The Workforce Shortages of Secondary Environmental Sciences Teachers: The Perspectives from Second Career Changing Teachers

L M Dos Santos
Woosong Language Institute, Woosong University, Daejeon, South Korea
Email: luismigueldossantos@yahoo.com

Abstract. The science, technology, engineering, and mathematics (STEM) education and teaching field is facing significant human resources shortages, particularly in the subject matter of environmental sciences. The current study collected interview and focus group data and sharing from 140 pre-service and in-service second career-changing teachers in the United States about their career decision and decision-making process. The results of this study indicated that the participants believe educating the next generation is their priority of joining the education and teaching profession. Many expressed that the populations of STEM teachers with professional and industry experiences are greatly needed. The outcomes of this study provided the blueprint for researchers, school leaders, policymakers and human resources planners to reform and polish their current plans for teachers training and professional development in order to solve the workforce issues in the fields of STEM education and teaching.

1. Introduction
Environmental science is an interdisciplinary scientific field that concerned about biology, chemistry, earth science, ecology, and geography. However, due to the human resources shortages of both Sciences, Technology, Engineering, and Mathematics (STEM) teachers and practising scientists, both fields face significant problems about qualified professionals [1]. Although there is a reasonable amount of STEM pre-service teachers graduated from one of the Bachelor of Education programmes with internships and placements experiences, many of these graduates may fill the human resources gaps of the traditional science subject matters, such as biology, chemistry, physics, and mathematics [2]. As environmental science and education is a unique subject matter, secondary school teachers need to complete a related degree in order to teach this subject matter at the secondary school-level.

As mentioned above, when talking about science subject matters at the secondary school environments, many studies and professionals may focus on the traditional subject matters, such as biology, chemistry, physics, and mathematics [3]. As environmental science teachers need to gain a particular license and registration in order to teach environmental science education, there is a need to recruit potential teachers with the relevant degree and background for this registration and license.

In fact, in the fields of engineering and the practise science industry, most of the scientists are male professionals where female individuals are considered as minorities. Some studies indicated that female scientists might face discrimination, social stigma and social bias due to their gender as the public members tend to believe the abilities and skills of male scientists and engineers [4].

On the other hand, both primary and secondary systems are considered as the female-dominated professions due to the non-profit status, social caring orientation, and lower-level of salary [5–8]. More
importantly, some studies indicated that the enrolment of faculties of education usually has higher-level of female students’ enrolment. The statistics indicated that it is more likely that female individuals would like to join the education and teaching profession as their life-long development. In short, the STEM education faces both conflicts and pressures from the gender and social biases. Therefore, the fields of STEM education experienced significant workforce shortages due to both of the conflicts and biases.

1.1. Problems of the Practice

However, based on the social bias between the gender and expectation of education and teaching professionals, there are three conflicts in the field. First, although there are no laws and regulations to limit the university selection and major choice for both secondary school graduates and adult applicants, the general public members still believe female individuals should study the liberal arts subjects. In contrast, male individuals should stay the science subject matters due to the gender bias [9].

Second, besides gender and social bias, the enrolments of female students in the fields of STEM are significantly lower than male students. Although teachers, parents, and counsellors encourage female students to join the STEM profession, the selection of university major is totally up to the career decision of the individuals [10]. In other words, the selection of non-STEM university major is controlled by the students but not the government agencies and human resources planners.

Third, education and teaching is considered as the female-dominated profession, particularly in the field of primary and pre-school environments. As mentioned above, female individuals have fewer interests in the fields of STEM subject matters [11]. However, male individuals do not have a strong intention to join the education and teaching profession. Based on these two factors, STEM education and teaching professions should have large human resources and workforce gaps due to both gender bias and personal preference.

1.2. Purpose of the Study

Based on the current problems in the fields of environmental education, there are three purposes of this study. First, currently, school leaders have a difficult time to recruit STEM teachers, particularly environmental science teachers, at secondary school environments. In order to understand why individuals would like to join the education and teaching profession in the fields of environmental education, the researcher collected data from a group of currently enrolled pre-service teachers who are going to join the secondary teaching after graduation (i.e. with the subject matter in environmental education). Second, second career-changing teacher is one of the significant workforces in the fields of education and teaching. In fact, secondary school students, parents, and leaders always welcome teachers with professional and industry background and experience for joining. These teachers may bring professional practices, hands-on experiences, lab experiments, and professional expectations from people outsides the classrooms. Based on the purposes of this study, the current study was guided by the following a research question:

- Why would second career-changing teachers (i.e. pre-service and in-service) with professional backgrounds and experiences in environmental sciences decide to join the education and teaching profession as secondary school teachers in the United States?

2. Methodology

A qualitative research method [12–14] has been employed in this study. Two tools have been taken, which were the interview and focus group activities. However, due to the COVID-19 pandemic and the recommendation of the social distancing, the interview sections and focus group activities were taken via social media applications (i.e. WhatsApp) online. Although the distance-based data collection procedure was new to most of the participants, all participants expressed positive feedback and opinions about the procedure and progression.

2.1. Participants and Recruitments
In order to increase the validity of the data, the researcher employed the snowball sampling strategy [15] to recruit 140 participants for the study in the United States. First of all, based on the researcher’s network, the researcher successfully invited 15 participants who met the criteria of the study. Second, all the 15 participants agreed on the study and were willing to refer potential participants with a similar background after the interview session(s). Third, after several rounds of referral and interview sessions, the researcher eventually collected 140 participants’ data from the interview sessions. Fourth, in order to increase the validity of the study, the researcher invited 10 participants into a distance-based focus group activity for further sharing. 14 focus groups were conducted. The participants must meet all the following points:

- Will complete or completed an initial teacher’s training programme.
- The subject matter or content area is in environmental science or a close related subject.
- Have at least three years of environmental science-related professional working experience.
- Will teach or currently teaching at a secondary school environment as environmental science or close related subject.
- Non-vulnerable individuals.

2.2. Data Collection

First, based on the researcher’s network from prior experiences, the researcher was able to invite 15 participants for the study. The researcher contacted each for this study alongside with the research protocol, interview questions, focus group questions, content forms and ethical approval. Second, the researcher arranged the individual WhatsApp interview session with each. During the interview session, the researcher employed the audio-recording function. Each interview session lasted about 60-83 minutes. After the interview session(s), each participant should refer to at least one individual with a similar background to this study. Fortunately, each participant referred at least two individuals with a similar background. Third, after several rounds of referral activities and interview sessions, the researcher arranged the distance-based focus group activities via WhatsApp. In order to increase the validity of the study, the researcher invited 10 participants into a distance-based focus group activity for further sharing. 14 focus groups were conducted. During the focus group activities, the researcher only worked as the facilitator for each focus group question. The participants shared their opinions, feedback and ideas based on their own background and experiences. Each focus group activity lasted about 100-134 minutes. Although each did not know each other, the distance-based focus groups were focused and smooth. The voice sharing was recorded for the reporting. After the researcher transcribed the voice messages to written transcripts, the researcher sent the related materials back to each participant for member checking purposes. All 140 participants agreed on their materials with the written agreement.

2.3. Data Analysis

After the data collection procedure, more than 600 pages of written transcripts were created based on the interview sessions and focus group activities. First, the researcher re-read the written transcripts multiple times in order to categorise similar groups and themes for reporting. Qualitative researchers advocated that large-size data should be narrowed down to meaningful themes and subthemes. Therefore, the researcher followed the general inductive approach (GIA) [16] for the data analysis procedure. Second, the researcher followed the open-coding technique to narrow down the large-size data to the first-level themes and subthemes. At this stage, 45 themes and 44 subthemes were merged.

However, it is impossible to have such large-size themes and subthemes for reporting. Therefore, as for the third step, the researcher employed the axial-coding technique to merge the first-level themes and subthemes to the second-level themes and subthemes. At this stage, the researcher categorised two themes and three subthemes for reporting.

2.4. Human Subject Protection

All signed and unsigned document, content forms, agreements, personal contacts, audio-recording, written transcripts, computer, and related materials were locked in a password-protected box for human
subject protection. Only the researcher has the rights to read the materials and information. After the study was completed, the researcher immediately deleted the soft information and destroyed the hard copies for personal privacy. Due to the privacy, each participant was provided with an anonymous for reporting (i.e. Participant #1). As the geographic location, age, gender, university enrolment, grade, and interned schools were not important for results and finding, the researcher decided to mask the information in order to protect the participants from potential employers.

3. Results and Discussions
During each interview session and focus group activity, the participants were asked the same interview questions and focus group questions. However, the answers and feedback were not similar due to the geographic location, life experiences, lived stories, background, and experiences. Unlike some studies with the focus on traditional-age students with directed experiences from secondary schools and peer influences, the career decision and decision-making process of second career-changing teachers, both pre-service and in-service, were influenced by various factors, such as life experiences, lived stories, prior background etc. It is surprising to note that all 140 participants shared the same idea, “educating the next generation” as one of their purposes and hopes for this career decision (i.e. from practising to teaching). More importantly, all expressed that they will stay in the education and teaching profession as long-term career development and investment. Table 1 outlines the themes and subthemes of this study.

| Themes and subthemes |
|---------------------|
| 3.1. Educating the next generation |
| 3.1.1. The needs for STEM |
| 3.1.2. The needs for professional teachers with industry experiences |
| 3.2. Personal development to the fields of education and teaching |

3.1. Educating the Next Generation

Education is the hope of our country. We need to have good and qualified teachers for our school systems and future...I am here to help... (Participant #33)

All 140 participants shared their ideas about educating the next generation is one of their most important factors for teaching in the fields of environmental science education. First, many expressed that their previous positions in the industry might earn much more resources and better career promotions. However, many decided to switch to education and teaching due to their sense of mission for the next generation, one said,

In the industry, I may earn more than 200,000 USD per year due to my experiences and scientific skills in environmental engineering...but I don’t think it is only about money but the mission for our children and the protection of our society...I would like to use my skills to tell children that...our environment needs your appreciation... (Participant #88)

Second, many indicated that they are interested in the field of education and teaching as they received positive learning experiences during secondary school and university periods. They could see that many of the teachers and instructors in the fields of scientific subject matters do not understand how to teach and create a positive classroom environment. Therefore, they want to enter the fields of education and teaching in order to upgrade the atmosphere of the current school systems. Two significant sharing was marked, said,

My university instructors at the Faculty of Sciences did not understand how to teach...the monotones, the textbook only classrooms, the boring exercises or so...these teaching strategies absolutely limited the creativity and interests of potential scientists and lab technicians...it is time...
to change this negative practices in the labs and schools. As I have the interests to upgrade the classroom environment, why not give me a try? (Participant #12)

The current science classrooms are very boring. Many teachers and professors only know how to do lab experiments and reports...But we need to have interactive classroom environments in order to increase the overall performance and interests of our learners and students...lab experiments should be given to graduate students but not high school students...I want to change this practice...(Participant #57)

3.1.1. The Needs for STEM. All 140 participants indicated that both industry and teaching areas do not have enough quality scientists and teachers in the fields of environmental sciences, environmental engineering, and environmental education. Although switching career between the areas and fields may solve the immediate and short-term human resources shortages, the long-term solutions would be positive training and recruitment for the potential newcomers. As one said,

We need to have new students and new scientists in our environmental sciences fields...just like me, changing direction from practice to teaching does not change the number of workforces...I am here to train up additional scientists from high school to university...so several years later...
We will have new and fresh scientists in the environmental science labs...(Participant #1)

3.1.2. The Needs for Professional Teachers with Industry Experiences. Many of the teachers in the K-12 systems do not have professional and industry experiences as many joined the education and teaching profession right after university graduation. In fact, the lack of professional experience in the subject matters do not only happen in the STEM classrooms but also other liberal arts and social sciences classrooms. In other words, K-12 teachers usually do not have the hands-on experiences and practices of what they are teaching in classroom environments. As one said,

My high school and university instructors in environmental sciences did not even work in the professional labs before they joined teaching...so some technical terms and procedures...they do not understand...but I think schools should have a balance between professional teachers and classroom-based teachers...instead of thinking about how to encourage lab technicians to join, I join it first...(Participant #119)

3.2. Personal Development to the Fields of Education and Teaching

Many participants expressed the interests of transferring the professional and industry procedures, experiences, experiments, and practices beyond the textbook materials to classroom students and their co-workers. Many indicated that although the textbook materials shared the steps and procedures of the lab experiments, these procedures are not upgraded and updated in the contemporary lab environments. In other words, no lab technicians would use these procedures anymore as the developments of the scientific areas changed overnight. Therefore, they want to bring new stimuli to their next generation for creative thinking and updated knowledge, one said,

Many scientists believe that water is the essential item and element for all life matters in the universal system...I learnt this from elementary school...but who can prove this is the fact or truth?...who has the experiences...to interact with aliens? Life matters on Mars...do they have the same physical structures as life matters on Earth? We have to import some new and updated knowledge to our children...(Participant #47)

In short, based on the current findings and results, many believed that the future of the next generation and the education quality of the school systems take the important roles and positions of their second career switching decision to education and teaching. It is important to note that many believe resources and financial incomes do not change their decision but the mission of serving the society and community. Therefore, they have established a sense of belonging to their country, community, and people as people.

4. Limitations, Future Research Directions, and Conclusions
4.1. Limitations and Future Research Directions

Each study has its own limitations. The researcher concluded three limitations with potential future research directions for this study. First, as this is a research-in-progress study, the researcher will continue the development and discussion chapters of this study. However, based on the current results and findings, the researcher could indicate that their (i.e. the participants’) personal goals and interests significantly impacted the career intention instead of financial considerations and external factors [13,17–19]. A further conclusion will be established for the future version.

Second, many STEM subject matters in the current school systems are facing significant shortages of qualified teachers. Future research studies should cover the workforce problems in other subject matters, such as biology, chemistry, and physics in order to create a better picture of the current human resources problems [20].

Third, the current study only covered workforce problems in the United States. Other countries should face a similar background and problem as well. Therefore, future research studies should collect data from participants in different parts of the worlds in order to establish the holistic performance of the current human resources shortages [21].

4.2. Conclusion

The completion of this study provided two significant insights into the human resources shortages in the fields of science education. First, although many human resources planners, university leaders, policymakers, and researchers always encourage the government to provide additional funding and scholarships for scientific training and projects, not much of these funding has contributed to the upgrading of the K-12 science teachers’ professional development. Currently, the salary and incomes of science teachers are below average when comparing to lab technicians and scientists. Therefore, the appropriate personnel should reform the current school systems and the salary scales in order to encourage additional teachers and second career-changing teachers to the fields.

Second, many of the current textbook materials were written by teachers and professors without any professional and industry experiences. Therefore, there is a need to create balance and coordination between textbook materials and professional practices in the K-12 and university classroom environments. Otherwise, school graduates would only gain textbook-oriented knowledge and outdated practices from the classroom environments, which cannot be applied to the lab and professional environments in the future.

References

[1] Dos Santos L.M 2019 Engineering education as a second career: The experience of female practising engineers. Glob. J. Eng. Educ. 21 202–7.
[2] Reinhold S, Holzberger D, Seidel T 2018 Encouraging a career in science: a research review of secondary schools’ effects on students’ STEM orientation. Stud. Sci. Educ. 54 69–10
[3] Daskolia M, Dimos A, Kampylis P 2012 Secondary teachers’ conceptions of creative thinking within the context of environmental education. Int. J. Environ. Sci. Educ. 7 269–290
[4] Shi Y 2018 The puzzle of missing female engineers: Academic preparation, ability beliefs, and preferences. Econ. Educ. Rev 64 129–143
[5] Skelton C 2003 Male Primary Teachers and Perceptions of Masculinity. Educ. Rev. 55 195–209
[6] John Martino W 2008 Male Teachers as Role Models: Addressing Issues of Masculinity, Pedagogy and the Re-Masculinization of Schooling. Curric. Inq. 38 189–223
[7] Martino W, Kehler M 2006 Male Teachers and the “Boy Problem”: An issue of recuperative masculinity politics. McGill J. Educ. 41 113–132
[8] Johnson S 2008 The status of male teachers in public education today. Educ. Policy Br. 6 1–11
[9] Im S, Yoon H.-G, Cha J 2016 Pre-service Science Teacher Education System in South Korea: Prospects and Challenges. EURASIA J. Math. Sci. Technol. Educ. 12 1863–80
[10] Dos Santos L. M 2020 Becoming a pre-school and elementary school educator: How do male teachers describe their career decision and career development from the perspective of the social
Cognitive career approach and human resource management. *J. Educ. e-Learning Res.* 7 159–166

[11] Simon R.M, Wagner A, Killion B 2017 Gender and choosing a STEM major in college: Femininity, masculinity, chilly climate, and occupational values. *J. Res. Sci. Teach.* 54 299–323

[12] Tang K H, Dos Santos L M 2017 A brief discussion and application of interpretative phenomenological analysis in the field of health science and public health. *Int. J. Learn. Dev.* 7 123–13

[13] Dos Santos L M 2019 Recruitment and retention of international school teachers in remote archipelagic countries: The Fiji experience. *Educ. Sci.* 9 132

[14] Dos Santos L M 2019 Experiences and expectations of international students at historically black colleges and universities: An interpretative phenomenological analysis. *Educ. Sci.* 9 189

[15] Merriam S B 2009 *Qualitative Research: A Guide to Design and Implementation* (Jossey Bass: San Francisco, CA)

[16] Thomas D R. 2016 A general inductive approach for analysing qualitative evaluation data. *Am. J. Eval.* 27 237–246

[17] Dos Santos L. M. 2020 How does COVID-19 pandemic influence the sense of belonging and decision-making process of nursing students: The study of nursing students’ experiences. *Int. J. Environ. Res. Public Health* 17 5603

[18] Dos Santos L. M. 2020 I want to become a registered nurse as a non-traditional, returning, evening, and adult student in a community college: A study of career-changing nursing students. *Int. J. Environ. Res. Public Health* 17 5652

[19] Dos Santos L. M. 2020 Exploring international school teachers and school professional staff’s social cognitive career perspective of life-long career development: A Hong Kong study. *J. Educ. e-Learning Res.* 7 116–121

[20] Dos Santos L. M. 2018 Career decision of recent first-generation postsecondary graduates at a metropolitan region in Canada: A social cognitive career theory approach. *Alberta J. Educ. Res.* 64 141–152

[21] Dos Santos L. M. 2019 Investigating employment and career decision of health sciences teachers in the rural school districts and communities: A social cognitive career approach. *Int. J. Educ. Pract.* 7 294–309