ABSTRACT

The purpose of this study is to explore the in-service training and professional development of elementary school teachers in relation to their knowledge of and abilities in astronomy. The teaching content for the in-service training in this study mainly concentrates on the scientific revolution in astronomy, the solar system, planets, stars, space probes and a visit to astronomical science museum. The elementary school teachers are first classified into groups so as to conduct a group learning strategy and to enable them to complete group work and a special astronomical report at the end of the semester. This study adopts a case study method and the main sources for data collection and analysis consist of the group work of the elementary school teachers, their astronomical special reports, feedback on learning and other learning portfolios. The main research results are: (1) the enrichment in the learning attitude of elementary school teachers towards astronomy; (2) the growth in the astronomical concepts of the elementary school teachers; (3) the improvement in confidence of elementary school teachers regarding their astronomy teaching.

Keywords: Astronomy education, In-service teacher education, Professional development, Science education

INTRODUCTION

The mysterious and endless universe and the stunning and vast starry sky often inspire people’s imagination and creativity. Endless romantic legends and beautiful works of art are related to these topics. Comets and shooting stars streaking the skyline always stir up mysterious and touching feelings in people. Numerous space and science fiction movies, such as Close Encounters of the Third Kind, Star Wars, Star Trek, ET, Stargate, Apollo 13, Contact, Deep Impact, Mission to Mars, Prometheus and Gravity have deeply touched people’s hearts. In addition, specific major events, such as the return of Halley's Comet in 1986, the impact of a comet on Jupiter in July 1994, the successful landing of NASA’s Spirit, the Opportunity on Mars exploration in January 2004, the global astronomical events in 2009, the total solar eclipse on July 22nd, 2009 and the exploratory landing on Mars of NASA's Curiosity in August, 2012, have encouraged waves of astronomical observation and learning opportunities in Taiwan.

Based on career development theory, teacher education occurs in three stages: pre-service teacher education, induction education practice and in-service training. With regards to in-service training, Sun (2004) pointed out that the professional development of teachers is a type of professional learning and that education training for teachers should enhance their expertise in self-learning, reflection, management and growth so as to improve the depth and width of their knowledge. With regards to the professional development standards of science teachers, the National Research Council (1996) further pointed out that in order to achieve these requirements in the process of professional development, the important aspects are as follows: (1) teachers must demonstrate rich and deep science content knowledge
(CK) and adopt inquiry methods as the main strategy for exploring scientific activities; (2) teachers must possess complete pedagogical content knowledge (PCK), including an understanding and perception of key aspects, such as science content, curriculum content, learning principles, teaching principles, student characteristics, and the application of knowledge into the teaching of science; (3) teachers must develop various abilities during their teaching career and be equipped with knowledge and learning skills of their own.

The demands for in-service training sessions for elementary schools are increasing rather than decreasing along with the booming development of educational reform in Taiwan. Therefore, considering the importance of in-service training for elementary school teachers and the interest in astronomical observations, especially surrounding important events, the purpose of this study is to explore the professional development of elementary school teachers in relation to in-service training on astronomy. The research questions tackled and explored by this study, are (1) the learning attitudes of elementary school teachers in relation to astronomy, (2) the astronomy concepts of elementary school teachers, and (3) the confidence of elementary school teachers regarding the teaching of astronomy.

### PURPOSE OF THE STUDY

The major purpose of this study is to explore the professional development of elementary school teachers in relation to in-service training on astronomy.

### LITERATURE REVIEW

**Astronomical Concepts and Astronomy Education**

Students are always filled with immense curiosity and have unlimited imagination when learning about astronomy. Numerous studies have found that students show extremely high learning willingness and interest towards astronomy and astrology (Chen, 1999; Chen, 2000; Huang, 1996; Huang, 2013; Lai & Peng, 2014; Lai & Wu, 2005; Liao, Lien & Lu, 2013; Lien & Lu, 1996; Liu, Hwang, Wang, Lee & Chen, 1996; Shae & Huang, 2009). Furthermore, the space-time concepts of the sun, moon, and astrometry observation are important concepts for exploration in the topics of science and technology in elementary schools (Ministry of Education, 2008). Astronomy is closely related with daily life, but is relatively complicated, and thus often confuses students (Baxter, 1989; Crews, 1990; Huang, 2013; Jiang, 1997; Lee, Liu & Chiang, 2005; Liao, Lien & Lu, 2013; Lu & Chu, 2009). Consequently, elementary school teachers often lack confidence in their ability to teach the concepts of astronomy and teachers, thus, often void teaching units on this subject (Slater, Safko, and Carpenter, 1999; Westerback, 1982, 1984). Furthermore, because astronomy teaching involves space-time and movement, along with the interference of climate, light pollution, fields of view and other factors, schools face significant teaching limitations (Hsiung, 1995; Huang, 1995; Wang, 2006; Wu & Lin, 2006).

Secondly, some researchers have pointed out that the professional development of elementary school teachers has long ignored astronomy education. If pre-service teachers fail to receive a complete astronomy education during their training, they will lack understanding and in-depth knowledge of astronomical concepts. Consequently, in the real world of teaching, teachers often transfer hidden astronomical misconceptions to students, with the implication that the students are unable to develop accurate astronomical concepts of their own (Akerson, 2005; Brunsell & Marcks, 2005). Su and Huang (2002) found that misconceptions of elementary school teachers in central Taiwan include: (1) the reason
for the changes in the moon phase is that the earth covers the incidence light from the sun; (2) a comet is self-luminous; (3) shooting stars emit their own light and heat; (4) Mars has no atmosphere; and (5) Venus has satellites.

Therefore, many researchers and academic institutions promote the teaching perceptions of current teachers through in-service training (Akerson, 2005; Lai, 2006; Slater, Carpenter, & Safko, 1996; Slater, Safko, & Carpenter, 1999). Akerson (2005) explored the teaching process of an astronomy unit for three in-service teachers with incomplete content knowledge. The results showed that through the self-reflection and professional development of elementary school teachers and with the inspiration of experienced teachers, the in-service teachers gradually improved their interaction with elementary school students and enhanced their understanding of astronomical concepts.

Slater, Carpenter, and Safko (1996) planned and designed an in-service training curriculum featuring constructive ideas for high school and elementary school teachers. The main features of the curriculum include the construction of idea orientation, the adoption of research inquiry orientation, hands-on instruction and class discussion. The themes mainly include the nature of science, astronomical observation, field trips and learning in astronomical observatories, Kepler's law, the moon phase changes, astronomical telescopes, the solar system, planets, comets, shooting stars, space probes, the evolution of fixed stars, the Milky Way and the universe, astronomical special reports, astronomy teaching strategies, etc. Slater, Safko, and Carpenter (1999) implemented an astronomical teaching attitude on a teaching confidence scale within a training curriculum for high school and elementary school teachers. The results showed that both the initial post-test scores and the post-test scores after four years were significantly higher than those of the pre-test scores. Additionally, when comparing the post-test scores after four years with the initial post-test scores, there were no changes or decreases. The research results show that astronomy training curriculum for high and elementary school teachers which is oriented with constructive ideas validity promotes positive attitudes toward astronomy and increases teaching confidence.

Considering in-service training for elementary school teachers, Lai (2006) studied teaching practice through astronomical experiments. In the experiments, the teacher produced: (1) a gnomon and equatorial sundial, (2) a constellation disk with three-dimensional constellation, (3) a solar observation instrument, (4) a horizontal sundial, (5) a Mars simulation model, (6) a moon phase model, and (7) a comet and satellite operational model. The research results show that the astronomy practices and teaching abilities of the participating elementary school teachers achieved significant improvements and these teachers deeply experienced these astronomy topics in the science and technology section of the nine-year curriculum. This is conducive to the implementation of the Grade 1-9 curriculum introduced by the Ministry of Education. Furthermore, these students who have been involved in these teaching studies have benefited from the improvement in knowledge and abilities learned from the astronomy practices taught by their teachers. They now have more opportunities to gain access to astronomical learning and exploration, which can enrich the scientific and technological knowledge. At the same time, multi-dimensional teaching activity design can cultivate active exploration abilities, organizational practice abilities, problem-solving skills, teamwork, expression and communication, the application of technology information, and creativity.

In addition, included in the wave of science education reform, visits to and personal exploration and experiences in outside scientific venues, such as planetaria and museums, are some of the most valuable teaching methods (Fan, 2002, 2003; Fan & Fan, 2002; Kelly, Stetson, & Powell-Mikel, 2002; Knapp, 2000; Lai & Peng, 2014; Lai & Wu, 2005; Pugh & Bergin, 2005; Rennie & McClafferty, 1996; Summers,
2004; Talboys, 1996; Yu, 1998). Rennie and McClafferty (1996) pointed out that the interactive exhibits of science museums can promote the scientific understanding of visitors outside the school environment and it is worthwhile to promote experiential learning and visiting sites outside of schools. Hofstein and Rosenfeld (1996) pointed out that scientific venues are good places to promote and enhance the formal learning of schools. The unified implementation of formal learning at schools and outside scientific venues can create better scientific learning and can be important for educational development. Fan and Fan (2002) stated that scientific venues (such as a planetarium) offer material objects that encourage students to conduct active learning using sensual experiences to acquire first-hand data. By complimenting school textbooks that mainly focus on words and adopt passive learning, active learning can inspire students from different perspectives. Therefore, if we can appropriately design active learning topics and materials in advance, we can strengthen the teaching provided by school curriculum, cultivate cross-subject skills for students, encourage students to apply mental abilities, and inspire creativity.

However, Talboys (1996) pointed out that the benefits of outside scientific venues do not happen spontaneously when teachers just take students to a scientific venue. Instead, the learning is enhanced if there is prudent planning by teachers in advance. Fan (2003) emphasized that before taking students to a venue, teachers should become familiar with the environmental facilities, notices and related resources in advance. This can promote better teaching benefits when visiting outside venues. Summers (2004) emphasized that in order to enhance the learning validity of outside scientific venues, teachers should make appropriate preparations before a visit, adopt focused questions to attract the attention of students and conduct meaningful learning through questions that can lead the students through exhibits during their visit.

Fan (2002) pointed out that astronomy education can combine astronomical resources and teaching communities. Potential astronomy education strategies include: (1) when schools implement an outside visit in the curriculum, they should encourage teachers to conduct a pre-visit field trip to a planetarium or other scientific venue; (2) a pre-visit field trip can give teachers a better understanding of the venue, which is conducive to designing outside visit curriculum activities; (3) teachers should be encouraged to take part in astronomy learning camps to enable them to have a deeper understanding of astronomical knowledge and observation skills; (4) astronomical associations should be established inside schools, in which planetaria assist key students to gain access so as to promote astronomical knowledge and observation; (5) teachers and students should be encouraged to take part in voluntary activities in their local planetarium as such activities not only provide a sense of self-achievement but also improve teaching applications and expand the promotion of astronomy education through astronomical services.

Lai and Wu (2005) studied astronomical practices and teaching in planetaria. Their research results show that: (1) visits to a planetarium are conducive to enhancing the curiosity and exploration of children towards astronomical knowledge. According to feedback from students, 76% of students hoped to visit a planetarium again; this helps children establish lifelong astronomy learning; (2) after participating in outdoor astronomy observations at night, feedback from school students indicated that night observation is very successful and promotes the development of students’ cognition, attitudes and skills. Outdoor astronomy observations at night using telescopes fully satisfy students’ curiosity. Such observations also give a sense of accomplishment to school teachers and are help school students establish the constant dynamics of active observation.

In summary, students can enjoy high levels of interest through the exploration of astronomy. However, a deep understanding of astronomical concepts can be strongly affected by limitations of spatial concepts, orientation perception, reasoning ability and other factors. Therefore, curriculum can make use
of the resources of informal scientific venues to fill the gaps in classroom teaching so as to improve the scientific literacy of students and cultivate their interest in lifelong astronomy learning. Consequently, questions arise as to how to promote the astronomy knowledge and skills of teachers, how to encourage teachers to make use of the resources of local planetaria and how to promote the learning validity of astronomy education and teaching. Consequently, the professional development of teachers is an important part of promoting astronomy education.

**METHODOLOGY**

With the advances in scientific civilization and the development of the knowledge economy, the professional development of elementary school teachers has received great attention. Currently, more and more elementary school teachers are returning to colleges and research institutions to pursue further in-service training and postgraduate studies. The in-service astronomical teaching activities in this study are part of a postgraduate course at the National Taipei University of Education. All the graduate students are in-service elementary school teachers. Regarding the background of the researchers, there are two types: (1) graduates who majored in natural science and (2) current natural science teachers at elementary schools.

As for the methodology, this study adopted the case study method. In total, 27 elementary school teachers were involved. The main content of the in-service astronomy training for elementary school teachers included the astronomical scientific revolution, the solar system, planets, stars, space probes, visit to astronomical science museums, etc. The 27 elementary school teachers were first classified into eight groups in order to conduct group learning strategies and hand in group work and a special astronomical report at the end of the semester. The sources of research data, based on Clandinin and Connelly (2000), consisted of the teachers’ stories, autobiographies, diaries, notes made at work, letters, dialogues, research interviews, family stories and the stories from other relatives, documents, photos/memory boxes, life experiences, etc. All these can be used as sources for data collection. The sources for the data collection and analysis in this study consisted of the group work completed by the elementary teachers, group reports, learning portfolio data, etc. The data encoding is shown as Italian body font. After collecting the acquired data, the triangulation and cross-case conclusion analysis were made by three science education researchers (Bogdan & Biklen, 1982; Guba & Lincoln, 1999; Patton, 1999; Silverman, 1993, 2000), an a validity examination was completed to confirm the reliability and consistency of the data analysis and discoveries.

Secondly, regarding the narrative illustration of in-service training and the astronomical learning process of elementary school teachers, the teachers first described the group learning process and conducted a complete narrative analysis of their professional development with regards to their astronomical knowledge and abilities. After an exploration of the group learning process, the teachers answers the questions posed by this study (learning attitude, astronomy concepts, astronomical teaching confidence) to enable complete narrative analysis and the illustration of results.

**RESULTS AND DISCUSSION**

To explore the astronomical learning process in the in-service astronomy training of elementary school teachers, this study adopted the learning portfolios of groups A and B as examples when conducting narrative analysis of their professional development.
I. Astronomical In-service Training of Group A

There were four members in group A: Dorothy, Miranda, Charlize, and Veronica. Regarding her “feelings about astronomical studies”, Veronica stated that, “For most of us, the sense of “astronomy” is of a vast and endless universe, and a mysterious and unknown space-time. Stories woven by the constellations from the Eastern and Western world are rich and interesting. These stories more intriguing and arouse people’s curiosity. When space probes explore an area out of our reach, expectations arise spontaneously. The legends that talk about the astronomical scope of humanity are very vivid. These are my feelings about astronomy. Looking back the process of learning about natural science, astronomy was absorbed by physics and chemistry. I took some breaks in biology courses and was seldom deeply touched by the geosciences. I even took several tests to force myself to memorize some of the knowledge from this field. However, I felt like it is a rigid and difficult subject and did not have much interest. I was afraid of taking a compulsory course in the first year of my postgraduate studies. I was worried about the results and of being hurt when exploring an unfamiliar field.” From the feedback, we can conclude just appreciating the beauty of the starry sky is easy and burden free. However, when delving deeper into the subject of astronomy, it can seem abstruse and difficult to understand.

Dorothy shared similar feelings, stating that, “Regarding astronomy, it is still very deep. However, the beauty of the night sky and the strange astronomical phases always encourage me to deepen my knowledge of the subject. Both indoor introductory courses and outdoor visits are valuable chances to enhance my spiritual level, enabling me to know that there is always unknown knowledge that I need to obtain. Newton said, “I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now ... or prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.” This is so true and really appropriate. Even great men are so humble. We can do nothing but follow.” Dorothy’s statement shows that astronomy is deep and profound. Moreover, the night and stars arouse curiosity and are easy to approach.

In addition, after completing teaching activities during the in-service training in this study, both Veronica and Dorothy witnessed significant changes in their feelings. Veronicas pointed out that: “Time really flies. One semester has already flown by. During the learning process, I found that I became interested in Geoscience and I got rid of my distrust and fear of this subject. This was my biggest gain. My performance in the Geoscience is probably fine. I still need to pay attention to the guidance of my geosciences teacher though. This teacher enlightened and empowered me, giving me more confidence in my learning.” This statement shows that even though she was primary school teacher, she was still deeply moved in her exploration new scientific knowledge, because the teaching activities satisfied her needs.

Dorothy said: "This course is gradual and I am really impressed by the detailed explanation the teacher gives in every class. My interest in Geoscience has really grown, especially as it is not like physics or chemistry, where experiments are necessary in order to understand a concept and arithmetic is needed for verification. This course includes the reading of graphs and requires field trips, which are closer to our daily lives. Looking at the sun and the starry sky, for example, we can feel and experience them, which is easy for me to digest and get close to. The teachers offer guidance and a brief introduction to arouse our interests. The final goal is to generate proactive learning. Based on these examples, in our teaching, we need to arrange our courses regularly, have well-prepared lessons and appropriate and attractive teaching tools. We need to apply theories to our practices. In doing so, a lot of courses can be very exciting.” The above statement shows in-service training can improve learning attitudes towards astronomy concepts and astronomical learning. Moreover, the training strengthened Dorothy’s understanding of pedagogical content knowledge (PCK) and offered insights into the arrangement of
astronomy teaching activities, teaching strategies and the usage of the teaching environment and equipment. These teachers were convinced that well-prepared courses can benefit students. Dorothy’s feedback on the teaching and understanding of PCK show that in-service training provides good insight into astronomy and provided inspiration for future teaching.

The theme of the special astronomical report for group A was “the scientific achievements and contributions of Newton and Galileo”. Four members from this group worked very hard and successfully introduced the scientific achievements and contributions of Newton and Galileo to the rest of the class. These four members demonstrated considerable respect and appreciation of the ideas of Newton and Galileo. Charlize said: "Among all scientists, I admire Galileo the most. He was not arrogant because of his numerous discoveries and was always patient, offering detailed explanations when encountering inquiries and questions from children (quoted from A Brief History of Everything), which is a good example and worthy of deep consideration.” Veronica also said, “During the preparatory process of the astronomic report, I compiled numerous inventions and discoveries made by astronomy scientists. I appreciated the scientific stories and tried to understand the psychological process of the scientists when exploring astronomy from the perspective of a spectator. The impact and transformation from their difficulties and hardship, desires and contradictions are as vast as the universe, and as hard to touch.”

Dorothy spared no admiration for Newton and Galileo's achievements. Dorothy said, “During the collection of information, it was easy to know these two great men who are scientists, astronomers and physicists. Let us start with Galileo; he was bold enough to challenge theoretical authorities and to conduct experiments with real practice. Of course, during his era, he could not deny the supreme theocratic theories, but he sowed the seeds of practical demonstration in peoples' minds. Subsequently, Newton stood on Galileo's shoulders, leaving a good name forever. There might have been some deficiencies in Newton's scientific achievements, which were revised by Einstein. However, his accomplishments in mechanics, mathematics, optics and stars and the invention of the reflective telescope enabled humans to make giant steps of progress.”

The learning performance of group A also confirmed that for learners who are keen to reconstruct knowledge and concepts, the concepts of certain scholars offer much more validity than just the dissemination of information from teachers to students. During the discussion on the astronomical scientific revolution, the researcher mainly emphasized the key position of Newton and Galileo in this revolution. However, in order to complete the special astronomical report, team members worked very hard to collect, arrange and analyze data and they handed in a wonderful report. They demonstrated very clear perceptions and an understanding of the astronomical development during the era of Newton and Galileo and they were very skillful in collecting, arranging, analyzing and disseminating their findings. At the same time, they showed considerable respect towards the contributions of Newton and Galileo.

Secondly, the four members of group A listed the key points of the brief history of Newton and Galileo and the main aspects of their scientific achievements, including: (1) the astronomical exploration achievements by Galileo: Using a telescope to conduct celestial observations, he found that the Milky Way is a collection of stars instead of gas. He observed sunspots and the solar revolution, the satellites of Jupiter and the phase changes of Venus, the mountains and topography of the lunar surface and offered support to verify the heliocentric theory of Copernicus (the heliocentric theory); (2) the astronomical exploration achievements of Newton: Using mathematics to calculate the movement and orbits of the planets, he explored the motion and the tides of the moon, the precession of the equinox, the shape of the earth and the motions of comets. He even verified the existence of Neptune. Although this study did not conduct tests on the research objects in terms of the astronomical learning validity and did not adopt the
results of pre- and post-tests to describe the astronomical concept performance of the four members of group A, the accuracy and richness of the report, their comfort in delivering the report and the affirmation from the other groups clearly illustrate that the four members of group A significantly mastered the perceptions and understanding of astronomical developments during the era of Newton and Galileo and have a clear understanding of the astronomical exploration achievements of Newton and Galileo. Therefore, the four members of the group performed very well in terms of the report on the brief history and scientific achievements of Newton and Galileo. This fully illustrates that through the implementation of the astronomy teaching activities and special astronomical reports, the astronomical concepts of the four members of group A have been largely promoted.

In addition, Miranda also had deep feelings about the special astronomical report. Miranda pointed out that: “Regarding the feedback on the astronomical report, we demonstrated full cooperation among the team members, strengthened our emotional bonds, fully exerted the spirit of teamwork and ensured more time for preparation and discussion.” Their cultivation of team bonds and enhanced performance prove that with long and sufficient preparation, the team performed well. Moreover, group A’s received applause and cheers from the rest of the class.

Regarding the teaching visit to a planetarium, they all agreed that they learned a lot and praised the volunteer guide at the planetarium. Dorothy said: “We were lucky enough to encounter an enthusiastic guide. Because we had no preference towards the themes of the planetarium, she introduced the starry sky based on China and Western astrological signs. We were impressed by her overwhelming enthusiasm. The original 40 minute narrative guide was expanded to 90 minutes. My favorite place in the planetarium is the starry sky classroom.” Charlize also said, “When visiting the planetarium, the female volunteer gave a passionate narration about the ancient starry sky, the meanings of its appearance and the time of its appearance. We were impressed by the intelligence of the ancient ancestors who knew everything. When we visit the planetarium next time, we will definitely understand how to appreciate the layout and the meanings in the planetarium.”

The feedback from Dorothy and Charlize also confirm the perspectives of Fan (2002, 2003), Fan and Fan (2002), Hofstein and Rosenfeld (1996), Kelly, Stetson, and Powell-Mikel (2002), Knapp (2000), Pugh and Bergin (2005), Rennie and McClafferty (1996), Summers (2004) and Talboys (1996). The resources and educational services of astronomical scientific venues indeed create a joyful and pleasant learning environment so as to offer visitors the most direct self-learning and scientific exploration experience. Therefore, the exhibits in astronomical scientific venues and their volunteers not only left a deep impression on the elementary school teachers, but have also made them want re-visit and learn more at such venues in the future.

In addition, talking about the entire in-service astronomical training, Charlize also provided thought-provoking feedback: “As an ancient Chinese saying goes, ‘To see the world from a grain of sand’, this course certainly empowers us with the unknown secrets of the universe. With the invention of scientific tools, we can observe the sky, the winding and curling galaxy and feel the insignificance of humans. Are the great men still alive? The records of civilization empower the future generation to progress without repeating the footsteps of their predecessors.” The saying quoted by Charlize seems to agree with Dorothy’s quotation from Newton, “I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now ... or prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.” In other words, in terms of professional development courses, this course offers elementary school teachers the chance gain reinforcement and professional growth in relation to the theoretical and practical experiences of astronomy education.
II. Astronomical In-service Training of Group B

There were three members in group B, namely Jonathan, Anastacia, and Elizabeth. Discussing feedback and opinions about astronomy, Elizabeth said, “Since I was a child, I had no interest in the changes in the celestial sky. When I was in junior high school, in order to explain why there are differences in the four seasons, the teacher used a basketball and a water tank to illustrate the position of the sun for each of the four seasons. After that, I still did not fully understand the reasons. Therefore, I could not make a connection with the sky and stars. Afterwards, to retain astronomical knowledge, I forced myself to remember what I had learnt. What has really inspired me and aroused my interest in astronomy has been visiting the star observation room at the planetarium. Probably, it will be hard to forget the memory of lying on the ground at Cingtiangang and observing the stars and it will also be hard to forget the numerous stars we counted on the Ken-Ting beach. At the very beginning, I was confused about how to count the stars, but the teachers from the planetarium randomly pointed out stars and found Altair, Vega and Deneb of Cygnus from the Summer Triangle, refreshing my astronomical knowledge. We can learn a lot from the narration and the astronomical knowledge given by the planetarium, but personally speaking, I prefer experience and I can easily fall in love with it.”

Elizabeth's ideas fully reflect the dilemma of knowledge and concept teaching in traditional schools. When teaching astronomical knowledge, it is hard to acquire the acceptance and admiration of school children as they have to temporarily store astronomical knowledge through memories and recitation. However, when Elizabeth took on the position as a teacher and attended the observation training on the sky at night, she fell in love with astronomy and celestial observation. This agrees with the research results of Lai and Wu (2005), who pointed out, “A successful night star observation experience certainly enhances the development of students’ perceptions, attitudes and skills and is conducive to establishing the motives for active star observation.” Elizabeth further pointed out that although she was also impressed and learned a lot from the splendid narration given in the star lessons and at the planetarium, she still felt that personal observation was the real reason why she fell in love with astronomy.

The theme of the astronomical special report for group B was, “promoting education on space probes and astronomical knowledge”. The three members worked very hard, made a solid preparation and splendidly illustrated the development and status quo of space probes. They also explained how to promote educational activities by sharing strategies with the other groups. The key points of the report given by these three members are as follows: (1) the development and status quo of space probes: the manmade Sputnik satellite made by the Soviets in 1957, the space competition between the Soviet Union and the United States, the US Apollo moon landing plan and the new space competition among the US, Europe, Japan and Mainland China; (2) The practices and strategies used when promoting astronomy education: the importance and promotional methods in astronomy education, the types of promotional astronomical activities (including astronomical association activities, research activities, teaching and learning activities between parents and children, summer astronomy camp, the research and development of astronomy textbooks and the sharing of astronomical teaching resources), national astronomical associations (including The Astronomical Society of the Republic of China (Taiwan), Taipei Astronomical Society, Taichung Astronomical Society, Chiayi Astronomical Association, Tainan Astronomical Society, Kaohsiung Astronomical Society, and Taiwan Family Star Organization), etc. Taiwan had 28 different promotional programs and activities for the 2009 Global Astronomy Year (four hundred year anniversary of the start of Galileo’s observations).

The report given by group B covered two themes. The first one was concerned with the development and status quo of space probes. This theme was rich and deep and offered a complete
overview of space probes. The second theme reported on the practices and strategies of promotional astronomy education, winning affirmation from the other groups. The group offered many valuable resources and strategies for the promotion of elementary school astronomy education to the other groups. Therefore, their result fully illustrate that, through the implementation of astronomy teaching activities and special astronomical reports, the growth of astronomical concepts suggested by the three members of group B can be promoted. Moreover, educational theories on astronomy and the development of practical knowledge can be strengthened.

In addition, discussing preparation of the special astronomical reports, Jonathan also expressed the same concerns as Elizabeth. Jonathan said, "In preparing the astronomical report, we accumulated an enormous amount of related data, which required the ability to choose relatively important information. We cannot consider the perception of astronomical knowledge in elementary school teaching as the main teaching objective. Instead, we should prioritize skill, attitudes and design. There is an enormous amount of astronomical knowledge that is available. It is much more suitable to place more emphasis on skills and attitudes in terms of the design of science courses for elementary school students."

The feedback from Jonathan fully reflects the status quo of the online world in today’s knowledge economy. There is considerable information online or in libraries. It is extremely important to choose the right information and the key is to search, extract, arrange, analyze and illustrate the information and conduct meaningful teaching afterwards. Therefore, Jonathan placed more emphasis on the training of observational skills to illustrate the concepts and strategies of astronomy education and the cultivation of attitudes to show respect and appreciation of the sky in elementary schools.

Regarding the teaching visit at the planetarium, it happened to be a special 40 year anniversary exhibition of the first moon landing with a display of a meteorite weighing more than 1,000 kgs. Anastacia said "People always say that 'seeing is believing', and regarding the meteorite in the planetarium, there was a real sense of experiencing this. When I described the meteorite to the rest of my family, their dumbfounded look was unforgettable." The feedback from Anastacia fully illustrates the importance of the exhibition functions of planetaria. Ordinary schools cannot offer similar teaching resources, and special exhibits provide opportunities for learners to gain access to such resources and experience these kinds of activities. The exhibit at the planetarium had an interactive influence on Anastacia and her family. As a consequence, when promoting astronomy education, we should take more children to planetaria, making planetaria a second classroom for students. In addition, when arranging a teaching visit to a planetarium for elementary school teachers, it is better to ensure appropriate planning in advance to fully illustrate the teaching validity. The selection of teaching strategies can make use of the outside school teaching model proposed by Lai and Peng (2014) so as to guide students’ learning about a planetarium, including: (1) pre-visit activities, (2) field visit learning in the planetarium, and (3) post-visit activities. The experiences and self-participation of students can ensure they enjoy the completion of astronomical explorative studies in a planetarium.

In addition, when discussing the learning effectiveness of her group’s special astronomical report and astronomical units, Anastacia said, “After having listened to the other astronomical reports from the classmates, I felt like I was traveling in time, from ancient times to modern times. I could recognize the history of the astronomy scientists and had a deeper understanding of the eight planets in the solar system. In the past, I knew very little about astronomy. When I was assigned to teach astronomy in schools, all I could do is follow the textbooks and I could not explain the topic deeply enough to enable students to learn about astrology properly. Although I only added some astronomical knowledge, I felt intimidated when teaching astronomy. I now know how to search for astronomical data, how to attend an
amateur astronomical association and even which symposiums I can attend to broaden my horizons. It is the planetarium that broadens our horizons.” The feedback from Anastacia is similar to that of Peter from group C who had a positive attitude towards the report content and performance of each group and deeply felt that each group was successful. Anastacia further illustrated that through class teaching, the visit to the planetarium and special reports, she gained a deeper perception and understanding of the mastery of astronomical knowledge and concepts, the application of astronomy teaching resources and astronomical associations, which are conducive to her future teaching of astronomy. This fully illustrates that Anastacia enjoyed the growth in her understanding of CK (content knowledge) and PCK (pedagogical content knowledge). Similarly, Jonathan also said, “The courses throughout the whole semester, in terms of deep astronomy learning, have enabled the students to enjoy fruitful achievements and have more confidence in their teaching.” The feedback from Jonathan also shows that the astronomy course played an important role in promoting participants’ professional growth in astronomy and the validity of in-service training.

III. Explorative Results of the Group Narrative

Based on observation and analysis of the learning processes of groups A and B, this study summarizes the following points based on the three research questions (astronomical learning attitudes, astronomical learning performance, and astronomical teaching confidence of elementary school teachers). The descriptive exploration of this study is summarized as below.

(1). The astronomical learning attitudes of elementary school teachers: Based on the feedback from Veronica and Dorothy, before the implementation of the astronomical teaching activities, like others, they only appreciated the starry sky from a distance, believing that it was very beautiful, romantic and pleasant. They thought of the study of astronomy as being very abstruse and difficult. Fortunately, after the implementation of the astronomical teaching activities, their astronomical learning attitudes were significantly promoted and they were happy to get in touch with and explore astronomy.

(2). Astronomical learning performance of elementary school teachers: The feedback from Elizabeth fully reflected the problem of knowledge and concept learning in traditional schools. When teaching astronomical knowledge, it is hard to make children accept and love the subject. This is because they have to temporarily store astronomical knowledge through memory and recitation. Fortunately, after the implementation of astronomical teaching activities, the feedback from Veronicas, Dorothy and Anastacia fully illustrates the growth of astronomical concepts and that the students enjoyed learning. Secondly, the feedback from others in the groups also illustrates that, in addition to an increase in the understanding of astronomical concepts, they also respected and appreciated ancient scientists and enjoyed significant improvements in the accumulation and expression of their abilities. Furthermore, the completion of special astronomical reports by groups A and B also inform us that the implementation of astronomy teaching activities and special astronomical reports improved the growth of the elementary school teachers’ astronomical concepts.

(3). The astronomical teaching confidence of elementary school teachers: Through the implementation of astronomy teaching activities and from the feedback from Dorothy, Anastacia and Jonathan, the understanding of the PCK (pedagogical content knowledge) of the elementary school teachers was enhanced and their teaching confidence grew significantly. Elementary school teachers were able to fully master the astronomy teaching points and further understand how to make use of astronomy educational resources (including astronomical scientific venues and national astronomical associations) to promote the astronomical learning of their students.
CONCLUSION

After in-service teaching training sessions, class teaching, planetarium visits and special astronomical reports, the research results of this study show that the elementary school teachers who took part gained considerable achievements. Thus, these training sessions are conducive to promoting the understanding of astronomical concepts and the future teaching of astronomical units. The key research results of this study consisted of: (1) the shift in the astronomical learning attitudes of elementary school teachers: they were more willing to actively get in touch with and explore the subject of astronomy; (2) the growth in the astronomical concepts of elementary school teachers: there was an increase in the understanding of astronomical concepts, enhanced respect and praise towards previous astronomy scholars and a significant growth in the accumulation of astronomical information and expression abilities; (3) the growth in confidence when teaching astronomy: the participants were able to master the key points and strategies of astronomical teaching in elementary schools. They understood how to make use of astronomical educational resources to assist in teaching astronomy to students. Furthermore, the teachers fully recognized the values and functions of planetaria resources and were willing to use planetaria as a second classroom. They understood how to make use of the unique exhibits and environment of a planetarium to encourage students to take interest in our mysterious universe. Finally, to promote the practice of elementary school teachers, this study believes that we should give top priority to astronomical practices, personal experiences and the cultivation of the attitudes of those students who are willing to get close to astronomy and explore an astrological inquiry-based approach. Using more implementation practices and astronomical observations, we can enhance the interests of students towards astronomical studies.

REFERENCES

example. Science Education Monthly, 255, 12-23.


