

Religious science teachers' views on the relationship between science and religion and their practices in the classroom

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Abstract

This study delineated science teachers' views on the relationship between science and religion and their teaching practices in the classroom in Korea. We focused on the experiences affecting participants' views on the relationship between science and religion, and investigated how they related their views and practices to religiously minded science instruction and how they interacted. We interviewed four Christian teachers of science with an approach to oral history and interpreted the data categorizing different periods: before pre-service teaching, during pre-service teaching, and during in-service teaching. The participants held divisive views concerning science and religion: from the view that science is not only incompatible with, but also separate from religion to the view that science is an integrated subset of religion. They adhered to such views and their experiences in their college and workplace contributed to forming their views. In terms of teaching practices, they showed different levels of religious acceptance ranging from inactive to active. In addition, the participants' views on the nature of science and nature of religion, and their vision as science teaching hinged on their attitude towards science education as well as on religious practice. The study suggests that religious instruction of teachers is connected not only to their views on the relationship between science and religion but also to other values such as a vision of science teaching, the nature of science and religion, and religious commitment.

Key words: science teacher, science and religion, nature of science, practice, religious education

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I . Introduction

One of prolonged issues in science education is the relationship between science and religion (Brooke, 1991; Draper, 1910; Holtzman, 2003; Kitcher, 1982; Miller, 2007). Centering on the creation-evolution controversy, there have been many studies dealing with *the relationship between science and religion* (hereafter SAR). Scholars hold dichotomous views about the role of religion in science education. Religion is considered as an impediment to the development in science and technology (Gauld, 2005; Mahner & Bunge, 1996a, 1996b) and is also considered as reciprocal buttress to science (Cooling, 1990; Poole, 1996; Settle, 1996; Turner, 1996; Woolnough, 1996). That is to say, SAR has ranged from the view that they are totally incompatible and contradictory to the view that science and religion are substantially interdependent and complementary (Abd-El-Khalick & Akerson, 2004). In spite of the intense and long-term debates on SAR, there is little negotiation about how to mediate the two realms.

In science education, SAR is closely connected to students' views on the nature of science (NOS), which is considered as an important goal of science teaching (Abd-El-Khalick, Bell, & Lederman, 1998; AAAS, 1993; Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002; Lederman, Nola, & Irzik, 2011). One of feature of NOS is socio-cultural influence of science. For example, scientists' personal belief and values might affect their scientific achievement. Religious idea could also engage with science activities (Turner, 1996). In other words, a religious view plays a significant role on personal epistemology since religion is weighed in both personal beliefs and values. Various studies conducted have shown the significant role of personal epistemology between science and religion in education (Cobern, 2007; Fysh & Lucas, 1998; Gauld, 2005; Glennan, 2007; Martin-Hansen, 2006; Roth & Alexander, 1997; Stolberg, 2007). Roth and Alexander (1997) conducted a case study on students' scientific and religious discourse. The study addressed whether science and religion are considered absolute truths or socially

constructed knowledge consistent with their views. Martin-Hansen (2006) investigated students' views on NOS in relation to evolutionary topics. The study reported that a few of students who did not change their views on NOS supported creationism.

Besides, it is regarded that personal belief and value affect practice in teaching and learning (Briscoe, 1991; Cobern, 2000; Luft, 2001). This may be that a science teacher of religious conviction stands at a disputing point between science and religion. Fysh and Lucas (1998) examined the perceived conflict of teachers and students between the Bible and evolution in a Lutheran secondary school. About the fact that teachers tended to perceive conflict between the Bible and evolution less often than students, they assumed teachers understood better that "the same phenomenon is being examined from different perspectives". However, this idea is untested and does not explain the behavior of teachers in science classroom. Stolberg (2007) investigated how pre-service primary teachers related science to religion and what idea they adopted when teaching science. The framework was comprised of four quadrants, where science/religion is assessed as either "epistemic" or "pragmatic". In the quadrants, four ways of relating science and religion are found by: conflict, integration, independence and dialogue. In this vein, science teachers' views on SAR have been investigated as one of the factors in science teaching.

The clashes between science and religion emerge not only to evolutionism, but also to other parts of science such as the age of the earth, celestial motions and the origin of the universe (Glennan, 2007; Martin-Hansen, 2006; Miller, 2007; Zeidler, Walker, Ackett, & Simmons, 2002). Many Christian scientists follow religious perspectives on science like intelligent design and creation research (Lawrence, Smith, James, & Jensen, 2005). Nowadays, a religious movement to revise science curriculum by Christian scientists has been arising in Korea and biologists supporting evolutionism declared a statement opposed to the movement (Abd-El-Khalick et al., 1998). Moreover, unlike surrounded countries, Korea has a large population of

Christianity as much as 29.2 percentage of the total population (Korea National Statistical Office, 2006) and a large proportion of teachers are Christian. Especially, in Korea, it is disputable whether science teachers could/should deal with religion in science classroom. However, there have been a few of studies dealing with science teachers' views on SAR (Im, Cho, & Hong, 2007; Kang, 2010; S.-E. Kim & Cho, 2008; S. Y. Kim & Nehm, 2011) and most of them have focused on specific topics, creation and evolution.

Thus, this study aims to investigate science teachers' views on SAR and their practices in the classroom, and to examine the relationship between their views and practices. This study concentrates on the understanding of the practices of Christian teachers in the classroom and illustrates the character of teachers' commitment to science teaching in the classroom.

II. Research Design

This study relied upon a case study of four Christian teachers in regard to their views on SAR and practices. The cases we chose did not demonstrate the representation of religious teachers. Religious teachers of science had different religious faith, teaching subject, teaching careers and academic backgrounds. Thus, through maximum variation sampling, we tried to choose four science teachers who had different gender, religious faith, teaching careers and personal experiences as the extreme and typical case (Stake, 2005). Since personal beliefs, values and practices grow stubborn over time, an individual life should be understood from a holistic perspective. To delineate the process and result connected with personal views and behavior, we adopted oral history as a research method. Quantitative methods might not adequately study the issue. As information about religious science teachers such as the ratio or the number of religious teachers and studies on religious education in Korea is rare (Korea National Statistical Office, 2006; Lee, 2001), it is unlikely to perform probabilistic sampling on the

educational practice of a religious teacher. Oral history is similar to life history but distinguished from life history because of greater emphasis on a personal narrative (Creswell, 2007; Guba & Lincoln, 2000). This method has a limitation that it relies upon personal statements recalled in the brain. That is to say, personal narratives may be subjective, distorted or embellished. To raise the trustworthiness of the study, we not only interviewed the participants but also received their essays and commentary from their colleagues. The collected data were analyzed by the taxonomical analysis composed of the domain about science and religion (Spradley, 1980), and questions used in the interviews based on the literature review and the questions unstructured became more structured over time.

To answer the question of how Christian teachers cope with a contradictory situation such as creation and evolution, we selected participants who experienced conflict between science and religion or taught science religiously. The names of the participants have been assigned pseudonyms for anonymity. They were referred to in this article as Min, Young, Do and Soon. In the process of participant selection, we first chose two science teachers as the extreme-case (LeCompte, Preissle, & Tesch, 1993) : a female in biology and a male in physics. Their ways of teaching science differed religiously. While she was enthusiastic to the extent that she practiced religious faith in the classroom as often as possible, he believed it was the best not to show personal opinion in science class. Two other participants whose religious commitment and teaching careers differed from those of the first two teachers were interviewed; bringing the total to four (we added one more physics teacher and one general science teacher). This enabled us to have four participants whose gender, religious commitment, teaching careers and subjects, varied.

Through the collected data, a chronicle framework was constructed to present the interaction between the views of participants about the relationship of the two realms and their practices according to beliefs. Their views on SAR were presented as Figure 1. Their views and practices were divided

into three different periods in criteria of teaching career: before pre-service teaching, during pre-service teaching, and in-service teaching. By comparison of each case, the researchers intended to describe experiences of the participants and to find out the similarities and distinctions of each case. After interpretation of data, the paper was assessed by the participant as a member checking.

III. Research Participants

The participants were Christian teachers at public schools (see Table 1). Min and Young were male high school teachers while Do and Soon were female middle school teachers. Min was a veteran high school teacher who has taught for twenty years. He was interested in cutting-edge technology, devices, and books, and tried to introduce new ways of teaching his class to motivate students. Young taught physics and faithfully participated in church service. In college, he attended a religious club actively. Nevertheless, he never showed his religious faith connected to science. Do was a middle-aged science teacher and enthusiastic about creation research and the Bible. Though she taught biology, she also instructed in physics, chemistry, and the earth sciences at a middle school. Last, Soon's teaching career of five years was shortest among the participants. She taught every field of science at middle school and mentioned creationism occasionally. She was the only Christian in her family.

Table 1. Brief information about the participants

| Participants | Min | Young | Do | Soon |
|-----------------------------|---------------|---------------|---------------------------------|---------------------------------|
| Gender | Male | Male | Female | Female |
| Person Age | 46 | 36 | 48 | 26 |
| Teaching Career | 20 | 10 | 25 | 5 |
| Major | Physics | Physics | Biology | Physics |
| Highest Degree | PhD candidate | PhD candidate | Bachelor | Master |
| Teaching Subject | Physics | Physics | All fields of science | All fields of science |
| First moment as a Christian | Childhood | 3-4 years old | In teens, a believer in college | In teens, a believer in college |

IV. Results

We interviewed four participants, categorized the excerpts into several aspects of science, religion and personal life. Through analyzing the excerpts from research participants, it is found that they underwent major changes during specific periods and that they perceived similar events differently according to the formative time it was faced. Thus, we identified their academic life into three periods: before pre-service teaching, during pre-service teaching, and during in-service teaching. The period before pre-service teaching means the time they became a pre-service teacher (at college) since a birth; the period during pre-service teaching implies the period while they were taking courses at college for becoming science teachers; and the period during in-service teaching means the time after they served as a teacher in schools. Special attention was paid to their experiences, views on SAR, and teaching in connection with religious faith. According to primary analysis, the participants shared similar views on SAR though they had quite different

experiences about religion in adolescence. Their experiences in college were more influential to their views they currently held, and showed prominent differences of religious instruction during in-service teaching, regardless whether they held it.

A. Before pre-service teaching

Min, at the age of 5 or 6, first went to church with his mother. His atheistic father did not forbid church attendance. When he was about 10, he was diagnosed with osteomyelitis (inflammation of the bone) and his doctor told him that his leg had to be amputated. Min, however, healed without amputation thanks to the desperate praying of his mother. The experience made him dream to become a pastor because he received much help from others and felt responsible to reward them for the support he received. He read many books on various fields while he was bed ridden. Thanks to the reading, he showed good scholastic achievements, especially in social studies. However, he questioned criticisms heaped against science by religious texts. He became aware that there were discrepancies between scientific and religious ideas. He felt confused. An assumption occasionally entered his mind whether evolutionism was true and whether his religious idea was wrong. He seldom attended church despite his dramatic recovery. He thought that school knowledge was unrelated to religious belief.

Young also spent his teens like Min. He, too, believed in God since childhood but felt no conflict between science and religion. Young was left in the care of his grandmother due to economic hardship. He remembers his grandmother sometimes attending church and bringing him along. That was his first contact with Christianity. He started attending regularly after he moved to Seoul to be with his family. He stated that his family followed him to church and that he was the most passionate among them. Though he was enthusiastic about religion, as Min did, he also responded that he did not seriously learn about evolution since it was nothing but school knowledge.

While both male teachers had accepted God since childhood,

Do and Soon did not attend church until their teens. Do became aware of Christianity at her Christian high school. Her family were strict Confucians and performed sacrificial rites to ancestors a few times a year. She was disinterested in Christianity and looked down upon those who believed in Christ. However, that began to change. After belief, she did not experience conflict between science and religion because she did not associate it with religious indoctrination.

Soon's family situation reflect Do's as neither believed in God. When she was a secondary school student, she was led to church by a neighbor serving as a church teacher. She began to attend church but only once a week out of the four or five regular weekly worship services in Korea. As she began to attend the service, she became aware that her belief was inconsistent with her schooling. She ignored evolution theory. She worried more about religious arguments rather than the discrepancy between science and religion, as documented:

I used to worry about these questions: After death, can I go to the kingdom of heaven? Does the kingdom of heaven and hell exist? Well, when I heard about evolution, I asked myself, in my heart, how it could be and how is it done logically. But I was not that serious. [Evolution] is just learned at school but [creation] is my life at church. When I took an exam, I wrote down [scientific theories]. - from the interview on July 26

The participants considered science independent to religion. They distinguished scientific and religious knowledge but did not perceive serious conflicts between the two. When faced with contradictory topics such as evolution, they showed dichotomous responses; they followed science in school while the Bible in church. They did not interpret that God used evolution to create the world or believed school knowledge opposed religious argument. They took a similar attitude towards the relationship, irrespective of when they began to believe. In spite of the religious experience, they did not resist school science. For them,

it was more serious the question of whether religious argument was true as Soon mentioned above. Furthermore, they did not have abundant knowledge to evaluate or judge controversial issues. In other words, it seems they obsessed with the unimpeachability of religion without considering its rationality. Therefore, their falling short of conviction explains their inactive attitude and the view that subject matter is not a significant value but an instrument for higher education. As a result, they had a separated view that science and religion had different domains and did not perceive a conflict.

The experience and religious commitment of the participants did not pose an obstacle for them to seek the teaching profession. Their decision was irrelevant to religious commitment. Min's selfless mind and an interest in science encouraged him to be a science teacher. When he was admitted to university, Korea plunged into confusion following the assassination of President Park in a military coup, which resulted in a strong countermovement by students for democracy. In such a complicated time, he thought that he had to join the democratic movement or educate people for the country. Between those two options, he chose the peaceful and productive role of a science teacher.

In case of Young, the social atmosphere also affected his decision. He might have been affected by his class teacher. The teacher had worked there for six months before studying abroad. He returned with many science books and placed them in the classroom. Due in part to this, Young became more interested in physics. Furthermore, the government began to heavily subsidize science and technology education, attracting the most aspiring students to strengthen Korea's growth. Because his score was not high enough to enter a physics program, he pursued physics education. Though becoming a science teacher was not his dream, he favored entering a physics education department since it afforded him latitude to continue studying physics.

In case of Do and Soon, Do was interested in science and decided to be a teacher because of its guaranteed long-term employment. Soon's reasons parallel Do's. In addition, she

wanted to learn more about science at university.

As for entering the department of science education, all of the participants had in common an interest in science and a view about SAR. Religious faith did not prevent them from entering a science education teacher preparation. It is interesting to note that the male teachers were influenced by the social factors while the female teachers by personal ones.

B. The period in pre-service teaching

During pre-service teaching, the participants interacted with their surroundings that reinforced or diminished their views about science and religion. Young strengthened his belief that religion is more valuable than science. In college, Young joined a Christian club. He spent his university days consorting with club members. He participated in it as a freshman and continued until he was 28. The club made him skeptical about an intellectualism, insisting on Biblical knowledge as the most valuable. He held the view that religion is superior to any other study. He seldom read books except theological works. Such a change deprived him a chance to see the world outside religion.

When he graduated, he considered four occupations: journalism, office work, physics, and science teaching. He avoided working for the press because he did not want to reveal the weaknesses or faults of others. He rejected employment in the private sector because he felt it inevitably led to cheating, duplicity, and drinking with clientele. Physics, though on the forefront of his mind, was, too, foregone since it was too taxing on his religious life. A physics teacher career enabled him to study physics and did not burden his religious pursuits. He opined that faith encouraged him to pursue teaching and physics with a free conscience.

On the contrary, Min reinforced his thoughts through his college experience. His family had financial setbacks throughout his college years, and he looked at irregularity and inequality as contrary to the religious doctrine that "The Lord's curse is on the house of the wicked, but he blesses the home of the

righteous (Proverbs 3:33)". The worry that he experienced in college was attributed to discordance between religious doctrine and reality. To answer the dilemma concerning prosperity of the wicked while the righteous in anguish, he read broadly on philosophy, religion, and social science to find out what he had to believe by comparing every religion, clarifying the strength and weakness of each, and interpreting the Bible not literally but in context.

After some time, he realized that every religion could be differently interpreted by the individual and he believed that religion was helpful for humanity. He supported the idea that humanity needs to live with gratitude and to praise a god, no matter what it is and he invested his trust to a Christian God since he was accustomed to that culture. He thought highly of the connoted meaning of the Bible, not the reliance on a literal interpretation. For the Bible was written by numerous authors temporarily and spatially and it was natural to conclude that the Bible is subjective and that one should refrain from blind devotion. He did not care about controversial issues related to the Bible and concentrated on "What the Lord wanted him to do and what he had to do for the Lord".

As for science, he believed that science is provisional and inconsistent with reality because the terminology requires presuppositions. This is his view regarding the creation-evolution controversy:

I became aware of creationism from a brochure someone gave. Maybe, I was a freshman or sophomore in college. That was nice. It was plausible. Nevertheless, there was no development in creationism such as the increase of the evidence, the elaboration of the theory. However, recently my daughter brought home a similar brochure and I read it. There were some pictures, which I also saw 20 years ago... If creationism is real, more evidence should be found and the theory has to be developed... Evolutionism also has flaws. We cannot figure out what is right or wrong... If evolution was on-going, there would be many uncertain

species in the world as a product in the process of evolution. Some species would be prosperous, while others would be extinct... - from the interview on April 16

Do and Soon did not experience significant events. In spite of studying different majors in college, they held similar views. While there, Do (biology education) and Soon (physics education) attended church weekly and both became Bible tutors. The experiences they conveyed through the Bible with children at church provided more opportunities to become faithful. However, there were some problems with this. Do felt compulsory about maintaining a religious life and she prayed only when it was a necessity. Soon did not get acquainted with church members. As she grew in her non-religious family, many activities in church were unfamiliar and she felt lonely on several occasions due to her parents' atheism.

Both supported a separated view that religion is irrelevant to science and that knowledge and belief are mutually exclusive. Faith did not influence the views of science nor did science influence views on religion. After graduation, both passed the exam for a public school appointment and entered science teaching. Soon moved to a small city near Seoul.

The experiences of the participants during college made them re-consider their view of science and religion and, consequently, affected their view. For example, Young, who had been pious since childhood, joined a religious club and believed that its knowledge is more valuable than any other. Min, who suffered from family poverty and social irregularity, doubted religious dogma and pondered about SAR. Do and Soon had some trouble forming their faith though they did not assume the issue was serious.

The conflict that both had is related to their views on NOS. After entering college, all participants recognized that scientific theories beheld counter arguments. Science could be interpreted, disproven, or contradicted. Whilst Young underestimated science because of this feature, Min used science to solve his own problem by interpreting religious issues in the same way science

did. For the other female teachers, the tentative nature of science supported their view that science is independent of religion.

The intrinsic conflict in religion and a change of their NOS affected their view of SAR. They might have responded about their college experiences, regardless of whether they changed their view or not. In case of the two female teachers, their growth in religious faith did not connect with their views. Do and Soon thought the relationship between the two domains was independent regardless of conviction.

C. During in-service teaching

The pedagogical experience during the in-service period provided the participants with a chance to testify their beliefs. The female teachers were positive while the two men were negative about science teaching and faith. Initially, Do felt no issue teaching controversial material to religion since she regarded the two independent. This attitude changed after she visited the school of her 15-year-old son. Meeting her son's teacher, she encountered a great challenge between pedagogy and faith:

In 1996, I was not passionate about religion. At that time, I was put on leave because of an injury. One day I had to visit my son's teacher. She was Christian. She asked me where it hurt and prayed for me in midst of the aisle. I was shocked. If I were her, I would not have done that. I would have felt ashamed because many children were passing. Who could do that for the parent of a student? ... Following her, I prayed every morning and I worshiped every day in my house and sometimes at church... After which I experienced a miracle: the pain subsided by a prayer... I returned to my school one or two years later. The next year, I began to preach God's manifestation... - from the essay on January 16

Over time, she believed that science could be explained from

a religious perspective since they were within the same boundary: an integrated view that science is a subset of religion. She maintained that everything is derived from religion. Through participation in a training program for creation research, she framed her own religious interpretation and looked into science uniquely; she developed religious instruction for all possible science content. For example, evolution and variation as well as thermodynamic laws and celestial motions in physics were treated religiously. She set creationist topics as a performance test for students. She attempted to justify the rationality and superiority of creationism while endeavoring to reveal the mistakes of evolution:

In the ninth grade, students learn about the solar system, the distance between heavenly bodies, the brightness of a star and other objects according to the science curriculum. When I teach these topics, I apply God to the explanation of them. I say that people in the past regarded the solar system as the whole universe. However, it is not true. As you know that the universe is too broad, God exists even if we cannot see him... There are spongy tissues and stomas beneath the leaf. Palisade tissues are located on the leaf and photosynthesis occurs on it more vividly on one side than another. A textbook tells us only about the structure of the leaf. If the leaf were upside down, the plant would die of draught and strong sunlight. So the palisade tissue abundant in chloroplasts is on the upper side, while stomas are on the opposite ... This is made by God's elaborate plan. These are not found anywhere in literature... I am grateful to God for letting me know about that... - from the interview on July 10

Do pointed out the fallacies about evolution and contended that her religious view is an alternative. When some students protested, she apologized and justified her intent to religiously teach the claims. She was afraid of protest against her instruction. But because this never happened, she kept teaching

science religiously.

Soon also introduced theories into creation research for students. She did not perceive the controversy in the early days as a science teacher. She taught evolution theory and briefly told students about its limitation. However, she grew positive about religious instruction. For example, in the classroom, she claimed that evolution theory is not a theory but a hypothesis and that scientific argumentation could be modified since evolution has fallacies:

About evolution, the evidence is related to the ratio of change of copper or carbon. So I explained that the theory might be affected by the environment or anything else... First, I think I passed over concepts in the science text quickly, but now I say that [evolution theory] is a hypothesis and it is not absolutely correct. Modern evolution is comprised of fragmented principles... Each could be interpreted by the context ... - from interview on July 10

Her change during in-service teaching may be related to conviction of faith. In those days, she felt guilty not behaving like a "real" Christian. She had many questions remaining in her mind, and had to live apart from her family. She relied upon a religious life and became free through sermons of her church pastor. The pastor emphasized the creed of the Bible and explained events in the Bible in detail. His approach helped her answer the questions of why Jesus had to die on the cross and what was behind a specific event. As she ever identified as a Christian, she became more active. Hence, as a believer, she practiced science instruction according to her faith though the church community did not impel her to behave that way in her classes.

Yet, she held a separated viewpoint. She has never perceived conflict between science and religion until now. There was anxiety due to a lack of understanding about religion. She stated that SAR is independent since they have different domains. Science is regarded pragmatic learning while religion

plays into the criteria of her life. Nevertheless, she assumed that it is possible to unify science and religion:

I think that scientific knowledge is compatible with a religious one. It is my humble opinion. I cannot explain it because I am not versed in religion. A human being cannot do that because God created him ... Because I am human, I understand some of whole bodies: some of science and some of religion... I think there is a conflict between science and myself or between religion and my life rather than between science and religion. - from the interview on July 26

There is a subtle difference in teaching between Do and Soon though both teach religiously. Whereas Do intended students to believe in Christ and the Bible explicitly, Soon spoke about creation research as an alternative and let students judge. In addition, they held different views on SAR. Do supported an integrated view while Soon maintained a separated view. Yet, Soon is active about religious teaching of science.

On the contrary, Min and Young held varying views about evolution. Both of them viewed that there is no absolute knowledge in the world in any discipline including religion. They believed that all knowledge is both provisional and temporary. They supported the idea that the two domains have original ways of looking at the world. That is to say, religious faith is not based on logical inference; it is difficult to explain religion scientifically and the reverse. In case of the creation-evolution controversy, they felt that both were defective. Min contended that both theories are imperfect since right theories are confirmed by newly found evidence and refined rationale. In spite of belief of creation by God, Young also acknowledged the uncertainties of creationism as well as evolution:

I accept the idea that human beings were created by God. The Bible says that Adam was made from dirt on the sixth day. But I do not admit what the Bible says literally.

Actually, nobody observed the process of creation, and the Bible was not written by creation's witnesses. If we understand it literally, we will be misled ... It is difficult to take the Darwinian argument that human beings have evolved in a way such as natural selection or the survival of the fittest. From an inorganic matter to an organic matter and from an organic matter to a living thing accidentally by chemical reaction ... Considering the process of evolution, I think creation by God is more reliable and acceptable than evolution. - from the essay on August 7

For Min and Young, science teaching is related to their personal experience in college. From his early experience, Min has considered that science could be as subjective as religion. Based on the conclusion, He believed it is inappropriate to persuade students to adhere to his belief because a theory can be falsified. Therefore, he did not impose his religious opinion on students. His vision as a science teacher had an impact on his attitude towards science teaching. His pedagogical philosophy that science should be taught to help students live meaningfully encouraged him to respect their beliefs and values and to be cautious to prevent science from interrupting their ideas. He also tried to make students understand that what they learned applied to new teaching methods.

Though he held similar attitudes towards religious instruction, Min experienced a dramatic change about science and religion during his teaching career. He got along with club members and introduced occasionally religious themes in his class he felt responsible as a Christian. However, he fell out of contact with most members a few years into his teaching appointment because of school demands and the longer distance from university. Meeting Pastor Lee altered his views. Pastor Lee helped Young realize that the essence of Christianity is not exclusivity and egocentricity, but toleration and altruism. He pointed out that all knowledge in the world is meaningful and that it is intolerant to adhere to only one of them. Lee suggested he admit to other knowledge claims. Young realized

that he had held extreme religious beliefs. He, then, avoided presenting his religious opinion because prejudice was an obstacle to scientific thought.

With the help of the pastor, he formed a new view of religion. Initially considering science subjective in scope, after meeting the pastor, his view on it improved. He denied a literal interpretation of the Bible. He insisted that we should acknowledge uncertainty about Biblical views and we should consider the social context in that written era. Since religion is not based on rationality, scientific explanation of religion is ineffectual to an atheist. As scientific theory is improved upon and elaborated continuously, religious knowledge should, too. Both Min and Young held quite similar views on science and religion.

In spite of his neutral attitude towards religiously motivated science education, he contended that religion should be treated in science education from a cultural perspective if it is connected to context and the everyday life of students. He recognized that religion plays a significant role as the cultural foundation of personal values.

In the class, we can talk about religion. Religion is an important personal belief and it is the one of the most powerful cultural elements surrounding us. This is our undeniable cultural foundation... However, we should consider what students want to learn because society is multi-religious... When I was a novice teacher, I informed students about a Christian doctrine, but not now. Instead, I usually talk about church in cultural terms. 'Cause the church is a part of daily life for some students. - from the interview on August 3

The vision of the participants as science teachers was associated with their view of SAR. The vision affected their attitudes and practices in the classroom. Min thought highly of students with regard to education. He always considered science a tool for students to live meaningfully. He thought that the personal opinion of teachers should not be explained in science

class since instruction is meant only for students. He stressed the purpose of science education to improve the relevance between science and everyday student living. He tried to use everyday objects to motivate them. For instance, he entered class with skates to teach friction or action-reaction, or did an experiment with a cell phone to show the existence of electromagnetic waves. From this point of view, he gave his students some suggestions, which he heard from the pastor of his church. That was not missionary talk but a short, friendly, trial.

Young also respected his students. In the early days, he was skeptical about science education. He was cynical about teaching gifted students because they learned science without the help of a teacher. By contrast, it was important to help poor students understand science though it was difficult for him. Those thoughts troubled his passion about education. One common point in the pedagogy of both teachers is their altruism.

Do considered her occupation as God's messenger to transmit His creation principles of creation by God. She regarded science and religion the same since both originated from God and views science as a subset of religion. She believed the purpose of every discipline including science is to show His will to the world. It was natural for her to teach religious faith to students. She was grateful for becoming a biology teacher as opposed to mathematics or literature because of the chances to inform more students of religious interpretation of her missionary goals. She was prepared to resign if her teaching style becomes problematic at school.

Soon instructed creationism with evolutionism, but she differed from Do in that she did not take advantage of her preoccupation with missionary goals. She preferred to teach scientific concepts rather than persuade her students to believe in religious arguments because she thought highly of the accurate understanding of science.

V. Discussions and Suggestions

In this study, we tried to find out science teachers' views on SAR and their practices and investigate the relationship of the two. First, their views on SAR were distinct from a separated view to a superior view and to an integrated view, and changed their views during in-service teaching. Regarding the factors influencing their views, the personal and social environments might contribute to form their view on SAR. Young and Do changed their views due to the personal incidents, whereas Min maintained his original thought despite his personal setbacks and social irregularities. Do fortified her view of integration under the influence of creation research in Korea. It is interesting to note that the participants intended not to change their view of SAR (see Figure 1). Considering the practical effects of the two views, integration and separation, the former seemed more in-line with practice than the latter. The case of Do proves that integration encourages teachers to keep the religious action. However, it is insufficient to explain religious practice in the classroom. The case of Soon falsifies the aforementioned argument. In a previous study, it is expected she would not follow religious faith (Stolberg, 2007) since she recognized the mutually exclusive relationship between science and religion like Min and Young.

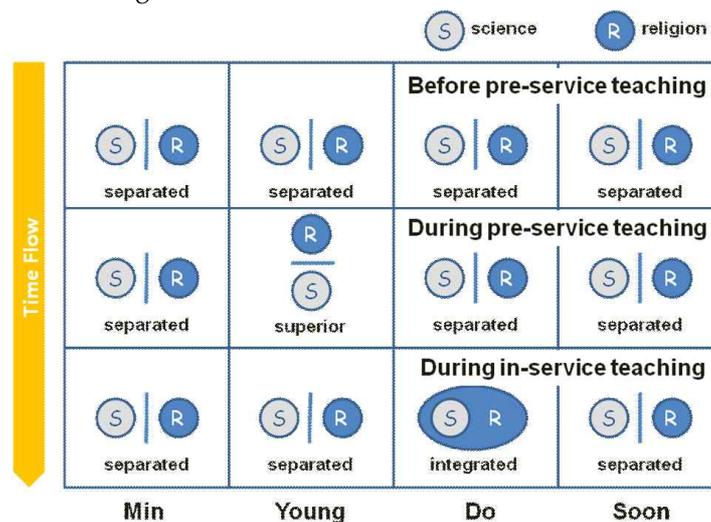


Figure 1. The participants' views on the relationship between science and religion

Moreover, considering their views on religion, the participants might relate their views on SAR to the nature of religion. For example, Min and Young thought we should consider the context where the bible was written and avoid literal analysis of religious texts. On the other hand, Do and Soon accepted religion as an absolute criterion. Further, the participants' views on NOS could affect their inclinations to the nature of religion. Min believed that scientific knowledge was tentative and influenced by the personal and social environment. When he suffered from discrepancy between religious orthodoxy and the real world, he intended to disentangle religious knowledge and scientific knowledge regarding his views on NOS. Young also applied his views on NOS to religion. Conversely, Do's views on NOS reflected her view on the nature of religion and considered scientific aims as a way to reveal the principle that the Lord operates the world.

With their views on SAR, the combination of vision as science teachers stimulates their decisions about religiously influenced instruction in the classroom. The inactive attitude of the two male teachers is consistent with their view that teacher should not impinge on individual freedom or coerce students but should instead teach science for its benefit. Do was enthusiastic about discussing religious ideas since she regarded her occupation as a messenger of the Lord. Last, Soon was able to involve religion in her class since it is connected to her religious identity. Dealing with controversial topics stimulated the females' reflection about the issues.

Division of teachers' lives may provide some explanations about practices of the participants according to each of periods. Among the three periods, the experiences during in-service teaching seem most influential than any other one. This is because there are a plenty of chances to tackle controversial topics such as evolution and they have formed their vision of science teaching during in-service period. Especially, it is important who plays a role model for them. The model can be a colleague or a religious leader like the case of Do, Soon and Young. It means that educational practice relies upon a mentor's

viewpoint whether or not to mention pedagogic statement explicitly. The vision of science teaching also infuses practical aspects of the participants considering they intended to implement praxis appropriate to their vision. These personal opinions are being formed throughout their whole lives.

One interesting thing is the discrepancy between views and practices of the participants. The recognition of teachers' views does not guarantee what they are doing and are going to do (Brickhouse, 1990; Cronin-Jones, 1991; Hashweh, 1996). Previous studies of SAR have focused on the view of pre-service and novice teachers and prediction to their future practice (Cooling, 1990; Fysh & Lucas, 1998; Gauld, 2005; Shipman, Brickhouse, Dagher, & IV, 2002; Stolberg, 2007). Albeit there is a limitation that this study is based on teachers' reflection on action, it is assumed that various personal aspects were intertwined to affect their practices in the classroom: the view of SAR, vision of science teaching, religious commitment and the NOS. Hence, educational practice should be investigated from a holistic perspective including longitudinal and societal viewpoints (Jones & Carter, 2007; Roth & Alexander, 1997).

There are some points to be discussed despite the results of this study may not be generalizable. Irrespective of whether religion-oriented teaching is helpful to science teaching, religious teaching is dubious. Science teaching based on religious belief is susceptible to infringe students' rights in a compulsory education system. Further, it is unclear how to cope with various kinds of identities: Buddhist, Muslim, feminist, environmentalist and other minorities. They may have perceived a conflict between their beliefs and the dominant surrounding circumstances. Even without any conflict, they may have talked about what they believe in the classroom, and it is impossible to rule out engagement of personal view with science teaching because teaching is inevitably reflecting one's past experience, view and vision. As well, many discoveries and episodes in history of science are associated with religious ideas such as Mechanistic worldview of Descartes, Galileo in an ecclesiastical court and electromagnetic equations of Maxwell (Cushing, 1998; Harman,

1982; Wilson, 1999). This issue has to be discussed more elaborately. Moreover, the distinction between knowledge and belief is vague in a deep sense (Cobern, 2000). Therefore, SAR needs to be considered in line with the issue of teaching ethics and there should be an investigation of teachers' views and practices with a larger numbers of participants.

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