International Journal of Education and Practice
2019 Vol. 7, No. 3, pp. 146-157
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/journal.61.2019.73.146.157

PRE-SERVICE TEACHERS' PROFESSIONAL DEVELOPMENT THROUGH FOUR-STEP PROBLEM-SOLVING MODEL: A SEMINAR METHOD

Luis Miguel Dos Santos

Woosong University, 196-5 Jayang Dong, Dong Gu, Daejeon, South Korea.
Email: luismigueldossantos@yahoo.com

Article History
Received: 16 January 2019
Revised: 8 March 2019
Accepted: 15 April 2019
Published: 4 June 2019

Keywords
Hong Kong education system
Initial license
Pre-service teacher
Seminar methodology
Registered teachers
Second career teachers
Teachers' education programme
Teachers' professional Development.

ABSTRACT

Effective teaching and learning strategy is one of the most important topics in the field of teachers' professional development. Teachers' education and pre-service teachers' training programmes provide necessary coursework, field experience, and student teaching internship experience to pre-service, potential, and second career teachers who are seeking initial license status. Due to the rapid developments in Hong Kong, China, school teachers face challenges, difficulties, and social problems due to excess enrolment of teachers from different backgrounds. The regular curriculum and material also fail to cover all these issues. The current study applied the seminar technique as recommended in Polya's *Four-Step Problem-Solving Model* with targeted discussion topics and engaged 12 STEM pre-service teachers at one of the Postgraduate Diploma in Education (PGDE) programmes. The results indicated that beyond regular coursework, field experience, and internship experiences embedded in the curriculum, additional seminars allowed the participants to establish inter-disciplinary teaching strategies and critical thinking skills. The results of this study serve as a blueprint for teachers' education programme leaders and school administrators to establish similar seminars and conduct such sessions for their pre-service and in-service teachers to refresh and advance their teaching and learning strategies.

Contribution/Originality: The study contributes to the existing literature on teachers' education programmes, teachers' training, and teachers' professional development. The primary contribution of this article is also to provide directions for school leaders and administrators to establish professional training to their in-service and pre-service teachers in K-12 school environments.

1. INTRODUCTION

How to employ effective teaching methods and how to transfer textbook knowledge into classroom management and practice are some of the significant elements for current teachers to understand (Clandnin and Connelly, 1995; Dos Santos, 2018; Dos Santos, 2019). Both pre-service and in-service teachers are expected to understand the most appropriate teaching strategy and method for their subject matter and classroom environment. Vasquez *et al.* (2013) indicated that teachers' education programmes for initial license should mainly focus on the areas of coursework, field experience, and student internship experience. Pre-service teachers should also learn how to manage and transfer their theoretical knowledge from textbooks and university classroom environments to real K-12 school environments. They might utilize the mentorship and guidelines from university professors and

experienced teachers at partnered sites. Once the pre-service teachers have completed essential training, they secure the teachers' license for their practice (Cochran-Smith, 2005).

In the current social environment in Hong Kong, China, students come from different backgrounds (i.e. nationality, culture, religion, language, gender, place of origin, social-economic level, and race) and their number is increasing in K-12 schools (Shek and Wu, 2014). Unlike other countries with only a few ethnical groups and populations, Hong Kong, China is well-known as a city where the east meets the west. In other words, due to the historical, social, economic, and political issues, people from all over the world establish their families and advance their career developments in Hong Kong, China (Pierson, 2018). Their children who are the next generation of their population need to enroll at one of the K-12 schools in the city (Bray, 2018). As a result, the school systems in Hong Kong, China have become more vibrant and more colorful (Leung, 2018). From the perspective of school leaders and administrators, it is imperative that K-12 school systems should provide additional preparations for their teachers to teach students from different backgrounds (Shek and Wu, 2014).

Traditionally, K-12 school teachers usually receive teachers' education training and get an initial license by acquiring Bachelor of Education degree from Faculty of Education at all local universities . This Bachelor of Education degree program offers, pre-service teachers a four-year university level education comprising coursework, field experience, student internship experience, and subject training. After completing this Bachelor of Education programme, graduates become qualified teachers with an initial license to practice teaching at one of the K-12 schools in Hong Kong, China (Pang *et al.*, 2016).

However, within the recent decades, school leaders and administrators have indicated that a few vocational and practical courses such as science, technology, engineering, and mathematics (STEM), business, technical skills, and fine arts require hands-on experience and industrial recommendations from skilled professionals external to the traditional educational environment. In other words, school leaders and administrators tend to seek licensed teachers with significant industrial experience in order to provide instructions to students pursuing vocational and practical subject courses(Sun, 2015). On the other hand, a few skilled professionals from industry may also want to switch to teaching career due to social, financial, and personal reasons (Lent *et al.*, 1994;2000; Lent and Brown, 1996). For such lateral entry candidates, alternative teachers' education programmes, such as Postgraduate Diploma in Education (PGDE), were introduced in order to meet the requirements.

This study was conducted in the context of PGDE programme meant for non-registered teachers seeking registered teacher (RT) status in Hong Kong, China. Unlike traditional pre-service teachers without significant work experience, mid-age adults and second-career teachers usually need additional help from mentors in order to utilize their work experience and industrial knowledge into teaching. In the other words, second-career teachers wish to bring rich industrial experience from their previous workplace. However, they lack guidelines to utilize these experiences into teaching practice. Hence, this study was developed with the premise that PGDE programmes promise to develop a teaching methodology for non-registered teachers in one of the fields of secondary school subjects such as science, technology, engineering, and mathematics (STEM), and assist teacher-learners in understanding how to provide effective teaching and learning experiences and strategies to their students (Smith and Foley, 2015).

The aim of this current study had two directions. First, the researcher employed the *Four-Step Problem-Solving Model* (Polya, 1957) to provide tutorial training to a total of 12 teacher-learners who were enrolled at a PGDE programme in Hong Kong, China. The details of this *Four-Step Problem-Solving Model* will be explained later. Second, more importantly, this research study tended to capture the feedback and opinions about this *Four-Step Problem-Solving Model* from the perspective of teacher-learners in the PGDE programme whether or not this *Four-Step Problem-Solving Model* and its related activities should be retained or discontinued. Feedbacks and opinions were collected from the participants to formulate guidelines to improve and enhance the structures and framework of this *Four-Step Problem-Solving Model* in future for potential trainees. In short, the study aimed to enhance the

experience, understanding, and teaching methodology for pre-service teachers who were enrolled at the PGDE programme in Hong Kong, China.

Based on the objectives of this research, the following two research questions were formulated:

1) How do PGDE learners of the *Four-Step Problem-Solving Model* make sense of tutorial sessions?
2) How does the *Four-Step Problem-Solving Model* enhance the learning experience of PGDE learners?

1.1. The Application of the Four-Step Problem-Solving Model

In order to carry out the current study, the researcher proposed to apply Polya's *Four-Step Problem-Solving Model* to administer problem-solving, teaching and learning strategies on a group of PGDE learners in the field of STEM teaching (Polya, 1957). Polya's problem solving approach allowed teachers to provide appropriate directions to students by conducting a seminar on program-solving techniques and self-solving and learning skills. In fact, Polya's model is already very popular in the Canadian educational system (Ontario Ministry of Education, 2005). This *Four-Step Problem-Solving Model* involves a seminar method acknowledging the problem, establishing and carrying out a plan, and revising and rechecking the results (Polya, 1957).

Other studies that have used this model showed that how the teachers were tutored to increase students' interest, engage them in peer learning groups, encourage them to seek answers outside of the classroom, and provide feedback on the activities (La Velle and Flores, 2018). After each seminar, teachers were also taught how to share their reflections and create portfolios on teaching and learning strategies, particularly with regard to the methods of integrating different theories and techniques into their classrooms (Gan *et al.*, 2018).

The current study aimed at making a paradigm shift through innovative methods in teaching secondary school students. For this purpose, this study has adapted, enhanced, and re-designed Polya's *Four-Step Problem-Solving Model* for PGDE learners who are currently working as student-teachers at one of the K-12 schools in Hong Kong, China. These adaptations were made in Polya's model in order to satisfy the needs of the current educational environments and participants in Hong Kong, China.

These adaptations of the model were based on the premise that the application of the *Four-Step Problem-Solving Model* requires at least four elements: first, underpinning theories (e.g., experimental learning) (Bell and Gower, 2011; Jolly and Bolitho, 2011; Reppen, 2011; Willis, 2011) second, various teaching strategies in relation to the application (e.g., outdoor education, jigsaw activities, and peer exchange) (Asmara *et al.*, 2016) third, problem-solving skills (Centeno-Cortes and Jimenez-Jimenez, 2004; Lehti-Eklund, 2013) and lastly, social interactions (e.g., community learning in schools and the neighbourhood) (Morris, 2001). It is worth to note that the abovementioned elements and features can be changed based on the classroom environment, the geographical context of the place, the population of classroom students, the subject matter, the learners at the PGDE Programmes, and so on.

1.2. Definition of Terms

In-service teachers refer to teachers who are currently working at one of the K-12 schools. However, currently in many countries and regions including Hong Kong, China, in-service teachers may or may not complete the teachers' education programmes for an initial license.

Pre-service teachers refer to teachers who are pursuing teachers' education programmes for an initial license. This group of pre-service teachers usually may not be practicing their teaching fully or practicing with some limitations at K-12 schools.

Postgraduate Diploma in Education (PGDE) is a teachers' education programme required to get an initial license for bachelor's degree holders aspiring to teach at K-12 schools. PGDE is offered at postgraduate-level which requires learners with at least a bachelor's degree in a field other than teaching. The admission criteria require prospective students to have this bachelor's degree in one of the subjects in the K-12 school system such as fine arts, physical education etc.

Science, technology, engineering, and mathematics are also known as STEM. This term was developed during the last two decades in the United States. The Permitted teacher, also known as PT, allows individuals to teach in Hong Kong, China without any teacher training certification or teaching qualifications, as long as they have a post-secondary qualification (e.g., a bachelor's degree without an initial license).

The registered teacher, also known as RT, in Hong Kong, China, is an individual who holds the initial license and has completed one of the teachers' education programmes for an initial license.

2. METHODOLOGY

This study was carried out with the assistance of a university course instructor who provided instructions and tutoring to a group of PGDE learners in Hong Kong, China. The researcher had invited this course instructor to employ the *Four-Step Problem-Solving Model* in the curriculum and in his instruction methods in tutorial sessions during the semester. Since the PGDE curriculum and its modules had been set and approved by the university department and government agency, this course instructor could not modify the materials, assignments, planning, and directions of the coursework. However, in order to provide the additional training and experience and to employ the *Four-Step Problem-Solving Model*, the course instructor was able to designe additional materials for reading and group discussions for PGDE learners in bi-weekly voluntary seminars during the semester. These bi-weekly seminars were hosted by the course instructor during the weekend at one of the classrooms on campus. Each seminar hosted no more than two hours duration. In total, seven sessions of each seminar were hosted. Table 1 outlines themes and discussion topics for each session of the seminar. The topics of group discussion were modified according to the situation.

Table-1. Lesson plan for the seminar.

Week	Theme	Topics
1	Teaching Theories	Experiential learning Constructivism
2		Behaviorism Cognitivism
3	Various Teaching Strategies	Outdoor education Jigsaw Activities
4		Peer exchanging Hands-on practising
5	Problem-Solving Skills	Critical thinking
6		How to understand, analyze, and solve scientific questions
7	Social Interaction	How to manage arguments with other classmates and students?
8		How to interact with our community and neighborhood?

A qualitative methodology using in-depth interview was found to be most appropriate for this study. Because the aim of this research was to understand how to enhance the teaching methodology of PGDE learners, in-depth interview technique enabled the researcher to conduct face-to-face questions with the participants and capture the desired first-hand information without any misunderstanding (Creswell, 2007;2012; Merriam, 2009; Tang and Dos Santos, 2017; Dos Santos, 2018).

2.1. Participants and Data Collection

A total of 12 PGDE learners were sampled for this study who participated in all the seven sessions of the bi-weekly voluntary seminars. All these teacher-learners had completed their bachelor's degree in one of the STEM subjects. All participants were second-career teachers with at least five years of professional work experience after their graduation from a university. Four of the teachers had completed their master's degrees. Table 2 outlines a brief background of participants. It is worth to note that all participants had given their consent to participate in this study.

An interview protocol was developed to explore the significant areas of this study. Hence, after the completion of seminars and coursework, the researcher invited participants to interview sessions for data collection and their feedback. Consistent with the interview protocol, these in-depth interviews were semi-structured, one-on-one; face-to-face with each lasted between 30-50 minutes. During the interview sessions, participants were asked to explain their potential or current teaching activities; discuss problems they face or may have faced in secondary STEM classrooms share their beliefs about this seminar; and discuss any advantages and disadvantages they might have encountered throughout the process.

After the researcher had collected and transcribed the data, participants were invited for a member checking interview for validity. Each member checking interview lasted 20-30 minutes. All participants agreed with the data that was transcribed. Once the participants approved their transcripts, the data was analyzed employing the MAXQDA v.11 qualitative data analysis software.

Table-2. Demography of the participants.

Name	Education Level	Years of Experience
Teacher # 1	Bachelor	6
Teacher # 2		8
Teacher # 3		10
Teacher # 4		5
Teacher # 5		7
Teacher # 6		12
Teacher # 7		11
Teacher # 8		8
Teacher # 9	Master	13
Teacher # 10		8
Teacher # 11		15
Teacher #12		10

2.2. Data Analysis

Themes and patterns during the interview sessions were identified. An inductive approach was used in this study (Thomas, 2006). The inductive approach allowed the researcher to understand the feedback, opinion, and before-and-after beliefs about these seminars. The researcher followed a general inductive approach also to narrow the large-size transcripts into first-level themes by employing the open coding technique (Seidman, 2006;2013; Creswell, 2012). After the first-level open coding technique, the themes and categories were still too large to be reported. Therefore, the researcher employed the axial coding technique to narrow down the themes and data into second-level themes (Merriam, 2009).

2.3. Protection of Human Subjects

The protection of human subjects was essential to this study, particularly because it dealt with the field of career development and teachers' education training. Unlike the fields of business management and commerce, the education and teaching profession is relatively tidy where the school leader and administrators locate the participants by name and university. Therefore, the researcher made every effort to protect the identities of the participants by masking their names. Protecting participants' identities allowed all the participants to remain anonymous to any potential employers and freely express their understanding, feedback, and opinions. Also, the researcher decided not to disclose the name of the PGDE programme and the university as the identities of these two items may not have made beneficial impact on readers.

3. FINDINGS OF RESEARCH

The aim of this current study was to explore the feasibility of providing additional tutorial or a seminar to PGDE learners by applying the *Four-Step Problem-Solving Model* (Polya, 1957). More importantly, this research study tended to capture the feedback and opinions about this model from the perspective of teacher-learners in the PGDE programme to know whether this *Four-Step Problem-Solving Model* and its related activities should be retained or discontinued. Feedback and opinions were collected to improve and enhance the structures and framework of this *Four-Step Problem-Solving Model* for current and future trainees. After the semester-long coursework with seven sessions of seminar adopted as per the guidelines of the *Four-Step Problem-Solving Model*, the participants expressed significantly positive opinions about the model. They also suggested how to bring classroom knowledge into practice, how to develop additional materials, assignments, and devise discussion topics in order to make use of the model. The following section will outline the findings and results based on the data collected from the participants.

During the course of the study, the researcher tended to capture the feedback and opinions of the participants instead of making standardized scores and formative assessments. In other words, the reports of the findings of this study summarized how PGDE learners expressed their feedback and opinions of this *Four-Step Problem-Solving Model* (Polya, 1957) as well as the recommendations for bringing reforms in the model for future applications.

3.1. The Transferrable Application of the Four-Step Problem-Solving Model

The study revealed that the voluntary seminar method served as an additional workshop, encouraging teachers to apply the knowledge on top of their PGDE coursework. Although the seminar repeated some information from the PGDE programme, all the participants stated that such tailor-made workshops enhanced their techniques with regard to teaching strategies and classroom management.

Regarding the information given in the seminar, participants stated that the teaching and learning methodologies from the PGDE coursework remained in their assignments but were not applied in classroom management. After the seminar, all 12 teachers not only discussed the applications to their teaching strategies, classroom management, and employment of the techniques (e.g., jigsaws and experiential learning) but also the way in which they had learned how to apply these techniques into the *Four-Step Problem-Solving Model.*

For instance, Teacher #3, a physics teacher, said,

"The textbook asked us to practice the jigsaw activities but did not teach us how to employ this in large-size classrooms with non-motivated students. So, how can I teach these groups of unmotivated students…The additional seven sessions of the seminar provided me with the chances to discuss topics with students outsides the classroom…"

Teacher #3 also indicated sharing and chatting with other learners of the PDGE programmes. The idea of sharing was also advocated by other participants.

Teacher #1 indicated thus:

"The additional seven sessions (seminar) were the best arrangement for this PDGE programme. Although I understand and advocate that field experience and student teaching internship serve as another milestone, but I liked to discuss with other classmates and the course instructors in detail…it also offered me an opportunity for some interpersonal interactions…

Teacher #8 further echoed this idea:

"The seven sessions of the seminar after class is the best arrangement. I can even ask questions about other issues…how to use the jigsaw activities in a science lesson…how to use both English and Chinese to teach a science lesson…In fact, some schools in Hong Kong, China, require us to use both languages to teach… …"

Although Teacher #5 had learned some techniques and teaching strategies from her PGDE coursework, she said, "I learned from interaction and peer exchange but not sure whether it is a suitable technique for teacher-

centred classrooms?" Teacher #7 shared, "I realize I can ask students to take their disposal cups and chopsticks for an experiment." Furthermore, Teacher #8 stated, "Community learning is uncommon in Hong Kong, China, but the seminar method provided us with recommendations about how to guide students to learn from our neighborhoods and national parks." Teacher #1 reflected, "The *Four-Step Problem-Solving Model*, alongside the integrated skills, such as outdoor education and peer exchange, encourage students to participate in interactive discussions." It is worth noting that all 12 teachers expressed a similar understanding of how the seminar provided opportunities for tailor-made and active discussions between peers regarding how to integrate teaching and learning techniques into the *Four-Step Problem-Solving Model*.

In short, the participants advocated that the seminar technique as recommended in the *Four-Step Problem-Solving Model* provided opportunities for discussions in peer-exchanging and social interactions even outside the classroom. Although a number of participants indicated that the typical PGDE classrooms provided a reasonable amount of time for additional discussions and exchange with peers, the duration of each classroom discussion was however limited. The seminar technique within the *Four-Step Problem-Solving Model* therefore if combined with the classroom knowledge of the targeted discussion topics may engage the participants to seek and share the most appropriate teaching strategies for their classroom environment.

3.2. Transforming and Transferring Textbook Knowledge into the Classroom

Another advantage of this seminar technique was the primary focus on STEM classrooms and teachers' teaching styles. Unlike the westernized teaching and learning strategies with a large component in hands-on experiments and interactions with peers and teachers, Chinese teaching and learning strategies and styles tend to be textbook knowledge and observations from teachers. As these participants had received their primary and secondary school education in Hong Kong, China, they never experienced how to teach science subjects effectively for their classroom environment.

3.2.1. Understanding of Science Teaching and Learning before the Four-Step Problem-Solving Model Seminar

Before the seminar, most of the teachers believed that learning in the field of science relies on observations and textbook instructions. Teacher #2 stated that students could learn science from "observing their teachers and the formulae in the textbook, PowerPoint Presentation, and online social media video." Teacher #1 said, "Observation is advocated by Bandura's social learning style. I would like to employ that in my classroom." Teacher #12 also further indicated that science teaching should focus on examination preparation, Advanced Placement, SATII, and what the Hong Kong Diploma of Secondary Education exam recommends. Teacher #12 sums up thus:

"In Hong Kong, China, most of the students and their parents focus on grades and achievements. They do not care about knowledge a student can gain…before the seminar and throughout the PGDE programme…I believed getting grades was the main objective of teaching and learning…"

3.2.2. Changing of Beliefs after the Four-Step Problem-Solving Model Seminar

The seminar method assisted the teachers in upgrading their previous understanding of science teaching and learning practices and to appropriate teaching strategies for STEM subjects in their classrooms, leading to a good experience for both teachers and students. Seven participants indicated that science should not be a standalone subject, but it should be inter-disciplinary. Teacher #4 advocated that,

> …before I completed these additional seminars, I mainly focused on how to teach physics as a subject only in my classroom…but once I have completed…I am now thinking how to combine elements of fine arts, mathematics, and even Chinese Language into my physics classroom…These subjects can be combined for further teaching and development…

The idea of combining different subjects or their elements into teaching of science and its learning were shared by other participants too; for example, Teacher #5 indicated that science teachers should encourage outdoor education such as sports:

> In the seminar…we discussed topics of outdoor education…although the campuses of most of the secondary school in Hong Kong, China are not large enough, I can still bring my students to the sport's field with a physical education teacher as a learning opportunity outside the classroom…I realized we can even learn biology and environmental science in an outdoor sport field or over a mountain…"

Hence participants have indicated that the seminar method and its discussion topics allowed them to think about the opportunities of making use of inter-disciplinary elements as teaching and learning strategies in their science classroom.

A few participants advocated that the *Four-Step Problem-Solving Model Seminar* allowed them to think about social interactions and peer exchange as alternative teaching and learning strategies of their science subjects. For instance, Teacher #3 stated that the seminar allowed him,

> "…to upgrade the social constructive teaching method into the *Four-Step Problem-Solving Model* strategy, which I found more appropriate for mathematics students…although this the model is just a tool for all of us to modify our teaching , the application and the critical thinking opportunities are vital…"

Teacher #4 stated that the seminar technique of *Four-Step Problem-Solving Model* allowed her to gain the ideas of social and peer interactions from peers (i.e. for herself and for students):

> "…now, my chemistry lab classes do not only involve observations of my experiments. Students can identify the problem, establish a plan, carry out the plan, and revise and recheck the results with their peers through discussions…I am glad that the seminar technique taught me how to employ social and peer interactions…I actually read about this strategy in books…But I actually learnt how to practice this strategy in this seminar…by sharing and discussion from other classmates…"

Teacher #6 also stated that social interactions and discussion on topics of community members and neighborhood during the seminar technique of *Four-Step Problem-Solving Model* allowed her to gain ideas about "…the outdoor technique, how it allowed us to set up questions in a classroom and how students can find a solution through useful items in a playground, and then bring them back to the biology lab."

In short, these findings show how a tailor-made seminar technique of Polya's *Four-Step Problem-Solving Model* allowed the participants to upgrade and apply their PGDE textbook knowledge. They learned how to make use of their knowledge relevant to their current and potential classroom environment through the semiar technique of the *Four-Step Problem-Solving Model.* These findings thus reveal that the seminar technique not only added a new dimension to teachers' and students' experiences but also allow them to apply appropriate textbook theories and knowledge in the classroom environment. All participants finally shared the idea, what Teacher #9 commented, 'Without this tailor-made seminar, which aims to put STEM instructions and applications from the textbook into practice, I do not believe pre-service and PGDE teachers will be able to upgrade their teaching strategies appropriately. This seminar should be continued."

4. DISCUSSION

The findings of this study show that the seminar technique recommended by Polya's *Four-Step Problem-Solving Model* expanded the horizons of teachers' ideas about teaching and learning strategies in STEM classrooms. The technique offered them an appropriate model showing how to use different techniques for individual situations, and demonstrated how to facilitate the application of textbook knowledge into practice beyond regular PGDE coursework (Polya, 1957). This technique is useful particularly in Hong Kong, China, where both pre-service and in-service teachers encounter a large number of challenges and issues about different backgrounds, such as nationality, culture, religion, language, gender, place of origin, social-economic level, and race (Shek and Wu, 2014).

The current findings have also indicated that most of the teachers gained benefits and personal advancements from the seminar technique of Polya's *Four-Step Problem-Solving Model*. On top of the regular coursework, field experience, and student teaching internship experience under the PGDE programme arranged by the university and the partnered site, this seminar technique served as an additional source for pre-service teachers to bring personal questions that had not been addressed in the large-size classroom environment at the university. In fact, some participants also indicated that the site supervisors at the partnered secondary school were not able to answer their questions. In order to transfer the textbook knowledge from the university classroom environments to the practice, therefore, additional tutorials are essential.

More importantly, additional tutorials or conducting seminars should be in the form of an effective technique. There was an evidence that the current *Four-Step Problem-Solving Model* with targeted discussion topics through a seminar method arranged by the course instructor and the researcher allowed the participants to establish critical thinking skills. Such critical thinking skills not only taught the participants to teach their future students how to establish critical thinking skills but also allowed them to become critical thinkers themselves. This practice is echoed in previous literature too which have examined how to first train teachers to become critical thinkers before they provide training to their students into critical thinking techniques (Gan *et al.*, 2018; La Velle and Flores, 2018).

In addition, the findings have also revealed that tutorial sessions provided opportunities to the participants to establish inter-disciplinary teaching strategies and methodologies. Most of the participants indicated that before the seminar, they did not have the ideas about how to establish inter-disciplinary teaching plans as they believed science should be a standalone subject. It is worth to note that all the participants in this study were second-career teachers, who had worked in industry for at least five years. The techniques and ideas about teaching for inter-disciplinary subject matters were minimal (Sun, 2015). Therefore, by introducing the seminar technique of the *Four-Step Problem-Solving Model* using the targeted discussion topics allowed the participants to transfer their industrial experience into their classroom environment.

5. CONCLUSION

Overall, the *Four-Step Problem-Solving Model* proved to be an excellent training model for PGDE learners who aimed to enhance their teaching and learning strategies into their classroom. More importantly, a large number of learners believed the tutorial and seminars provided inter-personal and peer-exchanging opportunities to express, share, and apply their textbook knowledge to their classroom practice and management in the real-world practice.

For practical implementation, first, the seminar introduced a tailor-made *Four-Step Problem-Solving Model*, which makes use of appropriate techniques that have been widely used in the Canadian educational system and STEM classrooms for decades (OME, 2005). It allowed STEM teachers to understand how to deliver STEM knowledge and effectively encourage STEM learners. University administrators, lecturers, and partner-school supervisors may employ this *Four-Step Problem-Solving Model* into their teachers' professional development programmes and training for both in-service and pre-service teachers and also to increase teaching strategies and self-efficacy of their teachers.

Second, the seminar allowed teachers to incorporate textbook knowledge into their practice. In fact, a large number of teachers in Hong Kong, China need to conduct multiple and interdisciplinary lecturing and teaching due to the shortage of qualified teachers. Therefore, some teachers may need to teach one or more subject items related to their major. Therefore, school leadership may employ this *Four-Step Problem-Solving Model* to provide additional support and training to their teachers in order to increase their experience in multiple directions.

Third, the seminar technique provided appropriate recommendations about how to engage large-size classrooms for effective discussions, which was previously only viewed to transmit textbook knowledge and conduct project assignments.

The seminar technique provided an additional channel for PGDE students to excel, apply, and share their ideas and practice with their peers and instructors beyond the borders of a traditional classroom setting. As the traditional classroom is graded and compulsory, voluntary seminars also encourage teachers to share their ideas without significant pressure placed on their learning specific to PGDE curriculum.

In conclusion, although this is a small-scale study with a sample of only 12 teachers, it provides effective recommendations and examples for administrators pursuing program such as PGDE and other teachers' professional development.

Given the limited size and location of the study, further research is necessary for a wider application of these findings. As traditional classroom environments in Hong Kong tend to be large-size classrooms with teacher-centered instructions, various applications of this tailor-made seminar for teachers' professional development can be exercised.

Funding: This research is based on a support from Woosong University Academic Research Funding, 2019.
Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.

REFERENCES

Asmara, C.H., K. Anwar and R.N. Muhammad, 2016. EFL learners' perception toward an outdoor learning program. International Journal of Education and Literacy Studies, 4(2): 74-81.Available at: https://doi.org/10.7575/aiac.ijels.v.4n.2p.74.

Bell, J. and R. Gower, 2011. Writing course materials for the world: A great compromise. In B. Tomlinson (Ed.), Materials development in language teaching. 2nd Edn., Cambridge, UK: Cambridge University Press. pp: 135–150.

Bray, M., 2018. Hong Kong education in an international context: The impact of external forces. In G. A. Postiglione & Y. M. Leung (Eds.), Education and society in Hong Kong: Toward one country and two systems. London, UK: Routledge. pp: 83–97.

Centeno-Cortes, B. and A. Jimenez-Jimenez, 2004. Problem-solving tasks in a foreign language: The importance of the L1 in private verbal thinking. International Journal of Applied Linguistics, 14(1): 7–35.Available at: https://doi.org/10.1111/j.1473-4192.2004.00052.x.

Clandnin, D. and F. Connelly, 1995. Teachers' professional knowledge landscapes. New York: Teachers College Press.

Cochran-Smith, M., 2005. The new teacher education: For better or for worse? Educational Researcher, 34(7): 3-17.Available at: https://doi.org/10.3102/0013189x034007003.

Creswell, J., 2007. Qualitative inquiry and research design: Choosing among five approaches. Thousand Oaks, CA: Sage.

Creswell, J., 2012. Qualitative inquiry and research design: Choosing among five approaches. Thousand Oaks, CA: Sage.

Dos Santos, L., 2018. The cultural cognitive development of personal beliefs and classroom behaviours of adult language instructors: A qualitative inquiry. Brain Sciences, 8(12): 220.Available at: https://doi.org/10.3390/brainsci8120220.

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 Journal of Educational Research, 64(2): 141–152.

Dos Santos, L.M., 2019. Mid-life career changing to teaching profession: A study of secondary school teachers in a rural community. Journal of Education for Teaching, 45(2): 225-227.Available at: https://doi.org/10.1080/02607476.2018.1548168.

Gan, Z., H. Nang and K. Mu, 2018. Trainee teachers' experiences of classroom feedback practices and their motivation to learn. Journal of Education for Teaching, 44(4): 505–510.

Jolly, D. and R. Bolitho, 2011. A framework for materials writing. In B. Tomlinson (Ed.), Materials development in language teaching. 2nd Edn., Cambridge, UK: Cambridge University Press. pp: 107–134.

La Velle, L. and M.A. Flores, 2018. Perspectives on evidence-based knowledge for teachers: Acquisition, mobilisation and utilisation. Journal of Education for Teaching, 44(5): 524–538.Available at: https://doi.org/10.1080/02607476.2018.1516345.

Lehti-Eklund, H., 2013. Code-switching to first language in repair – a resource for students' problem solving in a foreign language classroom. International Journal of Bilingualism, 17(2): 132–152.Available at: https://doi.org/10.1177/1367006912441416.

Lent, R.W., S. Brown and G. Hackett, 1994. Toward a unifying social cognitive theory of career and academic interest, choice, and performance. Journal of Vocational Behavior, 45(1): 79–122.Available at: https://doi.org/10.1006/jvbe.1994.1027.

Lent, R.W., S. Brown and G. Hackett, 2000. Contextual supports and barriers to career choice: A social cognitive analysis. Journal of Counseling Psychology, 47(1): 36–49.Available at: https://doi.org/10.1037//0022-0167.47.1.36.

Lent, R.W. and S.D. Brown, 1996. Social cognitive approach to career development: An overview. The Career Development Quarterly, 44(4): 310–321.Available at: https://doi.org/10.1002/j.2161-0045.1996.tb00448.x.

Leung, Y.M., 2018. Education in Hong Kong and China: Toward convergence? In G. A. Postiglione & Y. M. Leung (Eds.), Education and society in Hong Kong: Toward one country and two systems. London, UK: Routledge. pp: 265–272.

Merriam, S.B., 2009. Qualitative research: A guide to design and implementation. San Francisco, CA: Jossey Bass.

Morris, F.A., 2001. Serving the community and learning a foreign language: Evaluating a service-learning programme. Language, Culture and Curriculum, 14(3): 244–255.Available at: https://doi.org/10.1080/07908310108666626.

Ontario Ministry of Education, 2005. The Ontario curriculum grades 1-8: Mathematics. Toronto. Available from http://www.edu.gov.on.ca/eng/curriculum/elementary/math.html.

Pang, N., W. T. and L.M. Leung, 2016. Educational reforms and the practices of professional learning community in Hong Kong primary schools. Asia Pacific Journal of Education, 36(2): 231–247.Available at: https://doi.org/10.1080/02188791.2016.1148852.

Pierson, H., 2018. Cantonese, English, or Putonghua: Unresolved communicative issue in Hong Kong's future. In G. A. Postiglione & Y. M. Leung (Eds.), Education and society in Hong Kong: Toward one country and two systems. London, UK: Routledge. pp: 183–202.

Polya, G., 1957. How to solve it. Princeton: Princeton University Press.

Reppen, R., 2011. Using corpora in the language classroom. In B. Tomlinson (Ed.), Materials development in language teaching. 2nd Edn., Cambridge, UK: Cambridge University Press. pp: 35–50.

Seidman, I., 2006. Interviewing as qualitative research: A guide for researchers in education and the social sciences. New York: Teachers College Press.

Seidman, I., 2013. Interviewing as qualitative research: A guide for researchers in education and the social sciences. 4th Edn., New York: Teachers College Press.

Shek, D. and F. Wu, 2014. . Positive youth development in junior secondary school students: Do gender and time matter? In D. Shek, R. Sun, & C. Ma (Eds.), Chinese adolescents in Hong Kong: Family life, psychological well-being and risk behavior. Singapore: Springer Singapore. pp: 35–49.

Smith, L. and J. Foley, 2015. Talking together, learning together: The story of English PGCE Student teachers' adventures in classics. Changing English, 22(1): 60–71.Available at: https://doi.org/10.1080/1358684x.2014.992212.

Sun, R.C.F., 2015. Teachers' experiences of effective strategies for managing classroom misbehavior in Hong Kong. Teaching and Teacher Education, 46: 94–103.Available at: https://doi.org/10.1016/j.tate.2014.11.005.

Tang, K.H. and L.M. Dos Santos, 2017. A brief discussion and application of interpretative phenomenological analysis in the field of health science and public health. International Journal of Learning and Development, 7(3): 123–132.Available at: https://doi.org/10.5296/ijld.v7i3.11494.

Thomas, D.R., 2006. A general inductive approach for analyzing qualitative evaluation data. American Journal of Evaluation, 27(2): 237–246.Available at: https://doi.org/10.1177/1098214005283748.

Vasquez, V.M., S. Tate and J. Harste, 2013. Negotiating critical literacies with teachers: Theoretical foundations and pedagogical resources for pre-service and in-service contexts. New York: Routledge.

Willis, J., 2011. Concordances in the classroom without a computer: Assembling and exploiting concordances of common words. In B. Tomlinson (Ed.), Materials development in language teaching. 2nd Edn., Cambridge, UK: Cambridge University Press. pp: 51–77.