Identity Formation of Pre-service Science Teachers: Focusing on Those Who Changed Their Major to Earth Science Education in Korea

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Abstract

This study is aimed at understanding the identity formation of pre-service science teachers (PSTs) who are transitioning from students to teachers and from science/engineering majors to education majors. This was done using the conceptual lens of identity within a specific socio-cultural context. The participants were three undergraduate students in their mid- to late twenties who had transferred to science education from natural science or engineering majors. Collection of data included in-depth interviews, story timelines, e-mail surveys, and participant drawings. The study revealed that the PSTs' identity formation was not one common universal process; rather, each person's experiences were individually affected positively or negatively by their life history. Although the three PSTs came from very similar social backgrounds in Korea, their identity formation was categorized into three different types: determined effort, critical exploration, and continuous confusion. This research shows that the life history model of PSTs' identity formation can be based on the individual and practical support to reduce the gap between the actual self and future self within science education.

Keywords

identity – pre-service science teacher (PST) – life history – major transfer – science education

1 Introduction

It is essential in teacher education to understand the complicated learning processes of pre-service teachers who are undergoing gradual transition from students to teachers (Armstrong, 2004; Atkinson, 2004) and developing a personal and professional identity. Identity is not something one possesses at birth but is something that is developed during one's lifetime (Beijaard et al., 2004). Development of identity occurs through various interactions, which include the recursive interaction between genetic and environmental factors. Moreover, identity development can be characterized as an ongoing process: "a certain kind of person one is recognized as being, at a given time and place and can change from moment to moment in the interaction" (Gee, 2000, p. 99).

In education, researchers' awareness of the professional identity of teachers has increased remarkably since the 1990s, becoming a unique discipline during the last decade (e.g., Bullough, 1997; Connelly & Clandinin, 1999; Knowles, 1992). Pittard (2003) emphasized that identity development plays a central role in becoming a science teacher. In addition, many educators believe that learning is not a mere accumulation of knowledge but a process of becoming a certain kind of person operating within a specific socio-cultural context (Lave & Wenger, 1991).

While research into these topics has provided numerous exploratory studies of professional identity development that have given potentially useful information for teacher educators, there has only been limited understanding of how pre-service science teachers (PSTs) construct a professional identity during their lives (Volkman & Anderson, 1998). PSTs build their teacher identity by reflecting on their own perceptions, beliefs, experiences, and practices and also through effective mentoring. To go further, pre-service teachers' identities enable them to understand what teaching is and what it is like to be a teacher (Walkington, 2005). Though identity formation of PSTs is a significant area to be investigated, most of the studies of teacher identity have been conducted in a Western context.

In Korea, little attention has been given to the learning processes of PSTs through the conceptual lens of identity and the country's specific socio-cultural

context. The rate of high school graduates in Korea pursuing college education is 68.9%, the highest among OECD countries (Korea Educational Development Institute, 2018), but there is a deep shadow behind this trend. Many students pursue prestigious universities without any regard to their own academic interests because the name value of a school is equated with happiness and success. As a result, there have been a large number of students who restart their undergraduate education by repeating the admission process and constantly switching their majors (Kim et al., 2018). This trend reflects Korea's education culture where the students prioritize the prestige of the college, secondary education primarily evolves around college admission, and certain majors are preferred due to rapidly changing popularity and perceived competitiveness.

There are two ways to change one's major: transferring departments and starting college over from the beginning. In the United States, about 30% of the students change majors, but in Korea only 2–3% do so due to various restrictions. The internal movement between departments of the university system is strictly limited, so undergraduate students have to re-enter the university to change their major (Kyunghyang Shinmun, 2020). Transfer admissions are also systematically rigid due to legal regulations on the number of admissions to universities. As a result, the choice of major is not as important as the prestige of the school to Korean students (Oh, 2005).

In Korea, the total number of applicants for the 2021 College Scholastic Ability Test (CSAT) was 493,433, of which 133,069 were retakers, accounting for 27% of the total (Korea Institute for Curriculum Evaluation, 2020). Given this context, the students who change their career paths to teaching focus on the stability and the reputation of becoming a teacher rather than considering their personal interests or skills as job insecurities continue grow and the economy struggles.

This study is aimed at understanding the similarities and differences in the identity formation and development of three PSTs. The study takes place at the top university in Korea; this contextual factor adds to the particular characteristics of how identity formation influences where PSTs work and how they develop personal or professional identities.

In order to achieve the objectives of this study, two research questions were formulated:

1. What are the processes of change that the PSTs go through in regard to their identity formation as they gradually mature, both personally and professionally?
2. What are the characteristics that define the types of identity formation of a PST?

2 Conceptual Framework

2.1 *Personal Identity*

The term “identity” originates from the Latin word *idem* which means equal or sameness and was first used by psychoanalyst Erikson (1968) to identify stages of personality development that individuals go through in a step-by-step fashion during their lives. He also defined identity as the chronological achievement that moves toward the critical stage of becoming a productive adult. In contrast to Erikson’s view of identity as a step-by-step process, a large number of contemporary researchers are emphasizing identity as “a construction, a process never completed and always ongoing” that is not determined in the sense that it can always be sustained or abandoned (Hall, 1996, p. 2).

For this study, we combined the identity framework of Gee (2000), Helms (1998), and Sfard and Prusak (2005), as shown in Table 1.

The reason this study paid special attention to the framework of Helms (1998), Gee (2000), and Sfard and Prusak (2005) as an identity analysis tool is as follows:

First, in order to explore the identity of PSTs, the specific characteristics of science as a teaching subject must be considered. Helms (1998) argued that the inherent features of the subject are important factors when understanding a teacher and provided the conceptual definition for professional identity. He also defined the relationship between the subject and the identity of secondary science teachers. We use Helms’ concept of future self: what someone wants for themselves in the future. If this is very divergent from one’s current situation, one has a weak sense of identity. Helms (1998) developed a multi-dimensional model of identity from secondary science teachers that consists of four major dimensions: actions, others’ expectation, values and beliefs, and future self. These four dimensions are closely related to each other with values and beliefs and strongly linked with future self.

Second, in order to understand and interpret the development process of PSTs, identity needs to be defined as a specific conceptual tool. Prior research on identity studies within the field of the science education had been limited to describing and surveying the phenomena without conceptual definitions until the work of Gee (2000), which presented a very specific definition of identity as an analytical lens for pedagogical research. Gee (2000) categorized identity into four sub-components: nature (N), discourse (D), institution (I), and affinity (A), each of which contributes to being a certain kind of person. N-identity is a state developed from forces in nature. D-identity is an individual trait recognized during the discourse or dialogue between rational individuals. I-identity is a position marked by authorities within institutions. A-identity is experience shared during the practice of affinity groups.

TABLE 1 Personal identity framework

Gee (2000)	Helms (1998)	Sfard and Prusak (2005)	This study	
Nature	Value, belief	Actual	Actual self	N-identity
Discourse	Other's expectation			D-identity
Institution	Action			I-identity
Affinity		Designated	Future self	A-identity
	Future self			

Lastly, to describe PSTs' identity formation in the specific context of Korea, we focused on Sfard and Prusak's (2005) concept of identity, which explains identity as a conceptual bridge between learning and sociocultural context. They compared the learning of immigrant learners with native students, explaining that learning is to reduce the gap between actual and designated identities. In this study, actual identity (referred here as "actual self") is a concept taken from Sfard and Prusak (2005). Actual identity consists of stories about the actual state of affairs as told in the present tense. Therefore, actual self contains Gee's sub-identities: N, D, I, and A. In contrast, designated identity consists of narratives presenting an expected state in the future, much like Helms' (1998) concept of future self.

2.2 *Professional Identity*

Danielwicz (2001) and Luehmann (2007) have noted that becoming a teacher means developing a professional identity. Professional development is a learning process in a particular community of practice (CoP). According to Wenger et al. (2002), a CoP can be defined as

a unique combination of three fundamental elements: a domain of knowledge, which defines a set of ideas and issues; a community of people that cares about this domain; and a shared practice such as developing to be effective in their domain. (p. 27)

To create, nurture and sustain a dynamic community, members must participate in active relationships over time (Lave & Wenger, 1991; Wenger, 1998) and organize themselves around issues that matter to members of the community (Wenger, 1998).

In this study, a department of Earth science education will be regarded as the CoP. In other words, the members of the CoP (college of education) share

FIGURE 1 Life history model

the same interests, a series of problems, and passion for a certain topic (Earth science), while continuing to interact with each other to deepen knowledge and expertise (teaching) in the field. Based on the literature of CoP, we will examine the professional identity of PSTs in the three aspects of college of education, Earth science, and teaching, focusing on how PSTs relate to these three elements in their lives and what experiences they have had. These three components are not mutually exclusive but overlap and affect each other in forming their professional identity.

2.3 *Life History Model: Personal and Professional Identity*

This study relates the personal and professional identities to time using a life history model of identity formation as a PST (Figure 1). Based on the work of Feiman-Nemser and Buchmann (1985) and Lave and Wenger (1991), we use a time concept of identity: past self, actual self and future self. Through time, the PST's identity moves from past self to actual self and then to future self. The narrower the gap between the actual and future self, the more stable the identity of the PST.

3 Methodology

3.1 *Life History*

Narrative is well suited to making sense of particular experiences, stories, and moments of a person's life (Hatch & Wisniewski, 1995). In order to gain a better understanding of the PSTs' identity formation, we established the constant comparative method to generate a grounded theory through systematic and explicit coding and analytic procedures. This methodology aimed to

reach both the personal and social dimensions of a person's life. A life history approach was chosen to more fully understand the participants' complicated experiences within the socio-cultural context with the focus on the individual and their subjectivity (Ellis & Bochner, 2000; Hatch & Wisniewski, 1995). This focus is considered essential for understanding PSTs' identities, personally and professionally, as a member of a community of practice: a department of science education.

According to Hatch and Wisniewski (1995), life history is an analysis of the social, historical, political, and economic contexts. Moving back and forth from the personal to the social situates the stories in a place or context (Clandinin & Connelly, 2000), thus giving the teachers' stories more substance for understanding their personal and professional identities and the complexities of their lives. In this paper, we examined the participants' integrated and systematic identity formation.

3.2 *Context and Participants*

PST identity development in Korea may be different than reported in literature from the West because of the tremendous pressure on students with regard to higher education and the academic focus dominant in teacher education. According to a study on the motivation and adaptation process of Korean teachers' college students (Kim, 2003), there are four reasons students decide to go to college of education: to become a teacher, based on their college entrance exam score, because of the prestige of the university, and recommendation from parents or teachers. What is interesting is that there were more students who entered the college of education who had no desire to teach than the students who entered the college of education because of their motivation to become teachers. Therefore, many students did not actively pursue their goals during college and were continually seeking other interests and searching for alternative career paths. All of these factors greatly influence PSTs' identity formation, and by studying the development among Korean PSTs who have changed their major to science education, we may be able to gain a greater understanding of identity in an Eastern context as well as a fuller understanding of the identity formation of PSTs worldwide.

This study was conducted in a prestigious university in Korea. In the department of Earth science education, there were 30 students, 6 of whom were transfers. The participants for this study were the six undergraduate students in the department of science education who had transferred from natural science or engineering majors. Although we started this study with six PSTs, we narrowed the number of PSTs down to the three who were more committed to the study and showed more condensed and particular characteristics in

their identity formation processes. The three PSTs eliminated from the study showed less distinct and more mixed patterns of identity formation as compared to the three PSTs chosen.

Mr. Woo was a senior undergraduate student who transferred from atmospheric science to Earth science education in order to be an Earth science teacher. He showed a high interest in the subject of Earth science and eagerly hoped to be an Earth science teacher.

Mr. Choi was a junior who had changed his major from engineering to science education. This was done after retaking the university entrance test in order to earn a secondary teaching certificate as a career back-up plan.

Ms. Jung was a senior who had graduated from a gifted high school known for its prestigious science program. She reported that she had performed poorly in high school on standardized exams and assessments, and in comparison to high performing peers, she felt she was not as talented as her classmates and she reported that she felt inferior to them. Even though Ms. Jung gained admittance to a top university, her relatively low performance on the entrance exam forced her to consider her future and she was forced to change majors from biology to science education.

3.3 *Data Sources*

Data were collected over 7 months from March to September through different channels, including in-depth interviews, drawings, story timelines, participant observation, and e-mail surveys. Several strategies were used in order to confirm the trustworthiness of the data and findings. The data were collected from two courses – Theory of Earth Science Education and Inquiry and Experiment of Earth Science – in the spring semester, which allowed us to make multiple observations of the attitudes and discourses of the PSTs. Because we worked with the participants three times a week as their lecturer and teaching assistant, we were able to continuously confirm the data and reconstruct our previous findings. During each class, they discussed problems regarding science education in Korea, and we were able to share our thoughts and opinions on this matter. The participants were recorded during the discussions, and they wrote their opinions on the given topic in a daily journal. We also held a seminar at least once a week in order to discuss our findings with other science educators acting as critical reviewers, which allowed us to triangulate the findings.

In addition, researchers sent four email surveys, which included several questions regarding the reasons for transferring their majors and questions related to current concerns. Each survey included six to ten items. Through the results of these surveys, the researchers were able to collect preliminary data

from the participants on their unique life histories. Based on these data, we prepared to conduct an in-depth interview with each PST.

We conducted three to five interviews with each PST, each lasting one to five hours. During the interviews the PSTs talked about critical events in their lives that influenced the marked change of their personal and professional identities. By conducting these interviews, we became acquainted with what happened to the participants throughout their lives. All interview data were audiotaped and transcribed. After each interview, the participants were asked to evaluate experiences or events in time and to present these by drawing a story timeline. The steeper the incline of the story timeline, the more influential and important the experience or event was for the participant. In general, an important event happens when a story timeline alters direction, either up or down (Beijaard et al., 1999). Based on this story timeline, the researchers were able to divide the participants' lives into several periods. We asked additional questions to thoroughly understand each phase and change in the story timeline. Finally, we requested drawings to capture their psychological states. They drew images of their past, actual, and future self with additional explanations of the drawings.

3.4 *Data Analysis*

Data collection, coding, and analysis were iterated until no further information could be gathered. Data coding and analysis were conducted in five stages: preliminary, embodiment, supplementary, case analysis, and cross-analysis. Each stage was performed with analytical induction and constant comparative approach suggested by Lincoln and Guba (1985). In the preliminary phase, we repeatedly read the collected data without fixed theoretical tools to look for inspiration as to how to investigate the participants. At first, we tried to see participants from various points of view and understand them without any researcher prejudice. Through this phase, we discovered both common and differing characteristics in their life histories. In the second phase, the embodiment phase, we focused on specific information regarding the processes of the PSTs' identity formation. We constructed and deconstructed their life history with a categorization concept to analyze the subjective reality. The third phase was the supplementary phase where inconsistencies in the analysis were pruned and missing information about the participants was added. During this stage, researchers grew in their ability to reconstruct participants' stories in chronological order. Fourth, researchers carefully analyzed each case with conceptual tools of personal and professional identity. This stage was the core phase of this study, and we described the participants' identity formation by means of dividing them into several periods related to critical events. Finally,

we compared our analyses of different participants' identity formations to find a more meaningful analysis at the final cross-analysis phase. The data analysis was based on three types of coding procedures: open, axial, and selective (Strauss & Corbin, 1998). Open coding occurred at the beginning of this study to conceptualize and categorize data. In axial coding, we related categories to their subcategories by linking properties and dimensions to surface themes pertinent to the differences and commonalities among the PSTs' identity formation. Lastly, selective coding was used to select the central or core categories.

4 Results

4.1 *Case One: Determined-Effort Type*

Mr. Woo was a senior in college who transferred to science education after obtaining a B.A. in atmospheric science. When we first met him, he was in his late 20s and seemed to be quite sensitive and hardworking (N-identity). We were surprised to learn about his past life as he used to dye his hair in many colors, skip classes, and get drunk often. Now, however, he had several part-time jobs to support himself, since his single mother could not help with tuition. In addition, he was participating in an Earth science study group and preparing for the secondary school teacher selection test. He desperately wanted to be a science teacher to get a secure job and support his single mother and do his duty as an only son. He was completely focused on this goal, unlike other classmates who dreamed of many career alternatives because they were uncertain of their futures. He described his future as having only one career choice: Earth science teacher.

We found several critical events in his life by examining where the story timeline changed direction: entering university, his father's death, and transferring to a different university (Figure 2). Based on this timeline, it was possible to divide his life into four periods, each of which was named according to his subjective evaluation of the significant experiences and events: blind, contradictory, turning, and convergent.

4.2 *Before Changing Major: Childhood and Adolescence (Blind Period)*

The "blind" period is when he starts forming his identity during his childhood and adolescence (Figure 2, through Point c). Mr. Woo had a very happy childhood (Figure 2, up to Point a), and, although he had been a troublemaker (D-identity), he tried to change his image in secondary school because he realized his bad behavior had done great damage to others. Figure 2 reveals that during his secondary school (I-identity) period, the evaluation of his

FIGURE 2 Mr. Woo's story timeline (left) and his original drawing (right)

life contained regret. His life on weekdays was entirely different from that of weekends, when he would resort to partying (A-identity; Figure 2, Points *a–b*). At that time, he hated his teachers because of their conservative attitudes toward students' hairstyles and clothing. At the height of his hatred for teachers (Figure 2, Point *b*), he happened to meet an Earth science teacher who seemed more genuine and enthusiastic about teaching (Figure 2, Points *b–c*). This eventually changed his attitude towards all teachers.

I reacted against the oppression by the high school teachers to free myself from the hell of taking exams, the narrow gate to enter a university. Whenever somebody tried to lock me in a strict rule, I always put up a fight. I like to be seen as someone special and creative in contrast to others. Not getting caught with strict policies that put restrictions on students on what to wear, appropriate hairstyle, etc.

MR. WOO, third in-depth interview

Despite his mother urging him to enter a college of education to be a teacher, he never thought of actually becoming a teacher because of his past experiences with teachers. However, because of the positive influence of his high school Earth science teacher's enthusiasm and his joyful experience of being with that teacher, he eventually chose to enter the department of atmospheric science.

He loved teaching itself. I respected the attitude with which he was teaching Earth science. He always did his best to teach students. It seemed as if

teaching was a calling for him, not just another job. He directly motivated me to choose my major in atmospheric science.

MR. WOO, first in-depth interview

4.3 *Before Changing Major: College of Science (Contradictory Period)*

The “contradictory” period seems to have been the hardest time for him because of the discordance between the actual self and the future self in his life as a science major. Therefore, there are two different lines of evaluation during this period: one that is a sharp rise followed by a steep fall and another that falls without rising. Both lines finally meet at the lowest point. He chose atmospheric science as his major (I-identity) because he loved this field of study and wanted to be a scientist (Figure 2, Point c). At first, he was really happy to be a college student (first critical event) because he could do everything without any authoritative supervision (Figure 2, Points c–d). However, his father’s death (second critical event) during his senior year served as a significant wake-up call because of his great responsibility as the only son. He was very confused as to what he was going to do with his major after graduation. A fundamental concern behind this confusion was his realization that a career as an atmospheric scientist was not guaranteed given Korea’s financial crisis at that time. Even though Mr. Woo’s graduation was only two months away, he had no concrete plans for his future (future self). Despite his deeper internal misgivings, he ignored the reality of the situation and wasted time. This is reflected in the seemingly hopeless downward curve in his story timeline (Figure 2, Points c–e).

As a way to dispel the fear of an uncertain future, he took a leave of absence (D-identity) and concentrated on working several part-time jobs (A-identity) in order to earn money. Though his father’s death was the most difficult point in his life, this critical event was a turning point that made him think seriously about his future. As he recalls, observing his father on his death bed was difficult to bear.

The more I thought about my dark and gloomy future, the more I abandoned myself to despair. Having no dream and no hope, I was wasting my valuable time and youth as a first-year university student. Nothing was certain for me: my father’s long illness, upcoming military service duty, and an uncertain future. In the uncertainty, I just spent my youth in the pursuit of immediate pleasure. Of course, at first, I tried to do everything to get rid of the fear about my future. I tried to apply to graduate school, obtained several certificates in computer competency, gathered information about employment, and studied business as a minor. But I

could not concentrate on any goal during economically hard times. My father's demise finally made me face the reality of my urgent situation. So, I decided to go to the military and hoped to have enough time to reflect on my life.

MR. WOO, second in-depth interview

4.4 *Before Changing Major: Military Service (Turning Period)*

The “turning” period is the phase of recognizing the responsibility to his family and determining his goals. He was able to get over his gloomy daily life with the hope of becoming a teacher. After his father's passing, he had to serve in the army for over two years, a duty for all Korean males. Military service (I-identity) made him forget about his past and see a brighter future. In this period, his evaluation of his own life moved from negative to positive. He used the compulsory military service as an opportunity to change his attitude and outlook on life. He became determined to be a good role model to students. In the military, he concentrated on his future preparation and took advantage of every potential opportunity he had to support his family.

Luckily, during his service, he could spend all night preparing for his transfer exam (D-identity). As his goal of becoming an Earth science teacher (Future self) became clear, he was no longer worried about his future. After finishing his military service, he did his best to prepare for the exam, constantly spending his time in the library (A-identity). He passed the exam and was able to change his major (third critical event) from science to education. He was very satisfied with his achievement in this particular period.

4.5 *After Becoming a PST: College of Education (Convergent Period)*

The “convergent” period began when he transferred to the college of education (I-identity). The evaluation of this period in his story timeline shows a long-lasting fluctuation (Figure 2, Points f – m). Mr. Woo had a hard time during the first year of his new major because he had conflicting feelings of both satisfaction and dissatisfaction. However, he was eventually able to narrow the gap between his actual self and future self and seemed to be stabilized (Figure 2, Point m onward).

Since every student studied hard at his new university, he was also motivated to do his best (D-identity). However, it was not long before he realized how difficult it would be to become a public school teacher. It would be especially difficult as he was preparing for Earth science teacher selection, which had limited openings. Therefore, during his first year after transferring to the college of education he continuously suffered from periods of great mental fluctuation because of repeatedly regretting and reaffirming his choice to transfer.

My new university is the top ranking school in Korea. Of course, I am very proud of myself for being a member of this prestigious university, but this college seems to cultivate professional teacher educators and not practical secondary school teachers. I hope to be an Earth science teacher in secondary school, but in the college of education many students avoid majoring in Earth science because of the relatively low employment ratio of Earth science majors in the secondary school teacher selection test. Now, I am so confused. If I had chosen another mediocre university instead of this top-ranking university, I would have concentrated on the teacher selection exam. I heard some universities exclusively prepare PSTs for the exam like a private academy. I know this is not a good thing, but I was so confused at that time.

MR. WOO, third in-depth interview

He was particularly disappointed to see a lot of students giving up Earth science education and transferring to biology or mathematics education to raise their potential of being hired as a teacher (future self). He joined a study group (A-identity) to prepare for the teachers' exam and deepen his professional content knowledge as a science teacher. Figure 3 shows his self-image of his past self – science major – and his actual self – education major.

As shown in Figure 3, he expressed himself as a sharp-edged star with many peripheral conflicts, and he drew an uncertain desire at the center of the star. On the contrary, as an education major, he depicted himself as a round face with a big smile and a drop of sweat and taking control of his desire, drawn as a shadowed star in his picture, out of his mind and into his hand.

In Table 2, we summarize his life with the conceptual lens of identities. Each period is separated by a critical event that decisively affected his personal and professional identity.

Based on the understanding of his whole life, we summarize what he has experienced with the three components of CoP to construct the professional

FIGURE 3 Mr. Woo's self-image in college of science (left) and in college of education (right)

identity – Earth science, college of education, and teacher – and how he has negotiated meaning in each of these components.

Mr. Woo's high school earth science teacher's passion for earth science (domain) had a large influence. This played a decisive role for him in choosing his major when entering college, but even his enthusiasm for science diminished due to the feeling of despair that the future as a college of natural sciences student was not so bright. When his father passed away, Mr. Woo searched for a stable future, combining his interest in Earth science (domain) and the stability of a teaching job. Since his transfer to the college of education, he was able to form a solid professional identity by pursuing his passion for earth science (domain). When he was in high school, his parents had recommended that he enter a college of education (community) for a stable job. However, he ignored their advice and entered the college of natural sciences because the social status of teachers was low. However, after his father's death, he felt responsible as the head of the family and applied to the top university to be a teacher. At his new school, he was disappointed with the curriculum of the college of education (community), which aimed to train scholars rather than teachers. He was conflicted with his choice due to this discrepancy because his goals of becoming a teacher did not align with the school curriculum.

Lastly, looking at the process of negotiating meaning for teachers (practice), he had extreme antipathy for his high school teachers (practice), who had a strong tendency to be conservative. However, he was greatly impressed by a high school earth science teacher (practice) who taught with passion even though he was facing retirement. He then appreciated the value of teachers and the rewards of teaching (practice). His desire to become a teacher (practice) was gradually strengthened as he realized that his mother's desire was for him to become a teacher (practice).

5 Case Two: Critical-Exploration Type

Mr. Choi was a junior in college who entered the science education major from engineering. He was in his late 20s and actively participated in class discussions and expressed himself without any hesitation (N-identity) on various educational problems in Korea. He received a scholarship from the government (A-identity), so he was able to attend the university tuition-free. Even though he was six years older than his peers, he was still exploring his future career options: a teacher, a public officer, an investment expert, an owner of a bookstore, and so forth. We found several critical events where his story timeline changed direction: entering an engineering college, observing empty

TABLE 2 Mr. Woo's identity formation

Period			Before changing major			After becoming a PST
			Childhood & Adolescence (Blind)	College of Science (Contradictory)	Military Service (Turning)	College of Education (Convergent)
Critical event			Entering University ↗	Father's Death ↗	Changing Major ↗	
Personal identity	Actual-self	N-identity	liberal, independent, creative			
		D-identity	Trouble-some kid	Leave of absence	Diligence and responsibility	Model student
		I-identity	Student	Atmospheric science major	Military service	PST
		A-identity	Lack of responsibility and rebellious in society	Part-time jobs	Bettering himself (frequent visits to library)	Attending study group
	Future-self		Scholar	Lack of motivation and desire	Pursuance of a stable job	Earth science teacher
Professional identity	Earth science (Domain)		(+) Motivation stimulated by an Earth science teacher (EST) who gave him further encouragement for studying	(+) Entrance to College of Science to major in Atmospheric science from the positive influence of his EST	(+) The positive influence of EST caused an urge to choose a job related to Earth science	(+) Was satisfied with his major in Earth science education and would not trade his major for anything
	College of education (Community)		(-) Though parents wanted him to enter College of Education for attaining a secure job, he never considered entering college of education due to strict discipline		(+) Changed his mind to viewing College of Education in a positive way and, thereafter, wanted a secure job in this field	(- +) At first unsettled, but now settled on his decision to transfer to science education major
	Teacher (Practice)		(-) Ultimate antipathy to conservative teachers (EST aside)		(+) Desired to become an Earth science teacher	(+) His desire to become a teacher was exceptionally strong/the competition to become a teacher in Seoul is extremely difficult as well

(+): positive influence, (-): negative influence

classrooms due to the students leaving the university, and entering the college of education (Figure 4). Based on the story timeline he drew, it is possible to divide his life into four periods: independent, peripheral, tuning, and investigating.

5.1 Before Changing Major: Childhood and Adolescence (Independent Period)

During Mr. Choi's childhood and adolescence, the "independent" period, the evaluation of his life shows a gradual increase until he failed to enter the top-ranking university (Figure 4, until Point a). Mr. Choi was an introverted kid who was always absorbed in books (D-identity). Due to his mother's love for reading, he had countless books at home and he mainly spent his childhood reading books. When he was 10 years old, he learned about artificial rain from a science book, and he dreamed of becoming a scientist who could control the rain to

enhance people's lives. Every summer vacation during his middle school days, he participated in a science club (A-identity) as a representative of his school.

His contented life changed after enrolling at a very competitive high school, where most of the students were from wealthy families. This sudden change in environment caused him to suffer a sense of inferiority. He was determined to overcome the socio-economic inferiority through excellent academic performance. He studied relentlessly and succeeded in being an outstanding student (I-identity) in his high school. However, he lost his special interest in science:

In high school, we rarely had a chance to conduct scientific experiments because we had to prepare for the university entrance exam. I was good at science, but science didn't grab my interest anymore. So, at that time, like other male students with good grades I dreamed of becoming an engineer.

MR. CHOI, third in-depth interview

Because he graduated from high school with honors, every teacher believed that he would be granted entry to the best university in Korea. Unexpectedly, he failed to get a high score and had to choose an alternative school.

At first, I couldn't take the fact that I failed the exam. It was shocking for me and my friends, but I couldn't wait another year. So, I decided to choose the next best university with an engineering major (first critical event). I was extremely disappointed with my status, but I didn't have any other choice.

MR. CHOI, fourth in-depth interview

5.2 *Before Changing Major: College of Engineering (Peripheral Period)*

Mr. Choi started his first college period, or the "peripheral" period, with great discouragement. His evaluation of this period shows a dramatic decrease to the lowest point of his whole life (Figure 4, Point *b*). Even though he was not able to meet the expectations of others (D-identity), he enjoyed the freedom of being a college student. However, it was hard for him to make friends and he had a difficult time trying to develop a sense of belonging due to the large class sizes.

During his high school days, high-achieving students tended to go to colleges of engineering (I-identity). After the Asian Financial Crisis (commonly referred to as the IMF), students started to avoid natural science and engineering majors. While in college, Mr. Choi observed that many of his peers were preparing to enter a medical college or a higher-ranking university even if they could not major in their desired area.

FIGURE 4 Mr. Choi's story timeline (left) and his original drawing (right)

Our university students often felt inferior to the number one university in Korea. I knew there wasn't a big difference between the best and the second best, but we still had some regrets about not being accepted into the best university. Thus, many students tried to re-take the college admission test the next year to get another shot at entering any medical school or the best university disregarding their choice of major.

MR. CHOI, third in-depth interview

On the first day of his sophomore year, he observed mostly empty classrooms with just a few students (second critical event), as so many had opted out of the engineering major (I-identity). Frustration and disappointment preoccupied his emotions; he felt no incentive to continue his studies at this institution. He finally decided to take a leave of absence (A-identity) to fulfill his military duties, taking time away from studies in order to resolve his conflicting feelings (Future self).

5.3 Before Changing Major: Military Service (Tuning Period)

Through this "tuning" period of the military service (I-identity), Mr. Choi gradually recovered from his confusion. His evaluation in his story timeline rises, and even surpasses his baseline (Figure 4, Points *b*–*c*). Despite the exhausting training, his mind began to regain self-confidence (D-identity).

I learned a lot in this period; specifically, I realized what I wanted and how to achieve that goal. I appreciated the fact that I could have time to reflect on my life during this period.

MR. CHOI, second in-depth interview

During one of his leaves from the army, he was able to meet an old high school friend (A-identity). In high school, Mr. Choi could not understand the friend's choice to go to a college of education. Now, that friend seemed to be more confident with a firm purpose in his career, which was different from those who had an uncertain future, including Mr. Choi himself.

Through thorough self-reflection, Mr. Choi realized that there was no future as an engineering major at this period of economic slowdown (future self). As soon as Mr. Choi finished his military duty, he withdrew from his university. He then prepared to retake the college admission exam and reapplied again to the best university (third critical event). Additionally, Mr. Choi planned to change his major from engineering to a more secure and practical area of discipline: science education. Compared to the other students who took their first college entrances exams, he was late in choosing a career.

I thought a diploma from the best university and a teaching license could act as insurance for my future [Future self].

MR. CHOI, first in-depth interview

5.4 *After Becoming a PST: College of Education (Exploring Period)*

During the “exploring” period, it seems that Mr. Choi was in the middle of an emotional turmoil even though there is only one minor dip in the curve (Figure 4, Points *c–d*). This minor isolated dip in the curve may be a coincidence and we cannot verify at the present moment if there will be repeated dips in the near future. At first, the acceptance into the best university made Mr. Choi feel like every past hardship was worthwhile. First and foremost, he was greatly satisfied with his relatives' enthusiastic reaction (D-identity) to his acceptance (Figure 4, Point *c*). However, as time passed, his dissatisfaction with the college of education (I-identity) started to steadily increase (Figure 4, Point *d*).

Many PSTs in our university are considering a career as a researcher or a scholar instead of becoming a teacher. It is very difficult to pass the secondary school teacher selection test. However, compared to the stiff competition and the necessary effort required to become a science teacher, the socio-economic status of a secondary teacher is not that high. Therefore, many PSTs in our college do not take the exam and prepare for a more respected occupation as a scholar or as a doctor. So I am very confused with what I have to do to prepare for my future [future self]. I would like to be a science teacher, but I still don't have a definite answer, as of yet, about my future career.

MR. CHOI, fourth in-depth interview

FIGURE 5 Mr. Choi's self-image in college of engineering (left) and college of education (right)

His conflict seems to come from the gap between actual self and the future self as a PST. He also added that unless the social value of a secondary teacher improved, this dilemma regarding his future career would continue. Many PSTs hesitate to become science teachers for these same reasons. There is a big difference between his past self and the realization of his actual self. As seen in Figure 5, the drawings of his self-image show that he is now at the center of his life and not in the periphery looking in.

When he was in the college of engineering (Figure 5), he was just a wanderer. Despite the fact that he is still searching for his future career, he is not an outsider anymore. Rather, he is in the center of his life. Considering Figure 5, it is clear that Mr. Choi was a person who was looking for an identity but was not sure of where he was headed. Since becoming a PST, he has had an identity and purpose in what he wants to do and has been able to find an identity that is relatively stable for him. His identity formation is summarized in Table 3.

Mr. Choi's internal conflict continues to this day because the concepts of college of education (community) and teacher (practice) did not really exist for him until recently. First of all, we will examine the process of negotiating the meaning of the domain of professional identity (Earth science). As a child, Mr. Choi was immersed in books and he encountered the concept of artificial rainfall in his readings (domain). He was so fascinated by the idea that he could control rain, he started to dream about being a weather forecaster. In junior high, that dream evolved into wanting to become an engineer or a scientist. However, he struggled with the process of negotiating meaning when he entered engineering school because all of his classmates were looking to transfer out. In the turmoil, Mr. Choi decided to enlist in the army and changed his career path, applying to the college of education (community) after discharge. Once Mr. Choi entered the department of science education, he chose Earth science (domain) because of the variety in applied sciences. He also believed that it would give him more choices for his future.

TABLE 3 Mr. Choi's identity formation

Period			Before changing major			After becoming a PST
			Childhood & Adolescence (Independent)	College of Engineering (Peripheral)	Military Service (Turning)	College of Education (Investigating)
Critical event			Entering University	Mass exodus of students	Changing Major	
Personal identity	Actual- self	N- identity	Relentless pursuit of goal, self-confident			
		D- identity	Loved reading books	Not able to meet expectations	Found self- confidence	Able to meet family expectations
		I- identity	Student	Engineering major	Military service	PST
		A- identity	Science club	Absence of membership	Maturity shown in various aspects of life	Fellowship
	Future-self		Scientist (Engineer)	unstable	Certificate of science teacher as a back-up plan	Many career options due to back-up plan
Professional identity	Earth science (Domain)		(+) Saw something interesting in a scientific book / encouraged to read more books in science			(+) Chose Earth science among others such as physics, chemistry, biology
	College of education (Community)		(-) As a high school student, he mocked his friend who chose College of Education			(-+) Initially disappointed in curriculum of the College of Education but was satisfied with many open options
	Teacher (Practice)		(+ -) Was praised for good work by most teachers but was not happy with few low-quality teachers	(+) Realized that meaningful help could not be attained by college professors but could be received by high school teachers	(+) Through deep reflection, the thought of becoming a teacher gave a positive influence, esp. considering the job stability	(-) Constantly going back and forth between pros (security, benefits) and cons (low social status)

(+): positive influence, (-): negative influence

When he was in high school, he did not even think about applying to the college of education because his image of teachers was that they were conservative. However, when he met a friend attending a college of education (community), his concept of teaching changed; his friend seemed like he had a purpose, striving for a bright future. It was an economically difficult time in Korea, and many young adults were struggling to figure out their futures. While Mr. Choi had other dreams, he realized that teaching (practice) is a secure job and could potentially be a stepping stone to other bigger opportunities. He had been a top student since elementary school, and his teachers all had high expectations from him. He was uncertain about his future and was continually chasing larger dreams because being a teacher (practice) was not enough for him; he could not close the gap between his present self and future self.

This idea was reinforced in the college of education (community) because the curriculum focused on academics and theory as opposed to the practice of teaching. Being the top university in the country, they encouraged students to pursue academics and professorships to maintain their social status. This caused a lot of internal conflict because Mr. Choi believed that there were many benefits to being a teacher (practice): secure future, guaranteed leisure, and pursuing his own interests. However, he could not make up his mind because of the opposing views.

5.5 *Case Three: Continuous-Confusion Type*

Growing up as a single child (N-identity), Ms. Jung filled the void with animals as close companions (A-identity). Her dream was to become a zoologist (future self), and she hoped to do animal research and observe the behavior of wild animals. She graduated from a prominent science high school, but she was lacking self-confidence (N-identity). Although she was satisfied with her biology major (I-identity), she chose to transfer and change majors so that she could attend the best university. Unfortunately, Ms. Jung failed her first year at the top university: She was the only one who had to repeat the year. After repeatedly failing (D-identity), she was extremely disappointed and felt uncertain about her future goal (future self). Again, we found several critical events that happened where the story timeline changed direction: entering a science high school, losing a soulmate, and becoming a PST (Figure 6). Based on the story timeline she drew, it is possible to divide her life into four periods: dependent, anonymous, turning, and chaotic.

5.6 *Before Changing Major: Young Adolescent (Dependent Period)*

During Ms. Jung's first "dependent" period, her storyline shows a gradual increase from negative to positive because she was accustomed to her mother's education style. Ms. Jung's mother was overly ambitious about the education of her only child. Her mother always wanted her to become a doctor (future self). The mother's ambitions for her daughter were so strong that Ms. Jung did not have time to play with classmates (A-identity), as she was pushed to do things based on her mother's excessive study schedule (N-identity). While Ms. Jung often complained about this egregious pressure, she met her mother's expectations. Ms. Jung was a high-achieving student (I-identity), always ranking top in both elementary and middle school. Due to her outstanding academic achievements, all of her school teachers recommended that she apply for a gifted science high school (I-identity). Although she had never prepared for the science high school, she met the entrance requirements for

FIGURE 6 Ms. Jung's story timeline (left) and her original drawing (right)

exceptional students and was admitted after an interview. Ms. Jung's mother was especially proud of her daughter's outstanding achievements (Figure 6, Point *b*).

5.7 Before Changing Major: Science High School and College
(Anonymous Period)

While attending the science high school (first critical event), referred to as the “anonymous” period, Ms. Jung's evaluation of her life decreases dramatically and arrives at the lowest point of her entire life (Figure 6, Points *b–g*). At first, Ms. Jung was extremely happy to have entered this prestigious science school; however, it was not long before Ms. Jung realized that she could not keep up with her peers due to her lack of preparation for this level of competition (Figure 6, Points *b–c*).

Since Ms. Jung lived in a school dormitory, her mother could not manage her schedule. She confessed that managing her time without her mother's constant watch (N-identity) was a big problem for her; she had never once planned her study schedule alone. Even though she tried to do her best in the competitive atmosphere, she could not narrow the big gap between herself and her classmates (A-identity). As we see in Figure 7, she gradually began to feel a sense of inferiority and eventually felt that she was useless (Figure 6, Points *c–d*).

Sometimes she regretted the fact that she did not attend an ordinary high school. When most of her schoolmates graduated early after only their second year with prestigious scholarships to outstanding domestic and international

FIGURE 7

Ms. Jung's drawing: low grade compared to her classmates

universities, Ms. Jung had to stay at her school for one more year (I-identity; Figure 6, Points *d–e*). Regretting the first two years of high school, she concentrated on her studies and eventually succeeded in entering a decent university (I-identity). Even though her university was not regarded as a prominent one compared to the ones her friends entered, she was nevertheless satisfied with her major in biology (I-identity; Figure 6, Points *e–f*). However, since her relatives expected her to be a student in the top university, they were extremely disappointed (D-identity) by this unexpected turn of events. They gave her much criticism, which hurt her deeply. One day, her best friend suddenly told her that she would discontinue her relationship with Ms. Jung (second critical event) without any explanation. These events made her decide to transfer to the top university (I-identity).

5.8 *Before Changing Major: Ruminating at Home (Turning Period)*

The “turning” point was when she did not want any contact with anyone due to the frustrations and feelings of failure (D-identity) since she was perceived as such by her parents and relatives. During the short turning point, her evaluation in her story timeline improved up to the neutral line (Figure 6, Points *g–h*). Although Ms. Jung's decision to quit her college (I-identity) was rather erratic, this event motivated her to concentrate only on the goal of entering the top university (future self) just as her high school friends had done. With her mother's help, she succeeded in entering the most prominent university in Korea (third critical event). When Ms. Jung was admitted to the top university (I-identity), her father cried silently because he was overwhelmed with happiness for his daughter (Figure 6, Point *h*). Her relatives were impressed, and they encouraged her (D-identity) on her new life at the university. Since she chose the top university, she had to deal with the fact that she was limited in her options for a major due to her relatively low entrance exam score. Her first choice had been medicine and her second

choice veterinary medicine, but she was accepted to the department of science education (I-identity).

5.9 *After Becoming a PST: College of Education (Chaotic Period)*

At the time of this research, Ms. Jung was in a “chaotic” period; the joy of being accepted into the top university was short lived and her story timeline decreased after a short period (Figure 6, Points *h–k*). During her first year in the department of science education, she participated in various activities in the school and enjoyed her life without worrying about her GPA (Figure 6, Points *h–i*). Most students wanted to major in biology or chemistry education because these majors provide more opportunities for future jobs than physics or Earth science education. Ms. Jung also hoped to major in biology education; however, her GPA was so poor (D-identity) that she was not allowed. Instead, she was assigned Earth science as her major (I-identity) without giving consideration to her interests (Figure 6, Points *i–j*). Up to that point, Ms. Jung was interested in biology, which she had also majored in at her former university. She therefore spent another year trying to attain a better GPA but failed once again (A-identity) to get the necessary grade to major in biology education (Figure 6, Points *j–k*). She was deeply disappointed with herself and avoided meeting her peers (A-identity) because she was so ashamed. Ms. Jung depicted her current situation as follows:

There is no exit from the deep hole that I put myself into. I don't have any hope now [future self].

MS. JUNG, third in-depth interview

Although she knew that teaching in secondary school is a secure job, she could not imagine herself being a science teacher. Ms. Jung was extremely depressed because she felt that she had to become a doctor, an international lawyer, or an outstanding professor in the field of science because of the pressures put on her from her gifted peers from high school, parents and relatives. Her identity formation is summarized in Table 4.

Ms. Jung's professional identity formation was full of turmoil, which has continued until the present. Thanks to her mother's educational fever, she excelled in elementary and middle school, securing a spot at a competitive gifted science high school. However, she struggled in high school because she did not have her mother around to help her. Her classmates graduated early and were attending top universities in Korea and abroad, but she stayed the full three years and entered a good university, although it was not the best. While she

TABLE 4 Ms. Jung's identity formation

Period			Before changing major			After becoming a PST
			Childhood & Adolescence (Dependent)	Science high school & College of Science (Anonymous)	Ruminating at home (Turning)	College of Education (Chaotic)
Critical event			Entering science high school	Loss of best friend	Changing Major	
Personal identity	Actual- self	N- identity	Loneliness, conflict, dependence, strict education-driven mother, only child			
		D- identity	Well-rounded student	Wasn't able to meet lofty expectations	Ambitious mother drove daughter to study	After meeting expectations of relatives, could not cope with stringent study demands
		I- identity	Student	Science major	Drop out of college	PST
		A- identity	Love for animals being the only child	Very unreliable and a poor student	Regained self- confidence by studying diligently	A recluse in the College of Education
	Future-self		Doctor	Veterinarian/Biologist	Only had best university in mind despite the major	Zoologist with uncertainty
Professional identity	Earth science (Domain)					(-) Despised, lacked confidence, hated earth-science major
	College of education (Community)				(-) Reluctantly, she chose College of Education in order to enter a top university	(-) Even though she was satisfied with her entrance into top university, she was not satisfied with the dept.
	Teacher (Practice)		(+) Received much praise from teachers because she was an outstanding student	(-+) In the gifted high school, she was not respected due to her lack of academic ability/in mediocre university as a biology major, she really desired to get meaningful advice so she went to middle school teachers for help		(-) As a graduate of gifted high school, she could not accept the fact that she would become a teacher

(+): positive influence, (-): negative influence

was able to major in biology, which she had wanted, she felt ashamed because she was always being compared to her classmates and the high expectations her parents and relatives had of her since her childhood. When her best and only friend left her, she decided to quit school and, under her mom's direction, started to study again to enter the best university. In Korea, students are able to apply to certain colleges and departments based on their CSAT score. Given her CSAT score, she applied to the college of education (community) to study biology, which was her main goal. She was accepted but her grades did not allow her to choose her major and was instead assigned earth science (domain). This was disheartening for her because she had no real desire to be a teacher (practice). Her professional identity started off rocky and became even more unstable as the discrepancy between her present self and future self increased.

6 Discussion

This study deals with the aspects of personal and professional identity of three PSTs who changed their majors. N-identity encompasses personal beliefs and values and is considered the core identity as it has an impact on the other components of personal identity: D-identity, I-identity, A-identity (actual self), and future self. N-identity seems to play a key role in guiding the life of PSTs. A comparison of the three types of PSTs indicates that the higher the coherence among the elements of the personal identity and its relationship with critical events, the more improvement there is in participation in the CoP, which leads to further improvement in professional identity. In addition, the positive experiences related to the science domain during primary and secondary schools have been shown to play a crucial role in the professional identity of PSTs. The more opportunities the PSTs had with meaningful negotiations within the components of the CoP, the less likely their identity formations fluctuated in the college of education.

The PSTs showed a considerable gap between the actual self and the future self as a member of the CoP, and each of the PSTs made different efforts to bridge the gap. The more the PSTs built a collaborative relationship with the members of the CoP and reduced the gap between future and actual self, the more they were satisfied with their identity formation, indicating an improvement with respect to engagement with and belonging in the CoP.

This study allows us to determine the common denominator of the three PSTs during the course of their identity formations. As shown in Figure 8, the three PSTs who changed their majors pursued futures that were thought to be more stable by overcoming today's unsatisfactory conditions. As persons who majored in either science or engineering, each experienced repeated disappointment, eventually reaching a point of despair and hopelessness. This is evidenced by the fact that all three PSTs quit college in order to take time to prepare for more desirable futures by going elsewhere. While they struggled to find purpose, they gradually recovered from their internal conflicts during the turning period. Consequently, they found new hope in the college of education and succeeded in changing their major and university. Since this was a second chance at trying to fulfill their future dreams, they tried to be more active as participants in their new CoP.

During the last period, when they were in the college of education, they tried to narrow the gap between future self and actual self as PSTs. Among the PSTs, one was finally able to construct a solid and comfortable identity, whereas, the others were not able to do so, resulting in an internal clash. The

FIGURE 8 PSTs' common and different patterns in their story timelines

PSTs could be classified into three types: determined effort, critical exploration, and continuous confusion, depending on the ways they chose to overcome their unsatisfactory condition.

Mr. Woo exhibited the determined-effort type. Currently, he is in a comfortable stage although he went through ups and downs on his decision to choose the top university where students wanting to become teachers were hard to find. However, he went through a long ordeal of thorough exploration with regard to his future career and succeeded in narrowing the gap between his actual self and future self. In a sense, the determined-effort type could be the most stable type of identity formation among the three PSTs.

Mr. Choi is the critical-exploration type. He is weighing the possibilities among various future careers. The life evaluation line in the story timeline shows a dip in the middle, but it recovers. Although he decided to change his major because of the security associated with being a science teacher during a period of economic crisis, he was still hesitant to commit to his decision to become a teacher because of the relatively low social status of teachers in Korean society. He is in the middle of uncertainty and keeping various career options open. In order to persuade this type of PST of the benefits of becoming a science teacher, educators for teachers should make the PSTs aware of the diverse positive aspects of becoming a teacher.

Lastly, Ms. Jung is the continuous-confusion type. She was suffering from deep disappointment after failing to secure her major in science education. Hence, she seemed to be discouraged, losing self-confidence, and not being

FIGURE 9 Life history model of the PSTs

able to overcome her extreme conflict. The evaluation of her life in her story drops and bottoms out without any visible recovery. She reentered university because of its name value without considering her future career goals. She is regretting the fact that she changed her major to science education and for a while she was in a state of denial about being a science education major, particularly Earth science (domain). She lives in a constant state of wanting to be a biology major at her former university. Even though she thought about becoming a zoologist, she cannot pursue this dream because of her current major. It is undeniably important to support this type of PST with warm and practical advice regarding alternative career paths in the department of science education.

Figure 9 shows how the life history model of an individual's identity formation can be based on the individual's effort to reduce the gap between the actual self and future self in the socio-cultural context. The gap between actual and future self is very small for determined-effort type and much larger for continuous-confusion type.

The research revealed that after transferring to the preferred university, the PSTs reached three different states of mind in coping with their new academic setting depending on their type.

In the case of the determined-effort type, there was a successful accommodation between the past, actual, and future self. While the PST experiences fluctuations in the beginning, they were largely positive in that they enabled the individual to reach stability. In the critical-exploration type, identity was continuously being explored and there was somewhat less stability in the past, actual, and future selves, showing some fluctuations in the process of attempting to reach their goal. In contrast, the continuous-confusion type was someone who was trying but failed and as a consequence continued to be in an extremely puzzled state of mind.

7 Conclusion

This study set out with the aim of understanding the identity formation of PSTs who changed their majors in Korea. One important finding of this paper is that we need to take the notion of PST identity seriously. The way a PST understands their identity will have an impact on how they position themselves as a symbol of professionalism within the science education system. This study provided an opportunity to pursue an in-depth understanding of PSTs' identity formation in Korea and, in the process, reinforced the need to use a theory of identity formation in the context of teacher research within science education. Consequently, this study proposes a model that enhances each PST's self-understanding in terms of their life history, which is represented in different life trajectories through time. The individual case studies provide examples of the methodology and theory in action.

The significance of this study is, therefore, not so much in the individual case studies, though they may be revealing, but in the adoption of a particular methodology and in the theory of PST. Specially, the model of life history, which yields invaluable insights into the ways in which the participating PSTs attempt to resolve the complexities of their individual situational problems, aims at explaining this in the context of their preparation to be teachers. This study not only aims at describing the three empirical cases of PSTs through a life-historical approach, but also attempts to refine the conceptual definition of identity. Further, this study endeavors to encompass a visual model of identity as a new experimental research tool in science education.

In order for the PSTs to secure an identity that is distinguished from the science majors in the college of natural sciences, the college of education should focus more on training teachers and not just the scientific content. Although the college of education is not a closed system built solely for the purpose of training teachers, it should support PSTs to continuously secure interest in content, teachers, and education and to establish their identity as science teachers. While PSTs start college with uncertainty about their career paths, many of them become teachers after graduation (e.g., Lee, 2004; Kim, 2003). Even some students who had had no desire to teach also ended up as teachers after going through 4 years in their CoP. In particular, these students paid attention to the security of the teaching profession and the fact that the more difficult the economy is, the higher the status of the teaching profession in Korean society.

Depending on the environment, conditions, times, and social context of a specific college of education, the life and identity changes of PSTs will appear

differently. However, PSTs cannot acquire a professional identity simply by participating in the CoP. Identity recognition and development is a complex process that is developed as a result of continuous deliberation and thought through a continuous process of self-reflection.

Given the small sample size, the relatively short period of the study, and the fact that the study was done in a particular social context, one must be very conscious of not over-generalizing based on these results. However, the research involving the three PSTs does seem to suggest that there is not one common universal process that the PSTs go through; rather, each person's experiences are affected by their life history. Moreover, the study does indicate, quite strongly, that science teacher educators need to be aware of the internal struggles of identity that their students may be grappling with in becoming a science teacher.

It also provides a theory and methodology that could be employed across a large sample of students, with a reasonable expectation that it will provide a useful research tool within a productive research program.

Abbreviations

A-identity	Affinity-identity
CSAT	College Scholastic Ability Test
CoP	Community of Practice
D-identity	Discourse-identity
EST	Earth Science Teacher
GPA	Grade Point Average
I-identity	Institution-identity
IMF	International Monetary Fund
N-identity	Nature-identity
PSTs	Pre-service Science Teachers

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Ethical Considerations

The data collected from this project was obtained with the necessary clearance from the school, guardians, and the students involved in the study. The names of the school and participants used in this study are all pseudonyms.

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