issues need to be clarified and explained well among society, especially religious sheiks to give the appropriate decision regarding the validity of these issues and how they are compatible with Islam instructions. Salih on the same hand believes, “Religion is not at all a closed entity where the mind has no space or maneuverability. Still, we value the religious explanation behind some issues but the sheik himself is a human himself that means he would right and he might be mistaken on some issues.” Salih also emphasized that he faced and met many of his teachers’ counterparts who share similar thoughts. He said, “Within the globalization era and the social media, finding the information is easy and getting in touch with the external world is easy. We have to keep up with this rapid world.” Salih emphasis on renewing the religious language was clear throughout his interview. Even though his ideas were not fully accepted by other teachers but they mention that there is a need for understanding these issues comprehensively to give the appropriate religious decision.
Freed believes that the religious understanding usually is based on the period where it applies. He understands Islam as not static but rather as lively and active discipline that tries to understand people and their surroundings. He said, “In its entirety religion does not contradict science and science do contradict religion, they have a mutual relationship.” Freed refers those ideas that state that science contradicts religion to misunderstandings to the religious opinion.

When asked about how would he understands the religious influence of some SSI within the Saudi society Jawad said, “Even though some issues contradict religious understandings, we need to understand that things change over time. Whatever is controversial now may not be in the future. We need to understand this fact.” Jawad highlights that teaching many SSI is important regardless of the religious belief that do not support many of them. He gave an example of how he addresses genetically modified food lessons with his students. He said, “I usually have this argument with my students who refuse genetically modified food for different religious and health reasons. What I say to them is: Do you want us to spend more money on planting and pesticides to get the same or even weaker results? I usually convince my students with the answer.”

Many teachers also emphasized that religious beliefs should not be at all barriers to teaching SSI.

**Religion dominates science.** As an example of how Saudi teachers see the superiority of religion over science, some teachers even think that religion controls science and its development. Within the Saudi society. To those teachers’ this is not a problem at all as science and Islam are very connected as was shown earlier in this
analysis. For example, Ali, a biology teacher for 5 years, saw a controversial interrelationship between science and religion but only among scientists, however, he saw science as only part of religion and supported his view using some verses from Quran like that in Surat Al-Isra (And of knowledge, you (mankind) have been given only a little). Ali thinks that all sciences are only one way of understanding life and the world but he does not see science as a separate discipline. He believes that all disciplines in life are part of a whole spectrum that is dominated by religion. In an example of how religion controls science, Shaher remembered one of his friends and said, “Personally, I discussed test tube babies with one of my colleagues when he suddenly stopped me and said:

Please, this is (HARAM), the religious opinion of rejection. He even did not try to justify his answer to me.” Shaher continues and explains how he knows that there are different procedures regarding this issue and what is banned is only one procedure of test-tube baby. However, his friend did not give him a chance to clarify his ideas. Shaher added:

One word of a sheik would destroy everything the teachers construct… for example, if one sheik makes a show on the TV and says that cloning is not ok or it violates Islam, then people will not accept this issue… our society is religious and if an issue has no support from religion then you will not get enough support to teach it in schools. Students will not discuss this issue scientifically. Rather they will focus on its religious interpretation. They will delete your scientific explanation completely.

Shaher emphasized that religion plays a crucial role within SSI. However, even though he agrees to teach many of these issues, he still hesitates on how some of these issues
influence his students, especially with their religious beliefs.

Similarly, Aaty realized and agreed that teaching some SSI is important, in this era where science is dominating a lot of peoples’ lives. However, he does not see the value of teaching them as it should be. He said, “Honestly, I am not versed into cloning. However, I believe it is a scientific issue that should be taught but to know it not to apply it. I prefer that we give students a hint about these issues and what is new in science. That is all.” Aaty thinks that science is huge and keeps expanding and therefore Saudis need to comprehend some of this expansion in science including discussing some SSI. However, he still does not see a value of applying issues like cloning on the Saudi society. Similarly, Aid believes that we need to understand the scientific part of issues like cloning. He thinks that “all we need to know that this issue exists.” Even though he added that cloning may have benefits for humanity, he insisted that there is no urgent need to teach it to our kids.

**Societal influences.** The other major influence that impacted Saudi science teachers’ views of SSI is related to many societal aspects and understandings of the Saudi society. These aspects included: the impact of culture, addressing Saudis’ needs, the relationship between science and Saudi people, and some characteristics of the Saudi society formed a framework that helped to shape how societal influences influence Saudis views of SSI. These different codes will be discussed under the category of societal influences.

**The influence of culture.** One of the major codes within societal influences that impacted how Saudis view their understanding of some issues is related to their cultural
understanding. Many teachers expressed how being in a different culture with different understandings to how knowledge is practiced and the different traditional and cultural underpinnings that formulate Saudis heavily influence their views of many SSI. For example, Malik who discussed how society views different SSI said, “Different cultures have different views of many SSI… essentially our society does not consider science a milestone in our lives, therefore, they will not accept many SSI.” The impact of culture was also discussed by Hamad who was talking about the obstacles that might hinder including and teaching these issues in Saudi Arabia. He said:

I believe that what is more influential more than even religion is the traditions, values, and customs of Saudis. I think people value the word (AIB), a traditional saying that states something bad concerning the customs of Saudis, more than (HARAM), a religious opinion of rejection. Some people sanctify their traditions and customs more than religion. We need to work hard to solve this problem through mass media and social media. It is important to educate people to understand the value of teaching some explain both the scientific and societal influences.

Coming from an environment where people value their traditions and costumes in parallel with religion formed specific understandings that influenced how Hamad thought about SSI.

Jawad, a physics teacher, on the same track emphasized that people value their traditions and tribal heritage heavily. Considering his discussion of SSI, he mentioned how being so versed into specific cultural understandings may serve as a concrete factor
that even hinder the religious influence on some people. He said:

Aside from the religious opinion, there are some traditions and costumes in the society that are still obstacles. I know that some of these obstacles have vanished, especially among the knowledgeable and educated people but still, I cannot ignore how these costumes are still making it hard for teaching some issues.

Jawad thinks that some of the people's cultural understanding influence their understanding of science. He also thinks that people may see science inferior to other disciplines. Such views of science reflect a specific understanding of how the culture of science in Saudi Arabia influence people's views of this important subject. Some other teachers, like Salih, called for changing and remodeling science studies in Saudi Arabia to be able to form a culture of science that could support a more focus on science studies and their values on the lives of Saudis. Jawad also emphasized that it is very important to work hard through mass media like newspapers and TV and try to change people’s thinking about science to form a proper ground of science studies among Saudis.

*The relationship between science and the Saudi society is not constructive.* The relationship between science and Saudis is an example of how society influences the way by which Saudis understand and view science in general. For example, Aid, a biology teacher, thinks that there is disharmony between science and the Saudi society.

Excluding biology, where Aid thinks that Saudis accept it more than other disciplines of science, he thinks that the main reason for Saudis’ repulsion with science is their lack of awareness about the value of science to their own lives. In fact, many teachers emphasized that Saudi society needs to change and get modified to be able and accept the
new discoveries in science including many SSI.

Jawad emphasized that the world is changing very fast and even science also is changing faster. He emphasized, “We are forced to keep pace with this speed.” However, Habbeb emphasized more on the relationship between science and the Saudi society in respect to some issues related to chemistry. He said, “The relationship between our society and chemistry is very week. Usually, we talk about issues like polymers and plastic products and their damage to the environment but many people and students do not know anything about this.” This weak relationship between Saudis and some issues related to different sciences was also clear with many teachers. Some teachers understood this weak relationship a major reason for not accepting issues like cloning. Freed said, “One of the major obstacles that prevent Saudis from good understanding to issues like cloning is because people tend to ignore the scientific aspect and focus on the religious of it. You can say they trust religion more than science.” Freed also emphasized that students grow up in such a situation of weak connection to science and when it comes issues that trigger some disagreements and arguments like cloning they will not be able to focus on the scientific aspect as their confidence in it has already been threatened throughout their years of studying science.

Moreover, some teachers realized this weak link of science among Saudis and called for more focus on science studies. Hamad emphasized that we do not live alone in this world and added:

The relationship between science and society needs more efforts as this relationship, in fact, is not constructive. People are still scientifically ignorant,
not all of them but the majority. Many Saudis do not differentiate between bacteria, germs, and viruses. They also no very little about sciences like physics and chemistry… I believe Saudis do not give more attention to science, which needs a lot of effort to change this reality and expand their knowledge and interest in science.

Hamad thinks that being science illiteracy is among the major reasons for Saudis’ rejection to SSI. He thinks that it is important to solve and support this aspect first before proceeding to discuss complicated issues like those of SSI. Moreover, Shaher focused on some obstacles that may hinder Saudis from proceeding to learn SSI. He said, “along with the religious reasons, like not accepting many of these issues due to sheiks’ Fatwas, still, there is a huge lack of knowledge about issues like cloning. People will ask about these issues but in a limited way because of the religious fatwa.” Shaher think that religion not only plays a concrete role influencing the inclusion and discussion of issues like cloning among Saudis. Rather, he thinks that such religious understanding hinder people from proceeding and trying to understand and learn more about this issue.

Science should address the needs of people. Even though Saudi science teachers expressed feelings of discouragement regarding Saudis’ views of science, they mention how approachable changing these view is in the Saudi society, especially when they address the needs of Saudis. Some of those teachers, like Hamad, expressed that Saudis are “open and able to accept change”, which was a great aspect of their emphasis that changing their scientific ideas would not be hard. Jawad who heavily expressed how Saudis can change said, “Saudi society became more interested in new knowledge,
innovations, and the new things in science and technology.” Jawad gave an example of his parents who are using new social media applications and mentioned how important these applications to them. Being connected to technology was seen by Jawad as something inspiring that may increase Saudis interest into science and technology.

Moreover, one of the major solutions that have been mentioned by Saudi teachers to fix the weak relationship between science and Saudis is through addressing people’s needs and necessities. For example, Habbeb said, “I would like our curriculum to connect students’ to their lives and see how science influences their lives and get influenced by their actions as humans.” Habbeb criticizes how science is not connected to students’ surrounding lives. Including these issues needs to be situated around the needs of the Saudi society. Similarly, Hamad believes that it is important to hold conferences and use mass media to increase Saudis’ awareness of science and connect science more to their needs. He said:

Let us say that there is a conference held in Al-Ahsa, an eastern province of Saudi Arabia, about genetic blood diseases, which is common in Al-Ahsa province. Moreover, why do not we hold similar conferences around Saudi Arabia to increase awareness of common diseases in different regions of Saudi Arabia? We also can hold other meetings to discuss cloning and its role in solving these diseases.

Hamad thinks that through these conferences and meetings there is a great chance of increasing peoples’ awareness of science in general and SSI through connecting these
issues into the lives of Saudis, particularly to their health. He believes that such meetings would increase people's interest in many SSI.

Likewise, commenting on how cloning could be introduced in the Saudi education system, Shaher said, “We can show how this issue could treat incurable diseases or even saving some animals from extinction or even animals to be extinct.” Shaher thinks that there is a need for more connection to how cloning could address the needs of people. He sees this way the best for introducing this issue in the curriculum.

**Saudi society is scientifically illiterate.** Many teachers expressed how the Saudi society is scientifically illiterate or at least does not give much attention or interest to science and its role in their lives. When asked about his frame of reference about teaching some of these issues, Jawad said, “For sure it is the religious aspect along with our traditions and costumes in Saudi Arabia.” Jawad is just one example shows how the Saudi society is more concerned about their traditions and religion more than science. When talking about how would he describe people where he lives in respect to science he said, “I do not see anyone interested in science except those who are specialized. Public does not give that much attention.” However, he emphasized that it is important to change those moderate people’s views about science and try to connect them more with science subjects and show the value of it to their lives.

Shaher also said, “The Saudi society is still having a lot of shortage in science. It is hard for me as a science teacher to introduce an issue like cloning to my students where the whole atmosphere surrounding them does not appreciate the discipline of science that much.” Shaher also thinks that there is a need to increase people's interests and
understandings of science. Moreover, he emphasized that a lot of his students keep asking him for the value of teaching some issues in science. Shaher’s students were more concerned about the pragmatic aspect of science. They did not see science as an enterprise where they discover their surrounding or try to understand it. Shaher thinks that this view of his students gave him the impression that students are not interested in science. Similarly, some teachers reported that they suffer from students’ lack of interest in science studies. For example, Fouad believes that the reason is because of a huge gap between science and Saudis. He said:

I can say that our society does not appreciate science as it should be… I regularly receive a lot of questions from students about the value of many topics we study in the classroom. They do not see how science is connected to many aspects of their lives…, I am not talking about all my students but a good portion of them. Fouad believes that there is a shortage in introducing science topics to Saudis. He emphasized that his students appreciate subjects like religion, literacy, and even math but they do not see a value of studying science.

Moreover, Hamad emphasized that Saudis are still in need for more focus on science studies. He said:

What drives me to think this way is the fact that we are, as a society, thirsty to new knowledge, discoveries, and new inventions from other countries. Until what time do we need to stay consuming others’ products and sciences? … our society needs to sacrifice, learn, and make a lot of efforts to change. We need to change our ways of thinking to able to add to this world.
Hamad criticizes the Saudi society. He thinks that what makes society focus less on science is the ways by which people adapt to the new discoveries in science and technology. Similarly, Aid believes that Saudis are “still did not acknowledge science … honestly, I believe that just a few groups of the population acknowledge and interested to know science and its importance.” Aid believes that Saudis needs much time for accepting science and its role in developing and influencing their lives.

*We get in touch with the outside world.* Many teachers emphasized the fact that Saudis do not live alone in this world. They mentioned how connected the world is and the importance of understanding this reality to keep pace with the fast-changing world. The societal influences between Saudis and other people from the world was another reason for teaching SSI to some teachers. Muhannad said, “of course, we relate to the world. You cannot exclude something of science that everybody else knows about.” He added, “Now we have scholarships that envoy students all around the world. It is not good when our students get in touch with others and discover that we do not teach this point because it is HARAM. We have to be knowledgeable enough.” He also added, “Anything in the world will reach us either agree or disagree with it.” Muhannad believes that Saudis need to take a step ahead and try to convince people of the value of science into their lives instead of waiting for these sciences to be applied in ways that may not be appreciated by Saudis. These different societal influences also were discussed by Salih who emphasized, “We are in this society in Tabuk but we are part of a bigger Saudi society that is also part of the Arab society and we have the global society. Each of these societal circles influences us and it does not matter whether we feel such
influences or we do not… we need to realize this fact.” Salih believes that Saudis need to understand that they are part of the whole world around them and they should interact with this world effectively. He thinks that these societal influences shrink and expand regularly and called for more understanding of these influences. Similarly, Hamad criticized how Saudis are concerned with “Halal and Haram” where the whole world around us is changing and improving. He believes that religious influences upon Saudis play a role of their thinking and occupies a considerable part of how they see life and the world, which he criticized and called for changing such views.

Likewise, Habbeb emphasized the importance of giving students the ability to be knowledgeable enough of these issues, especially when getting in touch with others who experience these issues. He said, “Tomorrow when our students go abroad they need to know about these issues.” Habbeb sees a value of teaching they may open students mind and help them to interact with others in the world effectively, especially when such discussions about these issues raise. Equally, Fouad believes that even though it is not important for students to comprehensively be aware of SSI, they need to “keep pace with world through focusing on science and the developments in it.” Fouad emphasizes the importance of introducing students to the new things in science, including SSI, as to be able to understand what is happening in the world scientifically.

*Anything new will face skepticism at the beginning.* Even though many teachers expressed that Saudi society is still in urgent need for advancing science studies among Saudis, as reported by the teachers in this study, many teachers like Salih, Jawad, Hamad, Majed, and some others reported that the Saudi society does not accept new things easily.
They mentioned that sometimes it takes time until people get used and understand these issues and their influence on society, especially for issues like these that include controversies in various levels. For example, Muhannad emphasized that the main issue is not whether people able to accept them or not, rather he thinks, “Everything new needs time for people to get used to it.” Muhannad thinks that there is nothing about SSI that makes teaching and addressing them hard within Saudis. Instead, he believes that it is a matter of time until Saudis accept any other new thing. Habbeb thinks in a similar way and said, “anything new will face huge objection at the beginning specifically issues like the theory of evolution with the dilemmas involved in it. I guess society will refuse it completely. However, if we start a step by step we will see that society will understand them at the end.” Even though Habbeb disagrees that issues like the theory of evolution are to be taught to Saudis, he believes that by time and gradual introduction this rejection may have less influence.

Saudi teachers in this study reported different thoughts and ideas that may increase their suspicion about including Saudi society. Some teachers, like Shaher, refer these suspicions to lack of knowledge and understanding among Saudis regarding the nature of many SSI. Some other teachers, like Hamad, think of different aspects. For example, when it comes to issues like cloning, Hamad mentioned how society would not easily accept this issues. He said, “Sometimes there are some classifications of people who support some of these issues. He may get called, liberal, who only wants to force us to teach western knowledge or infuse their understanding on us. People may not accept it at the beginning.” Hamad added:
Our society is like a human body. It may refuse a new organ at the beginning, but after taking antibiotics it will accept it… anything new will be refused among us. We need patience, a huge amount of time, ability to communicate with others, and ability to convince others to introduce these topics. We need to convince people that these issues are for their benefits and for solving their own problems to get accepted amongst them and remove their suspicions about the validity of them.

Hamad thinks that changing peoples’ ideas about SSI is hard, especially at the beginning. However, he emphasized that it is important to start working to change these views and rejection of some SSI.

Saudis’ suspicions about many SSI also were reported by many other teachers in this study. They suggested that it is important to start from mass media to change and modify these suspicions. In fact, mass media was criticized heavily by many teachers and accused it of the ways these issues and science, in general, is viewed among Saudis. Like Jawad, a physics teacher, who said, “Honestly, media is very important but it is very far away from science… it is important to form discussions, round tables and spread them to people to convince those who are skeptical and refute their arguments.” Habbeb, a chemistry teacher, also emphasized this importance aspect of media. He affirmed, “Media is the only way to change people minds about these issues.” Hamad, a biology teacher, also mentioned a language barrier that influences good understanding to the nature of cloning and called for media to fill this gap. He said, “Most of the studies about cloning is in English… we need to translate these studies and offer them for public to understand the new developments about this issues… social media and other sources of
media should be used also to clarify peoples’ ideas about this issue and explain the religious aspects that are related to halal and haram. This may be the reason for people skepticism.” Hamad thinks that media serve two main tasks: increasing knowledge about cloning, and explaining the controversy involved in cloning to public. These two aspects are important, as Ahmad thinks, to clear off people suspicions about cloning.

**Question 3: In What Ways Do Saudi Secondary School Science Teachers Describe their Strategies of Teaching Particular SSI?**

Responses to this question revealed different themes including: Teaching and SSI, preparation and gradual inclusion of SSI, and the superiority of the scientific method.

**Teaching and SSI**

Many teachers expressed how teaching science is requiring a lot of efforts in Saudi Arabia. For example, they mentioned a lot of obstacles including lack of resources, and time management. In this section, there will a discussion of two aspects. First, Saudi science teachers’ views of teaching SSI. Saudi science teachers showed positive views regarding teaching these issues. Many teachers expressed that it is important to keep pace with the outside world and refused to omit any issue even if it contradicts religious or societal values of them. For example, talking about genetic engineering Hamad said, “Teaching an issue that benefits humanity worldwide means a lot to me. In fact, this is science and it should be taught. I highly encourage and support teaching it.” Second, a discussion of some major teaching strategies that have been used by those teachers. Participants chose to teach these issues in several ways. For some, it
was through sharing students’ own experiences by using collaborative teaching strategies. Moreover, many teachers, except only one teacher, said that discussion is the best strategy for teaching these issues. They mentioned some benefits of teaching through discussion including a better way of assessing students’ views, and touching different aspects involved in SSI. Some other teachers preferred that teachers need to have negotiation strategies. Finally, some teachers also focused on the value of media, internet in teaching them.

**Views of teaching SSI.** Different views have been reported by Saudi science teachers in this study. In general, many teachers showed positive views about teaching SSI. They emphasized that teaching these issues is important and necessary particularly in this era where science is quickly expanding and getting more complex. Other teachers also expressed feelings of discouragement pertain to lack of resources and knowledge. Some other teachers expressed how Saudi science curriculum is strict and other also mentioned how time management is a huge issue regarding the teaching of many SSI.

**Teaching these issues is important and necessary.** Many teachers in this study explained and emphasized that SSI are important components of science education and should be taught for Saudi students. Hamad emphasized positive views of teaching these issues. He emphasized:

> I strongly encourage students to study SSI. As you know some students may decide to continue studying genetic engineering or stem cells or any other discipline. They need to have at least some information about these topics. I do not want him to face a new science when they enroll in the university.
Hamad believes that many considered genuine science in different countries around the globe. He does not see a valid reason for not including them in the Saudi curriculum. Salih on the same direction support including SSI into the Saudi science curriculum. He emphasized that the Saudi society like any other society need many of these issues. Particularly, he talked about cloning and described how teaching this issue is important by saying, “We will find some people who need cornea or anything else, would not it be good to have it through cloning?” Salih sees no reason for ignoring cloning. He thinks that Saudis as all societies in the world have different biological and medical needs. He also criticized the lack interest of science among Saudis and emphasized that it is one of the reasons why science is not appreciated in a proper way.

Likewise, Jawad emphasized that teaching SSI important and there is no reason to ignore them in science education. He affirmed, “These issues stimulate students’ and teachers’ minds to look for knowledge beyond that of the textbook… it encourages students to be in a self-dialogue, which is a good start for developing inquiry skills.” Jawad thinks that SSI are important not only because of their benefits to humanity but also because of the valuable outcomes pertaining to developing students’ research skills. Even with their controversies, Aid thinks that SSI are important. He said, “From start to end, teaching science is a message. Even if there are some issues may contradict our values, my job as a teacher is to clarify right from wrong and let students decide.” To Aid, expanding students’ views of science to include even those issues that trigger controversies was an important job of teachers. He also added that teachers are responsible for delivering these issues to students otherwise "students would have no
genuine access to them”. Similarly, Habbeb emphasized that these issues are good for their benefits to humanity. He added, “At the end, I think these issues serve humanity… also, our students need to know what is happening in the world.” He thinks that teaching open students’ minds to different aspects related to improving the lives of people, which is considered the important task that should be addressed.

**Difficulties of teaching SSI.** Some teachers expressed different obstacles regarding these issues. Some of these obstacles were internal as some teachers expressed a lack of knowledge and understanding of many their religious and societal beliefs related to teaching these issues. Some external obstacles were mentioned also including the strict curriculum applied on science studies in Saudi Arabia and the lack of resources and materials needed for teaching SSI. Since teachers’ religious and societal influences were discussed earlier under the main theme influences in this analysis, more focus will be given to the rest of the obstacles in this section.

**Lack of knowledge.** Many teachers in this study emphasized that it is important for them to comprehend and know all aspects involved in the issues they teach. They also reported that teaching difficult as these issues are difficult themselves. For example, Majed said, “I think many SSI are above students’ understandings. Talking about cloning, nuclear energy or some other topics involve complexity that I believe students would not be able to comprehend.” Majed suggested that students only need some information about different SSI in a very little way. In addition, being knowledgeable was also accompanied with being confident and able to teach science and SSI smoothly. Some other teachers, like Hamad, emphasized that misunderstanding of religious
instructions behind some issues could play an obstacle toward accepting them, cloning for example. He criticized how sheiks could judge some of SSI based on lack of knowledge about the nature of these issues. He said, “Some sheiks would not cover all aspects of cloning. They may give a false judgment because they do not comprehend how this issue could save thousands of lives. Unfortunately, people take their judgments seriously.” Hamad thinks that these issues require a great amount of knowledge that far surpasses the already existed information among people. In addition, Hamad thinks that many of SSI are considered new knowledge that need time to be absorbed by Saudis. He said, “why do not we provide courses that explain cloning and show people how beneficial this issue is to their lives? ... Preparing the ground for these issues through focusing on the intellectual aspect is far more important than anything else.” Hamad believes that teaching issues like cloning lack an informative base that is still missing from the Saudi curriculum.

Some other teachers, like Majed, think that knowledge of these issues is important and unavoidable. He, therefore, thinks that having good awareness about these issues is a key principle for teachers to help them teach these issues. He said, “These issues need comprehension, which is hard to students… it also needs depth…, therefore, teaching it is complex… I do not expect that we can teach it in-depth in the Saudi curriculum… at least now.” Majed sees these issues complex and involves a lot of information that are not easy to be delivered to Saudi students within the already existed curriculum. However, some teachers think that a lot of teachers know little about many sometimes just key aspects of them. When asked about whether he encourages other teachers to teach SSI
Ahmad, a biology teacher, said, “Teachers in my current school and even in my previous school do not have adequate information about many SSI, for example, stem cells. They may have only small headlines. It is a new science and needs time to be absorbed.”

Ahmad thinks that the major obstacle is not teachers’ willingness to teaching their knowledge and awareness about them.

When asked about some major reasons for rejecting these issues in the Saudi context, Saeed, another biology teacher, emphasized that lack of knowledge is a major reason. He said, “Knowledge about these issues, as the nature of science, expands gradually and that would be a reason why teachers do not have enough knowledge about these issues when they teach them. I believe it is one of the major reasons for rejecting these issues.” Saeed’s emphasis on the importance of having adequate knowledge of these issues was also reported by many teachers in this study. Similarly, Hamad emphasized that these issues require a great deal of understanding and depth. He mentioned, “Usually, SSI need research and adherence. I sometimes find myself delving deep into some issues to be able to solve its problems and adequately teach them to students.” To Hamad, teachers should have enough knowledge about these issues to be able to handle its whole aspects.

Freed also said, “Cloning is a huge issue… talking about it is tough… I still think that cloning is a huge subject and I cannot comprehend it socially religiously and even scientifically.”

On another hand, Habbeb emphasized on how lack understanding of some issues may lead to increase arguments and therefore less acceptance to them. He said, “One of the biggest obstacles to handling these issues is students’ lack of understanding and
knowledge about them. They may have false information about an issue and consider their knowledge to be true. It is hard to change such knowledge later.” Habbeb emphasized that there is a need to address these issues meaningfully and provide enough information to students about them to give them accurate ideas about the nature of them. Otherwise, he believes that students may look for information themselves that may lead to not accurate information about them through the internet or any other means and increase their controversy. Similarly, Aaty discussed how Saudis are more connected to social media than regular mass media and warned, “social media and the internet are not generally genuine sources of knowledge. They depend on ignorant sources that we do not know about, which makes their trustworthiness very low.” Aaty thinks that sources of accurate knowledge about different SSI are limited; even in the textbooks. He asks for more attention to different means including social media to expand awareness and knowledge about many SSI, which he thinks is appreciated among Saudis. Jawad on the same hand emphasized that Saudi society is more open and more developed. He mentioned how Saudi people started to get more connected to the new things in science and technology specially the new thoughts and ideas that have innovation and thinking out of the box. Like Habbeb and Aaty, Jawad emphasized that there is a need to provide enough knowledge to students about different issues in the Saudi science curriculum.

*Lack of resources.* One of the major reasons that influenced Saudi science teachers’ experiences with related to the lack of needed resources. For example, Majed thinks that what prohibits the good teaching of many that there are no “science labs” in his school. In fact, this issue exists in some Saudi secondary schools, especially the
rented ones. Some other teachers mentioned specifically some of the resources they think are missing from schools. For example, when describing some difficulties of teaching these issues Muhannad said:

> Usually, we have a lack of resources like proper labs, projectors, computers and others. When I have these resources in hand it is easier for me to teach these issues and science in general. However, sometimes these tools are used by other teachers in the school or not even exist. I, therefore, find myself should teach in a regular way using lecture type strategy. I know it is not enough, especially when I need to show students a YouTube video or so but I have no choice.

Muhannad believes that teaching complex as these issues are complex themselves. Such complexity requires appropriate resources to be able to address different aspects pertain to some of these issues. However, lack of these aspects was considered the main obstacle toward teaching them.

Ali, a biology teacher, who saw himself good at teaching science emphasized that his school does not provide appropriate labs and science resources that could help him to deliver the needed materials proficiently. Like Muhannad, Ali believes that teaching cloning or genetic engineering is more efficient using different resources like computers, projectors, smart boards and others.

*The Saudi science curriculum.* Some teachers emphasized that science curriculum in Saudi Arabia does not give a considerable attention to SSI. Teachers like Salih, Muhannad, Majed, Saqr and many others emphasized that they stick to the assigned curriculum. Ali was one of the teachers who expressed this confined freedom of
teachers that is controlled by strict curricula. He said,

The general department of curricula has no willingness to form and establish a curriculum that is specialized on our characteristics as a country with all its religious and societal features. I know science is not meant to be for specific people, but I think it is important to situate science curriculum within our understandings as Saudis. Unfortunately, we import some curricula from abroad and translate them thinking that they may fit in our society. What we do is only adding some materials and omitting others.

Ali was discussing the new curricula that were imported in cooperation with McGraw-Hill. He believes that despite its proficiency and advancement, they do not reflect us as Saudis. He mentioned how the ministry of education is omitting a huge portion of a lesson was talking about cloning and how such action is not professional.

Criticizing the science curriculum, Freed highlighted that the Saudi curriculum needs to change to be able to address SSI meaningfully. When asked about how would he evaluate the difficulties involved in teaching the Saudi curriculum he said, “We need to modify our curriculum… the ways that we teach these issues within the curriculum is very poor… we also need to educate teachers and make sure that they know what to do when they teach cloning for example or so. It is not an artificial process.” Freed thinks that Saudi science curriculum is way behind when it comes to teaching and addressing SSI. He also recognizes that due to some religious and societal reasons including and focusing on some issues within the already existing curriculum is difficult.

On another hand, many teachers expressed that they stick to the assigned
curriculum that comes from the ministry of education. Fouad, a physics teacher, said, “My frame of reference is the assigned curriculum. I rarely go beyond what is required in the textbook.” Similarly, Muhannad expressed how he is obligated to go with and adapt to a confined freedom that is applied to the curriculum when talking about some SSI. He said, “The choice is not mine. At the end, I have a curriculum that I am required to finish by the end of the school year. Since I am obligated to teach this curriculum, I would not go behind what is expected from me.” Jawad also mentioned that “when supervisors visit us in our classrooms, they would not ask about the types of questions that we already addressed or the ways by which we discussed SSI. Instead, they emphasize on finishing the assigned curriculum.” Jawad believes that teachers do not have an important freedom to address many SSI meaningfully.

Moreover, even though Salih believes that the new curriculum that is assigned to the secondary school levels in Saudi Arabia is still in need for some modification to be contextually situated around Saudi needs and understandings, he thinks that these curricula gave some ideas, even little, about some issues like cloning for example. However, he thinks:

Even though these curricula are new and involve new and inspiring topics, they face a lot of disapproval and condemnation, especially from the part of teachers. They criticize why these new curricula came from outside the country, (from McGraw-Hill Education), even though the ministry of education has already revised them and try to assure their adaptability to the Saudi context, teachers still argue about whether we teach it or not.
Salih thinks that Saudi science teachers are taking a position on some issues because they are already existing in these new curricula that are not affiliated to they think is their own norms and contexts. He does not see a real reason for rejecting these issues as he believes that the intellectual aspect of science should be the basis for any disagreement in any of these SSI.

**Teaching strategies.** Different teaching strategies have been reported by Saudi science teachers in this study. However, many teachers expressed how important it is to focus on students-centered strategies when teaching SSI. Some other techniques included the importance of being neutral when teaching SSI, the ability to control students’ behavior, the importance of given students’ freedom. They also mentioned how negotiation strategies are missing and the importance of extracurricular activities like the internet, workshops, reports, brainstorming, extra resources in teaching SSI.

**Neutrality and SSI.** With this vast and expanding nature of science as a discipline, some teachers called for more plainness and openness to understand science implicitly. Being implicit emphasizes the importance of having an open mind that is not interrupted by other disciplines like religion for example. Salih emphasized that one of the benefits of more focusing on the scientific method in the Saudi society, as a way of knowing, is to understand science neutrally, which he thinks needs openness and open thinking. Such openness, Salih thinks, “will lead to more understanding and therefore more reliance on science as a discipline in the Saudi society”. To Salih, being neutral is associated with more focusing on the scientific aspect of therefore the justifications that are derived from such understanding will lead to more acceptance of many SSI.
Moreover, on his discussion of teaching SSI, Jawad emphasized that due to the complexity of these issues he preferred to be neutral and not take any position with or against any issues while teaching. He said:

In these circumstances, I prefer to ask a question about any issues, let me say cloning for instance, after obtaining students’ attention I know that I will find some agree and some others disagree with the issues being discussed. My role here is to let students convince their counterparts of the validity of their ideas. I will serve as the judge who does not talk until the last minute… I would not give any opinion I just manage the discussion.

Jawad thinks that the best way to teach SSI or any issue that may trigger controversy is through letting students conduct their discussions by themselves. He thinks that students need to hear from each other. He also prefers that students generate ideas and try to validate them, which would be an impulse for them to look for answers to their own inquiries. In respect to teaching cloning, he added, “I usually find a lot of beautiful thoughts from students, I write them down, then I try to focus the discussion around some of these thoughts… sometimes I wait for more than thirty minutes in generating ideas with students… the discussion is great.” Jawad thinks that being neutral when teaching cloning would give students a hint that their ideas are valuable, especially when talking about such a controversial issue. Commenting on why he thinks this strategy is good for teaching SSI he said, “students will have a space to discuss their concerns… They will be able to touch on religious and scientific aspects of these issues.” Being neutral, Jawad thinks, is a good way to addressing students’ own concerns and understandings about the
controversy involved in SSI.

Shaher describes his understanding of being neutral in different ways. He emphasized that he does not limit or shrink students’ responses and participations. He said, “I do not have any problem with students who have different thoughts other than mine. Even if there are ideas that are religiously not correct I try to convince students of their mistakes.” Shaher thinks that teaching any issues with connection to religion or any other aspects is hard. However, he believes that being neutral is a good strategy for meeting students’ concerns and understandings about these different aspects. Similarly, Aid thinks that the best way to teach through tolerance and through receiving students’ discussions soundly. He said, “In general, as educators, we need to treat students in a very soft and sound mood. Whatever they say, start a conflict, or even misbehave we need to accept their actions and let them express themselves… later we can clarify their mistakes and concerns.” Aid thinks that teaching SSI requires teachers to be patient and accept students’ actions. He believes that being neutral is accompanied with being able to accept and tolerate students’ different concerns and inquiries about SSI that may include or drive to misunderstandings sometimes.

Moreover, Freed provided an example of how being neutral, that requires equal consideration to all aspects involved in many SSI, was important to address a lesson about plastic surgeries. He said:

I remember once when I was discussing plastic surgery with students… some students were saying (THIS IS HARAM) and they mentioned how God has already created us in the best of shape, (a meaning that exists of a verse of the
Quran) … at that moment I tried to accept all their concerns and I told them that it is not appropriate to reject some issues because we think it is HARAM. I tried to convince them of the validity of this science saying: for example, consider that someone has been set on fire, burned or has body problems from any type… would plastic surgery be OK with them? Would this surgery be important in their situations? I think some students started to change their views.

To Freed, being neutral is associated with being able to accept and absorb students’ different views of many SSI even if they contradict teachers’ own beliefs and understandings.

Controlling students’ behavior is important during teaching these issues. Many teachers in this study emphasized that it is important to have a control over students’ behaviors when discussing SSI. Teachers like Salih, Jawad, Fouad, Muhannad, Aaty, Majed, Saeed and others emphasized that students’ behavior during the teaching of many a concern to them. They think that these issues trigger disputes and sometimes such disputes would make teaching these issues more difficult, especially in the Saudi society they described as religious. However, they mention many strategies of dealing with such disputes.

Aaty, a biology teacher, thinks that students’ disagreement may force teachers to look for and do more research about the issues under discussing in class. He also added that he asks students to do more research themselves to find answers to their own arguments. Most important, Aaty thinks, it is important to convince students scientifically and if needed religiously by providing appropriate evidence to avoid
“students’ rejection or sometimes disrespect when addressing some issues like sex education for example. Some other teachers think that Including some of these issues is important to let Saudi students get in touch with different perspectives in science regardless of their behavior. However, Habbeb, who is a chemistry teacher for 8 years in a suburban secondary school, thinks that some SSI are hard to be taught in Saudi Arabia. He gave an example of the theory of evolution:

I remember once I was discussing the theory of evolution with my students. I explained the theory… of course most students knew nothing about the issue because it is not in the assigned curriculum. One student though said that this theory states that humans came from monkeys. When he said so all class were laughing and took him jokingly… I remember that I had difficulties to handle that situation… To be honest with you I had no answer

Even though the theory of evolution is not included in the Saudi curriculum, Habbeb tried to understand how his students would value and understand this issue. After this experience, he emphasized that teaching the theory of evolution in the Saudi society is hard, especially with students’ lack of understanding of the nature of this issue.

Fouad, a physics teacher, treats his students’ behaviors pertains to teaching SSI in a different way. First, he distinguishes between two types of students. He thinks that some students have goals of “wasting time, asking for fun, or even trying to embrace you as a teacher. Sometimes students ask to show themselves over you by focusing on your mistakes.” The other type is those who really “ask questions because they need answers… they need to know.” However, even though the first type is not trying to find
an answer, as he thinks, he treats his students equally. He said that he considers their concerns and tries to explain in detail the needed information to illustrate their inquiries.

Jawad has a different style of handling students’ behavior regarding SSI. He thinks that when there is a huge disagreement occurs between students, he intervenes and “focus on the scientific aspect of this issue.” Jawad believes that any religious disagreement should be set aside because it is the job for specialists. He said, “I always say to my students, take science as only science and when to have concerns discuss them later… Focus now on science.” Jawad thinks that delaying the disagreement or disputes about some of these issues is the best way to address any controversy within these issues as students would focus more on the scientific aspect that may get them more convinced about some of these issues. Similarly, Salih with his emphasis on the importance of the scientific thinking believes that science should not be controversial at all. It depends on “Causality” as he thinks. He believes that much of the attention should be given to the scientific aspect of these issues to avoid some controversies embedded in some of these issues.

However, Freed thinks that ignoring these aspects is not possible even if the teacher tried to avoid them in his teaching. Therefore, when he faces some disagreements or inappropriate behavior among his students, he tries to absorb these disagreements and remind them that science does not at all contradict religion. When teaching cloning he faced some disputes among his students, he said, “Sometimes I say to my students that we only need to study cloning because it is in the curriculum and it is science and we have to understand science. Applying cloning is something we do not discuss here in our
classroom.” Freed believes that students should learn cloning even though they may not be fully accepting this issue. He focuses on the scientific aspect and tries to convince his students that what is needed in his classroom is the scientific aspect only.

**Students should have freedom to discuss their thoughts.** Many teachers emphasized that students should be free to discuss their thoughts regarding these issues. Salih, Jawad, Fouad, Saeed, Aaty and some other teachers emphasized how important it is to leave a space for students to share their ideas about SSI. For example, Freed highlighted that he gives a space for students to express themselves freely when discussing cloning. He said, “I accept their perspectives, even if they contradict mine… sometimes I try to convince students that their ideas are not correct, however, if they have proof I tactically withdraw from the discussion and I review the topic again and read more about it to be able to respond to their inquiries later.” Freed thinks that it is important to leave a space for students to discuss many SSI. He thinks that such space would encourage them to share their ideas in a good way.

When talking about cloning, Jawad, a physics teacher, criticized those teachers who do not give appropriate space for students express their feelings. He said, “It is a genuine right for students to freely express their feelings and ideas about cloning… I think the teacher who does not give such space is afraid of his students… to me, it means that he did not prepare enough for teaching it nor did he realize the depth of this issue.” Similarly, Hamad highlighted, “I allow students to speak freely about the scientific aspect of many SSI. I give my opinion like anyone else in my class does. They need to have a free and honest environment to express their feelings not only about SSI also about
different science topics.” Hamad also believes that given students such freedom will allow them to touch on their concerns about these issues, which is very important he thinks.

However, Hamad emphasized that it is important to respect students’ beliefs and try not to violate them or prejudice against them. Hamad said, “We do not teach cloning because we want to challenge students’ own beliefs or make students suspicious about their beliefs. Rather, all I need is a space for students to discuss these issues.” Freedom was seen very important particularly when discussing SSI. Also, he emphasized that religion is a red line. He added, “Usually, I try to build constructive discussions with my students. I give them freedom for speaking whatever they think but with limits. They usually share their perspectives and I will share mine as well. However, we try not to intervene in religious arguments.” Hamad believes that it is essential for students to have a space to express their views about SSI. However, like some other teachers, he emphasized that such freedom should be limited. Similarly, Habbeb emphasized that he gives his students freedom to discuss many he intervenes when “Racist speech or strong views against other students… at this point, I stop the dialogue.” Habbeb also emphasized that it is important to convince students and address their concerns even if the time passes for the lesson. He thinks students’ interest in science should be increased through addressing their questions.

**Discussion is the best teaching strategy.** Many teachers in this study emphasized that discussion is the best strategy for teaching SSI. Some teachers like Salih highlighted that using discussion strategies is one of the best ways to address the importance of given
students’ freedom to discuss their thoughts about many SSI. He said:

Discussion strategies take away a lot of the burden from the shoulder of teachers and place it on their students… they give democratic means inside the classroom where an issue is presented for negotiation… teachers in this context are only part of the teaching process… the part is their students… everyone shares his ideas.

Salih added that teachers need to be well prepared to teach using these strategies as they are very difficult to be performed.

Similarly, Fouad highlighted that discussion is not even a choice by teachers but a necessity that needs to be performed during the discussion of many SSI. He said:

The idea that you can teach these by enforcing your views as a teacher on your students should be abandoned and it is impossible. People are different nowadays and are students … you may say something today and after a lesson or two or maybe the next day the student comes to you and say that he logged into some website and found another information that contradicts yours as a teacher.

Students nowadays are more open to discussion… I remember once that I discussed cloning with my students and we have a dense conversation about it… they told me how can we make this creature that we already cloned alive, from where did it get the soul… this something only God can do… and those sorts of questions… however, I think it is important to leave a space for them to ask these questions and try to convince them at least of the scientific aspect of cloning.
Fouad’s experience with teaching cloning using discussion was not easy as he reported. However, he believes that it is the best way to cover a wide range of students’ concerns to many SSI.

Moreover, using this strategy was accompanied with helping students to touch on their concerns and inquiries about different aspects pertaining to many SSI. Teachers like Jawad, Saeed, Majed, Shaher, Malik and many other teachers also reported additional reasons for their emphasis on the discussion as the main strategy for teaching many SSI. For example, Habbeb said “The best strategy is the discussion. It lets me hear all different perspectives from my students. I also try to engage all students even those who do not participate in enriching the discussion. At the end, I try to connect all different aspects and summarize their responses.” Habbeb believes that students need a space for discussing their views of SSI. Such space is hard to be obtained without letting students discuss and intercommunicate with each other to understand different perspectives about SSI. Some other teachers, like Hamad, used different strategies but he thinks the discussion is the best. He said:

To me, I use different strategies. I use active learning, cooperative learning, brainstorming, storytelling strategy and others… However, discussion strategies are best because they leave a space for students to express their feelings… It stimulates their thinking about these issues that I am talking about… This strategy also will help students to express themselves, talk freely and constructively under my supervision and in front of their classmates, which will be powerful for them.
Hamad believes that this strategy helps students to construct their ideas and build their views on concrete bases depending on how they see cloning, for example, and the different perspectives they receive from each other. He thinks that given them this freedom is the best for addressing their religious perspectives and help the teacher to avoid shocking experiences with students when touching some controversies as everything is under discussion. He emphasized that he likes to trigger some argumentative aspects during his discussion with some SSI to “Stimulate thinking and excitement among students with respect to each other’s opinions and without violating the good behavior.”

Similarly, Wesam, a biology teacher, thinks that discussion is not only appropriate because it gives a space for conversation about these argumentative issues, but also to address some of the “false ideas about these issues that have resulted from students' own search through internet or so.” Using discussion strategies, therefore, is accompanied with touching students’ concerns and understandings freely and in an open and easy way. In addition to the value of discussion strategies on increasing teachers’ neutrality when teaching SSI, Jawad also reported that he enjoys teaching controversial issues through discussion. He said, “You discover very beautiful ideas, sometimes I find a new idea from students that I know nothing about or do not know how to deal with at the time… however, I record it take notes and discuss it later with them when I figure out the answer… it is really fun.” Jawad believes that using discussion strategies are not only helpful for increasing students’ understanding but also for teachers as they may discover new directions that they did not think of earlier which would, “Enrich the discussion of
many SSI.”

The benefits of using discussion strategy were also pertaining to students’
happiness and love to get engaged in the different aspects involved in many of these
issues. Wesam said:

When I discuss cloning I start up a discussion table between me and my students
and among themselves… everyone shares his ideas… the door is open for every
one of them to express himself and discuss whatever he wants regarding cloning,
for example … and they know that their ideas are appreciated and valued… no
grades no pressure… nothing… students feel they are not forced.

He believes that discussion strategy is not only beneficial as it helps students to share
their ideas freely but also to take out the pressure that exists when they are required to
perform a test or so. He also added that this is the best way to assess students’
understandings and views of SSI, comparing to what he thinks the “outdated paper and
pen exams types.” Similarly, Aaty believes that discussion is beneficial as it gives
teachers ways by which they can determine the strengths and weaknesses of their
teaching practices, especially when teaching controversial issues. He said:

Some students have personal convictions that are hard to be extracted without a
discussion strategy that let you as a teacher to see the strengths of your
approach… when I discuss my students I can touch on those aspects of them that
make teaching and understanding SSI hard… sometimes I succeed to change their
views.

Aaty thinks that discussion is good for stimulating students to share their concerns related
to many SSI. Even though he believes that teaching these issues is hard in Saudi Arabia, he believes that many of students’ not accurate views would be easier to be addressed through discussion.

Using discussion strategies also was reported by Freed who thinks that he prefers to examine his students’ religious views of many SSI through a specific class that is aimed to extract these views and address them. He said that he divides his class into two separate sections, especially when the issue has controversy. The first section is dedicated to “Discuss the religious and societal aspects… I try to bring their views together, discuss them and make sure that they understand everything related to them… when I make sure that I addressed all of their concerns I move up to the scientific aspect of the issues.” Freed believes that discussion is important to handle students’ values systems. He thinks that through discussion he can see how these views are constructed and try to bring these different views together to be able to discuss the scientific aspects of SSI after making sure all the religious and societal aspects are addressed and discussed.

**Preparation, Comprehension and Gradual Insertion**

Using discussion, negotiation, and other student-centered strategies were crucial to introduce a lot of Saudi students. However, many teachers expressed how teaching Saudi students are not easy and need a lot of efforts. For example, Ali believes that science is still conceived as a hard and tough topic that “Is hard to understand due to a long history if seeing it within Saudis.” He suggested that science should be introduced differently to be able to get accepted among students. Otherwise, Ali thinks it is
important to discuss deeper topics like SSI. Ali highlights that it is important to think deep into the scientific arena in Saudi Arabia and focus on procedures and ways that are more approachable to introduce SSI effectively.

**Gradual insertion.** One of these procedures that have been reported by many teachers is their emphasis on gradual and slow introduction of these issues to let students absorb and comprehend them. The emphasized that since a lot of these issues have different religious and societal interpretations, there is a need for more in-depth and comprehension when teaching them.

For example, in his discussion of how would he teach some religious related aspects to SSI, Jawad said:

At the beginning, if that thing (issue) is HARAM then I will try to understand the parts that have problems with this issue. Then, I will try to bring together all different opinions of these issues until I believe students are aware enough of all aspects… We need to focus on the scientific aspect pertains to this issue and how it is beneficial and understand the reasons for the religious disagreements with it to be able to reevaluate our understanding of this issue and reflect this understanding to the society.

Jawad believes that even if there is a religious influence of issues that prevent people from taking advantage of them, it is important to cover all aspects pertain to these issues and let people decide later. Such gradual inclusions, he thinks, may dissolve, or even refute the religious misunderstanding that pertains to many SSI. Habbeb emphasized this way of solving controversies involved in some of these issues however he also
emphasized that teachers need to have “a great deal of science and understanding to this issue to be able to convince and refute arguments.” Later Habbeb emphasized that focusing on the scientific aspect of an issue at the beginning then trying to include all aspects involved in them gradually may lead to more acceptance “Even if there is an argument here and there.” Habbeb added, “I try to convince my students scientifically, then socially, and virtually… I mean from all aspects possible I try to convince them.” Hebbeb thinks that introducing the scientific aspect then gradually discussing all aspects involved in some issues is the best ways to introduce and discuss the different religious and societal controversies of these issues.

**Comprehension and preparation.** Preparing science teachers and providing them with enough knowledge and understanding to deal with the different aspects involved in these issues was also an important aspect that has been mentioned by many teachers. For example, when asked about the best way to deal with these issues Jawad said, “The beginning is from teachers themselves, we need to prepare them to able to handle these issues correctly and clearly to assure that we do not face obstacles when they teach them and to refute all arguments.” Jawad believes that teachers are the milestone for handling these issues. He calls for more attention to be given to comprehensively prepare those teachers to deal with these issues. He added, “The teacher needs to realize that these issues are complex. To teach them, he needs to get prepared very well and introduce the lesson with dedication.” Later in his interview, Jawad mentioned that he plans his lesson very carefully. He said, “In general I love science topics, however, when I teach issues like cloning a get more prepared as I love
those topics that trigger arguments and students’ curiosity.” Similarly, Majed said, “When I teach cloning I get prepared enough before class time. I usually get prepared with some questions in both scientific and religious aspects.” Getting prepared was accompanied with increasing ability to address students’ concerns and questions particularly with a controversial issue like cloning.

Getting prepared was not only related to teachers but also to how do Saudi science curriculum introduce these topics in Saudi Arabia. Some teachers think that these issues have a long history in the western world and therefore there is a need to benefit from all experiences all around the world before we apply such teaching of these issues in the Saudi science curriculum. For example, when applying and introducing issues like cloning in the Saudi curriculum Habbeb emphasized that there is a need for comparing experiences from different countries and choose what best fit our needs in the Saudi society. He said, “We do not need to limit our resources from only one country. We need to comprehensively understand how these issues were taught and introduced in different countries around the world and choose the best that fit our needs.”

Similarly, Hamad mentioned an example of teaching lessons like stem cells. He said, “My students were so confused and they even did not believe me when I said that we can get cells from fetus inside their moms… until I discussed some experiments that have been made in an American university where they understood how this issue is beneficial to help a lot of patients who lost some of their limbs.” Hamad also emphasized that there is a great need for comparing and evaluating experiences of teaching these issues to other countries to benefit from their experiences in this aspect. He also
emphasized that students need to comprehensively understand these issues from all aspects and in a top to down way. Explaining his idea about starting from top to down, Hamad said, “I prefer that we teach these issues at the university level first… then gradually we can introduce these issues to students in high school until society absorbs these issues slowly and gradually.”

On the other hand, Saeed emphasized that these issues are very deep and need specialists who can handle their depth. He said, “I believe it is hard for students in public school years to comprehend or even study these issues and understand them. I think all we need is to give students in school years just some ideas about these issues, not more.” Like Hamad, Saeed thinks that these issues are very deep and complex to the point that it is hard for students to comprehend. They believe that more disadvantages are expected if there is more focus on these issues on the curriculum.

Particularly, the emphasis on the importance of the gradual introduction of these issues was also mentioned in different interviews. For example, even though Muhannd disagrees with Hamad and Saeed on the best time to teach these issues to students, he agrees that these issues need to be introduced gradually. Muhannd emphasized that introducing these issues should start early in students’ lives. He said:

First, any start should be through schools from the early ages of students. We need to make students love science. The way we teach science in Saudi Arabia is very abstract and uninteresting. We only focus on textbooks or maybe sometimes a video episode or so, which is not enough as there are a lot of ways to reintroduce science among Saudis. Second, we need to comprehensively
introduce science to all society through TV, and newspapers and show people
how science is important to their lives by connecting these sciences to their lives.
Then, when such comprehensive and gradual introduction of these issues is
approached, society will be able to refute and even destroy any religious opinion
that may be seen an obstacle to teaching some of these issues… The society will
have no fear to discuss these issues.
Muhammad thinks that the reason why Saudis reject some of these issues is not only
related to their religious opinion alone but also is accompanied by a lack of knowledge
about these issues. He sees the gradual introduction of these issues to change this view
among Saudis. Ali, a biology teacher, supported his thinking of the importance of
gradual insertion of these issues in the Saudi society by proving an example of test-tube
baby issue that had some criticism in the past. He said, “a while ago, I would say ten
years ago, test-tube baby issue was banned and seen contradicting Islam, but now as you
see all is good and people started to realize its importance.” Commenting on the
importance of gradually introducing SSI to students, Freed said, “We cannot hit students
with these issues without proper insertion. Some of these issues are very opposed to
students’ religious views … instead, we can prepare some courses that show them the
interrelationship between science and both religion and society.” Freed himself
emphasized that he teaches these issues in a similar manner. He said:

Usually, before I teach these issues that have religious or societal problems, like
cloning, I allocate a whole class for preparing and touching those problems. I try
to handle the lesson religiously, societally and from all aspects, except scientific
until I make sure that those students understood the connections that exist between cloning and those aspects... the next day I will find my students prepared and ready to discuss the scientific part with a more open mind.

Freed's emphasized that students should be introduced gradually to these issues were the focus of many the rest of the teachers in this study.

**Scientific Understanding is a Base for Agreement**

Another example of how Saudi science teachers view and handle clear on their focus on the scientific aspect of them. Many teachers understand that even if there is a controversial aspect influence including some SSI, they emphasized the need for a more focus on the scientific part and its benefits to society and Saudi people. Some of those teachers said that Saudi students have the right to learn SSI implicitly. Other teachers said that science should not be devalued because of some religious beliefs that are not compatible with the good understanding of the nature of them. Therefore, they emphasized the superiority of the scientific aspect on many SSI. These different views will be analyzed in this section.

**Saudi students have the right to learn the scientific aspect behind SSI.** Even though these issues include difficulties in different levels, as reported by many teachers, they clearly emphasized that teaching them is a genuine right for students. For example, Jawad emphasized that teaching these issues is important and necessary. He affirmed:

As a science teacher, I need to introduce all aspects involved in these issues from all perspectives and all angles. I try to avoid completely my perspective about these issues when I teach them, for example, cloning... we need not refuse to
teach any issues even if it has a controversial aspect. As a teacher, you provide
the scientific aspect along with the controversial aspects for students to be aware of.

Jawad also expressed in detail how important it is not to limit students’ ideas about these
issues. He thinks that they need to comprehend all aspects involved in SSI being taught
and it is not the right for teachers to refuse teaching any issues.

Freed believes that his students are more orientated toward the understanding that
science and religion are two separate entities that should not shrink each other. He said,
“I can say that the new generation, my students, has an idea of disconnecting science
from religion because they think science does not contradict religion at all unless we use
it against religion.” Freed thinks that students are leaning more into the scientific aspect
of science more than anything else. The emphasis on understanding science implicitly
was affirmed by Freed in different spots of his interview. In comparison, Muhannad
believes that teaching these issues is important even if there are a religious or societal
controversial aspects involved in some of these issues. He said, “I need to provide the
information about these issues even with a focus on the controversial aspect.” Shaher
justified more on this aspect and emphasized that some of these issues have already
solved health problems like genetic engineering for instance. He added, “I think it is
indispensable to teach these issues and have students know all about them who will later
decide on the religious or societal aspects involved in them.” Shaher thinks that science
teachers need to understand their role only in terms of a neutral figure who is obligated to
avoid his beliefs and fully focus on teaching all aspects of these issues to students. He
also thinks that students have the right to accept or reject these issues and they should be given the choice to decide.

**Superiority of the scientific dimension in science.** Some of the teachers in this study revealed different understandings of the nature of science pertain to discussing some of SSI. For example, Fouad emphasized, “I believe that I focus mainly on science. I do not have much in common with humanistic dimensions' especially in my topic, which is physics.” Fouad believed that physics has no strong correlation with humanistic dimensions in comparison to biology, which he thinks is more connected. He also added, “The content that we have in science is constant and stable. The common knowledge in science does not change in all countries and all religions.”

Moreover, Majed emphasized that he focuses mainly on the scientific aspect when teaching science. He said, “I prefer that we focus on what scientists’ say and conduct on science.” When he was asked about how would he think if someone says that there is a religious opinion against science, Majed said, “But the scientific principles are correct.” Majed focuses heavily on the scientific aspect of many of these issues even though they may trigger some religious controversies. Moreover, some other teachers emphasized that the scientific method of obtaining knowledge is one of the strengths of science that should be emphasized among Saudis. Even though the focus on the importance of the scientific method was reported by many teachers in this study, which is a common misconception about the nature of science, many teachers understood this aspect to be a major aspect toward accepting and considering many SSI. For example, even though Salih emphasized that we may face some humanistic aspects in science, we
should focus on the “Scientific method of science as it is very important for the neutrality of experience.” He thinks that science needs to be practiced through the scientific method to assure more neutrality of the scientific experience. Otherwise, he thinks “We may face objection if we did not do so, especially with some aspects that may deter us from proceeding the work on some SSI.” Similarly, Jawad thinks, “We can teach cloning positively by focusing on its scientific dimension and explain how does it cure some health problems to be able to avoid genetic diseases.” Muhannad also emphasized that teaching any issue should incorporate how such issue would develop and change peoples’ lives and the benefits that society may get from applying it, but through a focus on the scientific aspect first. Similarly, Shaher emphasized on the positive aspects of called for focus on them when teaching or addressing these issues to students. He said, “We need to focus on the positive aspect of cloning to convince students of its importance.”

Even though some teachers focused more on the scientific aspect, they did not ignore the importance of the humanistic aspect when teaching these issues. One of those teachers was Aaty who expressed feelings about the importance of the scientific fact in science along with how such issues touch religious or societal aspects of people. He said, “Neither religion nor societal influences would change my focus on the scientific part of science. It is essential to teach it. However, I explain the religious judgment if there is one. I also believe it is my job to explain the religious or societal touches that are embedded in some issues as I believe it is important to connect science to our religion.” Aaty emphasized that this is the best way to bring together both what is required in the curriculum and the norms and traditions of the Saudi society. Similarly, Salih
emphasized that the humanistic aspect of science is important but should not be the focus at least at the beginning of discussing these issues. He emphasized that science should be conducted without such bias but employing the results of any experiments related to SSI should be done through humanistic means. Similarly, Jawad thinks that science usually is supported by evidence. He added, “Why cloning issues are controversial then. We need to free this issue from bias by focusing on the experiments and results that have been obtained scientifically and let people decide.” Jawad thinks that people, or “Wise people” as he called them, will realize these issues from all angles. He also emphasized that there is no need for controversy about this issue as he puts the burden on society to accept or reject them. When discussing how he teaches cloning he said, “To me, I discuss all the scientific aspects of cloning then at the end of my discussion I mention some controversial aspects involved.” Salih also believes that only through scientific discussions students will discover a lot about cloning.

Habbeb emphasized interest in teaching the scientific aspect of some SSI, but he thinks it is all needed by teachers. He said, “I teach the scientific aspect because at the end this is what you have to deliver.” Habbeb thinks that time and knowledge about some strong barriers that prevent or limit including some controversies in his teaching. Hamad also emphasized similar thoughts about focusing on the scientific aspects of some SSI. However, he differentiates between people’s values and morals and what he calls the real science behind these issues. He emphasized that even if there is some touch to people values it is important to mention where this touch exist but most important is to provide the scientific understanding. He said, “We need to mention that this issue is
under attack but to focus on the importance of understanding the science behind it.”

Hamad highlights that teaching genuine sciences where much of them are scientifically proven, therefore, it is important to teach them even if they have controversy as such controversy would be more clarified later.

**Conclusion**

The findings of this study reveal different perspective and teaching views of Saudi science teachers in this study. Even though this study tried to focus more on how Saudi teachers view these issues within the Saudi curriculum, other aspects were heavily reported during the interviews with those teachers. These aspects pertain to the nature of the Saudi education system that emphasized more religious and literature studies, as was mentioned by many teachers in this study. However, they also emphasized that the country is moving forward to changing this focus and give more attention, although slow, to science studies in Saudi Arabia.

Different themes have been focused during this analysis including; situating self as science teachers, the influence of societal and religious views, impact of society and Islam, and different views of teaching and teaching strategies have been reported in this analysis. These different themes are considered main reasons that influenced Saudi science teachers’ views and teaching strategies of SSI. In the next chapter I will discuss implications, recommendations and topics for future research. (see figure 1: Concept Map 0f the major findings in the next page).
Figure 1. Concept Map of the major findings
CHAPTER VI
DISCUSSION AND IMPLICATIONS

Introduction

Even though the Saudi ministry of education tried to renovate science studies in Saudi Arabia, through Tatweer project, little attention has been given to SSI in the new curriculum. It was important to understand how teachers feel about these issues as well as understand the nature of how teaching science using a wide range of aspects that are involved in SSI would be in Saudi Arabia. Specifically, with a lack of research that has been done to investigate this aspect of science education in Saudi Arabia. In addition, along with understanding of how Saudi science teachers view and teach SSI, this study provided a comprehensive overview of how science teachers place the aspects of religion and society within their framework when teaching science specially when touching SSI with their religious and societal complexities.

The inclusion of SSI has been emphasized worldwide as an important dimension of science education that provides more focus on the humanistic aspect of science and its interrelationship with people (American Association for the Advancement of Science, 2009, 2013; Aikenhead, 2006; 2007, Next Generation Science Standards, 2013). Along with ensuring more social justice practices of science studies among people (Zeidler & Sadler, 2008), as well as “contextualized learning environment for understanding the complexity of living and nonliving interrelationships” (Mueller and Zeidler, 2010, p. 106). Besides, despite the importance of discussing these issues worldwide, much of the attention has been placed within a western context (Sadler, 2011; Upadhyay, 2010;
Ziedler et al., 2005). This study tried to fill a gap in the literature and understand how Saudi science teachers view and teach these issues within a Saudi science education context. Mainly, with their different cultural and societal understandings that could be different from their counterparts in western countries.

Particularly, Saudi science teachers in this study provided varied and different views and teaching strategies of SSI. These views were consistent with some previous studies. For example, in this study, it is believed that different religious, societal, and cultural beliefs were reported by Saudi teachers influenced their views of SSI in both their experiences with different issues and the ways by which they address some of them in the science classroom. These different aspects were consistent with many previous studies that theoretically and empirically emphasized how such aspects inform thinking of many SSI with different contexts around the globe (Asgar, 2013; Barbour, 2010; Dodick, Dayan & Orion; Edis, 2009; Hsu, 2010; Martin-Hansen, 2008; Mansour 2007; 2008; 2011; Reiss, 2010; Roth, 2010; Sadler et al., 2006; Staver, 2010; Upadhyay, 2010; Winslow, Staver, & Scharmann, 2011). Therefore, the purpose of this chapter is to integrate the previous findings with previous literature review, investigate the implications of this study, show some limitations, and discuss some future research.

**Organization of the Discussion**

Early in this study, in chapter 2, I discussed the interrelationship between religion and science. I attempted to explain the role of causality on Muslims’ belief system along with other religious influences that frame Saudi science teachers’ religious worldviews of many SSI. Such discussion was important to reveal and describe Saudis’ frame of
reference when it comes to science studies, especially considering Pierre Bourdieu’s critical theory that I believe explains why Saudis stick to some views of SSI and ignore some others (Bourdieu, 1977; 1984; 2008). Bourdieu’s critical theory and his notions of habitus, field, and cultural capital informed the discussion of this study heavily as to why and how Saudis understand, place, and situate these different religious and societal considerations, and perceptions considering many SSI. Focusing on this aspect was important to understand and discuss the first question of this study that tried to investigate Saudi science teachers’ general and common ideas and perceptions of how they view SSI in the Saudi science curriculum, which is the first section of this discussion. Following, I will discuss some teaching experiences in both: views of teaching some SSI and actual teaching strategies that Saudi teachers used regarding SSI. This section will involve difficulties and promises that were reported by those teachers and compare them to other studies.

**Question 1: In What Ways, if any, Do Saudi Secondary School Science Teachers View SSI in the Saudi Science Curriculum?**

**Factors Influenced Saudi Science Teachers Views of SSI**

The first question of this study tried to investigate Saudi science teachers’ general views of SSI and the aspects that influenced such views. Having in mind the varied experiences and different backgrounds of the participants in this study, Saudi science teachers reported almost consistent views regarding many SSI to many previous studies that investigated the influence of such issues on teachers from different contexts.
Particularly, they reported multiple views and understandings that are integrated into different interpretations of how religion, society, and science interact within their own experiences, backgrounds and frame of reference considering many SSI.

Situating Saudi science teachers’ views of SSI (experiences, backgrounds).

Initially, Saudi science teachers represented variety of experiences and different backgrounds. Those teachers were affiliated into 10 different schools among which was one rural public school and another suburban private school. The rest of the schools were suburban public schools in the city of Tabuk. Teachers experiences of teaching science ranged from 3 to 14 years of experience with only one teacher has a Master’s degree in curriculum and instruction. Some teachers also mentioned the influence of other figures on their views on some SSI. In addition, three teachers were teaching physics, one chemistry, and the rest were teaching biology subjects.

However, even though this study tried to sample teachers from different schools’ backgrounds like Hamad, who is a biology teacher in the only rural school in this study, as well as Salih who was affiliated into a private school, further investigation is needed to assure that these different backgrounds influenced those teachers’ views of SSI. Particularly, future studies though need to investigate in depth views of how the type of school along with many different experiences and backgrounds of Saudi science teachers might make a difference in respect to viewing and teaching these SSI.

One might say that the strict science curriculum, along with the influence from principles and supervisors, as well as the lack of professional development that should meet the growing interest in SSI may be some of the reasons that emphasized the less
influence of Saudi teachers’ different backgrounds on their views of many SSI. In fact, many teachers have called for more focus on workshops and professional development courses that are dedicated to meet the new trends in science education and SSI that enhance their awareness and ideas about the new developments in many SSI. Others called for more freedom to cover the depth of some issues within their teaching practices. These findings are consistent with many previous studies that emphasized the importance of external factors like curriculum support for addressing many SSI (Deniz et al., 2008; Donnelly & Boone, 2007; Forbes, & Davis, 2008; Kara, 2012; Lee, Abd-El-Khalick, & Choi, 2006).

However, some teachers who held negative views of some SSI referred that to an influence of other figures like their professors during college years. For example, Ahmad, who is a biology teacher, emphasized the influence of his professor on him to refuse the evolutionary theory. He said, “The first time I learned about the theory of evolution was during my university years where the professor convinced me of the flaws of this theory and later I refuse to accept this theory.” This finding is consistent with (Winslow, Staver, & Scharmann, 2011) who found that some participants’ views of evolution in their study were influenced by their professors.

Many teachers in this study also emphasized the importance of addressing many SSI in the Saudi science curriculum. Some of these issues included cloning, and genetic engineering. One of the reasons of this desire to increase attention of these issues is that the Saudi science curriculum is addressing these issues and many others in a very limited way. Many teachers in this study reported that their exposure to in depth discussion of
SSI was limited in general. They also reported that the influence of supervisors, who are responsible for teachers’ evaluations, as well as the strict curriculum that those supervisors are more concerned with is huge as their evaluation is heavily connected to the assigned curriculum that those teachers need to meet literally to be on track with the topics involved in it. Such influence of the assigned strict curriculum, with its less attention of SSI, was huge on those teachers and caused less consideration to many important SSI, which was also accompanied with feeling uncomfortable when addressing some SSI. This finding is consistent with some previous studies (e.g. Deniz et al., 2008; Reis, & Galvão, 2004; 2009; Mansour, 2008; Moore et al., 2002).

In addition, the self-desire to learn more about many SSI was the main reason that increased some teachers’ acceptance of some issues like cloning in the case of Salih and Hamad, and genetic engineering in the case of Muhannad. To those teachers, these issues were very important to the development of the science studies in Saudi Arabia as they meet urgent societal needs of the Saudis, which signifies a considerable humanistic understanding of science among those teachers. This finding is consistent with some previous studies (e.g. Ekborg et al., 2013).

Religion and SSI. The different experiences and varied backgrounds of some Saudi science teachers influenced, even slightly, their views of many SSI. However, it was clear that Saudis’ faith and religious views including some terminologies like their understanding of the principle of Causality (Ali, 2009; Barbour, 2000; Saliba, 2007; Ibrahim, 2015); whether it is primary or secondary causality (Barbour, 2000), conflicts between science and religion (Asghar, 2013; Barbour, 2000), and some others have
heavily influenced their views of many SSI. Their religious understandings were a mirror through which they evaluate not only science but also life and the surrounding world. For example, to many teachers in this study, the relationship between science and religion is still considered in terms of conflicts that are hard to be solved (Barbour, 2000). What makes this conflicted relationship between Saudi and some SSI more noticeable is that I believe some Saudis have developed a specific identity that is highly influenced by their religious views (Mansour, 2008).

In addition, in comparison to Barbour’s (2000) understanding of the model conflict, it seems like many Saudi science teachers possess an understanding that Islam is in a high hierarchical status where many of them expressed themselves as completely immersed under Allah’s well. Look at this statement from Wesam, “our religion is infused into our lives… therefore the religious aspect in any SSI should be introduced, highlighted and considered very seriously… this is our sharia law.” This is just an example of how strict many of those teachers were when it comes to issues that may contradict their religious views. These views of the superiority of religious understandings were reported by different teachers no matter what subject they teach, years of experience, type of school or even how open they are when it comes to positively viewing different issues. This finding is consistent with some previous studies that concluded that Muslim science teachers’ religious views served as a barrier toward accepting some issues like evolution (Asghar, 2013; Edis, 2009; Mansour, 2011).

In another hand, teachers who reported that they have good knowledge about some controversial issues like cloning, and genetic engineering were more open to
address the religious aspects in their science classrooms. To those teachers, being knowledgeable was accompanied with being able to understand and evaluate the touches that such issues have with different religious views, even though they did not report good knowledge about the religious aspects pertain to many of these issues. Moreover, many of those teachers emphasized that since the scientific discipline develops, religion and how people adapt to such developments needs to develop in return. This finding is consistent with some research that emphasized that teachers who know more about some SSI were more willing to teach them even if they do not personally believe in them (e.g. Asghar, 2013; Deniz et al., 2008; Mansour, 2011), which was the case with many Saudi teachers in this study like Hamad and Salih.

However, when it comes to issues like the theory of evolution, many Saudi science teachers’ who rejected this theory did not focus on the scientific aspect behind it; instead they focused on how religion refutes this theory completely. Even though, this theory was not assigned in the Saudi science curriculum, it was important to mention that many teachers considered this theory amongst the most apparent examples of the clashes between science and religion. Similarly, Mansour (2011) believes that one reason for rejecting the theory of evolution in his study, that included Sunni Muslims, was due to the “teleological clash between Darwinian evolution and the Qur’anic verses regarding creation” (p. 296). This finding is consistent with previous studies in varied contexts (Asghar, 2013; Mansour, 2011; Moore, 2008). In addition, it is probably the personal rejection of this theory among Saudi science teachers that was one of the reasons for their not willing to understand the science behind it (Winslow, Staver, & Scharmann, 2011).
Yet, the clashes or conflicts between the scientific and the religious views pertain to issues like evolution is not easily identified as the distinction between the materialist views of science and the literalist views of religion may not be easily recognized (Barbour, 2000). Particularly, Saudi science teachers in this study seem to take in consideration a supernaturalistic point of view when addressing the theory of evolution. Therefore, they may reject this theory not only because of the different traditional interpretations of different verses in the Quran but also because they do not believe in the superiority of the scientific, naturalistic, view of the world (Edis, 2009; Iqbal, 2007). Therefore, when it comes to the religious influence, it seems like Saudi science teachers’ views of many SSI were theoretically in parallel with Barbour’s (2000) who believes, “religious faith depends entirely on divine initiative, not on human discovery of the kind occurring in science. … science is based on human observation and reason, while theology is based on divine revelation” (p.18).

Overall, like some previous studies, Saudi science teachers revealed a superiority of their religious beliefs that controlled the gaining of new knowledge and helped to embrace specific scientific ideas over others (Mansour, 2011). However, even though some scholars believe that scientific knowledge is a subset of religious knowledge (Reiss, 2010), it is important to note that science teachers’ views of science are multifaceted and included various directions especially when it comes to the influence of their beliefs (Barbour, 2000), which is the case with Saudi science teachers. In this case, Barbour believes that religious beliefs offer a wider framework of meaning in which particular events can be contextualized” (p. 14). As such, I believe that such framework heavily
influenced the ways by which specific issues were conceived by Saudi science teachers. Therefore, it is possible to state that Saudi science teachers in this study see the connection between religion and science in terms of a relationship between the source, Islam which is the source for all sacred and exist knowledge whether humans know or yet to know, and science as only a branch of knowledge that is only one foundation of discovering what is already been mentioned in the Quran or in Sharia. Particularly, Saudi science teachers’ in this study emphasized that science follows the religion, not the opposite, which signifies a directive relationship and more emphasis on the role of religion on their views of many SSI. Saudi science teachers under this understanding seem to not recognize the model of interdependency between science and religion (Barbour, 2000). To Barbour, interdependency is a good starting point for avoiding that conflict that exist between science and religion. He believes, “It preserves the distinctive character of each enterprise, and it is a useful strategy for responding to those who say conflicts is inescapable” (p. 21).

For many teachers in this study, there is no contradiction between science and religion. It seems that those teachers did not yet reach a point of understanding to the limits or boundaries between science and religion that would help them to start a wise dialogue of many SSI (Barbour, 2000). For example, Barbour believes, “if science and religion were totally independent, the possibility of conflict would be avoided, but the possibility of constructive dialogue and mutual enrichment would also be ruled out” (p. 21). Similarly, I believe that the dominance of religion over science studies among Saudi teachers is embedded, integrated, in ways that are hard to be dissolved or diminished. In
this sense, they do not see a competition between religion and science where each discipline tries to validate or justify its understanding of reality (Staver, 2010). Instead, they think or believe in a distorted notion of integration (Barbour, 2000) of the relationship between science and religion. Not taking into consideration the limits or boundaries that exist between science and religion may lead to less realization to the model interdependency that would lead to a wiser dialogue and conversation of those limits between science and religion (Barbour, 2000). Such position would help Saudi science teachers to be able to recognize the different parallels that exist between science and religion in both intellectual and conceptual bases to understand truth and reality that lay within these complex relationships between science and religion.

Therefore, the inescapable conflicted relationship between science and religion among Saudi science teachers seem to be controlling their views of many issues. This finding is consistent with some research that emphasized similar ways by which Muslim science teachers considered science as a sort of knowledge that cannot be separated from Islamic knowledge. Specifically, through understanding Tawhid or divine unity that has been mentioned earlier in chapter two from this study (Sabki & Hardaker, 2013; Mansour, 2011) as well as through some studies in different contexts (Barbour, 2000; Yasri & Mancy, 2014; Winslow, Stave & Scharmann, 2011). Many Saudi teachers do not think that science, or any other sort of knowledge, can be separated from religion because they believe that knowledge is holistic and therefore such divisions of knowledge do not go with their understandings of Tawhid. Knowledge, therefore, cannot be understood as secular versus religious, rather it is only one aspect of awareness that is
generated basically from religion as a source for all sacred and exist knowledge on this world (Mansour, 2011). I think this aspect influenced many Saudi teachers’ views considerably, even implicitly in some circumstances. This finding is consistent with some previous research (Mansour, 2007, 2011; Sullivan et al., 2014; Trani, 2004).

However, to many teachers, who were more willing to adopt more positive views of different SSI like cloning and genetic engineering, religion was not seen as a barrier toward accepting or rejection such SSI. They believe that any scientific issue can be integrated in ways that do not invalidate the instructions and understandings of religion. They did not believe that religion is a conflict; instead they believe that Sheiks or influential religious figures would direct religion instructions in ways that do not reflect the reality of the issue under investigation. To those teachers, religion does not oppose the developments of science in any ways and therefore they believed that such developments in science cannot and should not be hindered because of some religious beliefs that may change in the future. In this point, Barbour (2000) emphasized, “there are dangers if either scientific or religious ideas are distorted to fit a preconceived synthesis that claims to encompass all reality” (p. 37). Similarly, many Saudi science teachers in this study criticized the ways by which science is introduced in the Saudi curriculum and to society and called for more emphasis within which science is addressed in ways that do not trigger a preconceived notion of a conflict.

Many teachers in this study recognized this distorted picture of the relationship between science and religion and called for more conversations and approaches to ease the tension that should not exist between them. However, talking about the model of
integration that Barbour (2000) believes, it is important to take into consideration that most sciences in this era are westernized where some Muslims may think that “their beliefs marginalized by such a well-respected institution as modern science” (Edis, 2009, p. 901); especially when considering some issues that have a western origin like cloning, evolution, and genetic engineering within the Saudi science curriculum.

**Science, society and culture.** Saudi science teachers in this study mentioned how the Saudi society is rapidly modifying to the new trends in science. However, they thought that there are some aspects that influence their societal perceptions of many SSI. For example, some teachers emphasized that it is important to establish, or enhance, a culture of science that can defend science studies among Saudis and increase their awareness of the value of science to their own lives and mentioned how that is important to address many SSI. They reported that it is very important to prepare this ground for better understanding as well as situating more meaningful discussions among people when it comes to viewing and understanding the value and nature of many SSI to their own lives. Such culture of science is very important to ensure more genuine and situated understandings of many SSI among science teachers specially when addressing controversial issues (Barbour, 2000; Staver, 2010; Upadhyay, 2010; Winslow, Staver, & Scharmann, 2011).

Moreover, despite Saudi teachers’ belief that the Saudi society can change, they emphasized the importance of understanding the aspects that influenced society to approve some argumentative issues over the years. For example, many teachers talked about organs transplant as a historical incident where society, influenced by religious
understanding, refused this issue. They also reported different other issues that transformed and got accepted within the society, like genetic engineering. However, they mentioned that the societal necessity changed these negative views of these different issues. I think it is important to highlight in-depth investigation into how science is connected to the advancement of people’s lives as an important dimension to change their views of different SSI regardless of the religious stance, as it may change over time.

Given the status quo of science among Saudis and the superiority of some disciplines like religion and literacy over science studies in the Saudi curriculum, as was reported by many teachers, conveys a hint of how these disciplines are important to the Saudi society. Therefore, many teachers called for changing this reality and focusing more on science studies as an important dimension for the advancement of the country and called for less attention to religion and literacy. I agree with many of those teachers as I believe that one important aspect that influences people’s views of science is that there is a poor culture of science among Saudis, which does contribute to poor scientific literacy among them. Saudi science teachers did not see a constructivist relationship between science and society and they refer that to a missing culture of science in the country. In fact, this aspect has been emphasized heavily throughout the interviews. Establishing and trying to focus more on developing a culture of science is important to comprehensively understand not only science but also its connections to different aspects of the Saudi society including how people understand science as a humanistic discipline. Such understanding of the value of science on Saudis lives would change their views of science from not only focusing on facts and processes, as was reported by many teachers,
to increasing their understanding of science as a living and interactive discipline. This important dimension has been heavily emphasized in the literature (Akienhead, 2007; Sadler, 2011). Of course, SSI domain is a genuine way of introducing this important aspect of science to people (Sadler & Zeidler, 2005; Walker & Zeidler, 2007; Zeidler, 2007; Zeidler & Nichols, 2009).

Therefore, I believe that there is a barrier between what people think science is and the real nature of science. Such barrier is prohibiting Saudis from seeing how science influences their lives and decreasing their awareness of science and its value. The necessity of increasing people’s awareness of science to accept many SSI has been emphasized in different previous studies (Boujaoude, Asghar, Wiles, Jaber, Sarieddine & Alters, 2011; Hestness et al., 2011; Khalid, 2003; Reis & Galvao, 2004; Reis & Galvão, 2009; Klosterman, Sadler & Brown, 2012). Such awareness, however, cannot be achieved without real attempts that take into consideration more focus on the scientific literacy in Saudi Arabia.

**Question 2: How Would Saudi Secondary School Science Teachers Describe their Views of Teaching Particular SSI (e.g. Cloning, Evolution, Genetic Engineering,...)**

Even though it was hard to distinguish Saudi science teachers’ general views of SSI from their views of some issues, it was clear that Saudi teachers had specific views regarding some issues like evolution, cloning, and genetic engineering. In fact, teachers’ creationism ideas in this study were not even threatened when it comes to the theory of evolution, at least within the very few teachers who even mentioned it. This is different from Deniz et al., (2008) study in which they emphasized a positive view of evolution
among Muslim Turkish science teachers. In addition to Saudi science teachers’ views of creationism, it is important to mention that this theory is not even discussed at all in the Saudi curriculum. Therefore, the knowledge base would be another barrier toward fully understanding the nature of evolution within the Saudi context. However, even though some teachers like Salih who said that we can benefit from the science behind evolutionary theory in classification studies, other teachers like Habbeb, who talked about this theory did not see a value of teaching it in the Saudi context due to his religious views. These findings are consistent with some previous studies (Asghar, 2013; Trani, 2004; Mansour, 2007, 2010, 2011).

The other factor that heavily influenced Saudi science teachers’ views of many SSI is related to their societal understandings. When it comes to issues like cloning, genetic engineering, organs transplants, and others, many teachers emphasized a societal aspect involved in these issues but still they think that religion is the main source for their controversial stance on these issues. They emphasized that much of the argument lays on religion. This influence also is consistent with some research (e.g. Mansour, 2008; 2011).

Therefore, given all social and religious influences that were reported in this discussion, I believe that Saudi science teachers’ frame of reference regarding many SSI are influenced by a conceptual scheme that includes their societal and religious understandings as basic elements for their views of science and its value in the Saudi society. This conceptual framework is important to help Saudi teachers understand science not only as a way of knowledge but also in parallel with other ontological
underpinnings like religion for example. In addition, this framework would help Saudis to understand that science sometimes does not go with their religious and societal values. Such framework would give a glance of how situating their understanding of religious and societal influences embedded in many SSI would be in respect to many issues.

In addition, it is important to design and implement such conceptual framework around one issue each time to include all different aspects and directions that influence the discussion of such an issue within the Saudi science teachers’ understandings and views to meet their actual experiences regarding them. Moreover, to address these issues meaningfully within all these different interpretations and directions, I believe it is important to focus on creating a balance between the scientific and humanistic aspects of science through focusing on such a conceptual framework that can address these different issues profoundly. This framework would go with Levinson (2006, p. 253) who underlined that knowledge about science should be used for other purposes such as “ethical decision-making or countering opinions.” Some of the components that should be included in this framework will be discussed within the discussions of the third question of this study that focused on teaching strategies of addressing some SSI including discussion of some science teaching views and strategies that have been used by many teachers in this study.
Question 3: In What Ways Do Saudi Secondary School Science Teachers Describe their Strategies for Teaching Particular SSI?

SSI and Saudi Teachers, Difficulties and Promises

The third question of this study emphasized on Saudi science teachers’ views of the teaching and their teaching strategies used to teach SSI. Much work has been conducted to investigate science teachers’ views of teaching different issues. However, before proceeding to discuss the different aspects that influenced Saudi science teachers’ views of teaching many SSI, it is important to mention that their views of many of these issues influenced their views of teaching them. For example, Saudi science teachers’ religious views of many SSI influenced their views of the value of teaching them, particularly in issues like evolution and cloning. This finding is consistent with many previous studies (Sadler et al., 2006; Sadler, 2011; Ziedler et al., 2005; Hestness et al., 2011; Kara, 2012; Mansour, 2007, 2008, 2011; Asghar, 2013; Boujaoude et al., 2011).

Besides, in this study, I think Saudi science teachers tried to distinguish between the scientific aspect behind many of these issues and the different religious and societal interpretations pertain to them. For example, even though religion was a great component of teachers’ frame of reference, such emphasis did not prevent those teachers from talking about the theory of evolution as well as trying to understand and discuss it with their students. Focusing on the scientific part, clarifying students’ ideas, and given students more knowledge about these different issues were some of the reasons that supported Saudi science teachers’ positive views of teaching and addressing many of these SSI including the most controversial ones like cloning and evolution.


**Views of teaching SSI with Saudi teachers.** As mentioned earlier in chapter II, the Saudi science curriculum include some discussion of some issues including cloning, genetic engineering, test-tube baby, global warming, and nuclear energy. Saudi teachers in this study focused more on issues like cloning, genetic engineering from this list as well as some other issues that were not mentioned in the curriculum like evolution.

In general, except for evolution, many teachers saw the teaching of many SSI positively. I think the scientific understanding behind many of these issues did not only assist Saudi teachers to positively view many SSI but also to teach and address them to their students, having in mind the fact that many SSI are not introduced in the curriculum properly, as reported by many teachers. They thought that it is a genuine right for students to understand and be aware of different SSI. Those teachers also emphasized that there is no reason, even religious reasons, should prohibit students from studying these issues. Even though this trend is not shared by all teachers in this study, it was highly appreciated by many them. This finding is consistent with different previous studies specifically when having good understanding of the scientific aspect behind many issues (Deniz et al., 2008).

In addition, many teachers preferred not to share their personal and religious views with their students. They averted sharing their religious rejection to some of these issues because they think it is better to make students develop their own understandings without trying to impose their own beliefs on their students. This finding is consistent with Sadler et al., (2006). However, they emphasized that some issues like organs transplants, and genetic engineering, which had an inferior understanding among Saudis
in the past, has already been viewed positively recently after understanding the value of these issues into their lives.

One important dimension of Saudi science teachers’ strategies when teaching SSI is related to some difficulties that they face during their teaching. Some of these difficulties are related to the personal and religious views of some participants as they think would influence their desire of teaching many issues. These personal views include teachers’ own experiences with some issues, the influence of their religious views and other personal influences that seem to be affecting teachers’ practices of many SSI. This finding is consistent with (Hestness et al., 2011; Mansour, 2007; Sadler et al., 2006), especially to the relationship between science and religion, and teachers’ professional capabilities.

Moreover, consistent with previous research, Saudi science teachers reported different constraints including lack of time, which is consistent with (Boujoaoude et al., 2011; Sadler et al., 2006; Hestness et al., 2011; Mansour, 2007). Some other constraints also were related to the assigned curriculum, especially that most of the teachers mentioned that they should be heavily consistent with the assigned curriculum in order not to get in trouble. This finding is also consistent with (Forbes & Davis, 2008; Deniz et al., 2008). Some others reported that their students are not required to understand these issues because they will not be asked about them in the final exam. This finding is consistent with (Mansour, 2007; Reis & Galvao, 2004), especially the influence of the examination system. In addition, some teachers reported constraints related to lack of resources and materials needed for teaching different SSI, which is also consistent with
Forbes & Davis, (2008). For example, some teachers reported that they do not have appropriate labs, or even do not have labs at all, which they considered very important to teaching not only many SSI but also science in general.

It is also important to mention that throughout the discussion of previous literature; politics were the main aspect influencing science teachers’ views worldwide, especially in western countries (e.g. Hestness et al., 2011). However, it seems like this factor did not get a momentum among Saudi science teachers. Different reasons may be introduced here particularly that Saudis do not give more attention to politics, especially in schools. In addition, many of the issues that trigger such political stance, like climate change, did not get a considerable attention throughout the interviews, which signifies a cultural difference between Saudi science teachers and some other teachers in different studies, particularly western studies.

**The teaching of SSI in Saudi Arabia.** Like many previous studies, the main principle that all those teachers emphasized on when teaching SSI is related to teaching strategies that encourage more engagement from the part of students. Saudi science teachers reported the importance of student-centered strategies that are based on students own speed as they give them free space where they can express their feelings and ideas about these issues effectively. Such space was a required procedure by which students can understand these issues contextually and can find answers to their own concerns and therefore develop a more robust understanding of many SSI. This finding is consistent with many previous studies (Mork, 2012; Oulton et al., 2004; Sullivan et al., 2014)

Many Saudi science teachers in this study saw their role as only liaisons or
connection agents as they believe that infusing their views on their students would put them in a non-neutral position; a required position for adequately addressing students’ needs. They believed that their role should be connecting students’ different perspectives and trying to come up to a consensus, if possible, regarding the use and benefit of many SSI with their students. Moreover, being neutral was also accompanied with being able to listen to all students’ concerns as a way that would help students, even those hesitated, to share their ideas and concern. This aspect was reported by different teachers in this study.

As such, Saudi science teachers accompanied their success with teaching different SSI with providing an adequate environment where students can express and negotiate their ideas freely, which also requires greater emphasis on being neutral during the teaching process. Perhaps, such environment was seen essential for this purpose. However, they reported that such environment is not enough without providing appropriate tools, materials, the needed time, being open minded, and ability to accept even the most extremist views regarding many issues. This finding is consistent with some previous research (Boujoaoude et al., 2011; Hestness et al., 2011; Mansour, 2007; Sadler et al., 2006; Mccrory & Murphy, 2009). Especially, when teaching through argumentation strategies (Mork, 2012; Oliveira, Cook & Buck, 2011).

However, science teachers in this study also were more concerned about their abilities to address these issues meaningfully. They reported that it is very hard to handle all different aspects specifically those related to the knowledge needed for some issues, time, as well as ability to address students’ different societal and religious opinions and
behaviors pertain to many SSI. Thus, some teachers were more concerned about their self-confidence and lack of support when addressing many SSI. It is important to increase science teachers’ degrees of self-confidence, which is very important for raising their trust in themselves and their abilities to address these different issues. They also need to be trained not just knowledgeable for handling the different aspects pertain to teaching SSI. This finding is consistent with (Mork, 2012; Oliveira, Cook & Buck, 2011).

It was also reported that many teachers considered the textbook as valuable and important tool of teaching many SSI. It was a source for reliance that can bring different opinions together. They understood that the ministry of education gave much attention to design these textbooks to be compatible with what Saudi needs, recognize, and understand. Therefore, throughout different incidents in the interviews, many teachers reported using the textbook as a source for backup when different perspectives start to arise regarding many issues. This finding is consistent with some previous studies (e. g. Goldston & Kyzer, 2009) who reported that science teachers used their textbook for legitimacy and for avoiding conflicts. It is also consistent with Deniz et al., (2008) and Donnelly & Boone, (2007) who reported that teachers in these studies used curriculum standards for support when they face conflicts regarding the teaching of evolution.

Look at figure 2 where there is more explanation to the interrelationship that exists between the different religious and societal aspects that influence Saudi science teachers’ views of SSI.
Different teaching strategies. Saudi science teachers used different strategies for teaching many SSI. However, even though many of those teachers maintain that these issues need comprehensive and deep strategies like discussion or argumentation, many teachers reported that they use lecture type strategies. Different constraints have been reported in this study that have forced some teachers not to use deep strategies like discussion or negotiation. These constraints were the main reasons for not teaching
different SSI in depth. They reported that they needed to support their teaching with tools, materials, enough time, and other requirements but since many of these important requirements are missing they could not properly apply such deep strategies like discussion when teaching many SSI.

However, many teachers emphasized that teaching SSI is best to be conducted through discussion strategies. In addition, only one teacher emphasized that teaching SSI should be conducted through negotiation strategies. Even though the distinction between discussion and argumentation teaching strategies is not the purpose of this study, it is important to shed light on Saudi science teachers’ views of this aspect as it may reveal good understanding of how they see the value of negotiation strategies and in what ways do they distinguish between negotiation as a major strategy for teaching SSI from discussion, which is very important strategy as well.

Saudi science teachers reported that they love to have their students express their ideas and consider all their concerns regarding SSI. However, they emphasized on using discussion strategies for addressing these concerns. However, I think they meant negotiation almost all the time when they discuss their strategies. They realized that many SSI require students to make, discuss, negotiate or validate different religious or societal choices, which requires given more attention to arguments and counter arguments that may arise during the teaching of some SSI. It is very important to address these different opinions, otherwise, students may feel like they are in a vacuum where they could not support their arguments, nor could they reject other counter arguments pertain to different SSI during class time. This is the very important task of science
teachers (Osborne, Erduran, Simon & Monk, 2001; Duschl, & Osborne, 2002), especially that students need to know exactly how to argue and accept counter arguments (Von Aufschnaiter, Erduran, Osborne & Simon, 2008). However, Saudi science teachers in this study emphasized that they only open discussion for their students to express their views, which is not enough to get involved in deeper ideas and thoughts about many issues.

Furthermore, making students express their views and ideas about different SSI through discussion is not a bad idea but it is not enough. Whereas many teachers in this study emphasized that they think discussion meet many of their students’ concerns about many SSI, it seems like they do not get their students engaged in more robust positions during the teaching of these issues. Such lack of engaging students into deep and robust positions or stands may lead to lesser engagement and therefore less addressing to different aspects involved in many SSI. Therefore, and different from previous research (Goldston & Kyzer, 2009; Mork, 2012; Oulton, Day, Dillon & Grace, 2004; Oliveira, Cook & Buck, 2011), Saudi science teachers do not seem to get their students fully engaged in experiences where they make sure that their ideas and concerns are fully addressed and discussed.

Rare teachers reported that they teach using role plays strategies that meet students’ different opinions and put in the middle their concerns for negotiation. For example, only one teacher reported that he uses cooperative learning. In addition, all the teachers emphasized that they let students share their ideas but verbally. They reported that they encourage their students to discuss their ideas but no teacher, for instance,
reported using the board for recording students’ ideas and discussing them to publically generating and discussing these ideas and help students present their works through role plays or group presentations for better undertaking their arguments and discuss counter arguments from other students. On the other hand, different studies have emphasized the importance of using different strategies, like chalk talk, or post in strategies, that are helpful to address the controversies and arguments in a more meaningful way among students (Oliveira, Cook & Buck, 2011; Oulton et al., 2004; Mork, 2012; Taylor, 2013). Especially, science teachers should develop students’ abilities to be able to take parts in the discussions (Oulton, Day, Dillon & Grace, 2004). Therefore, it is clear enough to state that Saudi science teachers misuse the word discussion with the word negotiation. Even though they use the word discussion for explaining argumentation strategies, it is important to clarify that these two strategies are different not only in procedures but also in the ultimate goals that are approached. Such differences need to be clarified enough to apply more engaging strategies for addressing different controversies pertain to many SSI among Saudi students. 

In addition, many teachers reported that they avoid the conflicts or controversies of many SSI through focusing on the scientific aspects of some issues like cloning for example. Avoiding the controversial aspect involved in some issues seem to be helping many teachers to address many of these issues freely. This finding is consistent with some previous studies (e.g. Ekborg, et al., 2013; Reiss, 2010). In addition, having have clear cut differentiations between science and religion seem to be a good strategy among many science educators (Pigliucci, 2013).
Limitations of Study

This study revealed different findings related to Saudi science teachers’ views and teaching strategies of SSI that may contribute to the literature about viewing and teaching SSI, especially in non-western countries. However, this study is contextualized into a specific setting and frame of time. The sample and the context of this study may not reveal more in-depth generalizability of its findings.

For example, even though the sample of this study tried to represent a wide range of experiences and views of science teachers in the city of Tabuk, a limitation of this study is related to the aspect of generalizability. This study focused mainly on male secondary school teachers. Including female teachers to this study was not approachable for different cultural and societal reasons. Engaging women in future research about these issues is essential for more in-depth views of how teachers from all genders see the influence of these issues within the Saudi science curriculum system.

In addition, throughout the different interviews of this study, many teachers revealed different understandings of many SSI. These different understandings and information influenced their views of many SSI. As my findings and those of many previous studies (Oliveira, Cook & Buck, 2011; Sadler et al., 2006; Zeidler, Sadler, Simmons, & Howes, 2005) suggested, more focus on teachers’ knowledge bases pertain to these issues is needed to reveal more understanding of how their knowledge influence their views of many SSI. It was important to investigate this aspect in the present study for more robust and comprehensive understanding of the reasons that influence their views of many SSI.
Another limitation of this study is related to how Saudi teachers understand science as a discipline of knowledge. For example, throughout the different interviews of this study, many teachers expressed different and varied views about the NOS. It was important to investigate science teachers’ views of the NOS to articulate a more robust understanding of how such views of science influence their views of SSI. Especially, science teachers’ views of the NOS have a direct influence on their views of many SSI (Mork, 2012; Oliveira, Cook & Buck, 2011; Sullivan et al., 2014; Scharmann, Smith, James, & Jensen, 2005; Wong, Wan & Cheng, 2011).

It is also important to mention that more focus should be given to the context in which Saudi science teachers experience teaching and viewing these issues in the Saudi science curriculum. Even though the researcher tried to explain in detail the context in which they view and teach these SSI, more focus should be given to investigate economical, educational, training opportunities and other contextual backgrounds that could better explain the findings of this study. It is highly suggested that such data be accessible to researchers and scholars either through the Saudi ministry of education or even through the department of education in the city of Tabuk, which are missing from such agencies.

Implications for Practice

Almost no study has investigated Saudi science teachers’ views of teaching SSI. Therefore, the findings of this study yielded different implications for the practice of the Saudi science education system. More analysis was given throughout the discussion of the different aspects that have influenced Saudi science teachers views of SSI including
the influence of their religious and societal understandings on their views of many SSI. Throughout these discussions, there were more focus on the main aspects that inform Saudis science teachers willingness to positively viewing and teaching different SSI. Some of these aspects inform thinking of important dimensions that should be emphasized to develop more genuine practices that can include SSI properly in the Saudi science classroom.

Saudi science teachers hold different societal, religious and science understandings. These different aspects are constructed in different ways and influenced by different societal and religious interpretation of science and of the value of this subject in Saudi Arabia. Any discussion of teaching SSI should incorporate ways by which these different aspects are examined and undertaken through a conceptual scheme that could touch on their views and teaching strategies of SSI.

First, socially speaking, many teachers emphasized that the Saudi society is rapidly changing and they called for science education policies that undertake the issue of increasing Saudis’ awareness of science seriously. Such emphasis shed light on how important it is to develop a welcoming environment where students and the surrounding society appreciate the discussion of these issues. This environment was seen essential throughout different interviews with many teachers in this study. This important dimension should be a priority for educators and policy makers in Saudi Arabia to address many SSI in more concrete bases.

Saudi teachers in this study revealed and emphasized poor scientific literacy among Saudis. They reported how Saudis are still more concerned about religious and
literary subjects over science and other disciplines. Some teachers called for a new policy to undertake religion and Arabic studies in ways that do not overwhelm the importance of science into Saudis’ lives. They emphasized how important it is to develop the religious speech to be able to comprehensively understand science in a more open lens and include ways by which science reflect the needs of Saudis as people.

Moreover, in practice, many teachers criticized the focus on the quantity of information in science subjects over quality. They were busy in teaching heavy scientific materials to their students; however, they feel that such materials were not very important to their students. These emphases took so much valuable time from teachers and pushed many of them not to give much attention to many SSI. It is important to understand that science is not only facts to be saved in students’ minds but rather it is essential to assure that what students learn is related to improving their lives, touching their own needs, and keeping them in pace with the development of science education practices around the world. Especially, having in mind the developing nature of the Saudi society, as well as the need for modifying science education in Saudi Arabia to include ways by which these new developments find a space into the curriculum and reflect more supportive initiatives to increase science awareness among Saudis.

Second, even though many teachers expressed how religion and science do not support each other in Saudi Arabia, although most of them emphasized, even theoretically, a lively relationship between these two aspects. They recognize that religion should be addressed distinctively but they feel like such uniqueness should not devalue science and its developments. This finding promotes that discussing religion and
its connection to science as a discipline should be a priority as it would give more accurate views of how Saudis' religious views influence not only their views of many SSI but also their views of science in general. There is a need for interested Saudi educators to become involved in activities that promote more accurate views of the relationship between science and religion. Such awareness needs to expand among science teachers and among Saudi people of the value of a lively relationship between science and religion.

It is important to use the teaching and discussion of many SSI for understanding and increasing Saudi science teachers’ views of the NOS. Saudi science teachers in this study held different views of science, however, there was not enough space to discuss them in this study, as the purpose of this investigation was not focusing on these views. One of the basic analyses of the findings of this investigation is that any discussion of SSI should be incorporated using a framework in which the NOS is a concrete aspect that should be emphasized. It is important to focus on understanding science teachers’ views of SSI and trying to connect them to their understanding of the NOS behind them, especially to discover how those teachers understand the religious and societal influence within science.

Moreover, it is important to mention that many teachers in this study focused on how new things take time until people absorb them. Salih, for example, mentioned how the issue of cloning took several years until people got to accept, even partly, its value. I think Saudis are skeptical not because of the religious or societal influences but also because of the consequences that are already not discovered as they think. I believe any
future consideration to these issues should be placed gradually to let people absorb these issues contextually and in pace with other societal and religious understandings.

**Saudi Science Teachers’ Self-Desire to Address SSI**

Even though it is clear how religion and societal understandings influenced many teachers’ views of many SSI, it is important to mention that Saudi teachers’ self-desire to understand, address, and discuss many SSI was one of the greatest factors that influenced their willingness to teach them. It seems like the religious aspect influencing almost many teachers’ views of many SSI did not prohibit many other teachers from discussing and addressing some issues like cloning and genetic engineering. Many teachers emphasized that Saudi students have the right to know more about these issues as they are widely discussed worldwide. They do not see any reasons, even religious reasons not to teach these issues. Many of those teachers believe that the science behind those issues would be useful in twofold. First, it might clarify the ambiguity involved in many issues and show how many of them are important for the well-being of humanity. Second, the science behind many of these issues is evolving over time and therefore the religious explanation behind many of these issues may evolve too. Moreover, like some other studies (Mansour, 2008, 2011) Saudi teachers in this study emphasized how important it is to be up to date with the developments of science studies around the world and see the discussing of many SSI as a concrete aspect of that sake.

In addition, it seems like many teachers were confident to discuss many SSI even though they were not included in the curriculum like evolution. In addition to their willingness to discussing these issues it seems like they thought that they are obligated to
give their students some information about them. They mentioned how it is important for their students to know the nature behind evolution, cloning and genetic engineering and many other issues. Even though most of the teachers preferred to stick to the assigned curriculum, it is interesting to find some teachers are willing to go beyond curriculum and discuss some of these issues in more depth.

**Implications for Future Research**

Teachers in this study revealed different NOS understandings, however, many of these understandings are misconceptions about the NOS. It is important to conduct studies that are dedicated to investigating Saudi science teachers’ views of the NOS as they would give a hint of how such views influence their views of accepting or rejecting many SSI. As mentioned before, there is a clear correlation between science teachers’ views of the NOS and their views of SSI. To understand and comprehensively investigate Saudi science teachers’ views of SSI, it is important to discover how Saudi science teachers understand science as a discipline.

For example, the present study suggests that some teacher maintains strong understanding that science is best developed through the scientific method. Even though some teachers revealed that science, religion, society have interrelationships that form a specific understanding of science, still many teachers believe that science is only conducted through the scientific method. This view of science reveals some other concerns about Saudi science teachers’ views of the NOS along with their understanding of the societal and religious embeddedness of science as a discipline. Particularly, as
aforementioned in the limitation of this investigation, it is required that further investigation to Saudi science teachers’ views of the NOS be obtained during the discussion of these SSI to reveal a more accurate picture of how such views influence their SSI perceptions. It is important to understand the relationship between Saudi science teachers’ views of the NOS and their views of SSI to reveal how Saudi science teachers perceive NOS during the discussion of specific SSI.

Saudi science teachers in this study revealed varied views of how society perceive and understand science as a discipline. For example, they revealed different views of how society reject some SSI and accept others. Even though they revealed that society is highly influenced by religion and by the instructions of Islam, further investigation is required to reveal how and in what ways Saudi science teachers see the influence of society on their scientific thinking. Especially, many teachers, even those who were so willing to teach many SSI reported that society does not understand science and its value as it should be.

In addition, further investigation is required to focus on how Saudi science teachers understand the relationship between religion and science. Different interpretation has been discovered throughout this study that revealed how Saudi science teachers are heavily influenced by religion; particularly regarding many SSI that touch their religious understandings. It is important to investigate how those teachers understand the role of religion on developing science studies in Saudi Arabia as well as how and in what ways they see the correlation between science and religion within the new science curriculum that is applied by the project Tatweer.
One of the limitations of this study was related to science teachers’ knowledge and understandings of many SSI. As to my findings in this study along with some other findings of previous studies (e.g. Deniz, et al., 2008), such knowledge was correlated to more acceptance to many issues. It is important to apply more tests on some issues and reveal how and in what ways such knowledge of these issues influence their views and teaching of them.

In addition, to address the generalizability issue of this study, further investigation should be conducted in different regions in Saudi Arabia, especially in western and eastern coasts to reveal how such views of compatible with other settings and samples. It is also very important to conduct a similar research on Saudi secondary school women teachers for a more robust understanding of these issues within the Saudi teachers’ population.

To address the teaching strategies that were used in this investigation and the mix that happened between discussion and negotiation strategies, it is suggested that a further investigation to Saudi science teaching strategies is conducted to reveal how and what ways Saudi teachers are willing to change and improve their teaching style and the reasons behind such strategies. It is also suggested that further investigation is conducted to reveal the best ways to prepare Saudi science teachers for teaching science and SSI.

**Conclusion**

This study shows the importance of discussing different contexts and settings. Even though this study showed a greater connection to those of western contexts, it
provided a greater understanding of the role of religion in understanding the influences that impact teachers in non-western countries. The findings of this study suggest that more focus should be placed into Saudi science teachers’ preparation programs to be able to deal with science in a more comprehensive view that includes more focus on its value to people and the different influences that impact the understanding of science among Saudis. While the use of grounded theory as a method in this study provided in-depth views of those teachers regarding SSI, future research should focus on more diverse sample and more on understanding science teachers’ NOS views and the knowledge base to be able to situate more accurate views of how such understandings could influence Saudi science teachers not only to these issues but also to understanding science as a sophisticated, enrichening, and illuminating endeavor.
APPENDICES
APPENDIX A

RECRUITMENT EMAIL

ARABIC
Appendix A
Recruitment Email
Arabic

أعزائي معلمي العلوم بالمرحلة الثانوية بمدينة تبوك... المحترمون،

انتهى هذا الفرصة لأخبركم بفرصة المشاركة في دراسة بحثية حول وجهات نظر معلمي العلوم واستراتيجياتهم التدريسية المتعلقة بالقضايا العلم الاجتماعية. هذه الدراسة مدارة عن طريق الدكتور تود هولي وعزيز العمري من جامعة ولاية كنت. هذه الدراسة تتحاول معرفة كيف والى اية درجة يرى المعلمون السعوديون هذه القضايا والتي تشمل جانبين علمي واجتماعي.

نحن نتواصل معك عن طريق جامعة ولاية كنت لأننا نؤمن أنه من الممكن أن تكون مهتماً بالمشاركة في هذه الدراسة التي تمت الموافقة عليها لاستماع وجهات نظر معلمي العلوم السعوديون حول هذه القضايا. موافقتك على التواصل مع فريق البحث لتتعرف أكثر على هذا البحث لا تعني بحال من الأحوال موافقتك على المشاركة فيه.

إذا كنت تري معلومات إضافية بإمكانك التواصل مع عزيز العمري على الرم 812391679 أو الرقم 193611112610.

شكراً جزيلًا على اعتبارك المشاركة في هذا البحث،

عزيز بن سالم العمري
طالب دكتوراه
أستاذ مشارك
دراسات الاجتماعية
جامعة ولاية كنت

د. تود هولي
أستاذ مشارك
تدريس العلوم
جامعة ولاية كنت

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APPENDIX B

RECRUITMENT EMAIL

ENGLISH
Appendix B
Recruitment Email

English

Dear secondary school science teachers in the city of Tabuk,

I am writing to let you know about an opportunity to participate in a research study about Saudi science teachers’ views and teaching strategies of socio scientific issues. This study is being conducted by Dr. Todd Hawley and Aziz Alamri at Kent State University. This study is trying to investigate how and what ways do Saudi science teachers in the Tabuk view and teach socio scientific issues. These issues include both a scientific and societal influences.

We are contacting you for this study through Kent State University because we believe that you may be interested to participate in this approved study about Saudi science teachers’ views and

Agreement to be contacted or a request for more information does not obligate you to participate in any study.

If you would like further information, please call Aziz Alamri at 8123916705 or +966540046610

Thank you so much for considering this research opportunity

Aziz Alamri
Doctoral Candidate, Science Education
Kent State University

Dr. Todd Hawley
Associate professor, Social Studies Teacher Education
Kent State University
APPENDIX C

CONSENT FORM

ARABIC
Appendix C
Consent Form

Arabic

وجهات نظر والاستراتيجيات المستخدمة في تدريس القضايا العلم اجتماعية لدى معلمي العلوم السعوديين

هذه الدراسة تهدف إلى استتقاء وجهات نظر معلمي العلوم السعوديين وطرق تدريسمهم المتعلقة بالقضايا العلم اجتماعية التي قد تشمل قضايا مثل الاستنساخ، الطاقة النووية، الطاقة البديلة وقضايا أخرى. قبل المشاركة في هذه الدراسة يرجى منك قراءة نموذج الموافقة هذا والتوقيع على الفراغ (موافقة) إذا فهمت المعلومات المرفقة وقررت بحرية المشاركة في هذه الدراسة.

نموذج موافقة

في هذا النموذج يتم دعوتك للمشاركة في دراسة بحثية. نموذج الموافقة هذا يوفر لك المعلومات المطلوبة عن المشروع البحثي، ما تحتاج إلى القيام به، والمخاطر والمنافع المرتبطة بهذا البحث. سوف من المهم أن تسامي الأسئلة اللازمة للفهم الكامل لطبيعة هذا البحث. يرجى قراءة هذا النموذج بعناية. تتلقى نسخة من هذا الوثيقة في حال رغبتك أخذها معك.

هذه الدراسة تشمل نموذج مقابلة مقنن. سوف يطلب منك عدة أسئلة بخصوص وجهات نظرك المتعلقة بالقضايا العلم اجتماعية. بالإمكان التوقف عن الإجابة في أي وقت.

هذه الدراسة تحت إشراف الدكتور تود هولي وعزيز العمري من جامعة ولاية كنت والتي سبق وتم منح الموافقات اللازمة لها من مكتب المراجعات الأكاديمية بالجامعة. هذه الدراسة أصيلة ولا فيه خداع أو مكر ولا يمكن أن تسبب لكم أي ضرر فوق تلك المعتادة.

المشاركة في هذه الدراسة قد تستغرق حدود الساعة لإكمالها. سوف يكون جميلًا جداً لو تمت الإجابة على جميع الأسئلة المرفقة في المقابلة. هذه الأسئلة تشمل بعض القضايا مثل الاستنساخ، الطاقة النووية، وقضايا أخرى والتي قد تحتمل تأثيرات من جانبين علمي واجتماعي. البحث المتعلق بهذه القضايا لم يتم اشاعه بعد في السعودية.

بالتالي، فإن استجابتك للمشاركة في هذا البحث سوف تلقى الضوء على هذا الجانب المهم في تدريس العلوم في مناهج العلوم السعودية.

لن يتم التعامل مع بيانات محددة قد تشير إلى مقابل بعينه. وستبقى هذه تامة. سيتم جمع البيانات بسرية الاستمارة منفصلة تماماً عن بيانات الدراسة، الردود المستفصة لن يتم ربطها بالمقابلين بأي حال من الأحوال. مع ذلك فإن بيانات هذه الدراسة من الممكن أن تستعرض عن طريق مكتب المراجعات الأكاديمية بالجامعة كنت.
قد تكون استفادة المقابِل محدودة من هذا الاستبيان مع ذلك إن المشاركة في هذه الدراسة سوف تساعد البحث على فهم أفضل للأسباب التي تدفع معلمي العلوم لتدريس بعض هذه القضايا وبالتالي اكتساب مزيد من المعلومات والخبرات هذه القضايا في المستقبل. بالتالي، إضافة لبناء هيئة تتعلق بهذا الجانب في العلاقة بهذا المجال المهم لتحسين تدريس البحوث المتعلقة بهذه القضايا.

بالإمكان اختيار عدم المشاركة أو التوقف عن المشاركة في هذه الدراسة البحثية هو تماما متروك لكم. المشاركة في هذه الدراسة البحثية هو تماما متروك لكم.

التقديم: 

أنا أوافق طوعاً على المشاركة في هذه الدراسة.

أنا أفهم أن نسخة من هذه الموافقة ستقدم لي لتمكّننا من المستقبل، على المشاركة في هذه الدراسة.

توقيع المعلم: ........................................
التاريخ: .........................................
Appendix D

Consent Form

English

Saudi science teachers’ views and teaching strategies of socio scientific issues

This present study investigates Saudi science teachers’ views and teaching strategies of socio scientific issues that include issues like cloning, nuclear energy, alternative energy and others. Before taking part in this study, please read the consent form below and click on the "I Agree" button at the bottom of the page if you understand the statements and freely consent to participate in the study.

Consent Form

You are being invited to participate in a research study. This consent form will provide you with information on the research project, what you will need to do, and the associated risks and benefits of the research. Your participation is voluntary. Please read this form carefully. It is important that you ask questions and fully understand the research in order to make an informed decision. You will receive a copy of this document to take with you.

This study involves a semi structured interview protocol designed to understand how and in what ways Saudi science teachers view and teach about this important aspect of science in their daily science teaching practices. The study is being conducted by Professor Todd Hawley and Aziz Alamri of Kent State University, and it has been approved by the Kent State University Institutional Review Board. No deception is involved, and the study involves no more than minimal risk to participants (i.e., the level of risk encountered in daily life).
Participation in the study typically takes 20-40 minutes and is strictly anonymous. Participants are encouraged to answer a series of questions about their views of socio scientific issues in science education. These issues include cloning, climate change, nuclear energy, and others that trigger both scientific and societal influences. The research about these issues in Saudi Arabia has not been fully established yet. Therefore, investigating Saudi science teachers’ views and teaching of socio scientific issues would help to shed light on how would they see these issues in the Saudi science curriculum.

All responses are treated as confidential, and in no case will responses from individual participants be identified. Rather, all data will be pooled and published in aggregate form only. Participants should be aware, however, that your research information may, in certain circumstances, be disclosed to the Institutional Review Board (IRB), which oversees research at Kent State University.

This research will not benefit you directly. However, investigating this important dimension in a Saudi science teachers’ context would reveal significant outcomes of how their views and teaching strategies are informed and constructed that would add to the wide literature that is already exist in different contexts around the world.

Participation is voluntary, refusal to take part in the study involves no worries at all, and participants may withdraw from the study at any time without penalty or loss of benefits to which they are otherwise entitled.

If participants have further questions about this study or their rights, or if they wish to lodge a complaint or concern, they may contact the principal investigator, Dr. Todd Hawley at (330) 672 – 0670, Mr. Aziz Alamri (812) 391-6705; or the Kent State University Institutional Review Board, at (330) 672-2704.

I have read this consent form and have had the opportunity to have my questions answered to my satisfaction. I voluntarily agree to participate in this study. I understand that a copy of this consent will be provided to me for future reference.

__________________________________________________________
Participant Signature                        Date
APPENDIX E

RELEASE FORM FOR TEACHERS’ INTERVIEWS

ARABIC
Appendix E

Release Form for Teachers’ Interviews

Arabic

الإفراج عن نموذج لقاءات معلم

أنا أسمح باستخدام المعلومات التي سيتم جمعها من الأشرطة الصوتية، والمحادثة، والاستبيانات، و/ أو عينات العمل وعرضها في أي مؤتمر مهني تربوي أو أية مؤسسات تعليمية أخرى، أو النشر في المجلات المتخصصة، سواء على الإنترنت والطباعة، وأن أنا أفهم أنه لن يتم استخدام اسمي.

_________________________
اسم المعلم

يرجى اختيار أحد هذه الخيارات:

___________ أنا أعطي إذن

___________ أنا لا أعطي الإذن

توقيع المعلم

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APPENDIX F

RELEASE FORM FOR TEACHERS’ INTERVIEWS

ENGLISH
Appendix F

Release Form for Teachers’ Interviews

English

Release Form for teacher’s interviews

I allow information to be gathered from audiotapes, conversation, Surveys, and/or work samples to be presented at professional conference, educational settings, or published in professional journals, both online and in print, I understand that my name will not be used.

Teacher’s Name (please print) ________________________________________________

Please check one:

___________ I GIVE permission

___________ I do not give permission

_____________________________________ _______________

Teacher’s signature
APPENDIX G

DEMOGRAPHIC QUESTIONNAIRE

ARABIC
Appendix G
Demographic Questionnaire
Arabic

اسم: .............................................................................................................

اسم المدرسة: ............................................................................................

المادة التي تقوم بتدريسها: .................................................................

سنوات الخبرة: .........................................................................................

أعلى مؤهل تم الحصول عليه: ..............................................................

رقم الهاتف: ............................................................................................

الواتس اب: ...............................................................................................

الإيميل: ..................................................................................................

لو سمحت أرسل إجاباتك إلى إيميل aalamri2@kent.edu
APPENDIX H

DEMOGRAPHIC QUESTIONNAIRE

ENGLISH
Appendix H

Demographic Questionnaire

English

Name: ……………………………………………………………………………………………

School name: …………………………………………………………………………………

What do you teach? ………………………………………………………………………

Years of experience: ……………………………………………………………………

What is your highest degree? ……………………………………………………………

Phone number: ……………………………………………………………………………

WhatsApp phone number: ………………………………………………………………. 

Email: ……………………………………………………………………………………..

Please return to Aziz Alamri, aalamri2@kent.edu.
APPENDIX I

LIST OF PARTICIPANTS WITH SELECT DEMOGRAPHIC DATA

ARABIC
Appendix I

List of Participants with Select Demographic Data

Arabic

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APPENDIX J

LIST OF PARTICIPANTS WITH SELECT DEMOGRAPHIC DATA

ENGLISH
Appendix J

List of Participants With Select Demographic Data

English

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APPENDIX K

INTERVIEW PROTOCOL

ARABIC
Appendix K
Interview Protocol
Arabic

شرح إضافي لمحتويات هذه المقابلة

أخي مدرس العلوم... المحترم

يهدف الباحث إلى دراسة وجهات نظر معلمي العلوم واستراتيجياتهم التدريسية المتعلقة بالقضايا العلم الاجتماعية. هذه القضايا تشمل تلك التي قد تستدعى جدلاً اجتماعياً، دينياً، أخلاقياً مثل قضايا الاستنساخ، النظرية الوراثية، الطاقة النووية، الهندسة الوراثية، وخلافه.

عليه يتمنى الباحث مساعدتكم بالإجابة على نموذج الاستقصاء المرفق.

ملحوظة

1. الأسئلة المرفقة هدفها استقصائي بحت وعليه فإن استجابتك ستكون سرية جداً ولن يسمح لغير الباحث باستخدام البيانات المستخلصة في غير الأغراض البحثية بأي حال من الأحوال.

2. أرجو التواصل مع الباحث في حال وجود غموض في أي سؤال من هذه الأسئلة.

3. سيكون لطفاً جدًا لو أجبتم على كل الأسئلة المرفقة. مع العلم أنه من الممكن إرسال استجاباتكم الصوتية الإلكترونية عن طريق الشات الخاص بالواتس اب إذا كنت تفضل ذلك. كل ما عليك فعله هو مراسلتي على أي من الأرقام المرفقة بالأسفل. (وهي الطريقة الأنسب)

4. الاستبيان يتكون من 3 أقسام رئيسية: الأول يستقصى مفاهيم عن وجهات نظرك متعلقа بالقضايا العلم الاجتماعية، والثاني يستقصي وجهات النظر المتعلقة ببعض القضايا التي قد تهمك (على سبيل المثال قضية الاستنساخ، الهندسة الوراثية، الطاقة النووية وغيرها)، والثالث يتعلق بالاستراتيجيات التدريسية المتعلقة بهذه القضايا العلم الاجتماعية وكيف يتم التعامل معها في الفصل الدراسي.

5. لا يوجد جواب صحيح أو خاطئ لأسئلته. المرء فقط يعرف على وجهات نظركم تجاه بعض القضايا المتعلقة بالعلوم.

القسم الأول: وجهات نظركم المتعلقة بالقضايا العلم الاجتماعية في مناهج العلم:
1. كيف تصف نفسك كمدرس علوم؟
2. ما هو إطارك المرجعي عند تدريس العلوم؟
3. ما هو فهمك للعلوم كمسعى ومنهج إنساني؟
4. ما هي العلاقة بين منهج العلوم وغير مناهج المعرفة كالدين؟ لماذا؟
5. هل ممكن أن تذكر لي بعض القضايا العلمية التي تتعارض مع قيمك ومبادئك في مجال تخصصك التدريسي؟

(سادلر، 2006، ص 319)

6. هل تعتقد أن هذه القضايا التي ذكرت تعتبر جدلية؟
7. إذا كنت مهتم بقضية الاستنساخ فإذن تضع هذه القضية في كل الفراغات التالية: (مثال: النظرية الداروينية، القضايا البيئية، الطاقة النووية، الاستنسل، الهندسة الوراثية؟)
8. هل ممكن أن تذكر لي من وجهة نظرك بعض القضايا الجدلية في تدريس العلوم؟
9. هل من الممكن أن تسترسل أكثر؟
10. لماذا تعتقد أن هذه القضية/القضايا أصبحت جدلية؟
11. ما الذي يقودك لتفكر بهذا الأسلوب؟
12. ما هي المعوقات والتحديات التي يمكن أن تواجه إدراج قضية (....) ضمن مناهج العلوم في السعودية؟
13. ما هي الفرص التي يمكن أن تعزز إدراج قضية (....) ضمن مقررات العلوم في السعودية؟
14. كيف تستطيع تطبيق هذا المفهوم في المجتمع السعودي؟
15. كيف ترى تطبيق مفهوم أكثر إنسانية لعقد العلوم في المجتمع السعودي؟
16. كيف تستطيع زيادة الوعي العلمي في المجتمع السعودي؟

القسم الثاني: يتعلق بوجهات نظرك أخي المعلم المتعلقة بقضية من القضايا العلم اجتماعية (مثل: إذا كنت مهتم بقضية الاستنساخ، و踵ها وضع هذه القضية في كل الفراغات التالية التي قد تجدها في بعض الأسئلة السابقة)

17. لماذا تعتقد أنه من المهم أن تعرف أكثر على قضية (....)?
18. ما الذي يؤديك لتكشف بهذا الأسلوب؟
19. ما هي المعوقات والتحديات التي يمكن أن تواجه إدراج قضية (....) ضمن مناهج العلوم في السعودية؟
20. ما هي الفرص التي يمكن أن تعزز إدراج قضية (....) ضمن مقررات العلوم في السعودية؟
21. كيف ممكن أن تعزز هذه الفرصة؟
22. ما هي التحديات التي يمكن أن تثير إدراج قضية (....) ضمن مناهج العلوم في السعودية؟
23. كيف تستطيع تطبيق هذه القضية في المجتمع السعودي؟
24. بالنظر إلى مجتمعنا السعودي هل تعتقد أنه من المهم أن نركز أكثر على قضية (....)؟ لماذا نعم، أو، لماذا لا
25. ما هي بعض المشكلات والقضايا التي تعتقد أنها موجودة في هذا المفهوم؟
26. هل تستطيع ذكر بعض الأمثلة التي توضح إجابتك؟
27. كيف تستطيع تطبيق هذا المفهوم في المجتمع السعودي؟

القسم الثالث: يتعلق بالأستراتيجيات التدريسية المتبعة عند التعامل مع هذه القضايا العلم اجتماعية:
هل من الممكن أن تصف الدروس الأكثر أهمية التي تعاملت فيها مع قضايا علم اجتماعية؟ (شامروز، ٢٠١٤، ص١٧)

١٩. لماذا تدرس بعض القضايا العلم اجتماعية ولا تدرس بعض القضايا الأخرى؟
٢٠. ما الذي يعنيك شخصياً تدريس هذه القضية؟
٢١. كيف تدرس هذه القضايا (القضايا العلم اجتماعية) في فصل العلوم؟
٢٢. هل تملك استراتيجيات محددة لتدريس قضايا معينة؟ هل من الممكن أن توضح أكثر؟
٢٣. تدريس القضايا العلم اجتماعية يتطلب الكثير من مهارات التفاوض لوجود الكثير من وجهات النظر عند التعامل معها، عليه إلى أي مدى ممكن أن تقبل وجهات النظر المعارضة لك من قبل طلابك؟ لماذا؟ هل من الممكن ذكر أمثلة؟
٢٤. ما الذي يدفعك ويشجعك على استخدام وسائل وطرق تدريسية إبداعية عند تدريس هذه القضية؟
٢٥. إذا كان هناك تعارض بين معتقدك وقيمك وأخلاقك وبين حقيقة علمية تم إثباتها علمياً كيف يمكنك أن تعالج هذا التعارض؟
٢٦. عملياً: كيف تتعامل مع القيم والأخلاق في فصل تدريس العلوم؟ (ساذرل، ٢٠٠٦)
٢٧. كيف تعالج القيم الأخلاقية الخاصة بك عند تدريس مادة علمية معينة، هل تملك الحق أن تغير عن آرائك ومعتقداتك بحرية؟
٢٨. هل من الممكن أن تذكر لي بعض الأمثلة التي مررت عليك وتعرضت فيها لمعالجة والتعامل مع قضايا أخلاقية
في تدريس العلوم؟ ماذا حدث بالتفصيل وكيف تعلمت مع هذه الحادثة؟ (ساذرل، ٢٠٠٦)
مثال: هل سبب وأسباب أحد الطلاب عن النظرية الداروينية، القابلة النووية وماذا تمت صناعتها، الطاقة النووية وتطويرها، النظم البيئية وخلافه...
٢٩. مثالاً: ما هو الوضع المثالي الذي تعتقد أنه يجب أن يتبع عندما تتعامل مع القيم والأخلاق في فصل تدريس العلوم؟ (ساذرل، ٢٠٠٦)
مثال: هل هناك اهتمام أكثر للمحتوى العلمي للمادة العلمية على حساب قيم وأخلاق ودين الطلاب؟ مع التوضيح وذكر أمثلة إذا كرمت؟
٣٠. كيف تتعامل مع الجانب الجدلي المتعلق بهذه القضايا العلم اجتماعية مع طلابك؟
٣١. كيف تستطيع التحكم بسلوك الطلاب عند الحديث عن بعض هذه القضايا (مثال: عند الحديث عن الاستنسل، النظرية الداروينية، خلافها وخلافيهما)
٣٢. ما هو الدافع الباطني في ذلك عند تدريس مثل هذه القضايا في فصلك الدراسي؟
٣٣. كيف يمكنك تحديد مدى استعداد طلابك عند تدريس هذه القضايا؟
٣٤. هل تعتقد أن أسوب فعل؟ لماذا؟
٣٥. إلى أي مدى تعتقد أن المكونات الأخلاقية والقيمية في بعض القضايا العلم اجتماعية يجب أن تؤخذ بعين الاعتبار في فصل العلوم؟ (ساذرل، ٢٠٠٦)
٣٦. هل توصي بتدريس هذه القضايا لمعلمين الآخرين؟ لماذا؟ إذا كانت إجابتك بل لماذا لا؟

لك مني وافر الشكر وبالغ التقدير وأسف جداً على الإطالة...
APPENDIX L

INTERVIEW PROTOCOL

ENGLISH
Appendix L

Interview Protocol

English

Interview Introduction, (Overview of Study)

1. The questions attached are solely aiming to investigative your views, and therefore, your response will be very confidential and will not be allowed for us as researchers to use the data obtained in non-research purposes in any way.

2. Please communicate with the researcher if there is ambiguity in any of these questions.

3. Would be very nice if you answered all the questions attached. Knowing that it is possible to send voice your responses electronically through private WhatsApp chat service if you prefer. All you should do is e-mail me on any of the numbers attached below. (Which is the most appropriate way)

4. The questionnaire consists of three main sections: the first explores your concepts and views of the issues in the domain of science education, and the second explores views on some issues that may be of interest to you (for example, the issue of cloning, genetic engineering, nuclear energy, etc.), and the third section pertains to teaching strategies related to these issues, and how it is handled in the classroom.

5. This interview is not a true or false type. It is only Intended to identify your views about some issues related to science.
First: General overview of these issues in the Saudi education science system:

1. How would you describe yourself as a science teacher?
2. What is your frame of reference of teaching science?
3. What is your understanding of science as a human approach?
4. What is your understanding of the relationship between science and other disciplines like religion for example? Why would you think this way?
5. “What are some value laden issues within your discipline?” (Sadler et al., 2006, p. 374).
7. "Could you tell me, if any, about your thoughts and feelings when you learned" SSI? (Charmaz, 2014, p. 67).
8. Do you know some controversial issues in science education?
9. Would you tell me more about these issues?
10. Why do you consider it/them controversial?
11. What is/are this/these issue/s to you?
12. Some science educators suggest that controversial scientific issues such as cloning and gene therapy should be made an important part of the science curriculum. What do you think about this suggestion?
13. Why do you think this way?
14. Would you give some examples that could illustrate your answers?
15. How would you describe the correlation between science and society in Saudi Arabia? Why?
16. How would you approach a more humanistic understanding of science in the Saudi society? And How do we increase the scientific literacy among Saudis?

Second: investigating Saudi science views of some particular issues:

17. How do you think it is important to know about (..)?
18. Why would you think this way?
19. What are some of the major challenges you think are facing science curriculum in Saudi Arabia to include issues like (..) In the Saudi science curriculum?
20. What, if any, are the major opportunities to include and discuss (..) In the Saudi science classroom?
21. Would you describe how can opportunities to considering this issues be maximized?
22. What are some of the challenges you think are prohibiting real attempts to consider (..) In the Saudi science curriculum?
23. Would you describe how can barriers be overcome?
24. Do we need, in the Saudi society, to focus more on this issue? Why, or Why not?
25. What are some problems that might result from this approach?
26. Would you give some examples that could illustrate your answers? 
27. How would you approach this understanding on the Saudi society?

Third: teaching strategies used for teaching these issues:
28. Could I ask you to describe the most important lessons you “taught” through experiencing” SSI in your classroom? (Charmaz, 2014, p. 67).
29. Why do you teach the ones you teach? Why would not you teach others?
30. What is teaching (…) To you? Why?
31. How would you teach these issues in your classroom?
32. Do you have specific strategies for teaching specific issues? Would you explain?
33. Teaching many of these issues requires a great deal of negotiation strategies; therefore, to what extent would you accept opposing, or different views from your students? Why? Would you provide some examples to illustrate your answer?
34. What motivates you, if any, to use creative teaching techniques for teaching this issue?
35. If you find a contradiction to your belief that is scientifically proven, how would you handle such contradiction in the science classroom? Why?
36. “How do you deal with values and ethics in your classroom?” (Sadler et al., 2006, p. 374).
37. “How do you handle your own values relative to issues discussed in the classroom? Do you have a right to express your opinions; and beliefs?” (Sadler et al., 2006, p. 374).
38. What are some specific incidents during which values and/or ethics were addressed in your classroom? Describe what happened. (Sadler et al., 2006, p. 374).
39. “Ideally, how should values and ethics be handled in the science classroom?” (Sadler et al., 2006, p. 374).
40. How would you handle the controversy embedded in (…)?
41. How would you handle your students’ behaviors when you discuss (…)?
42. What are the final objectives in your mind when teaching these issues?
43. How do you go about assessing whether students grasp the issues that you present in class?
44. Is it working? Why or Why not?
45. To what extent should science teachers highlight the moral and ethical components of Scientific issues in their classrooms? (Sadler et al., 2006, p. 374).
46. Do you recommend teaching these issues to your colleagues? Why, or Why not?

Thank you so much and sorry if I got too much time from you…
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