THE TENSIONS OF BRIDGING INDIGENOUS CULTURE AND SCHOOL SCIENCE THROUGH ETHNIC EXPERIMENTAL EDUCATION IN AN ISLAND COMMUNITY IN TAIWAN

by

MU-YIN LIN

(Under the Direction of Under the Direction of David Jackson and Deborah Tippins)

ABSTRACT

Globally, Indigenous people are marginalized and underrepresented in STEM professional fields in settler societies. For scholars, educators, policymakers, and the public, the most important thing is that every student has access to an equitable education. Developing curricula that are more relevant for all students and promoting meaningful science learning are important goals in science education today. Even though the value of Indigenous Knowledge (IK) and the integration of IK into the curriculum are gradually being recognized in science education, Indigenous and culturally based knowledge are not treated with equal merit as Western science. They are only accessories of school science that can be explained in Western science terms. However, science learning can happen not only in science classes.

Experiment Education provides an opportunity to break out of the original curriculum structure. The passage of three-type acts of experimental education in 2014 gave Indigenous education an opportunity to reform. The core of the Ethnic Education curriculum is the Indigenous language and culture. It is integrated with other academic disciplines, and it is

designed, planned, and co-taught by interdisciplinary teachers. In Ethnic Experimental Education, students have the opportunity to learn science and conduct scientific inquiry in the context of learning cultural practices and knowledge of place.

To connect students' lifeworlds with the culture of school science, this participatory action research took place in an Indigenous high school in an island community in Taiwan. A science education researcher works with teachers and community members to seek what role science education can play in a culture-based Ethnic Experimental Education class.

The purpose of this study is to share the units of the integration of Western science knowledge with traditional knowledge in Ethnic Experimental Education curriculum and explore the experience of the teachers and researchers working together to design, develop, and evaluate the Ethnic Experimental Education curriculum. In addition, the study identifies the tensions that participants experienced in developing and implementing the Ethnic Experimental Education curriculum. A premise of the study is that Indigenous students should not be required to lessen their cultural identity in order to learn science.

INDEX WORDS: science education, Indigenous education, Ethnic Education, experimental education, culturally relevant pedagogy, participatory action research

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CHAPTER 1

INTRODUCTION AND RATIONALE

Introduction

In 2016, the President of Taiwan, Tsai Ing-wen, on behalf of the government, apologized to the Indigenous people of Taiwan for the "four centuries of pain and mistreatment [they] have endured." People of Indigenous Austronesian descent hunted and farmed Taiwan for thousands of years before the Dutch, the Chinese, and the Japanese. Taiwanese Indigenous people originally lived their own lives, with their languages, cultures, customs, and area of life. Then, without their consent, another external group of people came to the island, depriving the original group of everything, and letting them be displaced in the most familiar land, become outsiders, non-mainstream, and marginal. Although Indigenous people worldwide might have different social cultures, their historical development has been similar in many crucial ways. They have been ruled by powerful other ethnic groups, had their land and economic resources exploited, suffered separation or extinction, and were forced to receive assimilation education. Ethnic language and culture have gradually disappeared among many Indigenous populations.

American Indians and Alaskan Natives make up 1.2% of the total population of the United States; they have the lowest university enrollment and graduation rates of any group in the United States (J. Chang, 2015). They represent only 0.5% of students nationwide in science, technology, engineering, and mathematics (STEM) fields. Similarly, they are underrepresented as professionals in STEM careers and comprise only 0.4% of all engineering bachelor's degree

recipients, 0.3% of the engineering workforce, and 0.1% of all engineering faculty. As in the United States, Indigenous people are marginalized and underrepresented in STEM professional fields in settler societies, such as Australia, New Zealand, Canada, and Taiwan. Indigenous Australians make up 2.8% of Australia's population but are estimated to be only 0.2% of the STEM workforce (Scholes, 2019). Like minorities and marginalized groups globally, the Indigenous People of Taiwan are a minority in the population and disadvantaged in education.

In Taiwan, 16 major Indigenous groups make up 2.48% of the population. In the 2020 academic year, the top three major fields of Indigenous students in colleges and universities were: Nursing and midwifery, Recreation sports and leisure management, and Hotel and catering, together accounting for 22.2% (Ministry of Education, 2021). The top three major fields for general students were: Electrical and electronic engineering, Business administration, and Foreign languages and literature, accounting for 18.0%. In addition, in the 2021 academic year, there were 20,995 Indigenous college students, 20.7% of them majored in the Hospitality, Tourism, and Personal Service fields. However, only 1.2% of Indigenous students choose to study Physics, Chemistry, Earth Sciences, and Life Sciences (Ministry of Education, 2022). It means only 0.6% of the total students studying in science fields were Indigenous students.

This chapter contains four sections: Rationale for the Study, Research Purpose and Questions, Context of the Study, and Subjectivity Statement. The context of the study includes general Information about Taiwan and its educational system.

Rationale for the Study

Why are there so few Indigenous students majoring in STEM fields? Why do so few among Indigenous populations continue to pursue science and engineering-related careers?

These issues are reflected in the larger culture in which we educate students globally. For example, many textbooks are mass-marketed, created for majority populations instead of responding in a culturally relevant way to any specific gender or ethnic group (Davison & Miller, 1998). This may lead to the marginalization of ideas and language that represent the culture of Indigenous people. Furthermore, when instruction only occurs within one cultural context, students from other cultures are placed at a learning disadvantage (Davison & Miller, 1998).

Under the current education system in Taiwan, Indigenous students and non-Indigenous students primarily use the same curricula with the same content, take the same courses, and accept the same assessment standards to evaluate their abilities and learning effectiveness. While Indigenous students receive the "knowledge" and "education" of the mainstream and achieve academic success, as defined by mainstream culture, they are losing the wisdom and worldview passed down from generation to generation. Indigenous Knowledge and cultural activities are also facing difficulties in inheritance (T. L. Lin et al., 2017). All of the above suggest that Indigenous students should not be required to lessen their cultural identity to learn science.

To protect the right of Indigenous People to train and educate the skilled people they require and facilitate the development of Indigenous Peoples, the Legislative Yuan of Taiwan passed the Education Act for Indigenous Peoples in 1998 stipulating that,

> Governments at all levels shall provide students at the preschool level and all stages of their 12-year Basic Education with opportunities to learn the languages, histories, science, and cultures of Indigenous peoples and may plan courses on Indigenous peoples' knowledge and Indigenous culture related learning activities in accordance with the characteristic features of the area where each preschool and school is located and their resources. (Education Act for Indigenous Peoples, Article 29, 1998).

In addition, governments shall plan and implement “Ethnic Education” in schools at senior secondary level and below in Indigenous peoples’ regions. Article 4 defines “Ethnic Education” as education based on the cultural characteristics of different Indigenous peoples, providing the knowledge that belongs to different Indigenous ethnicities to Indigenous students.

Under the influence of the principle of multicultural education and the Indigenous movement, the education system in Taiwan has gradually integrated the language and culture of Indigenous people into the school curriculum with the concept of cultural response. However, from the perspective of Indigenous education, the curriculum structure still has the problem of shallow and fragmented knowledge of Indigenous culture (R. H. Chang, 2020; Saidai Trovecahe, 2017). Indigenous culture-related content is also marginalized. The multicultural education practice of integrating Indigenous culture into the mainstream culture in the curriculum still fails to realize the ideal of Indigenous peoples as the main body of Indigenous education in the Education Act for Indigenous Peoples.

Research Purpose and Questions

One of the important goals in science education today is to make the curriculum more inclusive for all students such that Non-Western or Indigenous students can gain access to better opportunities that are meaningful and engage them in science learning. After promulgating the Enforcement Act for School-based Experimental Education in 2014, the Council of Indigenous Peoples and the National and K-12 Education Administration encouraged schools below the secondary school level to conduct experimental education for Indigenous peoples (Enforcement Act for School-based Experimental Education, 2014). To deepen the connotation of Ethnic

Education and establish educational models that meet the needs of Indigenous peoples, reforms need to emphasize the restructuring of schools and curricula in ways that align and sustain students' lifeworlds. The implementation of Ethnic Experimental Education gives science education a chance to reform.

Therefore, the purpose of the study is to seek what role science education can play, in school-based Ethnic Experimental Education curriculum development in Taiwan, to connect students' lifeworlds with the culture of school science. How do students learn scientific content knowledge and scientific inquiry from the inclusion of Indigenous Knowledge (IK) in Ethnic Experimental Education courses? This study aims to understand the varying conceptions of knowledge, worldview, and epistemology of Indigenous Tao people in Taiwan, an Indigenous group living on a remote island, Lanyu. This is central to understanding and practicing Culturally Responsive Teaching for Indigenous youth in ways that support the development of scientific knowledge, skills, and values as students navigate the transition between their Indigenous culture and school science culture.

In this study, the curriculum development process includes three phases: design of the curriculum, implementation of the curriculum, and students' lived experience with the curriculum. This study uses the terms: Planned Curriculum, Translated Curriculum, and Experienced Curriculum to describe these phases.

- **Planned curriculum**

  How do teachers and researchers collaborate to plan a role for science in ethnic curriculum development?

- **Translated curriculum**

  What happens when teachers implement the planned curriculum in a dialectical way?

- **Experienced curriculum**

  How do students experience and learn from the curriculum? What is the nature of students' learning experience?

Based on the lead researchers' personal experience, there is a high turnover rate of schoolteachers in Lanyu. In the 2020 academic year, about one-third of teachers were new to the school. It is hoped that the findings of this study can be used as a foundation and resource for developing teacher support systems and professional learning programs. Therefore, the first phase of the study will primarily focus on Planned Curriculum. The three sub-questions in this phase of the study are:

1. How do the participants design, develop, and evaluate the Ethnic Experimental Education curriculum?
2. How do participants integrate scientific knowledge and inquiry with Indigenous Knowledge into the Ethnic Experimental Education curriculum?
3. What tensions do participants experience in developing the Ethnic Experimental Education curriculum and culturally relevant lesson plans?

The second phase of the study focuses on the Translated curriculum phase and includes the following the sub-questions:

1. In what ways does the enacted curriculum reflect interactions between students, teachers, and the environment?
2. What tensions do teachers experience as they enact the planned curriculum for Ethnic Experimental Education classes?

The Experienced curriculum phase will focus on students' experience on-site and their feedback, response, and performance in the context of culturally relevant science lessons for Ethnic Experimental Education classes. The Experienced curriculum can support a deeper understanding of the significance of the Planned curriculum and Translated curriculum. The data and information collected from all three phases will be used as data source triangulation to enhance the study's quality, diversity, and validity. By identifying the tensions, the research team can work together to make a more purposeful action plan to move forward in the following year.

Context of the Study

General Information

Taiwan is a small island country beside China in East Asia, about 13,974 square miles with a 23.58 million population, located the seventeenth most densely populated country in the world. Fifty years of Japanese rule of Taiwan ended after the surrender of Japan concluded World War II in August 1945, and the territory was placed under the control of the Republic of China (ROC). Chinese Civil War II immediately followed. In 1949, the Communists gained control of mainland China, established the People's Republic of China (PRC), and the ruling power of the Republic of China (ROC) retreated to Taiwan. According to Taiwan's government statistics, about 96.4% of the Republic of China's population is of Han Chinese ethnicity, including Hoklo, Hakka, and other groups from mainland China. 1.1% of the population is Taiwanese new immigrants, and 2.48% of the population is Indigenous people, including 16 tribes officially listed by the Taiwan Government Information Office (Ministry of the Interior, 2021).

The Mandarin of the Republic of China is currently the most popular language among Taiwanese, with traditional characters. Since English education starts in third grade, English is the second largest language in addition to Mandarin. The use of other languages, according to the proportion of the population, include Minnan (Hokkien), Hakka, and Taiwanese Indigenous languages. About 49.3 % of the population practice exclusively traditional folk religions, 14% practice Buddhism, and 12.4 % practice Taoism, with 13.2% not identifying with any religion. Christian (including Roman Catholicism, Protestantism, and few Orthodox Christians) believers comprise 6.8%. The majority of the Indigenous population is Protestant or Roman Catholic.

Educational System Background

Nine-year (Grade 1-9) compulsory education was implemented in 1968 in Taiwan. After 2014, cooperating with the 12-year state education policy, the country implemented tuition-free programs in high schools (Vocational/General). In the 2020 academic year, there were 197,412 junior high school graduates, and 99.8% continued their high school education. Taiwan spent 4.76% of its GDP on education (Ministry of Education, 2020a). Teachers' starting salary is according to teachers' degrees, from bachelor's degrees $40,869 per year to doctoral degrees $52,265 per year. The current labor basic salary is $770 per month in Taiwan; compared with other professions, teaching is a more stable job with higher socioeconomic status. Net teaching time in high school is 560-720 hours, around the average of Organization for Economic Co-operation and Development (OECD) countries – 662 hours.

To ensure the admission and schooling opportunities of Indigenous students in secondary education and above, students who have completed compulsory education in middle school and intend to continue their high school or college education will be given a 10% bonus increase in their admission examinations. If they pass the Indigenous Languages Proficiency Test, they will

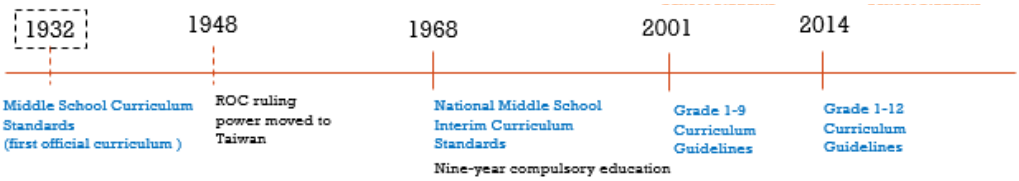
get a 35% points increase. This is based on Regulations Regarding Secured Admission for Indigenous Students and Government Scholarships for Indigenous People to Study Overseas.

However, Indigenous students entering urban high schools and universities with bonus points face challenges such as rural-urban disparities, maladjustment, and living constraints. They very often have to compromise their learning and life experiences and even end up having to quit school. Indigenous students' suspension and dropout rate in schools at all levels is higher than those of general students. (Ministry of Education, 2020b). In the 2017 academic year, the dropout rate of Indigenous students in high schools was 4.5%, versus 2.1% for general students. The withdrawal rate was 6.2% for Indigenous students and 1.9% for general students. In the 2018 academic year, 8.6% of Indigenous college students applied for suspension, and 12.8% withdrew from school. The top three reasons for leaving school are job needs, disagreement on aspirations and interests, and economic difficulties. Compensatory education policies do not fundamentally address the inequity of educational opportunity.

From 1948 until today, four official curricula have been implemented in Taiwan. The entrance examinations also changed as the curriculum changed. The latest Grade 1-12 curriculum guidelines were implemented in 2014. The learning focus includes "Learning performance" and "Learning content" in four stages: elementary education stage, middle school education stage, required course in the high school education stage, and elective courses in the high school education stage. Different from the curricula in the past, the "Natural Scientific Inquiry and Implementation" course was newly established in "Learning content," and biology, chemistry, physics, and Earth science became required courses in the general secondary school. This curriculum aims to develop students' ability to discover problems, recognize problems, solve problems, and communication skills in the material and lifeworld.

Figure 1. 1

National Curriculum reform of Taiwan



Subjectivity Statement

With our prior theoretical readings and life experiences, we have existing assumptions and things we want to see, which will affect our interpretation and analysis of data. Therefore, it is essential to acknowledge and draw on our prior experiences, and we should remain open enough to allow alternative perspectives to emerge (Sipe & Ghiso, 2004).

Because of my father's missionary calling, I grew up in Lanyu. It is the home of the Tao people. My father established a non-profit organization on the island in 1977, the Lan An Cultural and Educational Foundation. He started work in social welfare and education to empower the Indigenous community. Lanyu then became my first home. My brother and I were the only two students in the school who were not Indigenous. When ethnic languages were included in the formal education, I learned the Tao language and culture with my classmates at school.

Because of my bond to this land and its people, after obtaining a master's degree in Chemistry and a Secondary Natural Science Teacher's Certificate from National Taiwan University, I went back to Lanyu. I became a high school science teacher for two and a half years. I struggled to find a balance between teaching Western science and maintaining traditional culture under the competitive examination culture of Taiwan's education system. Even though I came to the United States to pursue a Ph.D. in science education, the school started developing

an Ethnic Experimental Education curriculum in 2017. I still connect with this school, working with teachers to develop curricula. In Ethnic Experimental Education courses, students learn the cultural and traditional knowledge of Indigenous Tao. This course provides a good context and environment for students to conduct scientific inquiry.

This study focuses on developing a Tao Culture-based curriculum and exploring how teachers and researchers can collaborate to plan a better role for science in Ethnic Experimental Education. The perspectives of both "insiders" and "outsiders" are needed to enable social scientists to gain a comprehensive view of social reality (Merton, 1972). I consider myself an insider and an outsider at the same time. I have an in-depth understanding of cultural norms and practices in the community from my growth, teaching, and life experience on the island.

During this study, some of the teachers were my previous colleagues and friends I worked with when I taught in that school. Some are new teachers who do not know me but might have heard of me. I first participated in the weekly class preparation meeting as a former natural science teacher and volunteer teacher and was treated as another teacher. However, I am also an outsider, bringing in different cultural practices, beliefs, and knowledge from my ethnic group, education, and the experience of studying and working outside of the community.

I am a researcher and a participant in this Participatory Action Research (PAR). The nature of this methodology requires researchers to find solutions and implement them with personal involvement. Potential biases cannot be avoided. PAR is different from traditional research in that it requires researchers to relinquish control and take the role of facilitator rather than the director of the process (Wadsworth, 2006). The researchers and participants identify an issue or situation that needs to be changed. Together they develop context-specific methods to facilitate this research/action/reflection iterative cycle. PAR embodies the process of

transformative reflexivity in which researchers and participants reflect on their understanding, negotiating the interpretation of data and information generated together. Their positionalities and subjectivities continuously change throughout the research process (Cahill, 2007; Kindon et al., 2007).

Summary and Preview

The researchers explored the possible role of science education in Ethnic Experimental Education through participating in the curriculum development of Ethnic Experimental Education. The study also discusses the tensions experienced by teachers in the process of developing and implementing Ethnic Experimental Education. This study is organized into five chapters. Chapter 1 is the introduction and rationale for the study. Chapter 2 is the review of literature. Chapter 3 describes the methodology. Chapter 4 includes findings overview of Ethnic Experimental Education curriculum and tensions. And finally, Chapter 5 includes discussion, and implications of the study.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

Abrams et al. (2014) described the explanations or stories of North American and Taiwanese Indigenous People and Western Modern Science about weather phenomena like wind, typhoons, and rainbows. Indigenous Amis people observe the direction of the wind and the dynamics of clouds to predict typhoons. They think the rainbow is a wall that can separate rain from good weather. In parallel Western Modern Science stories, even if they are different in linguistic characteristics, reporting similar genre, and ontological features, the observations of the natural phenomenon are the same. This echoes Baker (1996), "Indigenous science differs from 'Western science in its method and rigor, but not in its essential nature" (p. 18).

Science is a "way of knowing" and a "certain style of thinking and a certain way of asking questions and finding out answers" (Garroutte, 1999). Scientific methods are used in the framework of mainstream Western science – observation and experimental testing of hypotheses to understand the world around us. Native or Indigenous science allows for the possibility that there are multiple ways of obtaining knowledge – Indigenous Knowledge is not one concept, it is dynamic and evolving. Therefore, it is not intended to value one body of knowledge better than another, but rather to complement each other.

However, Indigenous Knowledge has been ignored and dismissed from science curricula for many years (Handayani et al., 2018) or included in textbooks just found in the form of

fragments. In the context of a Eurocentric backdrop, Indigenous Knowledge includes aspects that Western science cannot explain. George (1999) expresses in the form of her four categories of cultural knowledge (Keane, 2008, p. 590):

> Category 1: The cultural knowledge can be explained in Western science terms. For example, the practice of removing the astringency of plant seeds with water is explained in conventional science based on water solubility.
>
> Category 2: A conventional science explanation for the cultural knowledge seems likely but it is not yet available. For example, traditional medicines may have recognized pharmacological properties.
>
> Category 3: A conventional science link can be established but the underlying principles are different. The cultural knowledge states that sugars cause diabetes, whereas Western science claims sugars can worsen the condition.
>
> Category 4: The cultural knowledge cannot be explained in conventional science terms. For example, there is no conventional science explanation for the claim that spells cause lightning.

Using an entrenched Eurocentric system might cause problems to arise, because knowledge in categories 3 and 4 that are less acceptable to science teachers often convey different values and worldviews. For example, Tao people in Taiwan believe that eating other fish species in flying fish season will curse people and cause sickness. This cannot be explained by conventional science, but the meaning behind it is ecological balance and sustainability, which serves to revive other fish species during the flying fish season.

Indigenous and culturally based knowledge not only should be made accessible when studying content, it should be treated with equal merit (Gay, 2010). Indigenous Knowledge and practices are gaining more and more recognition of its value in education, because they provide Indigenous students with more culturally relevant or responsive curricula or pedagogies (Kim, 2015). The goal of reigniting tradition is for Indigenous students to gain access to Western science without losing or degrading their own cultural identity and epistemology.

The value of Indigenous Knowledge (IK) and integration of IK into the curriculum are gradually being recognized in science education. But most integration of IK in science curricula is still in the neo-colonial stage (Kim, 2015; Nhalevilo, 2013). In this stage, IK is included in the curriculum but is "decontextualized, expropriated and objectified" (Nhalevilo, 2013, p. 27). IK serves as a resource to clarify and validate Western science. Even if the Indigenous elements are added to the science curriculum, the ontology is still dominated by Western science, and cultural practices are only accessories to school science. In addition, it implicitly hints at the hegemony of Western science by only including the cultural knowledge that can be explained in Western science terms.

If the doors of science courses are too narrow to let IK in, then science education can try to enter Ethnic courses. Experimental Education provides an opportunity to break out of the original curriculum structure. In Ethnic Experimental Education, students have the opportunity to learn science in the context of learning cultural practices and knowledge of place.

This chapter is made up of two major parts, the review of literature and the theoretical framework of the study. The review of literature focuses on a brief history of Indigenous Science Education in Taiwan, Ethnic Education, Experimental Education and Ethnic Experimental Education, and an introduction of the secondary schools implementing Ethnic Experimental

Education in Taiwan. The second major part of the chapter is the theoretical framework of the study. This section also contains core elements of Indigenous Science Education/Pedagogy.

Indigenous Education in Taiwan

The characteristics of Taiwan's Indigenous education system can be divided into three periods: (1) the Indigenous tribal autonomy period, the Dutch and Spanish Formosa period, (2) the late Ming to the middle of the Qing Dynasty and (3) the late Qing Dynasty, the Japanese Rule and the Republic of China period (Z. L. Chen, 1997).

Education in Indigenous tribal autonomy period (before 1624)

Before the Age of discovery, in the period of Indigenous tribal autonomy, because of environmental isolation the tribes had minimal cultural exchanges. Indigenous youth learned their own culture from the Elders on their land, such as history, language, value, beliefs, worldviews, social system, traditional ecological knowledge, architectural art, living skills, taboos, life etiquette, etc. Teaching was carried out with the occurrence of events; education was implemented in daily life. It was very different from modern school education methods. The arrangement of the curriculum was indefinite; it was a holistic curriculum not divided into subjects.

Education in Dutch Formosa (1624-1662) and Spanish Formosa (1626-1642)

During the Age of discovery, beginning in 1624, the Dutch dominated the southwest of Taiwan. After two years, Spain occupied the north coast. Besides trade, the Dutch and Spanish colonial era's other key pillar was converting the natives to Christianity. At this time, the majority population of Taiwan were the Indigenous people, with some Han and a small number

of Japanese. Therefore, the Dutch took the cultivation of the Indigenous people as the primary goal of their efforts.

On May 26th, 1636, the first school had been recorded in written history, set up by the missionaries in the villages teaching the colonists' religion and other skills such as reading and writing (Campbell, 1903). The missionaries created a number of romanization schemes for the various Formosan languages, which is the first record in the history of a written language in Taiwan. In 1648, schools experimentally started teaching the Dutch language.

Education in Ming (Kingdom of Tungning) (1662- 1683) and Qing Dynasty (1683- 1895)

The education system in the Ming and early Qing Dynasty focused on Han culture education and reading classics such as Confucianism, also known as Ruism, the cultural mainstream thought and philosophy originating in ancient China, influenced and spread to other surrounding East Asian countries. All the eight-year-old Han Chinese were required to enter school. Although the educational system was different from the modern one, it was the beginning of national educational institutions. Strict legislation was adopted to control the Indigenous people, appease the obedient, and kill the rebellious. Because of the lack of appropriate policies, it ultimately failed. Education of Indigenous people was roughly the same as in the tribal autonomy period.

Starting from the 1885 Sino-French War, the purpose of education shifted from preparation for the imperial examination to cultivating trading and technical talents with a professional orientation, such as telecommunications and agriculture. The new western schools were established in 1887. Chinese and foreign scholars served as teachers and international students as teaching assistants. Subjects (courses) included foreign language (mainly in English),

geography, history, surveying, mathematics, physics, chemistry, and Mandarin Chinese (Ministry of Culture, 2009).

In the early Qing Dynasty, the Han people and the Indigenous people had conflicts due to land reclamation issues, and many Indigenous ethnic groups retreated to the deep mountains. In the beginning, Qing adopted racial segregation. In the middle of the Qing Dynasty, the government assimilated the Indigenous people with Confucianism education and Han culture.

Education under the Japanese Rule (1895 - 1945)

Japanese Colonial Education in Taiwan can be divided into four periods: 1896-1906 basic period, 1906-1918 extended period, 1918-1922 institutionalized period, and 1922-1945 Taiwanese – Japanese co-education, or educating both Japanese and Taiwanese students in the same environments (Tsurumi, 2013). Although there are differences in the division of periods by different scholars, the period 1918-1919 is considered the beginning of the establishment of modern education in Taiwan. In 1910, the Governor's Office of Taiwan clearly defined the six-year compulsory education regulations for 8-14-year-old Taiwanese students enrolled in school. In 1923, the first Primary Indigenous Educational Institution in Lanyu was established. However, schools were segregated according to Japanese, Taiwanese, and Indigenous people. Subjects were taught in Japanese schools such as Self-cultivation (civics), National language (Japanese), Arithmetic, Singing, Gymnastics, Japanese History, Japanese Geography, Science, and Drawing. Subjects in Taiwanese school were Self-cultivation (civics), Essay, Reading, Writing, Arithmetic, Singing, and Gymnastics.

In 1915, the first middle school for Taiwanese students was founded, teaching subjects such as the National language (Japanese), English, Geography, History, Mathematics, Physics, Chemistry, Natural History, Drawing, Gymnastics, Chinese, and Ethics. In 1943, to cooperate

with the emperor's people's movement, the Japanese government abolished the segregation of schools, and all of them were unified into a six-year national school. At that time, the universal compulsory education rate of 6–12-year-olds in Taiwan was as high as 70%, which reached the level of contemporary industrialized countries.

During the Japanese occupation period, the colonial government did not want the Taiwanese people to pursue higher education. Therefore, most of the higher education was only open to Japanese people. Under the colonial norms of the Governor's Office, the children of Taiwanese were not encouraged to study the humanities at the beginning and instead went to the normal schools and medical schools. It has made teachers and physicians a well-known profession in Taiwanese society and still affects education today. Because of teachers and physicians' high social status, it is very competitive to enter into those two types of schools.

The Japanese government adopted the assimilation and segregation policy of education for the Indigenous people. For example, Lanyu was ceded to Japan along with Taiwan's main island in 1895 until World War II. During this time, the Japanese government deemed it an ethnological research area, prohibiting outsiders from entering and excluding any outside influence that might drastically interfere with the Tao peoples' ways of life.

Indigenous Education in the Republic of China in Taiwan (1945 - Present)

Japanese rule of Taiwan ended after Japan's surrender concluded World War II in August 1945, and the territory was placed under the control of the Republic of China (ROC). Taiwan suddenly became a victorious country rather than a defeated country. Chinese Civil War II immediately followed, from 1946 – 1948, which marked a significant turning point in modern Chinese history, with the Communists gaining control of mainland China and establishing the

People's Republic of China (PRC) in 1948; and the ruling power of Republic of China (ROC) retreated to Taiwan. Therefore, Taiwan was in chaos between 1945 and 1948.

Indigenous Education of the Republic of China can be divided into four periods: assimilation period, germinating period, growth period, and enthusiasm period (S. Z. Zhou, 2007)

(1) Assimilation period (Before 1990)

The educational development of this period focused on the improvement of the lives of the Indigenous people. The education was still centered on the Han culture; "Ethnic Education" had not yet received attention. It was a chaotic stage. This implementation of the assimilation policy forced the Indigenous youth to enter school and accept a unified curriculum. The curriculum was divided into subjects, and the Indigenous culture was eliminated from the curriculum content; even the language was banned. It caused a severe loss to the Indigenous peoples' language and cultural heritage, with no written language system. Furthermore, Indigenous students entered the mainstream education system and generated many educational issues such as unsuitability, insufficient learning, low learning motivation, low academic achievement, and high dropout rates (Mou, 1996; Tang, 1998). In 1987, the "Declaration on the Rights of Indigenous Peoples in Taiwan," initiated by the Taiwan Association for the Promotion of Indigenous Peoples' Rights, demanded that the government of the Republic of China should grant Taiwan's aborigines the right to self-government and start a series of movements for Taiwan's aborigines. It included the Return Our Land Movement and allowed Romanized spellings of aboriginal names on official documents, offsetting the long-held policy of forcing a Han name on Indigenous people.

(2) Germinating period (1991-1995)

In 1991, teachers' training on the research and compilation of materials for Indigenous culture in various districts began. Education policy started to pay attention to and take action on Ethnic Education. In 1993, "Heritage & Culture Teaching Activities" was added to the elementary school curriculum standards, encouraging schools to develop curriculum with Indigenous culture characteristics, training Indigenous teachers, etc. In 2001, dialects were included in formal education, and the Indigenous language and culture formally entered the school curriculum.

(3) Growth period (1996 - 2000)

In 1996, to improve teaching quality, the Ministry of Education promoted the "Educational Priority Area Program." The *Education Act for Indigenous Peoples* was issued in 1998. It clearly states that the government shall protect Indigenous peoples' right to education, train and educate the skilled people they require, promote the Ethnic Education and culture, and fund the key Indigenous schools for educational resource centers and classrooms for Ethnic Education. At this stage, Indigenous schools were developed from place-based or school-based courses and focused on teaching ethnic culture and skills. Since then, Ethnic Education has been valued in Indigenous school areas. In 1999, representatives of various ethnic groups in Taiwan's Indigenous peoples' organization and the presidential candidate of the Taiwan Democratic Progressive Party, Chen Shui-bian, signed the historic document "A New Partnership Between the Indigenous Peoples and the Government of Taiwan" in Lanyu.

(4) Enthusiasm period (2000 - Present)

> In 2005, The Indigenous Peoples Basic Law was promulgated. Article 7 stipulates: "The government shall protect Indigenous peoples' rights to education by upholding the principles of versatility, equality, and reverence in accordance with the will of Indigenous peoples. The relevant issues shall be stipulated by laws." It has regulated the legality and legitimacy of Indigenous Ethnic Education. The government decentralizes the power of curriculum decision-making, giving schools and teachers more control over the curriculum. It promotes the trend of multiculturalism and school-based curriculum with Indigenous culture in various Indigenous schools. Indigenous cultural education is booming at this time.

However, in practice, most teachers still prefer to adopt the mainstream society's teaching materials and methods because of concern about the Indigenous students' advancement and social adaptation (Fu, 2003). Therefore, Indigenous students still receive the same science curriculum as general students. Indigenous students' conceptions are typically ignored or purposefully denied in the traditional teaching of science at school. When the curriculum is still dominated by mainstream culture, and the Indigenous culture is marginalized in the school curriculum, it causes difficulties for students in science learning and self-identification (Fu, 1999, 2003; H. M. Zhou, 2009; S. Z. Zhou, 2007). Therefore, the science education trend of the native science curriculum and instruction should situate the students' learning of science in its appropriate socio-cultural contexts, including the students' life experience and traditions. The educational activities should present the holistic and cultural connotation of the Indigenous people, rather than superficial and fragmented culture (Z. L. Chen, 1997; T. L. Lin et al., 2017).

In 2019, The Legislative Yuan passed the draft amendment to the Education Act for Indigenous Peoples with the goal of establishing a complete education system for Indigenous peoples and ensuring the right to education of Indigenous peoples. In order to promote mutual respect among ethnic groups and the development of multiculturalism, there were five major priorities of amendment including expanding the target of Indigenous Education from Indigenous students to all teachers, students, and citizens, improving the administrative support system, promoting the participation of Indigenous people, strengthening teacher education, and deepening Ethnic Education.

The influence of foreign culture on curriculum in Lanyu

Formal education began in the Japanese colonial period.

- In 1923, the Japanese established the Primary Indigenous Educational Institution in Lanyu (Lanyu Township Office, n.d.)
- In 1946, the Republic of China government retreated to Taiwan. Sinicization education (Han Chinese cultural assimilation education) officially started in Lanyu.
- The ban on settlement and tourism ended in 1967.
- In 1968, compulsory education was extended from six years to nine years. Lanyu Junior High School was established in 1969 (Taitung County Lanyu High School, n.d.).
- In 1989, Fishery Vocational School was established.
- In 1997, the school was restructured into a complete school, which refers to the middle school and high school in the same school, and the school affairs are operated under the same administrative organization system. Depending on the community's characteristics and needs, the school may offer academic-oriented courses or vocational courses at the high school level.

- In 2018, Orchid High School (pseudonym) committed to promoting the Tao Ethnic Experimental Education.

Regarding the influence of foreign cultures, besides the education system from the Japanese rule and the policy of the Republic of China government with dominating Han culture, Christianity has brought radical changes and influences on Tao people's lives. In 1954, Fr. Alfred Giger started missionary work in Lanyu. Even today, churches and crosses are everywhere on the island. The slogan "Welcome to Lanyu— the Island of Christ" has been erected in the port. Christianity has been integrated into Tao people's daily life, traditional rituals, and livelihood activities. The critical factor in how Tao people generally accepted Christianity was the way the way in which Tao perceived the Christian faith and the way they adapted to it. The church has also adapted to Tao's culture and traditional beliefs.

Similar to many Indigenous worldviews, animism is common in Tao culture. Tao people believe that everything in the environment is conscious and spiritual; it reflects the awe of other life forms and the natural environment. For example, the flying fish is regarded as God's fish, a highly respected fish in Indigenous Tao culture (Siaman misiva, 2012). Christian culture is integrated in traditional rituals today. For example, Tao people can hold a traditional ceremony, like *Meyvanwa* (Flying fish summon ritual), after attending the service of the Christian church, and praying for a good harvest this year.

Understanding the culture and history of educational reform in Taiwan and Lanyu can provide a perspective on current events. There is no single curriculum suitable for all backgrounds, past, present, and future. Curriculum reform is not a final product; it is a process of continuous development. "In the dynamics of Indigenous knowledge, purposeful, meaningful

lives are dignified and spiritual. This is what we strive for and hope that educational reform will help us achieve (Battiste, 2002, p. 30)."

Orchid High School developed its Ethnic Experimental Education curriculum based on Tao people's culture and knowledge; it provides perspectives from Tao's worldviews and integrates with general education subjects. Tao's knowledge and culture have also been affected, challenged, adjusted, adapted, and integrated with the changes of environment, the influence of foreign cultures, and government policies. As Battiste (2002) indicates, Indigenous knowledge is an adaptable, dynamic system based on skills, abilities, and problem-solving techniques that change over time depending on environmental conditions.

In recent years, Indigenous education policy direction has changed from a single strong dominant cultural viewpoint to multiculturalism by learning, respecting, and adopting the Indigenous culture. Further, it has promoted Ethnic Education based on Indigenous cultures. As teachers begin to confront new pedagogical schemes of learning, they need to decolonize education. By developing the Ethnic Experimental Education curriculum with students, parents, and community, the collective voice of Indigenous peoples is raised and this exposes the injustices and scars in the colonial history of this land. Most of all, the process of decolonization legitimizes the voices and experiences of Indigenous people in teaching their youth and recognizes it as a dynamic context of knowledge and knowing.

Ethnic Education

In order to protect the right of Indigenous People to train and educate the skilled people they require and facilitate the development of Indigenous Peoples; the Legislative Yuan of Taiwan passed the "*Education Act for Indigenous Peoples*" in 1998 with the aim of

implementing “Ethnic Education.” Article 4 of this Act defines “Ethnic Education” as education based on the cultural characteristics of different Indigenous peoples, providing the knowledge that belongs to different Indigenous ethnicities to Indigenous students.

From the promotion of ethnic language and local language teaching in the 1980s, to the full implementation of the Grade 1-9 National Curriculum in 2001, the “school-based curriculum” and “local language curriculum” were implemented into the formal education and schools began to teach Indigenous languages for 40 minutes per week in elementary schools.

In 2019, the Curriculum Guidelines of 12-Year Basic Education was officially implemented, and “Indigenous Languages” were listed as “Native Languages” in the Language Arts Domain. The Curriculum Guidelines of 12-Year Basic Education emphasize ethnic interaction, multiculturalism and the participation of Indigenous peoples. It is stipulated that the design of school curricula should incorporate “multicultural and Indigenous education issues” added to issues of global importance. Ethnic language teaching maintains one class per week at the elementary school level. To ensure the education rights of Indigenous students, at least one Indigenous language class session should be held weekly in alternative curriculum in middle school level. The Ethnic language courses may be held on weekends or during summer/winter vacations (H. Chen, 2015). But the question remains: how do students apply to life their limited learning from their 40-minute ethnic language lessons per week?

Indigenous schools (educational institutions that focus primarily on the knowledge systems of Indigenous peoples and implement the provision of education in accordance with the educational philosophy and goals of the particular Indigenous people being taught) and Indigenous key schools (schools at senior secondary level and below with at least a specific number or proportion of Indigenous students) can flexibly adjust the courses to implement

Ethnic Education (and language courses are preferred) according to the needs of the schools through the mechanism of the school curriculum development meeting. In other words, schools can adjust, for example, the number of periods in language and math courses to implement Ethnic Education. For example, they can combine science lessons with traditional Tao boat building techniques or traditional Atayal dyeing and weaving techniques.

The core of the school's Ethnic Education curriculum is Indigenous culture, rather than general subjects. According to the Indigenous Peoples Committee, the eight study areas of Indigenous Education include ethnic language and literature, traditional life skills, social organization, art and music and dance, traditional beliefs and rituals, ethnic relations and tribal history, tribal ethics and taboos, and environmental ecological conservation. (R. H. Chang, 2020; Z. L. Chen, 2013). However, many schools limit Indigenous cultural education to courses such as language, song and dance, and artistry, ignoring the connotation and development of Indigenous culture, and introduce the Indigenous peoples in a one-sided and fragmented way in the textbook. This approach is insufficient and narrow to promote the inheritance and development of Indigenous culture (Y. W. Kuo, 2012). Furthermore, "Ethnic Language" is not exactly the same as "Ethnic Education." There is only one Ethnic Education class a week. How can teachers teach students with "diversified" teaching methods and integrate examples and content of various ethnic cultures in only one Ethnic Education class a week? Under the constraints of insufficient quality and quantity of courses, how can students learn to respect their own culture and the culture of others? For many years, the education of Indigenous peoples has not been able to go beyond the scope of institutional education – the content and teaching methods of the curriculum still continue the mainstream Han model, and the direction and characteristics of Ethnic Education cannot be found (Zhang, 2018). For Ethnic Education to

work, legal systems, curriculum, teaching material content, and teachers all need to be strengthened (Z. L. Chen, 1997; S. Z. Zhou, 2007).

Experimental Education

In order to encourage innovation and experimentation in education, promote diversified development, and protect students' learning rights and parents' right to choose education, Legislative Yuan passed three-type acts of experimental education in November 2014. This includes Enforcement Act for School-based Experimental Education, Enforcement Act for Non-school Type Experimental Education across Education Levels below Senior High School and the Act Governing the Commissioning of the Operation of Public Elementary and Junior Secondary Schools to the Private Sector.

These acts laid the legal foundation for promoting experimental education and created a new milestone in Taiwan's experimental education. They are the basis for implementing Article 13 of the Educational Fundamental Act: "The government and the people may conduct education experiments as needed and strengthen research and assessment of education to improve education quality and promote education development. The characteristic of experimental education is to break the existing educational framing, and emphasize autonomous learning and student-centered learning." (Taiwan Experimental Education Center, n.d.)

With the increase of various experimental educational institutions and schools, students have multiple and appropriate educational choices, which also brings influence and problems. Because of the impact of declining birthrate, Taiwan's primary and secondary schools are generally facing difficulties in recruiting students. After the relevant laws and regulations on experimental education were passed, under the pressure of strong competition, schools needed to

develop their own school characteristics in order to attract students. In the future, the schools will move towards a trend of diversification and specialization, which is also a new opportunity for the development of the school (J. C. Lin, 2015).

Experimental education emphasizes personal development, the child's autonomy, and experiential learning, with an effort to break academicism and reduce standardized comparisons of academic performance. The teaching method has also shifted from the traditional teacher-centered to the "student-centered" learning model. This will affect the long-standing "subject-based" environment in education. Experimental education teachers should be creative, open-minded, and willing to try new thing, with enthusiasm for education. However, there is a shortage of diversified and qualified teachers in experimental education (J. C. Lin, 2015).

In addition, after the implementation of the multiple entrance program and 12-year Basic Education, the enrollment pipeline has changed from simply evaluating students' academic performance through written tests to multiple learning that needs to consider other special performances, such as competitions, service learning and other outcomes. Experimental education emphasizes the autonomy of students' learning and the development of students' professions, which is aligned with the conditions of the multiple entrance program for the cultivation of special talents.

Ethnic Experimental Education

Ethnic Education also gained an opportunity for transformation after the adoption of relevant laws and regulations in 2014. Schools can conduct Ethnic Experimental Education in accordance with the Acts of Experimental Education and plan the curriculum with Ethnic Education as the core. Its courses are not limited by the number of sessions of the Curriculum

Guidelines. Therefore, the school can incorporate more Indigenous culture into the school's experimental education system. As of the end of 2020, there were 35 schools below the high school level that have been reviewed and approved by the local government to conduct Ethnic Experimental Education (Department of statistics of Ministry of Education, 2021). The number of schools has increased from 7 in the 2016 school year to 32 in the 2020 school year (another 3 schools are in preparation), including 26 elementary schools (Grade 1-6), three middle schools (Grade 7-9), two elementary and junior high schools (Grade 1-9), and one complete school (six-year high school, Grade 7-12). With regional distribution throughout 10 counties and cities, more than 2,200 students participated in the Ethnic Experimental Education. The research-sited, Orchid High School, is the only complete school (Grade 7-12) that implements Ethnic Experimental Education.

Cases of Ethnic Experimental Education in secondary schools in Taiwan

The Comprehensive Assessment Program for Junior High School Students (CAP) is a standardized test for 9th graders that students take before going to high school or vocational school. Through this evaluation of students, teachers, schools, and parents get to know the students' learning quality. After the implementation of the exemption admission system in 2014, Taiwanese middle school students can, in principle, choose to study in high school without passing an exam. However, when the number of applicants for a high school or vocational school exceeds the school's approved enrollment, the Excess Competition Policy is still required. CAP is one of the comparison items of Excess Competition. Depending on the county and city, it can account for at most one-third of the total points in the excess ranking. Since most students can actually get full marks in most of the items in the excess ranking, the CAP is a key factor in determining high school admissions, similar to the role of the traditional admission exam

(Hwang, 2014). The CAP consists of Chinese Language (writing and reading assessment), English (reading and listening assessment), Mathematics (multiple-choice tests and calculation problems), Natural Science (Including: Biology, Chemistry, Physics and Science of Earth) and Social Studies (Including: Geography, History, Personal and Social Study, Politics, Laws, Economics and International Studies). Therefore, in the middle school stage, General Scholastic Ability is particularly valued, because it will affect students' further education and opportunities. This section examines the outcomes of the curricula arrangement in schools that implement Ethnic Experimental Education above the secondary level.

Panan Tribe Elementary and Junior High School—Bunun people

The school was officially transformed into an "experimental school" in the 2017 school year. With the efforts of the principal and the team of teachers, it was successfully extended to the middle school in the 2019 school year. In the 2021 school year it was extended to Grade 9. There are many ethnic groups in the school: 70% are Indigenous students, and 30% are Hokkien, Hakka, and new immigrants.

Different from the two-semester system of knowledge production in mainstream education, the school deconstructs time and makes an agreement with the land and millet according to the Bunun millet growing festival season. There are devotional ceremonies at different times—the Spring School *Minpinang* (Sowing Ceremony), the Summer School *Malahtangia* (Ear Festival), the Autumn School *Andaza* (Harvest Ceremony), and the Winter School *Min-ha-misan* (Year-End Ceremony). Each season school session lasts ten weeks.

After the time is deconstructed, the curriculum is adjusted accordingly. The main subjects and sub-subjects of mainstream education do not exist here. The school divides the curriculum into four major areas: cultural competence, logical competence, scientific competence, and

aesthetic competence. Twelve subjects are classified into four major areas according to their characteristics, connecting the themes of each school season's festival, including millet culture, Bunun language, cultural literacy, life mathematics, cultural English, land science, historical reconnaissance, video recording, mountain life, totem art, musical instruments, and performing arts.

Table 2. 1

Curriculum outline of Eighth grade summer school Malahtangia (Ear Festival)

Areas	subjects	Number of sessions in Season School
Cultural competence	Millet culture	20
	Bunun language	10
Logical competence	Cultural literacy	70
	Life mathematics	40
	Cultural English	40
Scientific competence	Land science	40
	Historical reconnaissance	40
	Video recording	20
	Mountain life	20
Aesthetic competence	Totem art	20
	Musical instruments	20
	Performing arts.	20

Note. The table curriculum outline is revised, translated and adopted from *Panan* Tribe Elementary and Junior High School 2021 academic year curriculum plan. http://www.loxa.edu.tw/schoolweb/view/index.php?WebID=749&schnum=124730&MainType=0&SubType=104&MainMenuId=44794&SubMenuId=69655&NowMainId=44794&NowSubId=69655

Each season of the festival has a main narrative that tells a story or incident. Each subject has its own sub-narrative, extending the theme of the main narrative. For example, the seventh-grade land science focuses on the hunter theme, exploring how hunters adapt to the environment

and why their heartbeats are much faster than usual when chasing prey, which is connected to the organ system of plants and animals. Although subjects incorporate cultural themes or start with cultural elements or events, each subject is still taught independently. For example, the content of land science is the content of general education science.

Datong Junior High School—Tayal People

Datong Junior High School was officially unveiled in 2018 as "Yilan County *LLAQI NA LLYUNG MNIBU TA TAYAL* (Lanyang River Basin Tayal Children) Ethnic Experimental Junior High School." It was the vision of "*Tayal balay*, the real Tayal people" and the concept of "affirming the value of Ethnic Education and restoring the essence of Ethnic Education." It expects that students become real Tayal people under the Tayal cultural heritage and environment.

With the efforts and assistance of all teachers, Knowledge Keepers and Tayal Cultural Advisors, curriculum professional education partners and scholars, the team of the County Government Education Office, and Mount Nanhu Tayal community schools, the curriculum modules for three grades were completed: Grade 7 - Swidden Farming and Reclamation Life and Skills, Grade 8 - Gaga Family and Weaving, Grade 9 - Wisdom of Mountains and Forests; a total of 41 units of lesson plan design and 1017 learning sessions. The school hopes that through teaching activities, experience, and exploration of the dynamic learning curriculum content, students will strengthen their cultural identity and confidence in their own ethnicity and cultivate teachers' and students' positive attitudes and beliefs in Ethnic Experimental Education, so as to jointly preserve the diverse ethnic cultures, languages, and histories.

Table 2. 2

Ethnic Experimental Education Curriculum outline of Datong Junior High School

Curriculum Oriented	Swidden Farming and Reclamation	Marriage culture	Rainbow weave	Mountain culture	Traditional wisdom
Theme content	Ethnic language and culture Traditional Songs and Dances				
	Plant knowledge and application	Marriage system	Knowledge of traditional costumes and utensils	Tribal Migration and Ethnic Relations	Traditional musical instrument making
	Reclamation and sowing	Family development and genealogy establishment	Table machine plain weave twill weave Traditional machine weaving	Gaga groups and tribal organizations	Fishing gear making
	Intercropping management	Property Management and Inheritance	Ramie Cultivation and Management Ramie twisting and dyeing	Tribal mountains and rivers traditional fields Tribal Mapping	Hunting equipment
	Harvesting and threshing rice	Traditional beliefs and customs of life	Shoulder bag making	Hunting ecology and experience	Three Stone Stove and Workhouse Traditional building
	Millet Cake Millet wine Millet cured meat	Tayal beauty and earring making	The use and creation of woven products	Fishing ecology and experience	Rattan utensil Bamboo utensil Wooden utensils

Note. The table curriculum outline is revised, translated and adopted from Datong Junior High School 2021 Academic Year Experimental School Curriculum Plan.

https://drive.google.com/file/d/1DcSqcJtKH6FPHrenz8GctIEntAAQRwTv/view

The school's experimental education curriculum structure adopts a bi-cultural learning design, hoping that students learn the knowledge and ability of the general education, and the traditional culture of their own ethnic group. Tayal cultural courses are conducted in a collaborative teaching method by cultural teachers, Elders and schoolteachers. Cultural teachers and general subjects' teachers discuss the content of the course and integrate relevant conceptual principles.

Table 2. 3

Number of class periods allocation of bicultural learning experimental education curriculum of Datong Junior High School in Seventh — Ninth Grade

Subjects	Number of sessions/weeks
Tayal Culture	9
Ethnic language	1
Diversified Elective (club)	2
Mandarin Chinese	4
English	4
Mathematics	4
Social studies	3
Natural science	3
Technology	1
Integrative Activities	1
Health and Physical Education	1
Arts	1
Alternative learning	1

Note. The table curriculum outline is revised, translated and adopted from Datong Junior High School 2021 Academic Year Experimental School Curriculum Plan.

https://drive.google.com/file/d/1DcSqcJtKH6FPHrenz8GctIEntAAQRwTv/view

In addition to 10 Tayal cultural classes (including ethnic languages) per week, the school also has two sessions of cultural elective courses (club activities). These include traditional songs and guitars, traditional dances, dyeing and weaving, and the combination of video and

mythology, competitive sports, etc. Among them, the Mountain club includes traditional mountain forest knowledge such as hunting, trapping, and ethnic plants. And one club collects Tayal cultural stories, cultural responses, and dialogues between culture and science to uncover the secrets of culture and science.

Municipal Hepingguomin Junior High School— Tayal People

Hepingguomin Junior High School is currently the smallest junior high school in Taichung City with the smallest number of students. Sixty percent of the school's students are Indigenous Tayal, the rest are Hakka, Minnan and other provinces, and a small number of new immigrants. The student population is diverse, but the majority are Tayal. It is the only Indigenous key junior high school in Taichung City, so it develops Tayal culture and singing and dancing.

The school began preparations in 2018, and officially transformed into the first Ethnic Experimental junior high school in central and southern Taiwan in the 2019 academic year. The school has planned an innovative "dual-track curriculum" model: the first track focuses on Chinese, mathematics, natural science and social studies, supplemented by technology fields to help students achieve the best learning outcomes, with the hope that every student can perform well in the Comprehensive Assessment Program for Junior High School Students. The second track is based on arts and humanities, health and P.E., and Integrative activities, supplemented by technology to plan a thematic Tayal culture Ethnic Experimental curriculum.

Based on "hunting and mountain life", "farming and family life", "weaving and totem culture", and "music and dance and festival culture", it provides students with different learning experiences and educational content. The goals of Ethnic Experimental Education are: (1) Continue the traditional content of Tayal culture; (2) Construct the basic knowledge of Tayal

tradition; (3) Improve students' understanding and identity of their own ethnic groups; (4) Extend the Ethnic Education curriculum of P'uma Ethnic Experimental Primary School and build a nine-year Tayal Ethnic Education with a consistent and complete knowledge and skill system.

Hsinchu County Jianshi Junior High School— Tayal People

There are 227 students in the school, and more than 90% are Tayal students. In response to the weakening of Tayal culture and the loss of language, the school applied for the Tayal Experimental School Project in 2017 to revitalize, inherit and continue Tayal culture and traditions. The school has established strategic alliances with other Tayal primary schools. After two years of preparation, the Tayal Ethnic Experimental Education was officially implemented in the 2020 school year.

The school divides the curriculum into two tracks: general education and cultural education. Cultural courses are divided into six areas, each area has two classes a week, a total of 12 sessions of cultural classes per week. Cultural courses focus on cultural knowledge and skills. However, only a few cultural subjects are integrated into scientific disciplines, such as weaving, and the introduction of plants and colors to understand the use and connotation of Tayal patterns. It is also connected to chemical dyeing and indigo dye chemical formulas.

Table 2. 4

Cultural areas curriculum of Jianshi Junior High School

Cultural areas	Subjects
LOHAS	Art music and dance
Agriculture	Farming culture
	Food Culture
Mountain	Cultural field of life
education	Taiwan's mountains and forests

	Big Tayal living environment Indigenous mountaineering in Taiwan Mountain Forest Survival Wisdom Disaster prevention and ecological engineering Leave No Trace Mountain Forest and Ecotourism
Tribal History	Indigenous Literature Tayal introduction Jianshi Township Hydrological Watershed War Community industry Indigenous Social Issues
Rainbow weave	Introduction of Tayal Costumes Weaving loom demonstration Fiber material Plant dye Apparel & Accessories Textile tools Texture and technique Fabric application and creation
Building craftsmanship	Introduction of process and application of traditional building Materials Traditional building Weaving artifacts Traditional utensil making Woodcarving Shaping process
Tayal language	

Note. The table curriculum outline is revised, translated and adopted from Jianshi Junior High School 2021 Academic Year Curriculum Plan - Cultural areas.

https://drive.google.com/drive/folders/1Z166vEuevtrus4vXg3sgSOPADhmknRYD

Alishan Elementary and Junior High School—Cou People

The school has 23 kindergarten students, 74 elementary school students, and 27 middle school students. There are a total of 50 faculty members (including itinerant teachers). The school entered the preparatory period for experimental education in the 2018 school year, and officially implemented Ethnic Experimental Education in the 2019 school year.

The school divides the courses into two types: (1) General Subject Field Courses (Chinese, English, mathematics, social studies, and natural science) — Improve social adaptability (2) Ethnic Culture Courses — Develop ethnic identity. Subject Field Courses refer to the nine-year and twelve-year basic education national curriculum for subject field courses and adjust the number of sessions. The elementary school stage focuses on cultural skills and cultural experience, and the ability to solve life problems from a cultural point of view; the middle school stage gradually transforms into Indigenous social issues and international Indigenous issues (including social politics, economy, culture, education, etc.), in order to enhance cultural awareness and confidence.

Table 2. 5

Number of classes sessions allocation of two kinds of curriculum of Alishan Elementary and Junior High School in Seventh — Ninth Grade

Courses type	Learning areas	Number of sessions/weeks
General Subject Field Courses	Mandarin Chinese	5
	English	3
	Mathematics	4
	Social studies	3
	Natural science	3
	Integrative Activities (Guidance)	1
	Physical Education	2
	Arts	1
	Alternative learning (class meeting)	1
Ethnic Culture Courses	Ethnic culture theme	4
	Indigenous clubs	1
	Cultural technology	1
	Indigenous Wisdom and Science	1
	World English	1
	Culture and art	2
	Cou language	2

Note. The table curriculum outline is revised, translated and adopted from Alishan Elementary and Junior High School 2021 Academic Year Curriculum Plan. https://course.cyc.edu.tw/course/pub/cou_exp.php?sch_id=104526

The core of cultural experimental curriculum structure is around the connotation of Cou whole-person education and supplemented by *Hupa* (field), *Hosa* (tribe), and *Kuba* (club) as the main essence of the curriculum. Students can immerse in the life of Indigenous environment; they can speak ethnic language. The full set of Ethnic Experimental Education course units include:

1. Beautiful Hosa: Tribal migration and territory, Architecture, Marriage norms and taboos, Life rituals, Traditional ceremonies.
2. The beauty of craftsmanship: Clothing and Weaving.
3. Legend of the Mountains / Tanning Culture: Hunting, Fishing, Sharing spirit, Ecological conservation and Tanning technique.
4. Cultivation life: Swidden farming (Slash-and-burn agriculture), Food production, Millet culture.
5. Community Industrial and Management: Modern Cou Indigenous Community industry, Cultural industry, Community development concepts.
6. Indigenous Social Issues: Discussions on domestic and international Indigenous society, Economy, Culture, Language development, Education and other issues.
7. Indigenous Arts and Crafts: Cultural inheritance and preservation technique, Cultural Innovation, Technological Development and Art Film.

Theoretical Framework

The theoretical framework of this study is structured by macro philosophical approaches, mid-level theories, and micro-level theories. Indigenous onto-epistemology (Barad, 2003) is the core theoretical framework of this research. Mid-level theories are the third space theory and the cultural border crossing theory, building on this Macro-level theory. They provide a lens for analyzing science learning in the development of an Ethnic Experimental Education curriculum. Ethnic Experimental Education can serve as a bridge or a space that allows cultures to communicate.

"Tao" is the self-proclaimed name of the Indigenous people on Lanyu. It also means "human" in their native language. The Ethnic Experimental Education takes the Tao spirit as the core, follows the annual rituals of flying fish culture, follows the pace and cycle of nature, and respects the relationship between humans and the natural environment. The goal of Ethnic Education is to bring the wisdom of ethnic life into the school curriculum. The core of Ethnic Education echoes the tenets of ecojustice, and is developed around Place-Based Education and Culture-Based Education.

Macro-level

Indigenous Onto-Epistemology

Although Indigenous people come from different cultural backgrounds, a common Indigenous worldview is that human beings and the natural world are intricately connected. They believe the universe is holistic in an indivisible and unified life form of perception. All "things" have agency and are interconnected through a system of relationality. They view Traditional Ecological Knowledge as the process of participating in relationships rather than a product or result of knowledge (McGregor, 2008).

It provides a different perspective on reconfiguring the separation of epistemology (method) and ontology (content/knowledge) because, in an Indigenous worldview, there is no separation between method and content (B. Martin, 2017). Barad (2003) describes this as terms of onto-epistemology:

> *The separation of epistemology from ontology is a reverberation of a metaphysics that assumes an inherent difference between human and nonhuman, subject and object, mind and body, matter and discourse. Onto-epistemology- the study of practices of knowing in being- is probably a better way to think about the kind of understandings that are needed to come to terms with how specific intra-actions matter*. (p. 18)

St. Pierre et al. (2016) draw on Barad's concept of onto-epistemology to rethink the empirical and ontology, "which makes it clear that how we conceive the relation of knowledge and being is a profoundly ethical issue, as is the relation between the human and the nonhuman" (p. 99).

Indigenous onto-epistemology, as the macro-level theory in this study, makes assumptions about the nature of knowledge (epistemology) and being (ontology). Epistemology and ontology are not separate; that is, the definition of one depends on the other's definition. This macro philosophical approach produces mid-level and micro-level theories. For example, the place-based approach is based on the belief that knowledge should not be separated from the environment because knowledge is not the content to understand but the process of obtaining and sharing amongst people.

Mid-level

Third Space theory

Glasson applies third space theory (Bhabha, 2012) to Indigenous science education. This is based on integrating various knowledge viewpoints and language teaching environments through the teaching environment's construction to establish an equal dialogue and construct new interpretations and meanings. The first space is the lifestyle of the ethnic group and the knowledge of Indigenous students. The second space is western science taught in school.

The third space is the dialogue between Indigenous science and Western science through the nature of knowledge in common. Within the third space, stakeholders, students, teachers, curriculum developers, and community Elders can collaborate in the co-construction of new hybrid meanings and interpretations of science (Glasson et al., 2010; Handa & Tippins, 2013). Ethnic Experimental Education is developed based on the third space. This might provide a space for Western science and Indigenous Culture to communicate.

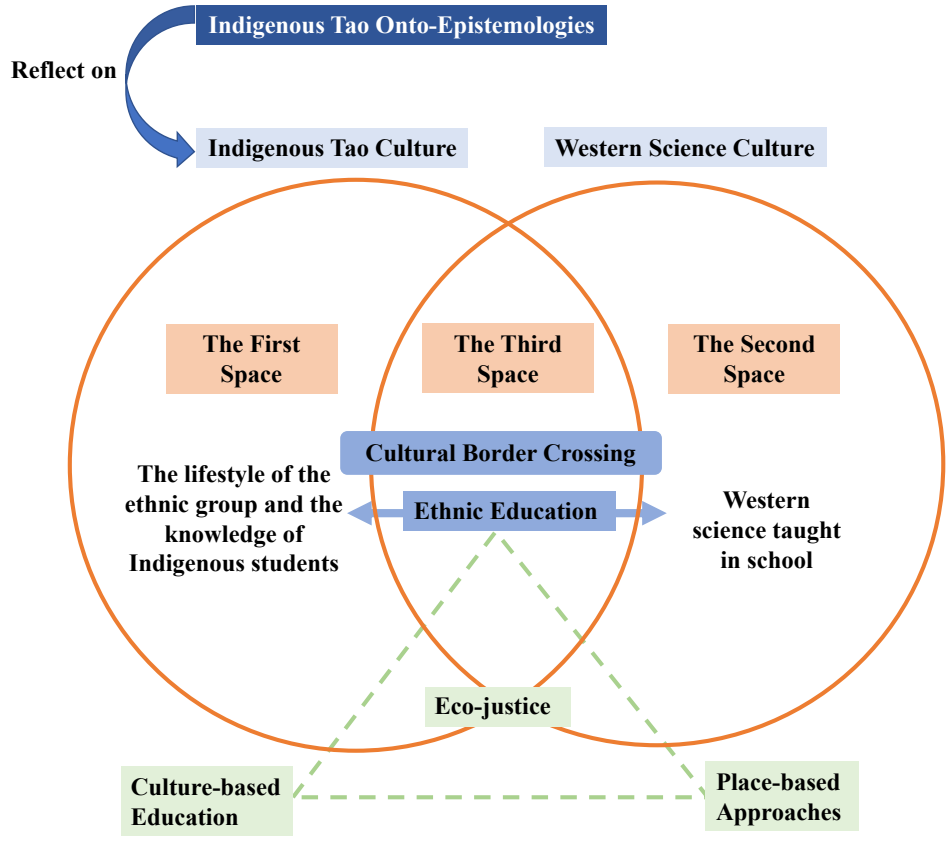
Cultural Border Crossing Theory

Another mid-level theoretical framework is the idea of cultural border crossing. By defining culture as the set of norms, values, beliefs, expectations, and conventions of a group, science is cultural, as well as an individual process of thought, and has been utilized in some form by every human cultural group. Science is the knowledge, skills, and values shared in the scientific community (Aikenhead & Huntley, 1999). Pickering (1992) explains that science is a subculture of Western culture, reflecting a Eurocentric worldview. The cultural border crossing theory posits that students cross cultural borders when entering and engaging with their science courses (Aikenhead, 1996).

These cultural borders arise because the cultural perspective in science classes and in science itself may differ from the cultural perspective present in students' family and peer subcultures. Students whose lifeworlds are not characterized by a Eurocentric worldview need to negotiate at times cultural borders from their everyday culture and school science culture. The difficult and insurmountable boundary crossing can cause students to avoid science classes (Costa, 1995). Aikenhead recognizes the various subcultures that students move through within their daily lives, including the subcultures of science and science classrooms. Every individual belongs to and navigates throughout any number of subcultures which themselves have common norms, beliefs, expectations, and conventions.

Figure 2. 1

Theoretical Framework



Micro-level

Ecojustice

The core idea of Ethnic Education is grounded in the tenets of Ecojustice. The purpose of ecojustice is to understand the tensions between cultures and the needs of the Earth's ecosystems (Karrow & Fazio, 2010). This focuses on the deeply rooted belief in local action and intergenerational knowledge. It encourages the uncovering of the cultural ideas and analysis of those assumptions. It provides the opportunity for the voice of the people and places to be recognized. It is congruent with Native Epistemologies, with an emphasis on exploring the relationship between people and the environment and between organisms and the environment.

Place-Based Education

Mueller (2009) indicates that "Ecojustice is an emerging perspective that addresses the confluence of social and environmental injustice, oppression for humans and nature, and ecological degradation" (p.1033). The Place-Based Education (PBE) theory from the cultural realm perspective is similar to the goals of ecojustice with the moral and conceptual framework. There is a close relationship between PBE theory and ecojustice, as Karrow and Fazio (2010) describe, "Hermeneutic phenomenology prepares the ground for what ecojustice accomplishes. It reveals the nature of being human, human beings' relationship with the Earth, and the Earth as the ground for the being of human being" (p.212). The philosophy of hermeneutic phenomenology which seeks the meaning of Being. PBE is not only to relocate learners to environments outside the classroom. Place-as-being is interested in the interrelationship between place and being. Different from taking place as the "context" of education or "the value of learning," the concept of place-as-being tries to break the framework of this place as the object and learning as the subject. Different from affective education, the emotional connection is the

prelude to an intimate relationship with a place. Once such a relationship begins, students, as a foundation to their Being-in-the-World, demonstrate care, and other forms of engagement may follow.

Also, Place-Based Education aims to situate learning based on local phenomena and students' life experiences (G. Smith, 2002). The local phenomena provide the context for scientific inquiry, which Indigenous People have traditionally engaged in science by narrating and observing natural phenomena to construct Traditional Ecological Knowledge. Indigenous Knowledge is rooted in the inseparable relationship between people and places. Like Indigenous cultures, Indigenous relationships to the land and place are diverse, specific, and un-generalizable (Tuck et al., 2014).

When an individual has emotions and bonding for a land and gradually gives meaning to it and feels that they belong to the place, this indicates that the sense of place can be used not only to define one's position, but also to judge one's value (Hung, 2013). When students think that teaching is relevant to themselves, they will likely have higher learning motivation and interest.

Disciplinary knowledge and cultural background integrate into place-based education. The interdisciplinary learning model allows students to jointly discover and solve or discuss a problem in a topic-based teaching method. For example, students can discuss the issue of coral bleaching that happened recently on the island. Coral plays a critical role in submarine biodiversity in the entire ecosystem. It is a primary consumer preying on plankton and a producer that works with algae to convert inorganic salts into organic matter. After the formation of coral reefs, it has become the base for many organisms grown in the seabed environment. Students can investigate and record the area and range of coral bleaching on the island. Then students need to

know the knowledge related to the biological environment of coral, such as coral living conditions, coral symbiotic algae, and possible causes of coral bleaching, such as climate change, seawater temperature rising, ocean acidification, or increase in tourism and marine activities and the harm of sunscreen to corals. This topic can involve biology, chemistry, geology, and social sciences. Besides, general subjects, native science, and cultural connotations are also included. For example, based on the observation of the ocean, the decreased amount of sea snakes means that coral reefs' ecological environment has deteriorated.

Culture-Based Education

Many scholars are committed to advocating connecting education to the students' cultural backgrounds. Ladson-Billings (1995) indicates "a *culturally relevant pedagogy* that would propose to do three things—produce students who can achieve academically, produce students who demonstrate cultural competence, and develop students who can both understand and critique the existing social order (p. 474)." Gay (2018) defined *culturally responsive educational practices* as "using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning more relevant and effective for them (p. 29)." Paris (2012) questions the usefulness of "responsive" and relevant" practices, arguing that they do not guarantee instance or meaning. One goal of an educational program is to maintain heritage ways and to value cultural and linguistic sharing across difference, to sustain and support bi- and multilingualism and bi- and multiculturalism. He used the term "*culturally sustaining pedagogy* which is more than responsive or relevant to the cultural experiences and practices of young people—it requires that they support young people in sustaining the cultural and linguistic competence of their communities while simultaneously offering access to dominant cultural competence (p. 95)." There are many other terms used to denote this culturally

connected education, such as *culturally appropriate/grounded* (Au, 1980; Au & Kawakami, 1994; Mohatt & Erickson, 1981) and *culturally compatible* (Jordan & Tharp, 1979; Jordan et al., 1985). Despite using different terms, they are all based on "cultural difference." However, cultural mismatch between students' home culture and the school's culture posits one source of learning difficulties for culturally-diverse students (Demmert Jr & Towner, 2003). Those culturally connected educations are the teaching practice orientations that multicultural education developed under the impetus of the civil rights era in 1960 (E. B. Smith, 2009).

The Ethnic Experimental Education curriculum developed in this study is based on the Tao culture. As a cultural theory of education considers how education occurs within a specified culture, Indigenous *culture-based education* explores science from Indigenous and holistic worldview and allows students to cultivate their own cultural identity. Different from the Cultural Deficit Model, Indigenous science education transforms cultural differences into teaching and learning resources. The course content integrates the Indigenous peoples' culture and life experience, making science learning more related. Students can connect their own ethnic culture and national knowledge to have more confidence in learning sciences. Therefore, Indigenous science education does not entirely disassemble the culture, life wisdom, and traditional ecological knowledge into the Western scientific classification but integrates Western science and the Indigenous Knowledge System with Indigenous epistemology in order to understand the process of scientific interpretation and induction in science learning from Indigenous science and worldview through scientific observation and empirical research with cultural connotations.

Core Elements for Indigenous Science Education/ Pedagogy

Worldview

Cajete and Little (2000) defined worldview as "a set of assumptions and beliefs that form the basis of a people's comprehension of the world" (p. 62). Although Indigenous people come from different cultural backgrounds, a common Indigenous worldview is human beings and the natural world are intricately connected. All living things are seen as interdependent and part of a larger whole. The universe is holistic, in an indivisible and unified life form of perception. Because everything is interrelated as the whole, including people, the Indigenous worldview emphasizes harmony and balance in relationships with others. Based on this principle, Indigenous believe that everything in the environment is conscious and spiritual, so animism is very common among Indigenous culture; it reflects respect for other life forms.

For example, the flying fish is regarded as god's fish, a highly respected fish in Indigenous Tao culture (Siaman misiva, 2012). For hundreds of years, Tao people observed that the flying fish swims back to the region around Lanyu regularly because it is the most numerous, providing the most protein for Tao people. It is deemed to be the most respected fish. Indigenous people have observed the cycle and circles of seasons, the sun and moon's movement, migrations, life, food chains, tide, and interdependence of each creature in the ecosystem (Snively & Williams, 2016). Time is cyclical rather than linear for Indigenous people. During flying fish seasons, Tao people do not catch demersal fish; it is an ecological revitalization period for other fish species. After the flying fish season ends, Tao people stop catching flying fish and preserve it as dried fish. All the dried flying fish are only available to eat until *manoyotoyon*, the day around the moon festival. This custom not only represents the wisdom of food preservation and preservation dates; it also means that Tao people do not overfish; they

only take what they needed from the ocean. Resources can continue to regenerate because of these interactive and reciprocal relationships with the land and other living things in the ecosystem. Human beings have roles and responsibilities in maintaining the balance between themselves, their families and communities, and the earth and the cosmos.

Cobern (1989) showed that the formation of an individual worldview depends on the experience of the individual's perception of the living environment and social culture interaction. From the perspective of science education, worldview is a set of self-contained logical mental frameworks formed by the individual's interpretation, views, and responses to the surrounding things and natural phenomena under the interaction with the living social culture and external environment. This mental framework determines the individual's internal scientific thinking and the explicit scientific learning behaviors (Fu, 1999).

The dominant group and marginal group's incompatible worldviews make Indigenous students feel difficulties in the mainstream education system. Indigenous worldview could emphasize culturally relevant pedagogy with appropriate scientific knowledge, skill, and value to support students negotiating the transition between their own culture and school science culture (Aikenhead & Huntley, 1999).

Fu (1999) developed a Worldview Oriented Learning Framework (WOLF) based on Kearney's (1984) worldview transformation model and learning circle, with the assumption that an individual's worldview determines how the individual perceives the phenomena or concepts encountered during science learning. According to Fu, science learning is a process of transforming worldview. The module is divided into five phases applied to disciplines with Indigenous cultures.

Phase 1: Inherit the traditional worldview

Science learning begins with content relating to the students' world in the learners' social and cultural contexts and geographical environments. Examples are inviting Elders to demonstrate the traditional skills or teach the conventional knowledge by passing on experience.

Phase 2: Express Personal worldview.

Guide students to ask questions about traditional culture or express how they and their tribes perceive the phenomena or concepts and engage students in dialogue.

Phase 3: Explore the worldview

Students experience cultural-related phenomena and the existing methods of interpretation of related phenomena. Allow students to explore their current worldview in a cultural context.

Phase 4: Form a new world view and present the concepts of related subject knowledge.

Gradually introduce the concepts of subject knowledge while transferring theoretical phenomena or conducting experiments to perceive the different interpretations and worldviews than the existing one. It shapes a new way of exploring the world with the current perceptual methods and the relevant subject content knowledge.

Phase 5: Connect the Indigenous worldview with the worldview of disciplines.

Students can view the disciplines' concept from their people's perspective; they can also reflect their ethnic group's views from the perspective of disciplines. It gradually establishes a dialogue between the home culture and the academic/scientific world.

Indigenous culture and knowledge are the WOLF teaching model's main body rather than only adding to the existing subject curriculum. The subject content and teaching of the general

education have been gradually integrated into the Indigenous knowledge system and Indigenous content-based curriculum.

Indigenous onto-epistemology

Indigenous epistemology must be applied to school science education because "Indigenous students need the latitude to reflect upon multiple dimensions of the world in which they live in order to develop the advanced critical thinking necessary for a greater understanding of the nature of Western Science and Indigenous knowledge" (Sutherland & Henning, 2009, p.176). One's epistemology is fundamental to how they see the world, understands knowledge, and lives and negotiates everyday experiences. For example, in Indigenous Tao culture, the fish are classified as edible and inedible fish; edible fish includes: "oyod" (men fish) and "rahet" (women fish) and elder fish (Siaman misiva, 2012). The Indigenous classification method is the wisdom of symbiosis with nature. When they catch fish, they catch different fish species for various family members to maintain species diversity.

Educators should engage in Culturally Responsive Schooling for Indigenous youth (Castagno & Brayboy, 2008). This does not mean teachers should give up their own epistemologies and adopt those of the community in which they teach. Instead, educators should be aware that multiple epistemologies exist and that their students may have a very different worldview from them. Multiple epistemologies can and must coexist within school settings.

Local and Indigenous Knowledge Systems

Local and Indigenous knowledge (IK) refers to "the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings (UNESCO, n.d.)." This knowledge is the sum of cultural knowledge and wisdom held by Indigenous peoples of the world. It is integral to the Indigenous worldview and

encompasses values and beliefs, language, history, social and economic systems, relationships with the environment, and science.

Indigenous Knowledge has some characteristics: Knowledge is place-based, IK reflects an intimate connection with their lands. IK is diverse because it is collective knowledge with a multitude of perspectives. Although IK is diversity between individuals, IK is shared with a worldview based on interconnectedness and reciprocal relationships with the natural world. In addition, even if IK is rooted in historical knowledge, it is also dynamic and growing. Cobern & Loving (2003) propose that Indigenous Knowledge should be regarded as another independent knowledge system that can be valued for its own merits and play a vital role in science education.

IK is the integration and application of daily life and traditional survival practices. It is an interpretation of individual phenomena, focusing on application. It is different from the nature of Western science in exposing the truth, abstract theoretical propositions, and the mechanism of macro and micro phenomena. However, Western science and Indigenous Knowledge share some common languages. They both understand natural phenomena and put forward interpretable theoretical viewpoints.

Indigenous way of knowing

Aligned to the Indigenous onto-epistemology and Indigenous Knowledge Systems, the First Peoples' Principles of Learning represents an attempt to identify common elements in the varied teaching and learning approaches that prevail within particular Indigenous societies. (First Nations Education Steering Committee, n.d.)states these principles as:

- Learning ultimately supports the well-being of the self, the family, the community, the land, the spirits, and the ancestors.

- Learning is holistic, reflexive, reflective, experiential, and relational (focused on connectedness, reciprocal relationships, and a sense of place).
- Learning involves recognizing the consequences of one's actions.
- Learning involves generational roles and responsibilities.
- Learning recognizes the role of Indigenous knowledge.
- Learning is embedded in memory, history, and story.
- Learning involves patience and time.
- Learning requires exploration of one's identity.
- Learning involves recognizing that some knowledge is sacred and only shared with permission in certain situations.

The Indigenous peoples have commonality in the way of inheriting traditional knowledge, such as experiential learning, learning by doing and observing, through listening to stories and imagination, through personal participation in rituals, apprenticeship learning, and learning through creative and integrated methods such as artistic creation. Therefore, educators should consider Indigenous students' learning characteristics in Indigenous science education and prepare appropriate curricula to replace the traditional teaching and learning models of Western society so that the Native science can be effectively passed on.

Similar to First Peoples' Principles of Learning, Snively and Williams (2016) conceptualized the critical components of an Indigenous Science Education Model:

Elders are keepers of knowledge.

In the Indigenous communities, the Elders and knowledge keepers pass knowledge and related wisdom practices to future generations through stories and demonstrations. They play a

key role as facilitators of lifelong learning, teach the responsibilities and relationships between family, community, and creativity. They also teach the belief and value in strengthening intergenerational connections and cultural identity. However, the new generations do not just accept the transfer of traditional knowledge blindly (Wu & Wu, 2015). They verify the knowledge taught by the Elders through various experiments based on their new experience, and construct their own knowledge from it. Indigenous groups also observe phenomena and derive specific knowledge(Corsiglia & Snively, 2001; Snively & Corsiglia, 2001).

Science education should add "Environment" and "Elders" in the 5E model (Engage, Explore, Explain, Elaborate, and Evaluate) for developing experiential learning activities for Indigenous science (First Nations Education Steering Committee & First Nations Schools Association., 2019). Environment refers to place-based learning, situating the lessons in the local land and environment to cultivate the sense of Place and build an appreciation for the land. The concept of everything is connected in a web of relationships. Elders and other knowledgeable community members represent the Indigenous Knowledge shared by the community. They can connect science activities with traditional knowledge.

Learning is a Community Activity and Rooted in Home Place

The traditional Indigenous classrooms are composed of communities and natural environments. The experiences that people have in their own land make learning meaningful. Indigenous knowledge is established through experience in life. Therefore, home place is a predominant theme in Indigenous Science education. As Christie (1991) asserted, "the most fundamental principles taught by Indigenous Elders is that our subject matter is to be examined and interpreted as it is found embedded within its context. This is in marked contrast with Western Science where environmental influences are considered confounding (p. 29)"

Learning is Holistic and Relational

Indigenous Knowledge is recognized as holistic and not easily subject to fragmentation. It emphasizes the social, emotional, mental, and spiritual aspects of learning. Learning is relational because all things are interrelated in the Indigenous worldview. IK values the interactive and reciprocal relationship between people and the environment. It cultivate the harmony of the environment and the value of humility, tolerance, tact, integrity, wisdom, courage, compassion for others. Therefore, a classroom environment can be established that encourages classroom work for others' benefit, instead of a competitive environment that only benefits oneself.

Learning is Experiential

Experiential learning is considered to associate with "life experience," such as learning through observation and imitation, which are part of daily family activities and community interactions. The lack of practical and experiential approaches is often mentioned as the major inhibitors of Indigenous students' success in the classroom (Barnhardt et al., 1998; G. A. Cajete, 1999; Snively & Williams, 2016). To learn Indigenous Science in school, learners must actively participate in the natural environment. This process can be transferred from formal curriculum-based science education to activity-centered inquiry-based experience, such as hands-on, tactile, concrete, and manipulative.

Learning is Intergenerational and Carried in Language

Since most Indigenous groups have not developed written words, most of them use oral narrative traditions and storytelling as their knowledge construction record books (Snively & Corsiglia, 2001). The knowledge and values have been constructed for a long time, passed on

from generation to generation through language. Indigenous languages encode unique ways of interpreting the world; they are viewed as the key to maintaining Indigenous Knowledge Systems (Herbert, 2000). Language is the relationship that connects people and the world. Therefore, language is the nature of being human. If language is gone, culture cannot be independent and prosperous.

Salient Terms

Indigenous People

According to the United Nations Permanent Forum on Indigenous Issues, considering the diversity of Indigenous peoples around the world, a modern understanding of this term "Indigenous" includes:

- Self-identification as indigenous peoples at the individual level and accepted by the community as their member
- Historical continuity with pre-colonial and/or pre-settler societies,
- Strong link to territories and surrounding natural resources
- Distinct social, economic or political systems
- Distinct language, culture and beliefs
- Form non-dominant groups of society
- Resolve to maintain and reproduce their ancestral environments and systems as distinctive peoples and communities.

This interpretation of "Indigenous" is the one that was used to guide this study.

Indigenous People in Taiwan

Indigenous people are called “yuan chu min” (原住民) in Taiwan, literally, “the people who lived here first”, or “aborigines.” It refers to the traditional peoples who have inhabited Taiwan and are subject to the state’s jurisdiction, including Amis tribe, Atayal tribe, Paiwan tribe, Bunun tribe, Puyuma tribe, Rukai tribe, Tsou tribe, Saisiyat tribe, Yami tribe, Tsao tribe, Kavalan tribe, Taroko tribe and any other tribes who regard themselves as Indigenous peoples and obtain the approval of the central Indigenous authority upon application (The Indigenous Peoples Basic Law, Article 2, 2005). According to Status Act for Indigenous Peoples (2001), the term “Indigenous people” includes native Indigenous peoples of the mountain and plain-land regions:

- Mountain Indigenous peoples: permanent residents of the *mountain administrative zone* before the recovery of Taiwan in 1945, moreover, census registration records show individual or immediate kin of individual is of Indigenous descent.
- Plain-land Indigenous peoples: permanent residents of the *plain-land administrative zone* before the recovery of Taiwan in 1945, moreover, census registration records show individual or immediate kin of individual is of Indigenous descent. Individual is registered as a plain-land Indigenous peoples in the village (town, city, district) administration office.

Indigenous schools refer to educational institutions that focus primarily on the knowledge systems of Indigenous peoples and implement the provision of education in accordance with the educational philosophy and goals of the particular Indigenous people being taught.

Indigenous key schools refer to schools at senior secondary level and below with at least a specific number or proportion of Indigenous students.

Secondary education refers to the Taiwanese education system in **junior high school** (Grade 7-9) and **senior high school** (Grade 10-12). **Junior high school** education is compulsory since 1968 in Taiwan. In 2014, the national education in Taiwan was extended from nine years to twelve years, and the Twelve Years of Basic Education policy was implemented with tuition-free programs in senior high schools. In this paper, **middle school** refers to Junior high school, and **high school** refers to senior high school

Curriculum

According to Webster's dictionary, "Curriculum" is derived from the Latin word "*currere*", which means to run; it emphasizes the verb form of curriculum. In New Latin, it means "a course of study" (Curriculum, n.d.). The narrow sense can be the aggregate of courses of study given in an educational institution, or the plans made for guiding learning in schools, usually described in documents (textbooks, curriculum guides, course syllabi, lesson plans), of several levels of generality, and the execution of those plans in the classroom as experienced by learners. In general it includes the composition of all the experiences children have under the teacher's guidance (Caswell & Campbell, 1935); those experiences occur in a learning environment (classroom, laboratory, outdoors), which also influences what is learned.

In this study, curriculum encompasses both narrow and broad definitions, including the course outline and syllabus set by the school, teachers' teaching plans, teaching materials, handouts and worksheets and other documents, as well as teachers' teaching methods, the

learning environment, the learning objectives and everything students experience in a learning environment.

Teachers in Lanyu

Teachers who come to Lanyu to teach have three identities: Regular teachers, Full-time substitute teachers with qualifications, and Full-time substitute teachers without teacher's certificate. **Regular Teachers** are qualified, full-time teachers with tenure. **Full-time substitute teachers** are contract-based. In this paper, 'substitute teachers' refers to full-time substitute long-term teachers, acting continuously for more than three months. More than half of the substitute teachers in Orchid High School do not have a teacher's certificate.

To obtain a Teacher's Certificate in Taiwan, students must have completed pre-service teacher education, passed a teacher qualification examination, and have completed the practical education training with satisfactory results during the period of studying for a bachelor's degree or higher. Qualified teachers may sit for recruitment of regular teachers.

Due to the low birth rate, the number of teachers in Taiwan is an oversupply. Recruitment of Regular teachers has a very low acceptance rate. The acceptance rate varies from year to year, but the average acceptance rate is around 0.4% to 5%(*教師甄試錄取率 [Teacher Screening Acceptance Rate]*, n.d.). There are also more and more restrictions on the qualifications for obtaining a teacher's certificate. Even if preservice teachers get a teacher's certificate, it is difficult to get tenure.

Regular teachers at schools in remote areas are employed in one of the following methods: (1) Joint recruitment; (2) Transfer; (3) Placement of government-funded student teachers;(4) Recruitment specifically for schools in remote areas.

Summary and Preview

After the implementation of Experimental Education policy, Ethnic courses have more room for wider and deeper development. However, at present, almost all secondary schools that implement Ethnic Experimental Education adopt dual-track curricula, which is divided into general education and Ethnic Education. Subject field courses and culture courses are not integrated. As mentioned in the curriculum plan of Datong Junior High School, the goal in the first three years is to construct a complete Tayal culture curriculum and adjust it according to the needs of the curriculum implementation. The goal of the mid-term three years is to combine the general education curriculum and the Tayal culture curriculum, not only to acquire basic academic skills but also to have a deeper understanding and experience of tribal life and traditional culture. The long-term goal is to turn innovative teaching materials and teaching methods into sustainable development when the general education curriculum and Tayal cultural curriculum are stable and mature.

In addition, schools at the secondary level did not implement Ethnic Experimental Education until 2018, and the six schools have different environments and resources. For example, the Tayal culture teachers at Datong Junior High School are all Tayal people, while at Orchid High School in the outlying islands, the culture courses are mainly taught by Han teachers. Several Tayal system schools have a relatively complete curriculum development organization system composed of teachers, Knowledge Keepers and Tayal Cultural Advisors, curriculum professional education partners and scholars, the team of the County Government Education Office, and the community to establish ethnic-cultural education curriculum.

However, most schools describe the outcomes of Ethnic Experimental Education but have few accounts of experiences and tensions in developing and implementing the courses. This

study hopes to explore the possibility of integrating science education into Ethnic Experimental Education. The study explores the role science education can play in school-based Ethnic Experimental Education curriculum development so as to connect students' lifeworlds with the culture of school science, as well as teachers' experiences and tensions in participating in Ethnic Experimental Education courses.

CHAPTER 3

METHODOLOGY AND METHODS

Introduction

This chapter is made up of seven parts, namely: (a) Setting of the Study, (b) Methodology, (c) Participants of the Study, (d) Methods, (e) Sources of Data, (f) Data Analysis, and (g) Ethical Considerations. In this chapter, the term "Ethnic Education" refers to the Ethnic Experimental Education that Orchid High School developed based on the Enforcement Act for School-based Experimental Education.

The setting of the study section describes the Tao tribe in Lanyu and the school context, a brief introduction to the Ethnic Experimental Education Curriculum, and the impact of COVID-19 on the study. It might help the reader understand specific research locations. In the Methodology section, the methodological perspective of Participatory Action Research as the research methodology is described. In the research participants section, participants are categorized as primary, secondary, and tertiary participants. This section includes a short description of the participants and the selection criteria.

The Methods section discusses the generalized description of the steps of Participatory Action Research needed to satisfy the study's purpose and explore the research questions. The description primarily revolves around the phases of the procedure, timeline, and study methods. The primary and secondary data sources are described in relation to the research questions and the contexts in which the data were collected in the data sources section. In the data analysis

section, the discussion provides the analysis foci and the theoretical basis of analysis of unit plans. The last section addresses the ethical considerations associated with the chosen methods.

Setting of the Study

Tao tribe in Lanyu

The Yami/Tao tribe is an Austronesian ethnic group native to the tiny outlying island of Taiwan's main island, Tao people call it *Pongso no Tao* (island of human beings). It is governed as Lanyu Township of Taitung County, Taiwan. Lanyu is also known as Orchid Island. Just like its name, this island used to be full of orchids, but because of the purchase by Taiwanese horticulturalists, people began to over-harvest and illegally harvest orchids. The orchid habitat was destroyed by human development, and the orchids slowly disappeared on Orchid Island.

Figure 3. 1

Geography Location of Orchid Island

Note. Google. (n.d.). [Google Maps of Orchid Island]. Retrieved December 4, 2021, from https://goo.gl/maps/zMk6FNyMFgoLHPXc7

Compared with other Indigenous groups in Taiwan, the Tao people living on the island are the only Indigenous group with complete geographic boundaries. In 1877, the Qing Dynasty claimed the island as part of the Chinese empire but could not effectively rule the people living on the island. The island was ceded to Japan and Taiwan's main island in 1895 until World War II. During this time, the government deemed it an ethnological research area, prohibiting outsiders from entering and excluding any outside influence that might drastically interfere with the Tao peoples' ways of life. Therefore, Tao people retain a higher proportion of their traditional culture than many other Taiwan's Indigenous societies. The Republic of China took control of Lanyu in 1945. Tourism was introduced to the island in 1967. In 1968, compulsory education was extended from six years to nine years. Junior High School was established in 1969 (Taitung County Lanyu High School, n.d.). The Atomic Energy Council (AEC) chose Lanyu as a temporary storage facility for mid and low-level nuclear waste and completed the facility in 1980 (Taiwan Power Company, n.d.). The first shipment carrying nuclear waste arrived in Lanyu in May 1982. The only power plant on the island was constructed in the same year. At this point, Tao people were gradually introduced to new varieties of modernization. In 1988, the Tao people launched the first "220 Expel the Evil Spirits of Lanyu" anti-nuclear waste campaign, which was the first demonstration of the Tao people's history.

Today, The Tao language is still spoken on the island. It is not a written language, but due to the missionary needs of the church, the writing systems of a number of romanization schemes have been used to write Tao languages since 1987. Due to tourism development and the implementation and popularization of national compulsory education in 1968, the population under 60-years-old all can speak Mandarin Chinese. In addition, most teachers are not Indigenous, and the primary language used in the school is Chinese. Therefore, the Tao language

is mainly spoken by grandparents and older generations; while the parent generation may understand it, they do not speak it to children or among themselves. In recent years, the school on the island has actively promoted Tao Language teaching and learning.

There remains no certainty as to how the Tao people began their lives on the island. However, the Tao people and the Batan people of the Philippines are similar in language and culture (West, 2009). Archaeologists and linguistics trace the history of the Tao people to ancestors that left the Batan Archipelago in the Philippines and made their home on the island approximately 800 years ago. The Tao culture has an intense connection to the ocean as being about much more than survival. It is significantly different from the other Indigenous groups on the main island of Taiwan. The Tao people are the only Indigenous group of the Republic of China that earn a living through fishing; however, they also grow crops such as millet, sweet potatoes, and taro.

School context

There are four elementary schools on the island, but Orchid High School (pseudonym) is the only high school on the island. In 1997, the school was restructured into a complete school, which refers to the middle school (7^{th} – 9^{th} grade) and high school (10^{th} – 12^{th} grade) in the same school. Depending on the community's characteristics and needs, the school may offer academic-oriented or vocational courses at the high school level.

In the 2020-2021 academic year, there were 30 teachers, including 14 tenured teachers, three of whom are Tao/Yami Indigenous People, and 16 substitute teachers, four of whom are Tao/Yami Indigenous People. There were 90 students in 7^{th}-9^{th} grade, and 97% of students were Indigenous. There were 55 students in 10^{th} -12^{th} grade, and they were all Indigenous (K-12 education administration ministry of education, 2021). After graduating from junior high school,

most students would go to Taiwan's main island to study for high school. More than 50% of students obtained a C level (needs improvement level) in natural science in the Comprehensive Assessment Program for Junior High School Students, which indicates that the students' ability in the subject is seriously lagging.

The lead researcher was a former teacher at the school. Based on her experience, teachers have a lot of interaction with colleagues in daily life because most of the teachers are non-locals. They live in the school's teachers' dormitory together. Many teachers cook and eat dinner together after getting off work; on weekends, some teachers also hang out, swim, or have a picnic on the island together for leisure and entertainment. In addition to the relationship between work partners, teachers have also established friendships. However, teaching on the island has many challenges for teachers; for example, transportation between Lanyu and Taiwan's main island is often shut down due to weather factors. In addition, most teachers were trained and grew up in a different culture. Even though teachers have certificates and teaching experience at other places, they are likely frustrated at implementing pedagogy because they do not understand the culture on the island and in the school.

The various inconvenient conditions cause teacher recruitment difficulties and a high turnover rate. Students have to face new teachers every year. The students need to adapt to new teachers, and the new teachers need to adjust to the new environment, while older teachers need to adapt to working with new teachers. Because the school is small, most teachers face out-of-field teaching experience. Moreover, many substitute teachers have no professional education training, no teacher qualifications, or even teaching experience.

Ethnic Experimental Education Curriculum

Orchid High School implemented the Ethnic Experimental Education Project and began to develop an Ethnic Experimental Education Curriculum in 2017 (See figure 3.1). The core of the Ethnic Experimental Education Curriculum is the Tao language and culture. It integrates the learning areas of the national curriculum. The national 12-year Basic Education Curriculum includes Domain-specific curriculum and Alternative curriculum. School separated the 18 sessions of Mandarin Chinese Language, English, Social Studies, Mathematics, and Natural Science from Ethnic Experimental Education and taught independently at other times because those five learning areas from the Domain-specific curriculum are the examination subjects of the Comprehensive Assessment Program (CAP) for Junior High School Students.

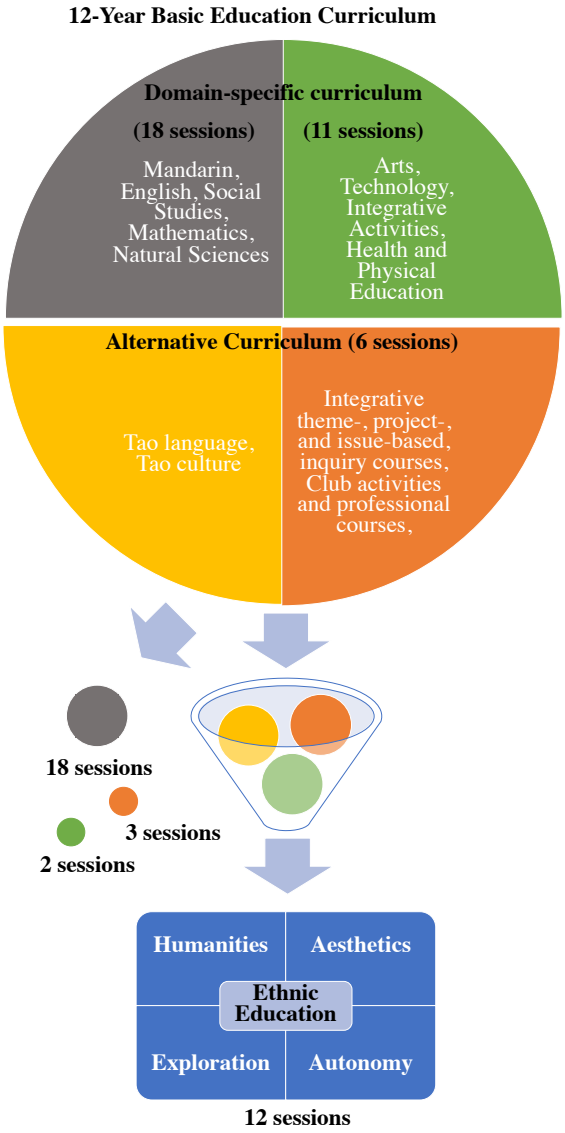
The school retains one physical education class and one technology class and merges the other nine sessions of Arts, Technology, Integrative Activities, and Health and Physical Education with three sessions from alternative curriculums to form 12 sessions of Ethnic Experimental Education Courses (Erin, personal communication, July 11, 2021). The school divided the Ethnic Experimental Education Courses into four areas for the convenience of the class schedule: Humanities, Aesthetics, Exploration, and Autonomy. Each area has three sessions and is co-taught by three interdisciplinary teachers. Among them, Humanities, Aesthetics, and Exploration courses have a cultural curriculum outline. The Humanities course talked about everything in daily life—the relationship between people in the community. Exploration courses focused on exploring cultural knowledge in the mountains and the ocean. The Aesthetics courses were the art of life.

Although science sessions are not included in Ethnic Experimental Education, the curriculum can be arranged so the teachers with a scientific background can participate in Ethnic

Experimental Education curriculum development. The traditional knowledge emphasized in Ethnic Experimental Education courses has the potential to connect with scientific inquiry and knowledge. Local phenomena can provide the context for Inquiry-Based Approaches because Indigenous People have traditionally engaged in science by narrating and observing natural phenomena to construct Traditional Ecological Knowledge.

Figure 3. 2

The Sessions Allocation of the Ethnic Experimental Education Curriculum



Impact of aspect of COVID-19 on the study

In December 2019, cases of pneumonia of unknown cause continued to appear in Wuhan, China. Neighboring Taiwan Center of Disease Control immediately initiated preventive measures such as travel notices and border control. On January 21, 2020, the first confirmed case of overseas immigration occurred in Taiwan. During the Lunar New Year holiday, the students had just started their winter vacation. To ensure campus environmental health and safety, complete epidemic prevention operations, and environmental cleaning and disinfection before beginning class, schools at all levels extended the winter vacation for two weeks to February 25. The Spring semester of the 2020 school year was from February 25 to July 14, 2020. Other than that, because of the improvement of the epidemic prevention strategy and the cooperation of the people, Taiwan had only 799 cases by the end of 2020. With the mandatory mask policy, life in Taiwan was normal, and students still attended school in person.

However, an outbreak among airline crew members in late April 2021 led to a sharp surge in cases. In response to the third level of the epidemic prevention alert, the Ministry of Education announced on May 18, 2021, that schools at all levels, including public and private kindergartens, would stop attending institutions. The various educational institutions, such as children's after-school care service centers, cram schools, etc., also suspended classes simultaneously. All students began to learn remotely at home. At the same time, public places such as concert halls, museums, art galleries, and cinemas were closed. After more than three months of hard work, the epidemic has slowed down, with about 16,000 confirmed cases, so the school started face to face again on September 1, 2021. One month after the start of school, the number of new cases per day was less than ten people.

The lead researcher returned to Taiwan in April 2021. After two weeks of home quarantine period of 14 days and two weeks of Self-Management, she arrived in Lanyu on May 2. The researcher expected to participate in the school curriculum development and teaching on-site from May to July. However, after two weeks, the school changed to online classes. Lanyu is an isolated island. On the whole, the isolated island is safer than Taiwan's main island, so most teachers remained in Lanyu. Teachers still lived and worked at the school. Therefore, the only difference was that the students were attending remotely while researchers and teachers hosted online courses in the classroom at school.

Because the teachers were busy adjusting the curriculum and adapting to the online teaching, it was difficult to schedule interviews with teachers. To improve the feasibility and complete the study, the interviews were maintained twice except for the five participants who had already been interviewed once. The interviews with the remaining nine participants were changed to one-time interviews. The interviews were face-to-face, about one hour to one and a half hours.

To understand students' experiences in Ethnic Experimental Education courses, the researcher planned to observe and have informal conversations with students in the classroom. Still, the courses switched to remote teaching, and the researcher could not interact with the students directly. The lead researcher could only obtain students' feedback from virtual meetings such as Google Meet and the worksheets or assignments they submitted to google classroom. It was difficult to control the learning situation of students. Teachers had to adjust the original class plans to online learning. Teachers faced different challenges than before. For example, Exploration classes of Ethnic Experimental Education were primarily outdoor classes. Still, in the Tertiary Prevention alert, students could not gather together, and teachers could not ensure

the safety of students going outdoors by themselves either. As a result, the courses had become more static, such as data organization, writing reports, making videos and presentations, and other digital technology learning.

Methodology

By examining science education as a cultural and cross-disciplinary phenomenon, this cultural study of science education was conducted as Participatory Action Research (PAR) in a high school in an Indigenous community in Taiwan. The goal was to restructure the curriculum in ways that fit the lifeworld of Indigenous students.

Participatory Action Research (PAR)

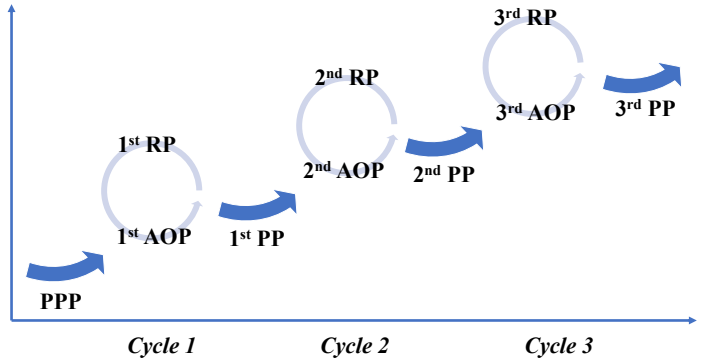
Participatory Action Research (PAR) is research conducted by participating with the goal of reform action. It is an approach to inquiry and resolving practical problems. The process involves researchers and participants working together to understand a problematic situation and change it for the better. PAR focuses on collaboration, education, and action (B. L. Hall, 1981) with an explicit social transformation orientation (McTaggart, 1997).

PAR considers participants as competent and reflective agents capable of participating in the entire research process, such as collecting and analyzing data and determining what action should follow (Kindon et al., 2007). PAR pays attention to power distribution and advocates that power is deliberately shared between the researcher and the researched (Baum et al., 2006). The line between researcher and participants is blurred in the context of PAR. The participants are treated as partners rather than research subjects. Therefore, the “researched” are expected to actively be involved in the process. In essence, PAR is the collaborative process of generating knowledge production that involves participants and researchers.

The research procedure of PAR is cyclical in nature. Each cycle of the PAR process comprises a planning phase (PP), an action-and-observation phase (AOP), and a reflection phase (RP) (Kemmis & McTaggart, 2005). To improve scientific rigor and enhance the engagement of participants, a preliminary planning phase (PPP) is added to the PAR cyclical process and the use of a professional co-development group (PCG) (Langlois et al., 2014). The Preliminary Planning Phase (PPP) work includes conducting a literature review on Indigenous science's empirical research in formal education, (virtually) visiting targeted workplaces, introducing the study to interested practitioners, recruitment, and identifying the studied phenomenon. Teachers participating in the curriculum design group can be regarded as a Professional co-development group (PCG). The common goal is to effectively improve practice through a participatory, systematic, and action-oriented process.

Figure 3. 3

Participatory Action Research Procedure



The rationale for the Methodological Approach Selection

Participatory Action Researchers believe that the world is constructed through action, interaction, and collective agency. This "participating" concept is similar to the viewpoint of

Traditional Ecological Knowledge (TEK), which "focuses on relationships between knowledge, people, and all of Creation (the "natural" world as well as the spiritual). TEK is viewed as the process of participating (a verb) fully and responsibly in such relationships rather than the specific knowledge gained from such experiences (McGregor, 2008, p 145).

Besides, anthropological researchers categorize Indigenous society into two types: equal rights society and class society. Tao people belong to an equal rights society. They believe that all people are equal; therefore, there is no official leader in Tao society; any decision is based on consensus; they respect each other's voices. They believe learning is holistic, reflexive, reflective, experiential, and relational, which focuses on connectedness, reciprocal relationships, and a sense of place. PAR's principles and characteristics are coherent to the Tao peoples' worldview, such as equal power distribution. Knowledge is contextualized in real-life problems, and they value diverse experiences. Therefore, PAR is chosen as the methodology of this study.

Participants of the Study

The researcher lived in Lanyu for two and a half months. Initially, she only recruited teachers who designed the ninth-grade Exploration course together as participants. Still, after interacting and communicating with other teachers and staff on the school site, she found that they had different experiences and ideas about Ethnic Experimental Education. Their voices should also be heard and included. The researcher joined the 9th-grade Exploration course and Autonomy course in the 7th and 8th grades as a volunteer teacher during the fieldwork period. Each course had three 50-minute sessions. In the end, the researcher interviewed 14 participants, including teachers, administrators, staff, Elder, and community members.

According to the level of involvement in this PAR continuum research study, participants are divided into primary, secondary, and tertiary participants.

The primary participants

The primary participants were co-teaching teachers of the ninth-grade Exploration course of Ethnic Education. They developed the curriculum, joined weekly class planning meetings, taught classes, and evaluated students together. They participated in two interviews and one focus group.

Mike (pseudonym) was hired as a math substitute teacher. He is a former colleague and friend of the lead researcher. After the researcher approached the school administrator and expressed that she wanted to participate in developing the Ethnic Experimental Education curriculum, Mike was her primary contact. He had taught at the school for five years. Besides 7th and 10th grade math, he also led the 9th-grade Exploration course and 7th, 8th, and 9th-grade Autonomy courses. Although Mike was not a science teacher, he committed to incorporating science into the Ethnic Education curriculum. He was not a certified teacher and had no formal teaching experience before working at the school. Still, he was very passionate about teaching and willing to try new teaching methods and materials.

Emma (pseudonym), a former English substitute teacher at this school, was a freelancer with an environmental education background. Because of her interest and enthusiasm for Ethnic Education, she participated in Ethnic Experimental Education for three years as a volunteer teacher.

Pat (pseudonym), a P.E. teacher, was an Indigenous Tao teacher. She grew up and studied on Taiwan's main island and only returned to Lanyu during the winter and summer vacations. Pat was not very familiar with the Tao language and culture. However, she agreed

with her identity as Tao. She participated in weekly meetings very seriously and provided resources and opinions as far as possible. For example, she asked her grandmother if the class could visit her taro field to incorporate relevant science into Ethnic Education.

Echo (pseudonym) is a former science substitute teacher at this school for two and a half years. She left Orchid High School to pursue a Ph.D. in the southeastern part of the United States of America before the school began the Ethnic Experimental Education program. She grew up on the island until fourth grade, so she was relatively familiar with the local culture. She is the lead researcher of this study. She participated in the weekly co-planning meetings with teachers via Zoom or other communications software. Her role on the team was that of a provider of scientific knowledge. When the team decided which cultural topic to work on, she provides the scientific knowledge that students learn in school that could be combined with that topic.

In fact, there was another co-teaching teacher, Sam (pseudonym), in the ninth-grade Exploration class. But he did not intend to participate in the research. He was also the only tenured teacher in this group. He had taught at this school for three years. However, this was his first year of participating in Ethnic Education courses. He attached great importance to his right to work only within the prescribed working hours. Therefore, it was difficult to engage him in discussing Ethnic Experimental Education outside of the class planning meeting.

This study can be roughly divided into two parts – (1) developing the curriculum for the ninth grade Exploration course of Ethnic Education and (2) the tensions that teachers and faculties and community members experienced in the process of participating in curriculum development and implementation. The primary participants were the professional co-development group (PCG) in the first part of the study. Outside the relationship of colleagues, their friendship was established, and they shared a common interest in education. The lead

researcher's previous identity as a science teacher in the school, in some sense disrupted clear boundaries between the researcher and the "researched" and allowed for the collaborative inquiry. The PCG had a LINE group chat, a freeware app for instant communications on electronic devices. They could discuss the courses and share information and photos at any time.

The PCG also gave ideas and suggestions for the second part of the study, such as the study focuses, procedures, interview questions, interviewees, and the methods of evaluating students' experience in Ethnic Experimental Education classes together. However, because of the time restraints and information confidentiality, the teachers did not conduct the Institutional Review Board (IRB) training. Therefore, the lead researcher had greater responsibility for all the interviews and the data analysis, while the rest of the team discussed the findings with her and participated in the member-checking.

The ownership of the first part of the study was shared with teachers who developed the curriculum together, including data such as unit plans and course teaching materials and publications. Teachers of the PCG were the co-authors when the lead researcher published conference papers. Results of the second part of this study were anonymized and shared with teachers in Orchid High School in summer 2022. In particular, the method of curriculum evaluation and analysis, as well as the curriculum and overall suggestions for the school to continue to implement Ethnic Experimental Education in the future were shared with participants.

The Secondary participants

The secondary participants participated in at least one interview. They were classified into three categories:

1. Teachers who co-taught Exploration courses in 7th -8th grades: Polly, Max, Eric, and Ivy
2. People who participated in Ethnic Experimental Education but did not teach in Exploration courses. They were included because they play an important role in Ethnic Experimental Education development or have different interpretations and ideas of Ethnic Experimental Education. This group includes teachers—Erin and Eva, administrator—Peter, assistant of the Ethnic Experimental Education project—Leo, cultural instructor Elder—Luna, and community members who had participated in the curriculum development preparations—Mary.
3. Teachers who had not participated in Ethnic Experimental Education had different opinions and their practice methods on Ethnic Education: Sophie

Polly (pseudonym), a tenured P.E. teacher, was a teacher in the 7th-grade Exploration course of Ethnic Education. She is from one of the Indigenous groups of Taiwan but not native of Lanyu. Polly has taught in this school for eight years, and she has participated in the whole process of Ethnic Experimental Education, including the preparatory period. She is a former colleague and friend of the lead researcher.

Max (pseudonym) is a Certificated Math teacher. He was new to this school and had been a substitute teacher everywhere. He has taught for ten schools. He co-taught the 7th-grade Exploration course with Polly and Eric.

Eric (pseudonym), an English teacher, is from one of the Indigenous groups of Taiwan but not native of Lanyu. This year was his second year participating in Ethnic Experimental

Education. He appreciates this kind of education and wants to bring this way of teaching back to his tribe.

Ivy (pseudonym) is an Indigenous Tao teacher who grew up and studied on Taiwan's main island, except for the middle school period. Because the former substitute teacher suddenly left, she joined the school for the first semester as a substitute teacher in the Integrative Activities. But Integrative Activities courses have been integrated into Ethnic Experimental Education. She and Pat co-taught the 8th-grade Exploration course. The other co-teaching teacher, Maggie, in the eighth-grade Exploration class did not intend to participate in the research. She is not Indigenous, and she is the only tenured teacher in this group. However, she said she "has no interest" in Ethnic Education, so she worried that the interview would only become a complaint.

Erin (pseudonym) is the main person in charge of the Ethnic Experimental Education project. She has been teaching on this island for more than 20 years. Although she is not Indigenous Tao, she has a considerable understanding of Tao culture.

Eva (pseudonym), one of the three Indigenous Tao tenured teachers in this school, taught English and Humanities courses. She is a former colleague and friend of the lead researcher. She participated in Ethnic Experimental Education, but she had a different perception of Ethnic Education as a local. She believed that Ethnic Education is a compensation for the previous assimilation education.

Peter (pseudonym) is a new administrator who had just arrived for two years. The Ethnic Experimental Education project started before he took office. Peter expected that the development of Ethnic Experimental Education could enhance students' learning motivation and

learning achievement. Especially with a STEM background, he supported learning scientific knowledge and inquiry in a cultural context.

Leo (pseudonym) is an Indigenous Tao community member who is working as an assistant with the Ethnic Experimental Education project. He did not participate in the discussion of the course preparation. Still, he acknowledged the progress of the course. Leo provided needed resources, such as looking for an Elder in the tribe to be a lecturer or preparing local materials used in the classroom, such as wood samples of different tree species, flying fish, sweet potatoes, taro, etc.

*Luna (*pseudonym), the Tao language and culture teacher, is also the Elder of the community. She only participates in the class planning weekly meetings when the co-planning team asks her to support their understanding of traditional cultural knowledge and provide guidance regarding the feasibility of the lessons. Luna offered suggestions and insights. For example, Luna would be consulted if the teachers want to know whether the current state of the field and the season are suitable for growing taro and whether it can be included in the class schedule.

*Mary (*pseudonym*)* a Chief Executive Officer of a Non-Profit Organization on the island. She has been an important community member in promoting the cultural industry and cultivated cultural education on the island for many years. Therefore, when the school started to develop the Ethnic Experimental Education curriculum in 2017, the school invited her to participate as a project member to provide cultural knowledge and suggestions.

Sophie (pseudonym), a tenured science teacher, was not Indigenous Tao but familiar with Tao culture because she had taught in this school for more than 20 years. She did not participate in Ethnic Experimental Education because she held different opinions on the current

implementation methods of Ethnic Education. However, she practiced culturally responsive teaching in her science classroom in her own way.

Table 3.1 describes the final participant list, including primary and secondary participants. The participants all speak Chinese; the Elders from the community originally spoke the Tao language and now have learned Chinese and communicated in both languages.

The tertiary participants of the study were the 28 students in the 9th-grade students in the Exploration course. They were all Indigenous Tao. They were the first batch of students in Ethnic Experimental Education. In the fall semester of 2018, when they were in the seventh grade, the school began implementing the Ethnic Experimental Education curriculum.

Selection Criteria

In 2019, the lead researcher contacted Erin (administrator) to express her willingness to participate in the development of Ethnic Experimental Education. After reading the Ethnic Experimental Education curriculum, the researcher discussed with Erin and they decided that the Exploration course had more places to integrate science education, such as traditional commonly used tree species with plant science, drying flying fish with osmotic pressure, and traditional canoe with density and buoyancy, etc.

The researcher and Mike, who taught the ninth-grade Exploration class, were former colleagues and friends. After Mike asked other teachers in the same group for their wishes, the researcher began participating in the ninth-grade Exploration lesson preparation from 2020. The lead researcher used snowball sampling to ask the teachers and community members she knows to work closely with her when inviting participants.

Because of Mike, the researcher also began to assist in the curriculum development of the Autonomy course. The purpose of the Autonomy course was originally to integrate other ethnic courses and record what students had learned. However, because of the lack of a cultural focus curriculum, Autonomy courses are often taught based on the class teachers' professional field, such as drawing histograms, Rubik's cube (mathematics), or using microscopes (science), rather than culture-based or place-based. This teaching content is different from the teaching philosophy that expects students to learn scientific knowledge while learning local and cultural knowledge. Therefore, the researcher focused on the 9th-grade Exploration class. In addition, this was the preference of the other teachers who teach Exploration classes in 7th and 8th grades.

Furthermore, the researcher wanted to include the voices and ideas of different people as much as possible. She interviewed one-third of the teachers in the school. Therefore, the final participant interviewees included Indigenous and non-Indigenous people, local and non-local people, new teachers and old teachers, tenured teachers and substitute teachers, teachers who participated and teachers who did not participate, young generation and Elder, administration, staff, etc.

Table 3. 1

Demographic Information of Participants

Participant Name **Bold=Primary Participant,** *Italic=secondary Participant*	Subjects/position	Male or Female	Age	Ethnicity (cultural group identification)	Tenured or Substitute/ Contract	Certificated in Field	Year teaching/ working at this school	Home and family context (Family in Lanyu)
Echo	Former Science teacher/ Volunteer Teacher in Exploration/Lead researcher	F	25-35	Han Chinese	Substitute	Yes	2.5	Single (no)
Mike	Teacher in Math / Exploration/ Autonomy	M	25-35	Han Chinese	Substitute	No	5	Single (no)
Emma	Former English teacher/ Volunteer Teacher in Exploration	F	25-35	Han Chinese	Substitute	No	3	Single (no)
Pat	Teacher in P.E./ Exploration/ Aesthetics	F	25-35	Indigenous Tao	Substitute	No	3	Single (yes)
Max	Teacher in Math / Exploration/ Autonomy	M	35-45	Han Chinese	Substitute	Yes	1	Single (no)

Polly	Teacher in P.E./ Exploration/ Autonomy. Administration	F	25-35	Other Indigenous groups	Tenured	Yes	8	Single (no)
Eric	Teacher in English/ Exploration/ Autonomy	M	25-35	Other Indigenous groups	Substitute	No	2	Single (no)
Ivy	Teacher in Integrative Activities /Exploration/ Humanities/ Aesthetics	F	25-35	Indigenous Tao	Substitute	No	0.5	Single (yes)
Erin	Teacher in English/ Humanities. Administration	F	45-55	Han Chinese	Tenured	Yes	24	Single (no)
Eva	Teacher English/ Humanities. Administration	F	35-45	Indigenous Tao	Tenured	Yes	12	Single (yes)
Sophie	Teacher Science. Administration	F	45-55	Han Chinese	Tenured	Yes	21	Single (no)
Leo	Assistant with the Ethnic Experimental Education project.	M	25-35	Indigenous Tao	Contract	No	3	Single (yes)
Luna	Cultural instructor/Elder	F	Over 60	Indigenous Tao	Contract	No	2	Married (yes)

Peter	Principal	M	45-55	Han Chinese	Tenured	Yes	2	Married (no)
Mary	Community member	F	45-55	Indigenous Tao	Contract	No	1	Single (yes)

Note. Han Chinese is an East Asian ethnic group and nation native to China. They make up over 95% of Taiwan's population. Substitute teachers refer to contract-based, full-time, long-term substitute teachers. Tenured refers to Regular Teachers who are qualified, full-time teachers with tenure.

Methods

PAR is contextualized and addresses real-life problems. It integrates and reflects the values and beliefs of the local community. It values the community's diverse experiences as an opportunity to enrich the research process. It emphasizes the action and reflection cycle through the whole research process in constructing knowledge. It includes various methods and measures to ensure the credibility/validity of knowledge derived from the process according to whether the resulting action solves problems for the people involved and increases community self-determination.

This science education study is focused on culture and cultural processes and is intended to illuminate the process of teaching and learning in science by using an anthropological approach (Hammond & Brandt, 2004). Based on notions of ethnographic data collection methods, this study employs inductive methods rather than experimental methods, interviewing or documentation of dialogue among participants, participant observation or observations, and extensive contact with participants. PAR mainly focuses on dialogue, and collective action, such as dialogic engagement with participants, shared learning, and flexible yet structured collaborative analysis.

PAR can be classified as a type of teacher-research; accordingly, the lead researcher arrived in school and participated in the 9th-grade Exploration course, 7th grade and 8th-grade Autonomy courses of Ethnic Education classes from May to July as a volunteer teacher. The premise of the research methods in this study is for the lead researcher to integrate into the activities and evaluation of the curriculum in a way that does not interfere with the course progress and does not lead to an extra workload for teachers and students. Only the interviews and focus group discussions at the end of the semester are additional research activities. All other

activities or documents are originally existing as part of the routine activities of classroom instruction. The PCG members are asked to participate in and analyze these activities and materials for research purposes.

The action research cycle frames the whole study and involves a dialectical relationship. After preliminary observation, in the planning phase (PP), co-participants collectively discussed various strategic actions to elaborate practical and realistic action plans. This phase took place during the weekly joint lesson planning meetings with teachers and community members to design the new Ethnic Experimental Education curriculum.

During the subsequent action-and-observation phase (AOP), co-participants experimented with these action plans and simultaneously observed the consequences. Teachers implemented the planned lessons in class with students and community elders in this phase. In the reflection phase (RP), students' experienced curriculum was considered. Co-participants engaged in follow-up discussions to jointly analyze their observations, engaged in informal conversations with students, solicited students' feedback and performance in classes, and sought other feedback through the worksheets. A new cycle began with a new PP after the last RP. However, this process was not linear but an iterative and open process to make sense of the learning results obtained in the previous procedure (Kemmis & McTaggart, 2005; Langlois et al., 2014).

Table 3. 2

Phases of Procedure and Methods of the Study

Phase of Procedure	Methods	
Preliminary Planning Phase (PPP) — March-May	Participant observation	• Virtually participate in the weekly collaborative planning meetings of the 9th-grade Exploration and 8th-grade Autonomy course via Zoom (a cloud-based video conferencing) Date: every Wednesday 2am - 5am EST
	Informal, unstructured interviews (conversation)	• During weekly collaborative course planning preparation meetings via Zoom Date: every Wednesday 2am - 5am EST • Conversation via Line (a mobile messenger app)
May-July—on-site research in Lanyu		

	Monday	Tuesday	Wednesday	Thursday	Friday
08:00-08:50					
09:00-09:50					
10:00-10:50		Evaluation—8th grade Autonomy			
11:00-11:50					
13:10-14:00	8th grade Autonomy	7th grade Autonomy			9th grade Exploration
14:10-15:00	8th grade Autonomy	7th grade Autonomy	Planning—8th grade Autonomy		9th grade Exploration
15:10-16:00	8th grade Autonomy	7th grade Autonomy	Planning—8th grade Autonomy		9th grade Exploration
16:00-17:00			Planning—9th grade Exploration		
20:00-21:00			Planning—7th grade Autonomy		

Planning Phase (PP) — May - July	Participant observation	• Participate in the weekly collaborative planning meetings of the 9th-grade Exploration, 7th grade, and 8th-grade Autonomy courses
	Informal, unstructured	• In the weekly collaborative course planning preparation meetings.

	interviews (conversation)	• Conversation via Line (a mobile messenger app) • Record in researcher journal
Action-and-Observation Phase (AOP) — May - July	Participant observation	• In the classroom as a volunteer teacher every week until the semester ends.
	Informal, unstructured interviews (conversation)	• With students in the classroom as a volunteer teacher every week until the semester ends. • Record in researcher journal.

Reflection Phase (RP) — May-July	Formal semi-structured interviews (audio records)	• Two in-person individual interviews with the three primary participants
		  • Initial interview approximately 40-60 minutes
		  Date: 5/15-5/27
		  • The final interviews were approximately 50-80 minutes
		  Date: Between 7/1-7/18
		• One to two in-person individual interviews with 11 secondary participants (five in-practicing teachers, one program assistant, and one community member).
		  • The final interviews were approximately 30-120 minutes
		  • Date:5/19-7/12

	Focus group discussion (audio records)	• One approximately 50 minutes focus group discussion with the three primary participants. Date: 7/6
	Survey	• Ask 9th-grade students to fill out the survey questionnaire to obtain their feedback and perspective on the Ethnic Education class at the end of each unit lesson. (The survey is a required part of course participation. It is not a research activity. Researchers just ask to analyze the surveys for research purposes.) • Date: 6/3
	photo-elicitation interview	• Provide students the photos taken during experiments or class activities in the Exploration course in the past three years. Ask them to review and reflect on what they have learned in Ethnic Education. • Date:6/3
	Document Analysis	• A combination of paper and electronic records in the researcher journal and memo, such as exercise books full of dated notes, minutes of meetings, researcher journal, and narrative field notes.

		• A spreadsheet of class plans and curriculum record-keeping for teams googles drive share. • Classes' worksheet papers or teachers made google forms. • Students' feedback on worksheets or google forms. • Photos and videos teachers take during classes and shared in the album in Line and google album as • Photos are taken during experiments or class activities without the face of people shown in photos. •
Reflection Phase (RP) — August - December	Data analysis	• All the data is collected in Chinese, but the quotes from interview transcripts, journal reflections, and informal conversations or documents are translated into English. • Throughout the action research cycle, the analysis focuses on Planned Curriculum, Translated Curriculum, and Experienced Curriculum

Observation

The lead researcher participated in 19 weekly planning meetings for the 9th-grade Exploration course and 8th-grade Autonomy courses via online software (Zoom). After the lead researcher arrived in Lanyu in May 2021 for the on-site study, she attended meetings and classes of the 9th-grade Exploration course and 7th-grade and 8th-grade Autonomy courses in person as a volunteer teacher. She attended five weekly planning meetings for the 9th-grade Exploration course, seven meetings for 8th-grade Autonomy courses, and seven meetings for 7th-grade Autonomy courses. She recorded what she observed and felt in the researcher's journal and memo.

Below is a detailed description of one of the class planning meetings with teachers as documented in her journal:

We were discussing what to incorporate in the 2021 Spring curriculum of the 9th-grade Exploration course. We wanted to use the process of making taro cakes (traditional food) to teach students to make a scientific inquiry.

Sam believes that there should be a standard process first, and then let the students follow the standard process to implement. But I think Sam's approach is too blunt, like the cookbook experiment teaching way.

But Sam criticized that we do not have the time and resources to do real inquiry-based learning methods.

Other teachers suggested that we let students arrange the steps order of the experiment on their own to discuss the impact on the experiment's results (such as How to make taro cake is the best (tasty)? steamed taro first or mashed taro first?) However, I think "delicious" is very subjective. Science experiment requires data and can be measured. Or they can inquire why the cooked taro is sticky. I think the focus should be on guiding students to think, not on meaningless exchange order of experiment steps (why change the order?) (Echo's Journal, 01/23/21)

The lead researcher participated in two face-to-face and three online classes of ninth-grade Exploration and three face-to-face and four online classes for both 7th and 8th-grade Autonomy courses. She recorded what she observed in class into the field notes, divided into four categories: [ON] Observational notes: a record of the situations, events, and conversations, in which the researcher participates; [TN] Theoretical notes: represent attempts to derive meaning from the observational notes; [MN] Methodological notes: personal reflections on activities in the field, and [OC] Observer's comments: personal comments on how the researcher

felt as they interacted and participated in the field setting. The researcher was not just a complete observer but also played the role of a co-teaching teacher. She assisted in the classroom activity during the classes. Therefore, many field notes were recorded after class by recalling.

Interview

There were three types of interviews in this research: Demographic Map, life history, and semi-structured interviews. The demographic information included positions held in the school, job responsibilities, subjects taught, and teaching experience. The life history interview focused on why the participants wanted to be a teacher, how they came to teach or work in Lanyu, and how they described the school in their words. The life story interview aimed to capture each participant's unique perspective and experience. Since most of the teachers in the school were not locals, they came to a remote and unique isolated island to teach with a different story. The reason they came to the island might make them have different attitudes in the face of cultural shock, education reform, and environmental adaptation, and these attitudes affected their decisions and actions. Semi-structured interviews included (1) teachers' beliefs and understanding of Ethnic Education, (2) the experience of Ethnic Experimental Education curriculum development and implementation (3) the tensions of Ethnic Experimental Education development and practice.

All interviews were digitally recorded and transcribed word for word. Transcriptions were then coded using constant comparative analysis methods.

Focus group

Three primary participants, Mike, Emma, and Pat, participated in one focus group. The focus group was based on the teaching meeting at the end of the semester, including teaching

sharing and reflection. The teachers expressed their opinions on curriculum planning, adjustment suggestions, and the way to evaluate students for the next academic year.

Survey

After the end of each unit, the research team collected students' reflections and feedback on the course with a google form. The google form sought feedback on what students learned, and any suggestions they had for the courses? Also, they used a Likert scale to investigate students' confidence and attitude towards cultural knowledge, scientific knowledge, and other skills. The research team received a total of three surveys from 28 students in the ninth-grade Exploration course.

Photo-Elicitation Interview

In the last class of the semester, the research team provided students with photos taken in the Exploration course over the past three years and let them review what they have learned and their activities. Then they asked students in groups of four to use these photos to make retrospective presentations and share them with classmates.

The presentations contained:

1. Which course units are most appealing to you (the most practical, the most meaningful, the most learned, or the easiest to understand)?
2. What did you do or what happened in this unit?
3. What did you learn?
4. Other things we want to say (course suggestions, tidbits sharing, thanks)

This Photo-Elicitation interview was not formal. It was unstructured and had more dialogue. It was mainly for students to share their learning experience in Ethnic Education.

Students' presentations were video recorded and published online in Ethnic Education Performance Exhibition at the end of the semester.

Sources of Data

The primary research data sources included the interviews, focus-group discussions, field notes, researcher journals, field notes, and culturally relevant science lesson plans. The secondary data sources included archival data, pictures, and video clips. Table 1 shows a matrix of data sources in relation to research questions.

Table 3. 3

Matrix of Research Questions and Data sources

Data Sources	RQ1: Planned curriculum (Development)			RQ2: Translated curriculum (Implement)		RQ3: Experienced curriculum
	How do the participants design, develop, and evaluate the Ethnic Experimental Education curriculum	How do participants integrate scientific knowledge and inquiry with Indigenous Knowledge into the Ethnic Experimental Education curriculum	What tensions do participants experience in developing an Ethnic Experimental Education curriculum and culturally relevant lesson plans	How does the enacted curriculum reflect interactions between students, teachers, and the environment?	What tensions do teachers experience as they enact the planned curriculum for Ethnic Education classes?	How do students experience and learn from the curriculum? What is the nature of students' learning experience?
Interview	X	X	X	X	X	X
Focus-Group Discussions	X	X	X	X	X	X
Field Notes	X	X	X	X	X	X
Researcher Journals/ Memo	X	X	X	X	X	
Culturally relevant unit plans	X	X				
Picture and Video Clips				X	X	X
Online survey						X
Archival Information	X	X			X	X
Artifact	X	X	X	X	X	X

In general, the entire study generated a total of 18 individual interviews, four focus group discussions, 19 field notes, 66 researcher journal entries, three surveys, one Photo-Elicitation interview video, seven culturally relevant unit plans, and unit-relevant archival documents, including worksheets and handouts.

Data Analysis

The analysis focused on Planned Curriculum, Translated Curriculum, and Experienced Curriculum. In the Planned Curriculum analysis focus, researchers aimed to understand how the participants design, develop and evaluate the Ethnic Experimental Education curriculum and what tensions participants experienced in developing the Ethnic Experimental Education curriculum and culturally relevant lesson plans. The primary data were collected from informal conversations recorded in the researcher's journal, observation field notes in the co-planning meeting, and audio records of formal semi-structured interviews and focus groups.

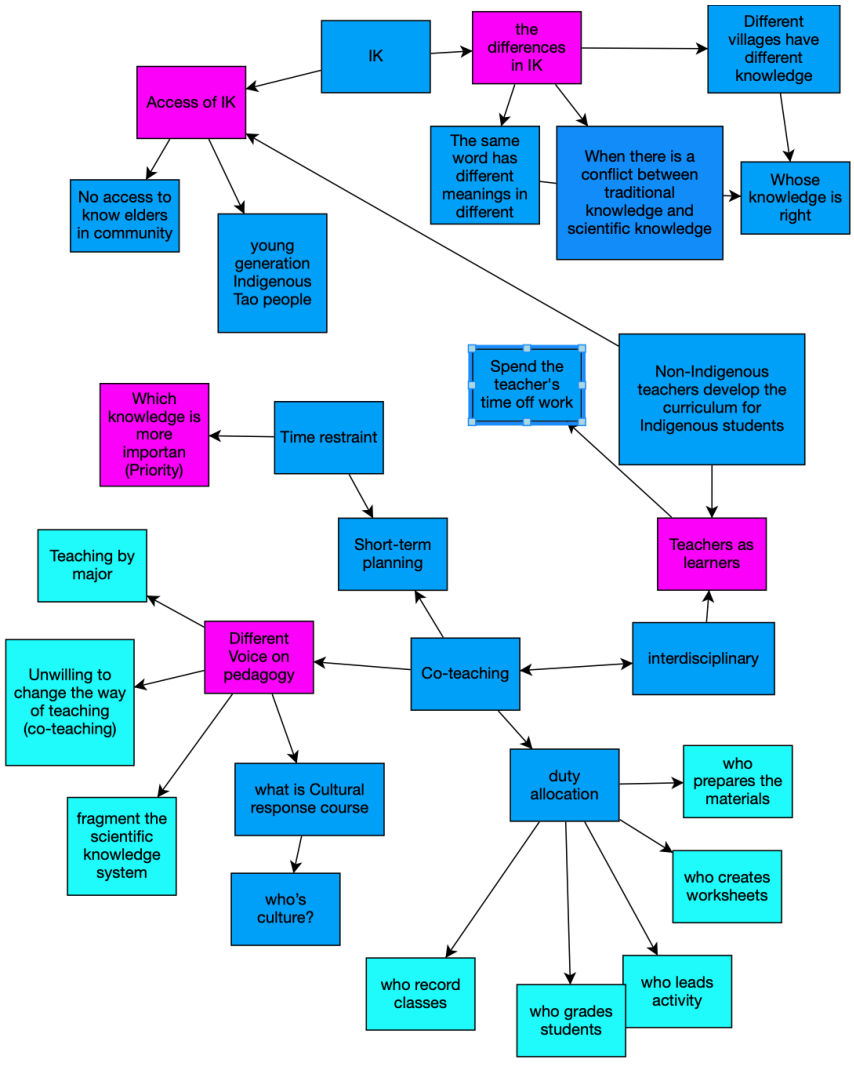
In the Translated Curriculum analysis focus, the researchers aimed to understand how teachers translated the planned curriculum into practice and the tensions teachers experienced as they enacted the planned curriculum for Ethnic Experimental Education classes. The primary data includes informal conversations recorded in the researcher's journal, observation notes in the teaching environment involving interaction with students and coordination of the environment, and audio records of formal semi-structured interviews and focus groups.

Thematic analysis was utilized in this study. To explore the similarities and relationships between different chunks of the data, the analysis started with open coding of the primary data and then the organization of meaningful units into core categories. Themes were developed from the data by coding and analyzing the data simultaneously. Themes were identified in the form of

tensions, a type of productive moment of change that captures the tug-and-pull of an issue. For example, the reason for the implementation of Ethnic Experimental Education — Why should it be changed? Why are teachers resistant to change? The method of execution —a tug-of-war between ideal and reality. What knowledge should be included? What is included? Who should teach it? Where to teach? Etc. Other categories include teacher and student gains and teachers' beliefs and values in relation to the implementation of Ethnic Experimental Education.

Figure 3. 4

The Analytic Memo



To understand how participants integrated scientific knowledge and inquiry with Indigenous Knowledge into the Ethnic Experimental Education curriculum, the unit plans were analyzed using the a priori coding approach. This is a process of qualitative coding of data whereby the researcher develops the codes ahead of time-based on a theoretical framework, the interview questions, or pre-existing knowledge. The researchers examined the cultural knowledge, and scientific subject knowledge integrated into the unit and then further analyzed the degree of integration using Banks' multicultural education model (2008). In addition, researchers used the AKRSI Unit Building Assessment Rubric (Stephens & Alaska Univ., 2001) to evaluate the comprehensiveness of the course, including Cultural relevance, Standard-based, Best Practices, and Assessment parameters.

In order to see how students experienced the curriculum, in the Experienced curriculum analysis focus, researchers analyzed the data collected from the informal conversations recorded in the researcher's journal, informal photo-elicitation interviews, and questionnaires teachers gave students to get their insight into their courses. Documents included the feedback on the worksheets and assignments students did for classes. The items analyzed included students' self-assessment of their learning in the Ethnic Experimental Education Exploration class, their favorite unit, and a description of the unit they would like to improve. The researchers used an inductive method to analyze students' expression of their feelings and learn about the three-year Ethnic Education Exploration course in the photo-elicitation interview.

The research team established the quality of findings in this study by triangulation of data and using various methods to analyze data on the same topic. This involved different types of samples and data collection methods. Because of the time restraint, the lead researcher had a

primary role in data analysis, and co-participants had secondary work involving member-checking. Peer review and member checking are used to making the study more reliable.

Ethical Considerations

Participation is a commitment to a set of values. Participatory research's unique and complex characteristics and contexts make it easier to encounter ethical questions and practical challenges than traditional research paradigms (Manzo & Brightbill, 2007). Compared with other forms of research, PAR might be more likely to reflect ethical dilemmas. For example, it is challenging to guarantee participants' anonymity in community group work. This brings risks to revealing participants' voices; it might cause people to participate in controversial social actions; problems can arise throughout the process and are difficult to predict at the beginning.

Because PAR advocates power distribution between the researcher and the researched (Baum et al., 2006), research may undergo unpredictable changes due to social dynamics and participants' needs. PAR is more dialectical rather than a relatively predictable and linear fashion. It makes PAR difficult to declare every ethical issue in the pre-planning stage. Besides, PAR researchers seek to make an impact, promote change, and create benefits for participants. It is different from other social research methods that believe that ethics means having no negative or perceptible effect on the research subjects. However, PAR researchers can ensure that participants understand the risks and benefits of participation; they have a legal right to know what these are. They only participate in research voluntarily.

Unlike more traditional research methodologies, PAR shortens the distance between researchers and community members and emphasizes the relationship between researchers and participants. Therefore, morality should be viewed as being able to participate effectively, not as

a constraint that restricts the pursuits. The standards of ethics may change over time and based on research projects. In the participatory approach, the nature of ethics is contextual, relational, and dynamic. Manzo and Brightbill (2007) suggested five dimensions of participation that directly have implications for ethical decision-making in PAR— Representation, Accountability, Social Responsiveness, Agency, and Reflexivity.

Researchers, teachers, and other community participants in curriculum development might represent the different knowledge systems and hold various values and beliefs. Researchers should value and respect participants' research interests and perspectives because PAR contains the worldview that all knowledge is situated. Researchers should also work with their participants, partners, and communities to decide whether the research is ethically reasonable, effective, and worthwhile. This way is different from the institutional ethical review procedure requirements that demand the researcher to plan the entire research work before the study. PAR is collaborative and change-oriented. It requires researchers to be responsive to the needs and perspectives of participants in a dynamic research process. It extends the concept of responsibility from academic units to broader social fields. "Every participant in a PAR process must accept the responsibility of recognizing that each of their peers has a right to a voice and a valuable contribution to make" (Manzo & Brightbill, 2007, p.38).

Due to PAR's dynamic and changeable nature, it is challenging to predict Ethical dilemmas at the beginning of the study. Therefore, PAR relies on and promotes the reflective ability of participants. At each stage of PAR, participants must continuously reflect on the ethical review of their projects. It means "the PAR process is flexible, socially responsive, and emergent, and so the questions and issues that require ethical decision-making only materialize as the collaboration between participants and researcher progresses." In addition, this study took

place during the time of COVID-19. It included meeting the quarantine policy of the government. Therefore, some modifications were necessary as a result.

Langlois et al. (2014) established scientific rigor based on Kemmis and McTaggart's philosophical position: Critical Theory. They propose three scientific rigor criteria, which apply to critical theory and thereby to PAR: empowerment through historical consciousness, action stimulus for personal and social transformation, and equity among PAR co-participants. This research was based on the cooperative relationship between researchers and participants, who experienced the process of developing Ethnic Experimental Education together. It provided trustworthiness for the research criteria and authenticity criteria of study by accommodating multiple perspectives in the research, improving participants' self-determination ability and influence on decision-making.

CHAPTER 4

FINDINGS

Introduction

This chapter aims to examine the development of Ethnic Experimental Education and participants' experiences in developing the curriculum. This chapter is divided into four major sections. The first section is the overview of the Ethnic Experimental Education curriculum. It includes the purpose of developing Ethnic Experimental Education and its content. The second section presents the seven culturally relevant units that teachers and researchers designed for the ninth-grade Exploration course of Ethnic Experimental Education in the 2020-2021 academic year and future plans. It reveals what scientific and cultural knowledge researchers and teachers incorporated in the units. The third section describes the tensions participants experienced in the process of developing and implementing Ethnic Experimental Education. The last section is the ninth-grade students' responses and thoughts about the Exploration course of Ethnic Education.

Overview of Ethnic Experimental Education Curriculum

The Orchid High School started developing the Ethnic Experimental Education in the 2017-2018 academic year. At the same time, the Curriculum Guidelines of the 12 Year Basic Education– also called "the 108-curriculum" were put into action in 2019. The Ministry of Education (MOE) promulgated the Curriculum Guidelines of the 12 Year Basic Education system in 2014 to stress the coherence and integration of the national curriculum from Grade 1 to

Grade 12. Therefore, the school organized a curriculum development committee to develop Ethnic Experiential Education courses keeping in mind the 12 Year Basic Education Curriculum Guidelines. The committee included the principal, school administrators (directors of various divisions), coordinators of multiple disciplines, academic program representatives, homeroom teachers, special education teachers, external scholars and experts, industry representatives, student representatives, and parent committee representatives. The school also held workshops to lead teachers to think about what kind of school they wanted, what they were doing, and where the school should go, and then run by the school's vision with the students (Erin, personal communication, July 11, 2021). They visited other Ethnic Experimental schools, visited tribes and community development associations, and other units. After one year of preparation, the Ethnic Experimental Education Curriculum was implemented in 2018-2019 with seventh-grade and 10th-grade students. The following year, eighth-grade and 11th-grade were included. From Grade 7 to Grade 12, the whole school ran the Ethnic Experimental Education courses in the 2020-2021 academic year.

The Orchid High School has 99% Indigenous Tao students. Therefore, the school hopes to establish a six-year consistent learning system based on Tao culture (Grade 7 to Grade 12). By understanding the culture and students' background in coordination with teachers' professions, teachers plan the place-based lessons and school vision with Elders and Ethnic Education teachers and plan professional courses that align with the future and the world. Ethnic Experimental Education corresponds to the core competencies of the 12-Year Basic Education. It brings the life wisdom of Tao people into the school curriculum and guides students to start from their own culture and see its depth in order to build self-confidence and cultural identity as Tao people. It promotes respect for diversity and practices cultural competencies and ethnic equity.

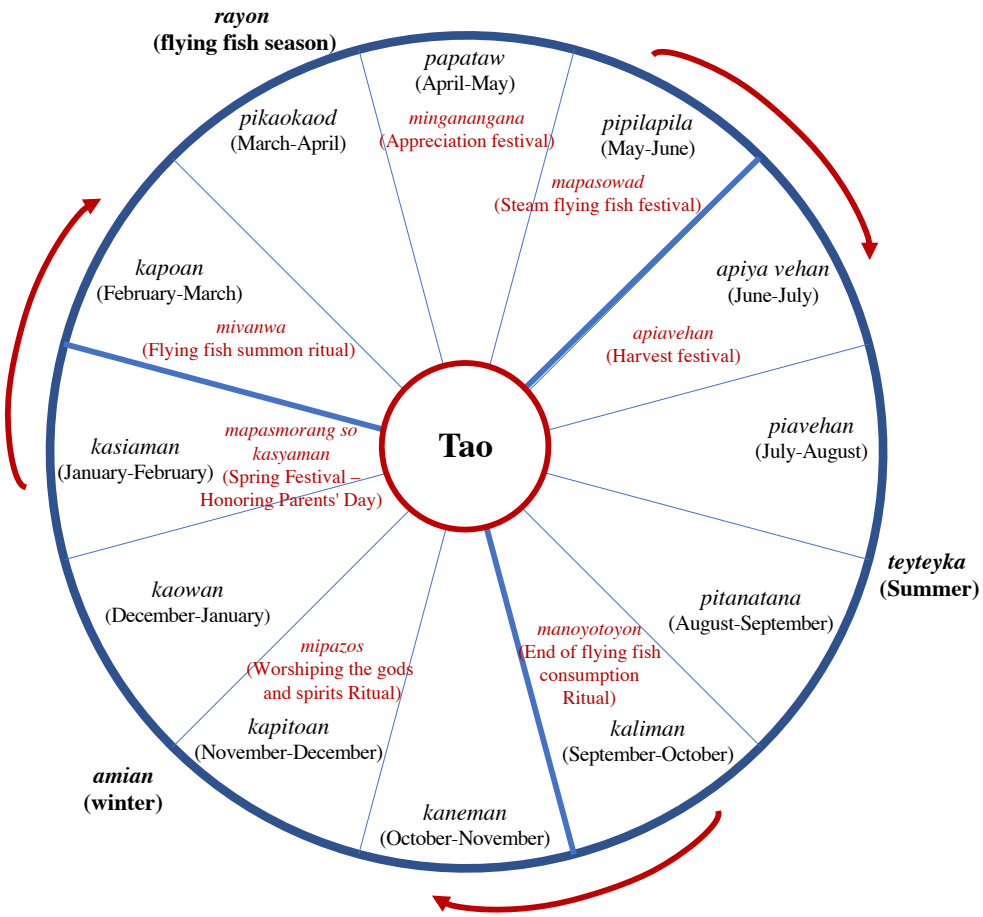
Through the development and implementation of Ethnic Experimental Education, Orchid high school hopes to achieve the school's visions—innovative learning, bravery and excellence, and sustainable Lanyu.

"Tao" is the self-proclaimed name of the Indigenous Tao people on this island. It means "human" in the native language. Ethnic Experimental Education takes the Tao spirit as the core, aligns the annual rituals of flying fish culture (Figure 4.1), follows the pace and cycle of nature, and respects the relationship between humans and the natural environment. Flying fish are regarded as god's fish in Tao culture (Siaman misiva, 2012). They are highly respected and play a vital role in the Tao traditional calendar. *Ahehep no tao* (Lunar Calendar of Tao) is based on phases of the Moon and takes the flying fish flood season as the standard to check and adjust time and divide seasons— *Rayon* (Flying Fish Season, Spring), *Teyteyka* (End of Flying Fish Season, Summer), and *Amyan* (Waiting Flying Fish season, Winter) (Orchid High School Curriculum Planning, 2021).

Flying fish are migratory fishes. They follow the Kuroshio northward to the Lanyu every February-March and return to the south from July-August. *Kasyaman* (January-February) is the month for welcoming flying fish. The *Imorod* tribe at the southernmost tip of Lanyu starts the ceremony of flying fish festivals. From *Kapowan* (February to March) to *Kalimman* (September-October) is the season for eating flying fish. All flying fish must be finished or discarded before *Manoyotoyon* (End of flying fish consumption Ritual) in *Kalimman* to ensure that flying fish is not overfished and to show the wisdom of "food shelf life." From *Kaneman* (October-November) to the coldest month, *Kaowan* (December-January) is the season for planting millet, preparing for the re-arrival of flying fish in the next season.

Figure 4. 1

The annual rituals of Tao culture



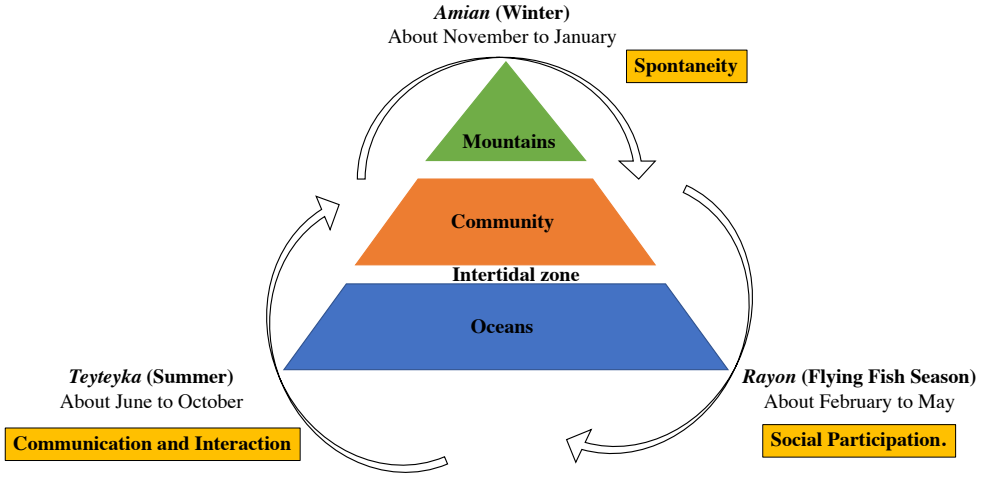
Note. The diagram of the annual rituals of Tao culture is revised and adopted from Orchid High School Curriculum Planning (p. 5), 2021.

Based on the significance of Tao, the three major parts of the Ethnic Experimental Education curriculum include mountains, oceans, and community (Figure 4.2). During *Amian* (Winter), the activity field is in the mountains, forests, and settlements to prepare for the flying fish season. In the spring, with *Rayon* (flying fish season), the activity field is shifted to the ocean area. After entering *Teyteyka* (Summer), the activity area is gradually moved from the ocean to the settlement and mountain forest area.

In the process of circular shifting of the time and space in Tao life, Tao culture also corresponds to the three dimensions of core competencies in the 12-Year Basic Education curriculum—Spontaneity, Communication and Interaction, and Social Participation (Ministry of Education of Republic of China (Taiwan), 2014). Spontaneity involves: Eliciting students' learning motivation and enthusiasm and cultivating active learners; Communication and Interaction involve: Guiding students to properly develop various interaction abilities with themselves, with others, with society, and with the natural environment; Social Participation involves: Assisting students in applying and practicing what they have learned, willing to commit to the sustainable development of society, nature and culture, and build a reciprocal relationship.

Figure 4. 2

Concept map of the combination of Tao culture as the foundation and core competencies of 12-Year Basic Education

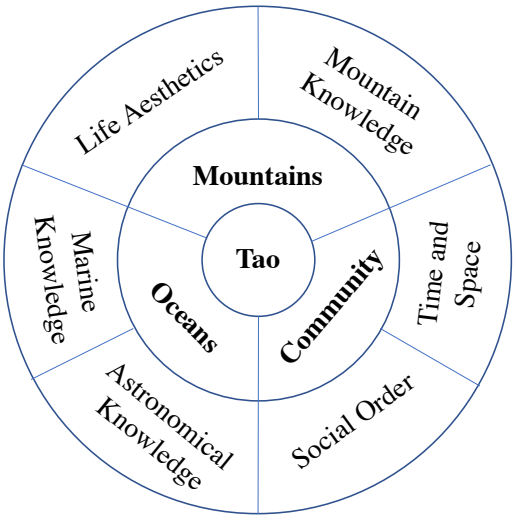


Note. The concept map is revised and adopted from Orchid High School Curriculum Planning (p. 8), 2019.

Based on Tao culture, Ethnic Experimental Education integrates the six aspects of "Time and Space," "Social Order," "Astronomical Knowledge," "Marine Knowledge," "Life Aesthetics," and "Mountain Knowledge" to establish an Ethnic Education knowledge system and develop a six-year consistent curriculum of Grade7 to Grade 12 (Orchid High School Curriculum Planning, 2019) (Figure 4.3).

Figure 4. 3

Ethnic Experimental Education curriculum structure diagram



Note. Tao is the core of the Ethnic Experimental Education curriculum idea, followed by three major topics—Mountains, Oceans and Community. It includes the six aspects of knowledge.

The development of the Ethnic Experimental Education curriculum at the middle school level (Grade 7 to Grade 9) includes 23 sessions of basic subject competencies (domain-specific curriculum) and 12 integrated Ethnic Education sessions (cross-field curriculum) (Table 4.1).

Table 4. 1

Curriculum structure diagram (Grade 7-Grade 9)

Basic subject competence domain-specific curriculum (sessions)	**Integration course of Ethnic Education Cross-field curriculum (sessions)**
Chinese (5) English (3) Mathematics (4) Society (3) Natural Sciences (3) Technology (1) Health and Physical Education (1) alternative courses (Clubs) (3)	Tao Humanities (3) Tao Aesthetics (3) Tao Exploration (3) Autonomy (self-directed learning) (3)
23 sessions	12 sessions

Orchid High School divides 12 sessions of Ethnic Education courses into four courses—Tao Humanities, Tao Aesthetics, Tao Exploration, and Autonomy. Each learning area has three sessions. This arrangement is because many Ethnic Education courses have field trips and practical class activities, such as catching land crabs in the Humanities course and cultivating the taro field in the Exploration Courses (Erin, personal communication, July 11, 2021). These outdoor activities also need to consider the distance and time consumed, so they require a relatively long period.

Table 4.2 shows the course outline of Grade 7 to Grade 9 Ethnic Experimental Education. Only Aesthetics, Humanities, and Exploration courses have a cultural curriculum outline. In contrast, Autonomy courses focus on independent learning and serve as an additional course to other Ethnic courses. For example, students learn to set up a study plan based on their interests. They use technology to summarize what they learned in other Ethnic courses. Or they organize information, arrange, and plan their graduation trips by themselves.

Table 4. 2

Grade 7 to Grade 9 Ethnic Experimental Education Course Outline in 2020-2021 Academic Year

Learning Area	Topic	Time	Grade 7	Grade 8	Grade 9
Exploration	Mountain	September-November	• Self-Exploration • Five sense observation • Dryland crops • Mountain forest Exploration	• Safety and first aid • Traditional plant • The wisdom of taro fields • Record family notation	• Survival in the Wild • Traditional commonly used tree species • Ritual plant planting • Record family water source and distribution
	Community	November-July	• Millet of Lanyu • Making flying fish ropes, and ritual bamboo	• Planting of millet • Land crab	• Methods of Proceedings Millet • *Manmey* (Taro cake)
	Ocean		• Marine life observation • Common fishes of Lanyu	• Snorkeling and swimming • Coral Reef of Lanyu	• Hiking around the island and weight training • Kuroshio Current fish
Humanities	Mountain	September-November	• Cultural reading and writing • Me and Family • The traditional territory of various tribes	• Cultural reading and writing • Clan and tribal organizations • Family woodland and water source	• Cultural reading and writing • Introduction of Taiwanese Indigenous peoples • Family woodland development and inheritance
	Community	November-July	• Cultural reading and writing • Life Etiquette and Norms • Tribe map • Lanyu three seasons	• Cultural reading and writing • Lanyu marriage Culture • Traditional landscape, place name • Traditional annual ritual	• Cultural reading and writing • Lanyu Ethics and Law • Tribal history • *Ahehep no tao* (Lunar Calendar of Tao)

Aesthetics	Ocean		• Cultural reading and writing • Intertidal culture • Flying fish season	• Cultural reading and writing • The sea and familiar creatures of Lanyu • Tribal fishing areas	• Cultural reading and writing • Traditional fishing gear • Tribe and ocean
	Mountain	September-November	• Collection of beauty • Traditional ornaments making • Introduction of totem • Traditional house/building	• Comparison of beauty • Mesh bag making • Elementary Sculptor • Traditional construction method	• Application of beauty • Traditional tool making • Pattern • Traditional totem carving • Traditional architecture explanation
	Community	November-July	• Culture and traditional costumes weaving • Cultural story show • Draw my hometown • Nursery rhymes	• Rattan collection and pre-work process • Cultural stage play • Hometown coloring • Songs of daily life	• Weaving practice (female), rattan weaving practice (male) • Cultural catwalk • Lanyu cultural and creative design • Ritual ballads
	Ocean		Introduction of *Tatala* (Tao Canoe)	Plane *Tatala* (Tao Canoe) carving	*Tatala* (Tao Canoe) model making

There are two classes in each grade, from 7th to 9th grade, and the school combines the two classes in Ethnic Education courses. Every course has three sessions and is co-taught by three teachers. The current curriculum arrangement has also been revised year by year, initially a week of general education courses in the morning and Ethnic Education courses in the afternoon. But some Ethnic Education class activities require a whole day, such as catching land crabs. In Table 4.3, same-grade humanities and Exploration courses are now scheduled on the same day, allowing for a full-day field trip if the courses are coordinated.

Table 4. 3

Seventh- Grade to Ninth-Grade Ethnic Education Courses Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday	
08:00-08:50						
09:00-9:50			9th Autonomy	8th Humanities	7th Exploration	9th Humanities
10:00-10:50						
11:00-11:50						
	Lunch Break & Nap Time					
13:10-14:00	7th Aesthetics	8th Autonomy	7th Autonomy	9th Aesthetics	8th Exploration	7th Humanities
14:10-15:00						8th Aesthetics
15:10-16:00						9th Exploration

Culturally Relevant Unit Plans in the 9th Grade Exploration Course of Ethnic Education

According to the Grade 7 to Grade 9 Ethnic Experimental Education Curriculum Outline, teachers and researchers designed seven culturally relevant units. The curriculum is very flexible and can be adjusted to match school activities. For example, the fourth-week overnight camping was initially held during the Grade 8 Spring semester, but it happened to be suspended due to

COVID-19, so it was postponed to the students' Grade 9 Fall semester. Teachers planned the curriculum outline for the next semester at the end of each semester. The ninth-grade Exploration course co-teacher discussed the detailed lessons for Friday's class at the co-planning meeting every Wednesday. After allocating responsibilities, teachers used their own time to prepare, such as creating training materials and tools, making slides, and designing worksheets. The Ethnic Experimental Education curriculum is integrated with different disciplines. Therefore, the learning content includes the "swimming test" of Physical Education and "camping" of the Integrative Activities courses.

Fall 2020 Semester

In the Fall 2020 semester, excluding the weeks without classes, 9 of 16 weeks were off-campus courses, covering four topics:

1. Survival in the wild
2. Traditional commonly used tree species
3. Ceremonial plant cultivation
4. Record family water source and distribution

Table 4. 4

Ninth-Grade Exploration Course Summary in 2020 Fall semester

2020 Fall			
Week	Date	Topic	Content Outline (Off-campus classes in Grey)
1	08/30~09/05	Survival in the Wild	**Preparation of Overnight Camping** 1. Course introduction, review of overnight camping, and tool inventory 2. Checked cooking boxes and tents 3. Reviewed pitching a tent 4. Assignment: Collect wood for campfires

2	09/06~09/12		**Swimming Test Practice** 1. Warm-up, the introduction of marine safety 2. treading water, jellyfish float, back floating, cramping treatment 3. Returned to school, changed clothes, and cleaned up
3	09/13~09/19		**Swimming Test** 1. Warm-up, swimming test, 2. Water safety- Handling of emergencies on the water 3. Returned to school, organized camping equipment
4	09/20~09/26		**Overnight Camping**
5	09/27~10/03		**Forest Field Trip** 1. Warm-up walked to the prayer mountain in the village 2. The lecturer (Elder from the community) introduced three wild plants: Fiddlehead, Spleenworts (*Asplenium*), and reed 3. Students brought samples back to school and completed the plant observation worksheet.
6	10/4~10/10		Moon Festival (National Holiday)
7	10/11~10/17		National Day of the Republic of China (National Holiday)
8	10/18~10/24		**Review of Forest Field Trip** 1. Students drew their review topics of survival in the wild. Photo review, topic description 2. Students answered five questions individually according to the topic they drew and then completed the group presentation poster 3. Each group shares their answers to five questions
9	10/25~10/31	Traditional commonly	**Yeyin Farm Field Trip** 1. The lecturer (Elder from the community) led teachers and students into Yeyin Farm to learn about common tree species 2. Each student collected and observed the appearance of leaves

		used tree species	3. Reviewed the characteristics of monocotyledonous plants. 4. Returned to school
10	11/01~11/07		Typhoon day-off
11	11/08~11/14		**Wood Density Lab** 1. Students measured the density and hardness of wood samples 2. Students watched the video to compare the differences between the Thao canoe (*Ruza*) and the Tao canoe (*Tatala*) 3. Experiment summary, discussion, and record
12	11/15~11/21	Ritual plant planting	**Taro Fields Field Trip** 1. Students walked to the taro field and allocated ditch works and tools 2. Digging drainage channels in taro fields 3. Back to school, pack up, and clean tools. Teaching and practice of Tao language of tools
13	11/22~11/28		National Paralympic Games (Adjust holiday)
14	11/29~12/05		**Taro Fields Field Trip** 1. Students walked to the taro field and observed other people's ditch. 2. Dug ditch in taro fields 3. Returned to school, packed up, and cleaned tools. 4. Tao language teaching of various parts of staple foods.
15	12/06~12/12		**Millet Field Field Trip** 1. Students walked to the millet field 2. Students observed the cultivation of taro in dryland. 3. Elders demonstrated how to plant *Patan* (*Dioscorea esculenta*) (lesser yam). Students planted *Patan*. 4. Returned to school, packed up, and cleaned tools.
16	12/13~12/19		**Review of Millet Field Field Trip** 1. Worksheets for reviewing the Tao language of farm tools and crop parts 2. Students arranged the planting process in groups and took the Tao language quiz

			3. Tided up information in small groups (including experience and content knowledge of plant reproduction, vegetative organs, and reproductive organs)
17	12/20~12/26		**Preparation of Ethnic Experimental Education Exhibition** 1. Students selected the topic and discussed the presentation mode. 2. Students made posters in small groups 3. Practiced presentation
18	12/27~01/02	Record family water source and distribution	New Year (National Holiday)
19	01/03~01/09		**Water Source of School** 1. Students learned how to use google map to locate the position of water sources 2. Students checked the specified location of the school water source route on google map 3. Students practiced using google map to measure the coordinates of four school buildings
20	01/10~01/16		**Review of Water Source of School** 1. Students converted the check-in coordinates from the google map of the computer 2. Students measured the distance of the water sources diversion route and the area of the school building 3. Course review and questionnaire
21	01/17~01/20		Winter Break

Survival in the Wild

The course of survival in the wild took a total of six weeks, including (1) two weeks of swimming testing, (2) two weeks of overnight camping and preparation, and (3) two weeks of wild vegetable collection and review. The swimming test was a requirement of the physical education class, so this two-week teaching content focused on the psychomotor domain, such as completing the ability grading test and self-rescue in water, including Back floating, Jellyfish

float, and Treading water. Swimming mainly relies on the body's neutral buoyancy in water. On average, the human body has a specific gravity of 0.98 in the inhaled state, which is slightly less dense than water so that the body can float in water. Buoyancy also varies depending on the body's tissue, the degree of air inflation in the lungs, the ratio of muscle to fat, the location of the body's center of gravity, and the salinity of the water. A higher percentage of body fat, or a higher salinity of water, will make the body less dense relative to water, thus increasing buoyancy. Through the opportunity of swimming lessons, the students experienced and experimented to determine whether it is easier to float on the water, back floating or jellyfish floating, and discussed the possible reasons.

Figure 4. 4

Swimming Test

Camping was one of the scouting activities in the 8th-grade integral activities course. This two-week course mainly focused on the psychomotor domain, emphasizing camping knowledge and skills, such as knotting, cooking in the wild, setting up campfires, setting up tents, etc., to improve the ability to survive in the wild. When reviewing the camping activities, the teacher also led the students to discuss why the campfire was difficult to light. The teachers incorporated scientific knowledge about the fire triangle - heat, fuel, and oxidant (usually oxygen). The teacher also brought knowledge related to environmental science to explore, implement and reflect on sustainable ecological protection in the camping activities, such as Leave No Trace and Ethics. The principles of Leave No Trace provide an easily understood framework of minimum impact practices for anyone visiting the natural environment.

Figure 4. 5

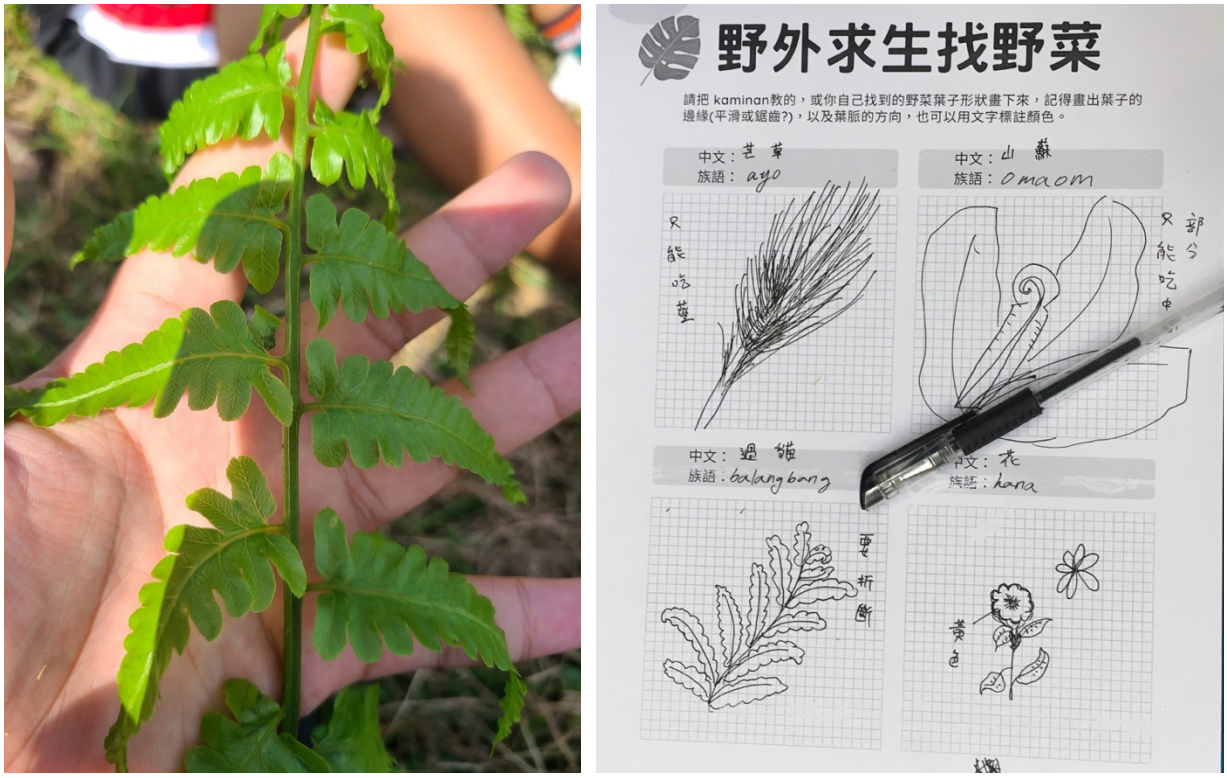
Students practiced setting up a tent.

In the wild vegetable lesson, the Elder from the community took the students to the tribal woods to collect edible wild vegetables. Students recorded the characteristics of wild vegetables

on the worksheets, including the shape of the leaves, the veins, the leaves' edges, and the feel of the leaves, integrating with plant science knowledge. Students collected and observed the sample of plants, including fiddlehead, reeds, coconuts, and hibiscus. In the last week of the "survival in the wild" unit, teachers summarized the three lessons. Students reviewed what they had learned in this unit and made posters in small groups to evaluate their learning effectiveness.

Figure 4. 6

Students observed the appearance of wild vegetables and recorded it on worksheets.



Note. Students recorded the wild vegetables taught by the Elders on the worksheets, including the Chinese name and Tao name, the shape of the leaves, the direction of the veins, the color of flowers, and the edible parts of the plant.

Traditional commonly used tree species

Trees play an essential role in Tao culture and are used to build boats, build houses, make tools, burn firewood, etc. Fiji longan, Breadfruit, and Taiwan Persimmon are used very often. Therefore, some parents plant valuable trees for their children when they are young, and when the children grow up, they can use them. Teachers and researchers used the traditional tree species to make *Tatala* (traditional canon) the topic for the design of this unit. During the first week, community members led teachers and students into the tribal woods to learn about traditionally commonly used tree species. Students observed the characteristics of plants, flowers, leaves, seeds, etc., and recorded them on a datasheet.

Figure 4. 7

The tribal woods field trip

The second week of the lesson class was canceled due to a typhoon. The third week combined the cultural knowledge of building Tao boats with density measurement experiments. *Tatala* (traditional Tao boat) is not made of a single piece of wood or tree. It is mainly categorized into *Tatara* (small boat) for single to two people, which is made of 21 pieces of wood, and *Chinurikuran* (large boat), which is jointly used by eight or ten people for fishing,

made of 27 pieces of wood. The keel is the skeleton from one end to the other end. Because it will move against the ocean and the ground, *Pometia pinnata* with a hard texture is most often used to prevent wear. The afterpart keel links up the bow of the keel with the stern's keel; solid and hard wood like *Neonauclea reticulata* is often used. Each deck level requires six planks to provide for the boat's symmetry and stability. The center of gravity and buoyancy must be considered for the selection of deck materials. For three-layer boards, such as one- and two-person boats, *Neonauclea reticulata* is often used in the first and second levels of the deck to place the center of gravity lower. The lightest and most buoyant wooden planks, such as breadfruit trees (*Artocarpus altilis*), are used at the highest level.

This unit was designed as inquiry based. To solve the problem of using which tree's wood to make keel, students measured and compared the density and hardness of wood samples and collected experimental data. Students designed their own experiments to measure the relative hardness of the woods and used the data they collected as evidence to support their claim. They also compared their result to the Ethnic knowledge they had learned from the Elders.

In addition, through the video, the students got to know another Taiwanese Indigenous group with boat culture, the Thao. The Thao people mainly live in the surrounding area of Sun Moon Lake. *Ruza* (Thao canoe) is the most important means of transportation, fishing, and hunting for the Thao people. *Ruza* is mainly made of camphor, which is cut in half and hollowed out. The general shape is a rectangular hull, the bow is pointed, the stern is squarer, and holes are drilled at both ends to tie the cables. Its size is varied according to the purpose; for transportation, it is larger, and for fishing and hunting it is smaller.

The students compared the differences between *Ruza* (Thao canoe) and *Tatala* (Tao canoe) and made an argumentation about why two Indigenous groups living in different places

used different shapes of boat. For example, the navigation environment is different; one is in the lake, the other is in the sea, so the structure of the bottom of the boat is different, the *Ruza* has a flat bottom, and the *Tatala* is a V-shaped hollow boat. A Flat-bottomed hull has a shallow draft, which is good for fishing in small lakes and rivers. A Deep-vee hull gives a smoother ride than a flat-bottomed hull in rough water. In addition, because of their different natural resources, the Thao living environment includes large woods such as camphor or cypress, which can be used to build single-wood boats. But the Tao people do not have this resource, so the way to make the *Tatala* (Tao canoe) is to splice different kinds of wood to build boats.

Figure 4. 8

Tatala (Traditional Tao boats) Structure Model

Figure 4. 9

Wood Density Measurement Experiment

Note. Students cut a piece of wood and use the water displacement method to find the volume of the wood sample and measure the mass of the wood sample with a scale

Ritual plant planting

In this five-week ritual planting lesson, students learned to grow ritual plants, including taro, millet, and *Patan* (*Dioscorea esculenta*, lesser yam). Community Elders led students to taro fields and dryland. Students dug ditches and learned the tools they used in the Tao language. Students learned the planting methods, parts, techniques, and times of various crops.

Figure 4. 10

Student dug ditch in the wetland taro field and planted Patan (lesser yam) in the dryland field.

In the last two weeks of the lesson, the students summarized all the crop cultivation methods they had learned in the past, including millet, taro, sweet potato, and *batan*. They integrated traditional planting methods with the plant reproduction methods they learned in science class, including sexual reproduction and vegetative propagation. Students worked in groups to create posters and present them in front of the class.

Record family water source and distribution

Although there is running water in Lanyu, most of the population still connects with water from the mountains by themselves, especially to the wetland taro field. Therefore, the locations of water sources are very important to the Tao people. In this lesson, students learned the cultural knowledge about water source location and used Google Maps to locate the school's water source and record its latitude and longitude. Then they recorded the route from the water source to their taro field or their village and calculated the distance between them. This lesson is

integrated with unit conversions such as kilometers to meters and the concept of latitude and longitude.

Spring 2021 Semester

The ninth-grade Exploration course held in the Spring 2021 semester, excluding national holidays, was only 14 weeks in length because the students graduated after the 17th week. However, due to the outbreak of the epidemic, the courses in the last three weeks could only be taught remotely. In the 11 weeks of the school's face-to-face classes, although only two weeks were off-campus courses, the on-campus courses also included practice and experimentation. The course focused on three topics:

1. Kuroshio Current Fish
2. *Manmey* (Taro Cake)
3. Methods of Proceedings Millet

Table 4. 5

Ninth-Grade Exploration Course Summary in 2021 Spring semester

		2021 Spring	
Week	Date	Topic	Content Outline (Off-campus classes in Grey, online classes in Blue)
1	02/07~02/13		Campus Disinfection
2	02/14~02/20		

3	02/21~02/27	Kuroshio Current fish	1. The teacher introduced the method of collecting information on the Internet and the format of citation, taking "Kuroshio" as an example. 2. Students collected information on Kuroshio fish species in groups 3. Students organized the information into posters and presented it
4	02/28~03/06		1. The teachers explained how to write the motivation and purpose of the research 2. According to specific research questions, students searched for information on the Internet and made posters 3. Group oral presentation
5	03/07~03/13		1. Teachers introduced the traditional taxonomy of Tao culture and the way of making biological identification keys in science. 2. Students made a biological identification key based on the characteristics of eight species of Kuroshio fish 3. Group oral presentation
6	03/14~03/20	*Manmey* (Traditional Taro Cake)	**Taro Field Field Trip** 1. Students reviewed the Tao language of farm tools used in the taro fields 2. Students weeded in the field 3. Students took turns planting taro in dryland, returned to school
7	03/21-03/27		**Taro Field Field Trip** 1. Students made plans for the weeding process 2. Students weeded in the taro field and dug ditches; four groups took turns 3. Returned to school, packed up, and cleaned tools.
8	03/28~04/03		Children's Day & Tomb Sweeping Day (National Holiday)
9	04/04~04/10		**Review the process of land reclaiming** 1. Teachers explained the flowchart planning method 2. Students used flowcharts to plan the process of land reclaiming and planting in groups 3. Each group shared their plans
10	04/11-04/17		**Plan the process of making *manmey* (taro cake)** 1. Students reviewed the Tao language homework and the process of planting dryland Taro

			2. Each group planned the process of making *manmey* (taro cake) 3. Each group shared their plans on the stage
11	04/18~04/24		**Cook *manmey* (taro cake)** 1. Prepared taro cake ingredients 2. Steam taro & Tao language teaching of the process of making *Manmey* 3. Mashed taro, shaped taro cake, roasted bacon, and dripped lard on *Manmey*
12	04/25~05/01		**Review and write a report on taro cake** 1. Teachers explained the report format 2. Students worked on their report on taro cake individually.
13	05/02-05/08		**Revise report of taro cake** 1. Based on the report students wrote last week, teachers explained how to write "Results and Discussion." 2. Students revised their reports 3. Students completed the report and searched for the production method of millet cake
14	05/09~05/15	Methods of Proceedings Millet	**Experiment of cooking millet** 1. (Class adjustment) no class in the first session 2. Teachers explained experimental methods and distributed equipment 3. Students cooked millet in groups and recorded the experiment results
15	05/16~05/22		**Experiment report of cooking millet** 1. Students modified the taro cake report. 2. Teachers explained how to write an experiment report on cooking millet 3. Students discussed the notes they took of the experiment in groups and finished the report as homework
16	05/23~05/29		**Modify experiment report of cooking millet** 1. Students modified their millet experiment report based on teachers' comment 2. Students took the online test for Tao language about millet and millet culture.
17	05/30~06/05		**Course summary and feedback** 1. Students recorded videos to present their millet experiment reports individually. 2. Students selected the photos taken in the Exploration courses of Ethnic Education in the past the three years and used google slides to prepare course feedback in groups

		3. Each group shared their feedback, thoughts, and suggestions about the Exploration course.
18	06/06~06/12	Ninth Grade Graduated

Kuroshio Current fish

With the opening of flying fish season, the 2021 Spring ninth grade Exploration class started with the Kuroshio Current fish topic. Students learned to use the format of scientific reports and use online resources to study Kuroshio fish, including yellowfin tuna, dolphinfish, flying fish, flathead grey mullet, swordfish, skipjack tuna, mackerel, etc. Students made posters in groups including research topic, research motive, conclusion, and references (title, author, search date, URL) and presented their study with their classmates. Teachers introduced the traditional Tao taxonomy of fish and the way of making biological identification keys in science. Students made a biological identification key based on the characteristics of eight species of Kuroshio fish

Taro cake

The taro cake unit took seven weeks. Continuing the ritual plants of the previous semester, the unit started with the planting of the taro. In the first two weeks of the unit, students went to the taro fields to weed, dig ditches, and plant taro, including planting depth and spacing. In the third week, students organized the process of planting dryland crops and preparing for the class to make taro cakes.

Figure 4. 11

The Elder from the community demonstrated how to grow dryland taro.

Figure 4. 12

Students planted dryland taro under the guidance of teachers and Elders

Students watched videos of Elders making *Manmey* (taro cakes) and wrote about the process. Students could adjust it if it differed from how they made it at home. Students made the flow chart of making *Manmey* in groups, including the required materials, steps, and precautions. In the fourth week, students completed the taro cake according to the flow chart they made in the

previous week. During the process, students checked and modified the process of making taro cake and learned the Tao language related to taro cake.

Figure 4. 13

Students made the Manmey (taro cake)

Note. The process of making *Manmey* (taro cake) includes peeling taro, steaming taro, mashing taro, shaping taro cake, roasting bacon, and dripping lard on *Manmey*.

In the last two weeks of the unit, students completed the taro cake report, including the materials, tools, procedures, Tao language related to taro cake, and discussions. Students

recorded and described the process of making taro cakes. In the discussion section, students discussed what difficulties they encountered during the making process. How they resolved them, and why *manjip* (peeling) of raw taro before steaming causes itchy hands.

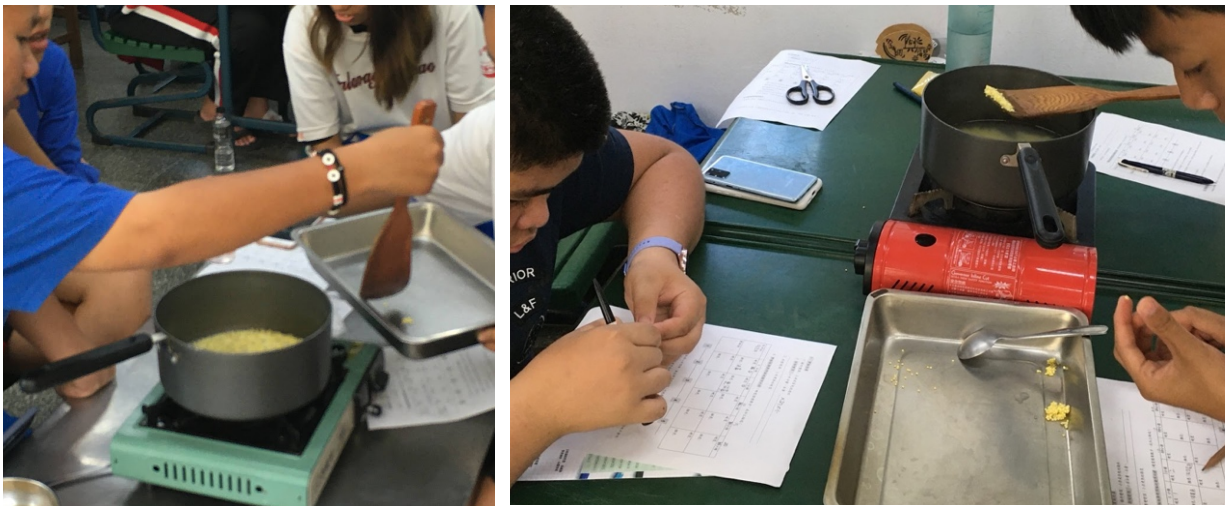
Methods of Proceedings Millet

The last unit of the semester was Methods of Proceedings Millet. Students already had learned about planting millet in 7th grade. Therefore, in this lesson, students did experiments to find the best conditions for cooking millet. Students learned the scientific experimental design, including control variables, independent variables, and dependent variables.

Students divided the millet into an experimental group and a control group to explore the effect on cooking time if the millet is soaking in water for 30 minutes beforehand. Every 5 minutes, students picked up some millet to observe its hardness and color.

Figure 4. 14

Millet experiment



Note. Students cooked millet and observed the hardness and color of millet every 5 minutes. Students labeled the control group as "A" and the experimental group as "B." The millet in the experimental group had been soaked in water for 30 minutes before cooking.

The original plan for the second week of the unit was to let students try different independent variables. Because of COVID-19, the Taiwan government issued a three-level alert on May 18th, 2021. The last three weeks of the semester were remote learning. Students completed the millet experiment report online and recorded the report in the form of a video, including the purpose, research questions, methods, equipment, procedures, results, and discussion.

Tensions

By the end of 2020, there are 35 schools at or below secondary schools that have been reviewed and approved by the local government to implement experiential education for Indigenous peoples. Among them, Orchid High School is the only six-year high school. In the process of developing Ethnic Experimental Education, designing and implementing the curriculum, participants experienced many tensions. They can be divided into Planned Curriculum and Translated Curriculum. Planned Curriculum discusses: Why implement Ethnic Experimental Education? How to implement Ethnic Experimental Education? What content does Ethnic Experimental Education include? Where is the learning field of Ethnic Education? Who should teach Ethnic Education? Translated Curriculum focuses on the tensions teachers faced in designing and implementing the Ethnic Experimental Education courses.

Planned Curriculum

Tension: Who wants change? Who wants to change?

"Ethnic Education is an opportunity for change," said Erin, who is in charge of the Ethnic Experimental Education Project. Because the students at Orchid High School are Tao Indigenous or mixed, the school was designated to implement Ethnic Experimental Education. In addition to this reason, teachers have different rationales for the meaning and purpose of implementing Ethnic Experimental Education. These include seeing the cultural loss of Indigenous peoples, viewing Ethnic Education as a kind of transformative justice, or regarding Ethnic Education as a compensatory education policy for assimilation education. The reasons, at times, reflect a negative voice, such as students not performing academically and their test scores not being satisfactory, so they should simply develop other programs. Assimilation education has been implemented for many years, but it has not improved the achievement gap, or more properly, the

opportunity gap (Flores, 2007), but it has caused the loss of Indigenous culture. Therefore, the positive thinking is, why not try another educational approach? Ethnic Experimental Education is an experimental attempt, which may be a means of academic success, or establish a different definition of academic success, not just the performance on the exam.

Erin indicated that in the past 10 or 20 years, she has seen many students lose their own culture and fail to connect to outside education (Erin, personal communication, July 11, 2021). According to Erin, assimilation only makes students lose themselves but not become someone else. Even talking about culture in the classroom, the students do not know anything about it, claiming that their parents did not teach them, no one taught them. Therefore, it is hoped that through Ethnic Education, students can have the opportunity to learn about their own culture, which may further promote academic success. Even if academic success cannot be achieved in the short term, at least the approach may cultivate students' cultural competence rather than empty ends—from learning the culture of one's own ethnicity to connecting with the world.

The Elder, Luna, had a different perspective on the purpose of Ethnic Education rather than compensating for cultural loss or enhancing academic success. She believed that the significance of taking ethnic classes depends on the students themselves, whether students want to learn this cultured knowledge, and whether they will practice it after learning it. The Elder emphasized life experience, attitude, and skills in life but noted that if students do not live like this, then it is useless to students. She said:

> Students went to plant a sweet potato. After they learn it, they can plant it on their own. If they don't do it, it's useless to them. If the way they live is no longer closely related to this place, then it is not their culture, then you have separated from their original culture. (Luna, personal communication, June 30, 2021)

Of the three Tao teachers interviewed, two did not grow up in Lanyu. Because they lacked the experience of living in this land, they were very grateful for the Ethnic Education class, which allowed them to re-learn their own culture alongside the students. Ivy said:

> After I came back [Lanyu], I was learning things. For me, these things should be very daily things, but why would I learn them again? It's just because I don't know. Then I think I am very fortunate, because of the Ethnic Education, I can re-learn the things of Tao. (Ivy, personal communication, July 10, 2021)

Pat said:

> I am very grateful for the ethnic courses; because of them, I can know myself and understand myself. When I was still studying or working in Taiwan, I knew other people's cultures in Taiwan, and I saw myself from other people's culture. I found that I have no knowledge of the culture of my own ethnic group. When people ask me about my culture, I can only say that I don't know. Because I don't know. When I came back, it was actually a change, establishing my understanding of the ethnic group for awareness, cognition, self-construction, self-worth." (Pat, personal communication, May 17, 2021)

Another Tao teacher who grew up in Lanyu, Eva, provided a different view about the teaching of the ethnic culture at school. She said, "Culture is the summary of life; I think it's something I can reflect right away. So, I would think that teaching culture is an incredible thing." (Eva, personal communication, July 05, 2021). Just because culture is life, learning culture at

school is a very unnatural thing, and it should be returned to the tribe and family. But she also compromised on this "change." She said:

> I didn't want to teach [culture] or learn culture from school because I still have that environment [to learn culture] in the natural way. But I think children [of this generation] need this gateway to learn culture, the more the better. Because their parents, like me, have gradually separated from this life, and the cultural matrix. Like I'm not a very...sound carrier of traditional culture anymore? It's just that we don't have as rich a cultural background as our parents, but it's not our fault. So don't beat yourself up. For this generation of students, I would hope that they can have a little more access, which is a good thing.

In the ethnic class, students learn how to grow sweet potatoes and taro, catch land crabs, collect creatures from the intertidal zone, and knowledge of common tree species in the forest. Students question why they should learn this. Ivy said, "I have been asking myself this question too, why do students need to learn this? But I answered them because you are Tao." For Tao people like Ivy and Pat, who did not grow up in Lanyu, learning the lost culture is to prove their cultural identity, "because you are Tao, so you have to learn this culture." However, for Tao people like Eva, who grew up on the island, she learned these skills and knowledge naturally in this environment to survive, not to prove who she is or her cultural identity. When students can only learn their ethnic culture in school, it means that students have lost the environment of naturally learning culture.

I am too old/ too tired to change!

Regardless of the reasons, curriculum reform is unstoppable. Ethnic Experimental Education has entered its fourth year in Orchid High School, but the voices questioning it have not stopped. One example is Eva, who is frustrated about regenerating the culture in the school instead of in the original habitat. Another voice of opposition comes from older school teachers who do not want to change, perhaps because they have been teaching this way for twenty or thirty years. For teachers of that era, learning was for exams. The older teacher who opposes the reforms believes the new practice disrupts her classroom management, with outdoor lessons and extracurricular activities distracting students from studying and preparing for exams.

On the other hand, the curriculum reform also makes teachers have a higher workload. In addition to designing new courses, they also need to make teaching documents, including uploading their teaching materials such as lesson plans, shorthand sheets, schedules, and slides to the sharing cloud, which is an extra burden for a senior teacher who is not familiar with computers and technology. It made the older teacher not want to participate at all. In education reform, the opposition is not necessarily a bad thing, and people can look at the reform from different angles. However, the words and deeds of senior teachers reduced to complaints will bring influence and burden to novice teachers. Recalling her first year of teaching and participating in Ethnic Experimental Education, Emma said: “I wonder why she [senior teacher] complained like this. It seems that this matter [Ethnic Experimental Education] is wrong. Then I don’t know if it is right or wrong, but I think I should give it a try. Why is she so pessimistic…”?

Although Orchid High School is small, there are few students, only a dozen students in one class and two classes in one grade. The workload of teachers is extremely large because a

teacher is responsible for many kinds of courses. For example, the lead researcher in her first-year teaching at Orchid High School taught 7th grade science, 7th grade health, 8th grade science, 9th grade music, 9th grade health, and 10th grade physics, chemistry, and biology. According to the act of standard for the number of teaching periods per week for teachers in national high schools (2014), teachers have a certain number of classes based on their positions and obligations, if they are in charge of administration or they are homeroom teachers. For example, a science teacher who is also a homeroom teacher has 14 basic teaching periods per week. On Taiwan's main island, a science teacher teaching in a large school with a large number of classes can teach only one grade of science classes to reach the required number of class hours. In addition to teaching science courses of different grades, teachers also need to teach other subject courses outside their major to make up for the prescribed class hours. This not only causes teachers to spend more effort preparing for classes of different grades and subjects, but also puts pressure on teachers to teach courses that are not their major.

This situation did not improve after the start of Ethnic Experimental Education, partly because of the high turnover rate of teachers. The teachers in the first year of curriculum preparation were different from the teachers who started the implementation. Furthermore, teachers still have to prepare courses for different grades and subjects, plus the integrated Ethnic Education courses. It's not that the teachers are unwilling to cooperate with the school curriculum reform, but they are tired. As Emma puts it, "Ethnic Education is resisted by some teachers, probably because they can't afford more."

Can the curriculum be changed?

Another voice of doubt mainly comes from some educationally trained regular teachers. They questioned the stability of the curriculum. Because the current Ethnic Experimental

Education curriculum gives teachers a lot of flexibility, teachers with a cultural topic can design the course according to their own expertise. For example, in the ninth-grade Exploration class of the 2020-2021 school year, a cultural topic was traditional common tree species. Because science teachers participated in this course, the teachers integrated this ethnic knowledge with scientific knowledge, including students measuring the density of samples of different wood species.

However, in 2021-2022, there is no science teacher involved in the ninth-grade Exploration class. If the same lesson is used, non-science major teachers will struggle with those science concepts. If the curriculum is changed this year according to the teacher's specialty (Math, English, PE), the course content of this year's ninth grade will be different from that of last year's ninth grade, which is not standardized and incoherent. On the other hand, there are also teachers who believe that teachers can make the curriculum diversified and flexible by designing courses according to their own professional expertise and combining this with the cultural themes. Although the curriculum varies from year to year due to different teachers, it is also a manifestation of multiple intelligences.

It's not that I can't change, I just don't want to be forced to change.

There is another kind of opposition as well. Sam, one of the co-teaching teachers of the Exploration course, is not against teaching different courses or developing a new curriculum. He opposes forcing teachers in the school system to do things like teach extra classes or spend more time preparing for unfamiliar courses. (Emma, personal communication, May 16, 2021). Such is the case with Sam, one of the regular teachers who refused to be interviewed, although he participated in Ethnic Experimental Education and was a very passive participant. He did not propose ideas or lead the course direction unless he was assigned work within his scientific expertise, such as a density measurement experiment or writing an experimental report, which he

would suggest and execute. He only appeared in two designated courses out of three co-teaching courses. For other unpaid class sessions, he would not show up. In fact, what he did was not wrong or in violation of the school code, but it created a sense of imbalance among diligent teachers who were willing to do more.

I can change, but I have my way.

Among the interviewed participants, Sophie was the only one who did not participate in Ethnic Experimental Education. She is one of the two science teachers in Orchid High School. She has been in this school for more than 20 years and has a certain level of understanding of Tao culture. Sophie had practiced an integration of local knowledge and Western scientific knowledge in her own classrooms before Ethnic Experimental Education began to develop in schools. For example, in her seventh-grade science class, she arranged an intertidal field trip to learn about intertidal biology and traditional naming methods in relation to Western scientific naming systems. She combined Taro Field Ecology with her eighth-grade science class. The ninth graders walked around the island to learn about the landscape of Lanyu, combined with the geology course. She said:

> I personally would not frame Ethnic Education in such a limited way; I think the term Ethnic Education is still a bit too narrow. Every place has its own culture, even urban people. Because what is culture? the way of life, values, worldview is the culture, so people in the city, rural areas, fishing villages, and Indigenous people in the mountains must all have their own culture, because culture is derived from the environment. People have their ways to survive in their place, to connect with the world and their cognition. I prefer to talk about "place education." I think when it comes to Ethnic Education, it's a political issue. ... The government is now promoting Ethnic Education; it's just a kind of

> place-based pedagogy that narrows down to ethnicity. (Sophie, personal communication, July 05, 2021)

Sophie agrees with place education but disagrees with the school's current Ethnic Education practices. She believes that the school's definition of the curriculum is not clear. She said:

> We often say that we are going to explore the aesthetics of humanity in Lanyu. I have Exploration, Humanities, and Aesthetics here. Why do you divide them into three disciplines [Exploration, Humanities, and Aesthetics]? What to teach? The definition of the curriculum is unclear; teachers don't know why their subject is included in Exploration, Aesthetics or Humanities courses, do not know what to teach or teach content that isn't their specialty." (Sophie, personal communication, July 05, 2021)

Sophie believes that schools should implement place education in a thematically integrated curriculum, where teachers bring cultural knowledge back to their specialized subjects. For example, in selecting a topic of local knowledge, when implementing this topic activity, the teachers of each subject will integrate the subjects that can be integrated. Therefore, during the lesson preparation process, all teachers need to experience and learn local knowledge first, then interpret the theme from the perspective of their own discipline, integrate everyone's majors, and form a consensus and context for the curriculum. Sophie would start with a theme of one integrated day per semester and slowly expand into a complete program of curriculum integration. She criticized the school's current practice of dividing fixed-subject teachers into specific Ethnic Education courses, and the subjects that can be integrated are fixed. For example, the teachers of the ninth-grade Exploration class were composed of science, mathematics, and

physical education teachers, so it did not integrate other subjects such as history, geography, and art. She said, “Can’t a geography class learn to ‘explore’?”

In addition, she thinks that the difficulty of integrating science subjects into Ethnic Education is that Ethnic Education does not have the participation and leadership of science teachers. The school separates Ethnic Education from general education subjects (Mandarin, English, mathematics, social studies, and natural sciences) but tries to integrate science subjects into Ethnic Education without it being carried out by science teachers. Each knowledge system has its own context and sequence; according to Sophie, in its current form, the integration of scientific knowledge into Ethnic Education is a fragmentation of scientific knowledge and curriculum. She believes that teachers should return to teaching their own professional subjects in order to interpret and integrate local knowledge in a deeper way.

Tension: How do we do Ethnic Experimental Education — Ideals versus Reality

Within the continuum of curriculum organization, there are five categories (Jacobs, 1989): discipline-based, parallel disciplines, complementary discipline units or courses, integrated days, and complete programs.

Ideals

In Sophie’s view, the ideal place for education is James Beane’s complete program (Beane, 1995), meaning that all school-wide curriculum is organized and designed in a way that transcends disciplinary boundaries, with local knowledge and real-world themes. The curriculum at A.S. Neil’s Summerhill School is a prime example of this type of curriculum. Sophie believes that at this stage, schools can achieve interdisciplinary or cross-disciplinary learning through interdisciplinary courses or an integrated day before schools can achieve the goals of a complete

program. Inter-disciplinary courses integrate all disciplines in units of days or weeks (Beane, 1997; Jacobs, 1989). Each discipline still maintains its own discipline-based view but supports and cooperates with each other. Teachers adjust the length of course units based on expertise and student interests. The integrated day is a whole day of teaching, decomposing all subjects, designing courses according to students' life experiences, and emphasizing students' interests and concerns. Curriculum standards set by school systems or administrative agencies do not need to be considered.

Reality

However, Erin, Director of Academic Affairs, who is responsible for arranging courses, held a different view. In accordance with the provisions of Article 6 of the Enforcement Act for Secondary School Experimental Education, if all or part of the school's classes carry out experimental education, its courses may not be restricted by the secondary school national curriculum regulations. Erin thinks that under realistic considerations, it is difficult to achieve Sophie's ideal goal under the current situation of the school. She said:

> But with the state of our school, we can't do that. Based on experience, teachers from Taiwan have encountered culture shock when they came here, the impact of students' teaching differences, and the impact of life adaptation, and then found that this school does not teach [general] school matters at all. When you hire a Chinese teacher or a math teacher, what do you want them to teach? So, at the beginning we divided the curriculum into two lines: general education and Ethnic Education. …I can only let students learn more about their own culture at this stage. In addition, I still have to prepare the students to connect with the world outside [of Lanyu]. We have to do both.

The premise of curriculum integration is the professionalism and stability of teachers. Teachers must have a certain degree of understanding of curriculum design and local cultural knowledge and be willing to integrate cultural knowledge into their subject-based curriculum. But the reality is that Orchid High School is a school with a high rate of teacher turnover and a high proportion of novice teachers, substitute teachers, and out-of-field teachers. According to Erin, it is very difficult to design an integrated curriculum in one's own subject when the teachers are not familiar with the curriculum and Lanyu culture. In addition, regular tenure-track teachers did not join this school necessarily because they agree with the concept of Ethnic Experimental Education. The traditional teacher education program they received was not trained and prepared for Ethnic Experimental Education, and teachers might think that they could not exert their expertise. When the senior teachers at the school are not necessarily willing to change and participate in the curriculum reform, it is very difficult to achieve a completely integrated program.

From the experience of the lead researcher, teachers will have to single-handedly find local resources if they want to incorporate local culture and knowledge into their disciplines. The activities that can be done in 45 minutes of a class are limited. Under the pressure of limited time and subject progress, cultural knowledge can be reduced to secondary knowledge or an adjunct to verifying scientific knowledge. Another practical consideration is the feasibility of scheduling courses. Since Orchid High School is located on an outlying island, if teachers leave the island to work or go home, they often need to take leave or switch classes with other teachers. It is difficult for the class schedule to meet all needs, conditions, and constraints. Erin also thought about various ways, noting:

> When we were arranging classes, there were originally 12 Ethnic Education sessions. I didn't want to divide it into Humanities, Aesthetics, and Exploration courses. The problem is that if I didn't divide it into courses, I couldn't arrange classes at all. In terms of the situation of our school, I have no way of arranging twelve sessions, and then the teachers can cross over. I have to pair teachers in the courses together. This is already the most workable way I can think of. In some experimental education in elementary schools, their arrangement is that one teacher teaches one unit. But this method will be more difficult to implement in our school because teachers take time off for work or going home, etc. What to do if the teacher is not available when it is the teacher's turn to teach the unit? There is a high chance of this happening in our school. There are too many situations that need to be considered, so we can only pair teachers and classes together.

In terms of practical conditions, the current way that schools can compromise is to divide the curriculum into General Education and Ethnic Education (Table 4.1). The general education curriculum remains subject-based and retains the original main subjects (subjects that students need to take exams for) - Chinese, English, mathematics, social studies, and natural sciences. The Ethnic Education curriculum integrates the characteristics and connotations of Indigenous knowledge with most of the remaining subjects that are not included in the exam — art, technology, integrative activities, health, and P.E. Ethnic Education courses are divided into four courses in the form of "Complementary discipline courses": Exploration, Humanities, Aesthetics, and Autonomy. Erin emphasized that the four courses of Ethnic Education are all Ethnic Education. In other words, they can be called Ethnic Education 1, Ethnic Education 2, Ethnic Education 3, and Ethnic Education 4. They are identified with four learning areas:

Aesthetics, Humanities, Exploration, and Autonomy, just to make the teachers of these courses clearer about the teaching direction.

Complementary discipline courses focus on a certain theme and bring together a number of related disciplines to jointly explore a specific issue. Teachers provide learning content and strategies from their respective disciplines so that students can gain complete knowledge and experience. For example, the Exploration course includes physical education, health, and natural sciences; the humanities course includes integrated activities and social studies; the Aesthetics course includes art and music; the Autonomy (self-directed learning) course combines technology and integrated courses. The same themes are interpreted from different perspectives in different ethnic courses. For instance, the traditional Tao residence is a semi-basement house, half above the ground and half underground. The Aesthetics course focuses on the introduction of traditional construction methods, structures, and models of traditional Tao residence; the Humanities course explains the life etiquette norms of the semi-basement house from the perspective of social norms; the Exploration course introduces the wood species used in the semi-basement house, connecting plants science. In addition to the horizontal connections between Aesthetics, Humanities, and Exploration courses, the same theme also needs to deepen and broaden the vertical connections from Grade 7 to Grade 9.

This approach assumes that the expertise of teachers in various disciplines should complement each other, and teachers must cooperate with each other in curriculum design and collaborative teaching. In the integrated curriculum framework, teachers make integrated plans from the professional field of their own disciplines. Therefore, what teachers focus on is, “what subject knowledge should students learn in my subject for this topic? In my subject, what is the

most worthwhile for students to learn? “The awareness of “discipline-based” is still very strong (Drake, 1993).

Has my class been sacrificed?

The school retains independent teaching time for the subjects included in the Comprehensive Assessment Program for Junior High School Students and integrates the subjects that are not included in the examination into the Ethnic Education. For example, students originally had two physical education classes a week, but now one physical education class is integrated into Ethnic Education courses. This approach seems to imply which subjects are more important and which knowledge is more valuable. It also makes some teachers whose courses are integrated into Ethnic Education feel that their professional courses have been ‘sacrificed.’ It’s like the P.E. teacher, Pat, said, “one session of the Exploration course should be a physical education class, but look at the content of our class, what does the cooking millet experiment have to do with P.E.? “(Pat, personal communication, July 01, 2021). When the curriculum content of Ethnic Education courses does not include or integrate the subject content that should be included, teachers feel compelled to teach other subjects.

But there are also teachers who see it as a great way to combine their professional classes with other subjects in a different way. For example, PE teacher Polly said:

> I think it is great to teach this way. I won’t feel like my class is gone, but I will bring in subject knowledge in other ways. It makes the class more complete, rather than just some fragmented knowledge in it. Instead, it is more diverse. Linking knowledge together makes the knowledge structure of the course more complete. Personally, I like this operation of classes very much, and I also feel that the course must be done in this way. (Polly, personal communication, June 18, 2021).

Co-teaching—1+1+1 >3 or =3 or <3?

In order not to let teachers go it alone and solve the problems of novice teachers, and have a long time for field trip activities, the school arranged for three teachers to co-teach three sessions of classes. For example, the ninth-grade Exploration course was taught by three teachers, Mike, Pat, and Sam. As shown in Table 4. 6, a class could only be assigned one teacher during a session. For example, in the first session, Pat is responsible for Class A and Sam is responsible for Class B. This means that Mike is not obliged and not paid to appear in the first session, but due to the co-teaching situation, the school hopes that every teacher could be in classes for the whole three sessions.

Table 4. 6

Ninth-Grade Exploration course Teacher Allocation

	9th grade Exploration Course	
	9th grade-Class A	9th grade - Class B
Session 1	Pat	Sam
Session 2	Mike	Sam
Session 3	Mike	Pat

However, this way of arranging the class schedule has been rebounded by some teachers, and it has also caused conflicts between teachers. For example, Sam would leave the classroom in session 3 as that wasn't his responsibility. Maybe Sam was just to defend his rights, but in the eyes of other teachers, he may become a teacher who is unwilling to devote more. This matter also caused co-teachers in the same group to feel uncomfortable. Pat said:

> Some teachers may only appear in his classes. Then he may not even be assigned work or show up at the co-plan meeting. The mood at that moment was "why are you not there in the third session?" I didn't have class in the second session either, but I didn't leave. It's

> everyone's own decision, and I can't interfere with him. All I can do is assign work to him. But this thing has become unbalanced in the mind of the teacher who has been in the classroom all the time. (Pat, personal communication, July 01, 2021)

In the process of co-teaching, teachers are constantly running in and adjusting at the last minute. It seemed like Pat was in conflict with Sam from the beginning, and then she adjusted her mentality to accept it. Because Pat couldn't ask Sam to devote more time, she found that if she kept targeting or obsessing about it, it would affect her own mood and indirectly impact the course and students. For Pat, teachers are exempt employees, not hourly workers. She thinks that Sam should understand the needs of this school. Otherwise, it would be very painful for him to stay here for several years.

The intention of teamwork is to let veterans lead rookies, but the distribution of work and responsibilities also needs to be adjusted accordingly. In the co-teaching team of the seventh grade, eighth grade, and ninth grade Exploration course, the roles of leader, active follower, and passive follower are naturally formed. The leaders are usually teachers with long experience in Orchid High School and have a certain degree of understanding of the school, students, local culture, and curriculum. Leaders drive the direction and content of the course and assign tasks or work with the rest of the team members. If there is a situation or problem, other members will tend to ask the leader for the final decision. Active followers usually identify with Ethnic Education or feel that it is worth trying. During the course discussion, active followers will engage and actively offer input, ask questions, help to identify and mitigate risk, demonstrate personal responsibility, and communicate their needs and goals. Passive followers, on the other hand, do not actively or proactively offer opinions during course design discussions. Passive

followers will only do the work they are assigned. Usually, they do not agree or feel that they are forced to participate in Ethnic Experimental Education. Another situation that arose was when the teacher's ability or professionalism was not enough, and the co-teachers were not at ease assigning the main work.

For example, in the team of the ninth-grade Exploration course, co-teachers included Mike, Pat, Sam, and volunteer teachers—Emma and Echo. Mike and Emma were the leaders of the team, guiding the discussion of course content and direction, assigning work, data and resource collection, designing study list, and responsible for main teaching activities, course descriptions, etc. Echo participated remotely in course discussions, providing scientific knowledge and a method of scientific inquiry that incorporates cultural knowledge. Pat was responsible for preparing materials and local resources for use in the classroom, as well as day-to-day tasks such as convening students, roll call, classroom management, and class discussions. Sam was the only one on the team who did not participate in an interview. From the account of the co-teachers, he was a passive follower in the Ethnic Education course. He only involved or assisted in teaching the parts relevant to his subject area of expertise. Therefore, when assigning work, the leader mainly assigned science-related teaching activities to him.

It is worth mentioning that Pat was an active follower in the 9th grade Exploration class, but in the 8th grade Exploration class she took on a leadership role. Pat was the longest-serving teacher in the 8th grade Exploration course at Orchid High School. When the discussion in the course co-plan meeting was too long and inefficient, she would jump out to guide and arrange the work according to the teacher's ideas of the course, teaching methods, and attitude and interest in Ethnic Education. Pat's co-teachers were Ivy and Maggie. Ivy was teaching at the Orchid High School in her first year. Pat and Ivy are both Indigenous Tao. Maggie was the only

Han and regular teacher in this group. In addition, she was the only one in this group who refused to participate in the interview because she said she had no interest in Ethnic Education. Pat mentioned that:

> When teachers have no interest in it [Ethnic Education], there is a lot of frustration. She would want to get out of here. All other teachers can do is help. She [Maggie] is a math teacher, and you want her to be an Ethnic Education teacher; she just doesn't think she can do it. All other teachers can do is to guide and encourage and then assist. The work assigned to this teacher is definitely not something very culturally related; it may be something that every teacher can do. Don't force her to accept it [Ethnic Education] at first. (Pat, personal communication, July 01, 2021).

Table 4. 7

The role of co-teachers in the 7th-9th grade Exploration courses

Grade	Name	Subjects	Ethnicity	Regular teacher	Year teaching in this school	role
9	Mike	Math	Han	No	5	Leader
	Emma	English	Han	No	3	Leader
	Pat	P.E.	Tao	No	3	Active follower
	Sam	Science	Han	Yes	3	Passive follower
8	Pat	P.E.	Tao	No	3	Leader
	Ivy	Integrative Activities	Tao	No	1	Active follower
	Maggie	Math	Han	Yes	2	Passive follower
7	Polly	P.E.	Other Indigenous	Yes	8	Leader
	Eric	English	Other Indigenous	No	2	Active follower
	Max	Math	Han	No	1	Passive follower

From Table 4.7 it can be found that the role of the leader in the team is not directly related to whether the person is a regular teacher or Ethnicity. Those who would be leaders in the

team mainly had relatively long experience in school, a positive attitude towards Ethnic Education, and the ability to learn and interpret professional subject knowledge and cultural knowledge outside their own. In terms of work distribution, leaders also shared more of the workload. Although Pat was also very active and willing to learn, the curriculum design of the ninth grade Exploration course incorporates scientific knowledge, such as taxonomy, plant classification, density experiments, and experimental report writing, content that was not relevant to Pat's field of expertise and learning experience. So Pat felt that what she could do was limited. Pat found her own shortcomings and limitations and learned from other teachers in the ninth grade Exploration course. Then she took on the leadership role in the eighth grade Exploration class. This change of identity in different courses also confirms that this co-teaching method allows teachers to learn from each other and grow. Co-teaching gives opportunities for teachers to engage in change together. Like Mike said:

> The opportunity now is to say that there are many teachers who can come together to make this change. So, you can see more and more different teaching strategies coming up here. It is not the traditional group teaching of the past, nor is it a shared-start pedagogy (flipped learning) or a learning community. As you can see, each teacher will teach using different methods and teaching strategies. While it (the strategy) may not have a name, it may be hybrid, so you can see a lot of attempts. I think flexibility brings a lot of different things to students.

Tension: What should be included in Ethnic Experimental Education? —Cultural knowledge vs. subject matter knowledge

I need school subjects to compete with others to fight against the world.

According to Article 3 of the Enforcement Act for the Indigenous People's Experimental Education, when schools conduct Indigenous experimental education, they should develop courses and assessments based on the characteristics and connotations of Indigenous knowledge. This means including Indigenous languages, history, literature, annual rituals, social organizations, traditional customs, crafts, music and dance, life skills, land and ecological wisdom, ethnic rights, and other cultural connotations. However, some younger generation Indigenous teachers had voiced their concerns as schools developed more than a third of the courses into Ethnic Education.

Ivy is Indigenous Tao, growing up on the main island of Taiwan. She thinks Ethnic Education is very important because she views culture as an identity, but in her opinion, the students seem too young to think about who they are and what culture means to them. Ivy said, "For them, Chinese, English, mathematics, social studies, and natural science seem to be knowledge that they can fight against the world in the future, but what can Ethnic Education make them fight against?" (Ivy, personal communication, July 10, 2021)

Pat made a similar point, she said:

> Our main mainstream courses are slowly disappearing, such as the health education because it is impossible that all health education [knowledge] or natural science knowledge can be integrated into it [Ethnic Education]. What exactly is Ethnic Education to learn, and how do you teach it? I think there are still some specific things to learn in

> national education. It is impossible for the national examination to test the annual rituals of Tao; it is impossible! It will not appear! It's not that we don't need to study Ethnic Education; it's how we adapt it to link the subjects to the Ethnic Education curriculum. (Pat, personal communication, July 01, 2021).

Both Ivy and Pat believe that the ethnic curriculum cannot only contain cultural connotations and cultural knowledge but must be combined with subject knowledge. From their perspective, cultural identity is important, but subject knowledge is a tool and language for them to compete and confront the outside world. Under Taiwan's test-oriented education system, knowledge of these subjects (Chinese, English, mathematics, social studies, natural science) is more valued than other knowledge, which also implies the values of mainstream society. The ideal of cultural equality and knowledge equality is difficult to achieve under the constraints of the current education system and the oppression of mainstream society.

Culture is the learning context for subject knowledge and inquiry

However, in previous assimilation education policies, Indigenous students remained marginalized in academic performance. Eric believes that culturally responsive teaching is a means and a new attempt (Eric, personal communication, June 24, 2021). He said, "Because Ethnic Education sounds like culture is the ultimate goal, hoping students learn the culture. But in the process of exploring culture, can some knowledge come in?" Culture provides a learning situation integrated with disciplines, improves students' subject ability, and connects with the world. Ethnic Education is not self-isolation, content with staying in one place, or only learning the things of one's own ethnic group. Rather, Ethnic Education should interpret the world and walk with the world through the perspective of its own culture. This echoes the components of

culturally relevant pedagogy, focusing on student learning and academic success and developing students' cultural competence to assist students in developing positive ethnic and social identities (Ladson-Billings, 1995a).

In addition to academic performance, learning should emphasize the application of knowledge and the ability of logical thinking and inquiry, which are abilities that students can take away and use even after leaving school. This echoes the Indigenous onto-epistemology that knowledge is practice. Inquiry refers to the engagement of students in behaviors similar to those of scientists such as asking questions, developing models, planning experiments, analyzing and interpreting data, using computational thinking, constructing explanations, engaging in argument from evidence and obtaining, evaluating and communicating information (NRC, 1996; NRC, 2000; NGSS, 2013).

Students engaging in scientific investigation require not only skills but also the knowledge that is specific to each practice. The local phenomena and cultural practices provide the context for inquiry-based learning. In Ethnic Education class, students learned to solve practical problems in real life, such as doing experiments to choose a suitable wood to make a keel of boat or making plans to dig trenches for taro field reclamation. They worked in groups to put their learning in practice. This is consistent with the characteristics of inquiry-based classrooms: situating instruction in authentic problems; grappling with data; collaboration of students and teacher; connection with society; teacher modeling behaviors of a scientist; and development of student ownership (Crawford, 2000).

It's grandparents' culture, not students' culture — Combining with modern knowledge makes culture meaningful to students

When asked what the most important element of Ethnic Education is, the first word participants mentioned was 'culture.' What is culture? Luna: Culture is life. Polly: Culture is the attitude to life. Eric: Culture is accumulated life experience. Sophie: Culture is a way of life, values, and worldview. Eva: Culture is the sum total of life. However, with the changes of the times, the development of science and technology, and the influence of foreign cultures, the way of life of the Tao people is gradually changing. Emma said, "Sometimes I think it's not their [students'] way of life anymore; is it still their culture?"

> When we are talking about traditional culture, they [students] may feel that this matter has nothing to do with them anymore; this is what people did in the past. How can the teacher make this culture meaningful to the problems they are facing now? (Emma, personal communication, May 16, 2021)

Emma believes that the combination of modern knowledge and traditional culture allows students to interpret and connect with traditional culture. She said:

> For example, what is the problem with the existing knowledge from a cultural point of view? Use current knowledge to understand what viewpoints the previous culture was based on. Because what they see now is the present, the big society they will enter in the future may also be based on the knowledge of the current textbooks. So how do they explain to others, 'I think my culture is still meaningful.'

In the days when there was no refrigerator, the preservation of food mainly depended on drying, pickling, fermentation, dehydration, etc. Tao people smear the flying fish with salt, dry it in the sun, and preserve it as dried fish. Osmosis occurs when flying fish are smeared with salt. The osmotic pressure generated when the salt dissolves is used to balance the salt inside and outside the food. The high osmotic pressure of the salt can prevent the reproduction of microbial cells and achieve the effect of food preservation. Students can learn about traditional life wisdom through the lens of modern science.

Furthermore, all remaining flying fish must be eaten or discarded before *Manoyotoyon* (End of flying fish consumption Ritual), which is mid-August lunar month, near the Moon Festival. This is the concept of food shelf life. But in the modern age with refrigerators, food can be kept longer, so does the *Manoyotoyon* (End of flying fish consumption Ritual) still need to be followed and taught? In fact, in addition to the concept of health and hygiene, the *Manoyotoyon* (End of flying fish consumption Ritual) also reminds the people not to overfish and only catch what they need, as the remaining flying fish are also thrown away. This sustainable spirit, no matter how the times change, should be preserved. Incorporating subject knowledge into ethnic courses allows students to see their own relevance and value in traditional cultures and to engage in dialogue with other cultures.

When culture changes, old knowledge no longer applies — Reconstructing local knowledge system with subject knowledge

Ethnic Education starts from local knowledge and culture, but does culture change? Participants answered in the affirmative. Leo: Culture is a way of life in the context of time and space. With different environmental backgrounds, lifestyles will also be different, and culture will change; Mike: Culture is the way of life that has been handed down from the past, and

slowly make rolling corrections and adjustments, so culture can be changed. Culture comes from the environment. As times and environments change and technologies develop, old local knowledge may no longer be applicable in the new context. For example, the ecology of taro fields has been destroyed by modern agriculture.

Since the Tao people started living in this land, the tribe has depended on taro to sustain their lives. The maintenance of taro fields contains wisdom passed down from generation to generation. This wisdom categorizes weeds into good grasses and bad grasses. To prevent weeds from invading the taro fields, the ancestors of the Tao people used the principle of mutual restraint of plants. Because of the absence of pesticides, a natural ecosystem was also formed in the taro field. Cone snails, *Clithon Retropictum, Pueraria Lobata, Nostoc Commune* (star jelly), land crab, white-breasted waterhen, and common moorhen are all members of the taro field ecosystem. In addition to using the food chain to prevent pests, it also provided a richer food source for the Tao people. However, some Tao people started using pesticides and herbicides when they were introduced into Lanyu. In the face of cultural changes and shocks, knowledge of the past is not enough. They do not know what effect pesticides and herbicides have on the environment since these have not happened in past experience.

In the face of contemporary issues and challenges such as climate change, tourism development, environmental damage from coral bleaching, waste management, and pollution, the old local knowledge systems are no longer sufficient, and the role of schooling is to reconstruct local knowledge systems. Because the environment has changed, the culture has also changed. In the process of change, what needs to be retained and what needs to be adjusted can be discussed with the help of disciplinary knowledge. As Sophie said:

> The purpose of these disciplines is to help you [students] and empower you to construct new local knowledge systems. You have the ability to choose, you have the ability to create, and then the goal is sustainability. So, sustainability is our constant goal, but the way of survival will definitely change. But how to create a sustainable way of living with a new knowledge system. I think that's what school education is going to provide.

Disciplinary majors in Ethnic Education should cultivate students' ability to make cultural comparisons. This involves, for example, learning the Western scientific knowledge system and local knowledge system, thinking about new problems from different perspectives, and further adjusting the way of life and culture.

Disciplinary knowledge is the language of culture

In Indigenous Tao culture, the fish are classified as edible and inedible fish; edible fish includes "*oyod*" (men fish) and "*rahet*" (women fish), and elder fish (Siaman misiva, 2012). Everyone can eat women fish, but men fish are prohibited to women, and only Elders can eat elder fish. The Indigenous Tao classification method is the wisdom of symbiosis with nature. When Tao people catch fish, they catch different fish species for various family members to maintain species diversity. Furthermore, women need to conceive life, and children need to grow, so they save the best fish for those who need it most. The Elders' life experience and wisdom let them know how to deal with and eat complicated fish (elder fish). Indigenous people construct knowledge based on the need for survival by observing the phenomenon of the natural environment. They use various methods to generalize specific knowledge and find the answers to their ethnic group's concerns.

However, from scientists' perspective, the fish are classified into three classes — the *Agnatha*, jawless fish such as the hagfish and lampreys; the *Chondrichthyes*, fish whose skeletons are made of cartilage rather than bone, such as sharks and stingrays; and the *Osteichthyes*, referred to as the bony fish, such as bass, perch, catfish, and flounder. In the science community, the purpose and essence of the taxonomy is to find a general rule to classify each object on the earth and give it a unified name, a scientific name. Then people can communicate with each other, and scientists will know whether the research materials belong to the same category and whether the research results should be stored in the same folder.

There is no right or wrong between the two classification methods, but the purpose is different. Students learn their own language, also the language of science, so that the two cultures can communicate and learn from each other. This is the significance of bridging subject knowledge and cultural knowledge. Starting from local cultural knowledge to cultural comparison, to the revision and reconstruction of local knowledge systems, to cross-cultural communication, and then connecting with the world is the goal of Ethnic Education. As Sophie said:

> When it comes to the fish classification of Tao, it is only meaningful to people living in Lanyu and has no meaning to others. But when you communicate with other people, you have to use what they know. He knows the science, so you have to use the science to talk to him. Then you use your own language to communicate with your people.
>
> Also, there is something called cultural exchange. How do I let others know and see my conventional wisdom? Let others know about my culture, why I classify creatures this way, and what kind of impact they will have. It's a mutual cultural learning, which I

> think is important, and that's what you call bridging. (Sophie, personal communication, July 05, 2021).

Tension: Who can teach Ethnic Education?

What role do Indigenous Knowledge Keepers and Elders play?

Orchid High School invited Indigenous Knowledge Keepers and Elders to prepare the curriculum in the first preparation year of developing Ethnic Education, with a focus on Tao annual rituals and Traditional Ecological Knowledge (TEK) and cultural traditions that students should know. However, when it comes to implementing the curriculum, the teacher is in charge. Usually, after co-teaching, teachers decided the class plans. At this point, they would ask the Ethnic Education program assistant to prepare the local teaching material or resources. For example, preparing the flying fish for flying fish observation lesson or asking Elders to take students and teachers on field trips. Leo, an assistant for the Ethnic Experimental Education program, said he did not participate in lesson preparation or teaching because that was not his profession, and he did not know what subjects could be integrated into the local knowledge. He felt that his job was to find local resources and human resources. He only attended outdoor classes when they needed more staff for safety reasons or as an interpreter between Elders and teachers and students. Some Elders do not speak Mandarin very well. Although there were two cultural instructors in school, they did not participate in every class. Like invited Elders and Knowledge Keepers, they are passive consultants. When teachers have questions, they come to ask them or ask them to help with teaching. For example, Polly said that when she taught human organs in her seventh-grade Exploration class, she would invite cultural instructors to teach students the Tao languages of these organs.

Are foreign teachers qualified to teach Tao cultural knowledge?

For the Exploration course, although the course was designed according to the topic of the cultural curriculum, the specific content and classroom activities of the course were led by the teachers. However, most of the teachers were not locals. Seven of the nine teachers in the 7th to 9th grade Exploration courses were foreigners, and two of them belonged to other Indigenous groups. Some teachers held an open and positive attitude towards teaching ethnic courses as outsiders, believing that they could bring different perspectives, cultures, and specialties into ethnic courses to enrich the curriculum. Also, because foreign teachers did not belong to any local tribe, when there were different perceptions and disputes between villages, the teachers could provide a neutral platform for discussion. Furthermore, foreign teachers felt less pressure to ask Elders about cultural knowledge and could even ask about taboos because people would give them more tolerance for the things they did not know. A foreigner who does not understand the local culture can be forgiven.

Even if there is more tolerance for foreign teachers making mistakes in teaching cultural knowledge, teachers' professional identity is sometimes questioned by themselves or others. Some teachers resist teaching cultural knowledge because they do not think it's their area of expertise. Parents think that teachers may teach wrong, which makes teachers' educational professionalism questioned and authority challenged. This is a situation that teachers rarely encounter in their own professional subjects. Some teachers also mentioned that they felt denied because of their outsider status. Some parents do not try to understand Ethnic Education in schools just because it is taught by foreign teachers. They do not consider it as Tao culture. Emma said:

> As an outsider, I'm more concerned about things like— 'are you qualified to teach Ethnic Education?' I felt a little sad if they [parents] said that. It was like we were trying very hard to pass on the culture in the school or want to interpret this culture, but it seemed that we had not been trusted. In other words, the attitude of the parents is not so supportive. (Emma, personal communication, July 18, 2021)

Do the new generation of Tao people have enough cultural literacy to teach the next generation?

In the ninth grade Exploration course, the integration and connection of cultural knowledge was mainly the responsibility of the foreign teacher Emma and the supporting cultural instructor, not the Tao teacher Pat in the same co-teaching group. Although Emma is a foreigner, she was very interested in Tao culture and learned the Tao language through her talent for language learning.

The advantage of local teachers is that they have more local resources than foreign teachers. Because they have more relationships with students, they have more connections and understanding with students, and they feel closer to students (Pat, personal communication, July 01, 2021). But the two Tao teachers, Ivy and Pat, who participated in the Exploration class, both grew up on the island of Taiwan.

Ivy mentioned that students may have lived in Lanyu longer than she did, and during class, she would be questioned by students about whether she really understood the traditional knowledge and skills. Therefore, she had to spend more time studying Tao culture. Because of her local identity, she felt more pressure. This is both a form of resistance and boost. In the process of re-learning the culture, Ivy experienced being questioned and having to admit her own

shortcomings. Nevertheless, it is important that the young generation Tao teachers act as role models in the classroom and like big brothers and sisters in the tribes so that students can learn with them.

Tension: Where should students study culture? —Location of Ethnic Education

Does millet have to be planted in the community? Can't we just grow it at school?

The traditional Indigenous classrooms are composed of communities and natural environments. The experiences that people have in their own land make learning meaningful. Indigenous knowledge is established through experience in life. Therefore, the home is a predominant theme in Ethnic Education. As Christie (1991) asserted, "the most fundamental principle taught by Indigenous Elders is that our subject matter is to be examined and interpreted as it is found embedded within its context. (p. 29)"

Therefore, when the school started developing the Ethnic Experimental Education curriculum, they discussed where the tribes would be at this time and what they would do based on Tao annual ritual. For example, with *Manoyotoyon* (End of flying fish consumption Ritual in October, the weather starts to get cold, and the activities of the tribe will gradually move from sea areas to community and mountain forests. At this time, community members began to grow millet. In Lanyu, millet is also called *avat no inawan* (for lifesaving), because it is a life-saving food in winter. In the Ethnic Education class, the students followed the Elders to grow millet in the millet field and learned how to thresh, remove the shell, cook the millet, and various knowledge related to millet.

It is the original intention and consensus of the development of Ethnic Experimental Education curriculum to let students leave school during ethnic class, return to their tribe and

natural environment, and learn culture in the most natural situation and space. (Erin, personal communication, July 11, 2021), because Ethnic Education should not be just a school subject. If learning to grow millet is regarded as a subject knowledge, then it is only needed to invite an external lecturer, an elderly person, to come to the school to tell the story of millet and plant millet at school. But this is not real life (Mary, personal communication, July 13, 2021). Just like a foreign language that students learn in school, if the student does not use it in life, that language is just a subject knowledge to the student.

Learning is a community activity rooted in the home place. However, there is a time cost to shift the field of learning to the tribe. For three ethnic class sessions, the students spent about half to one class walking between places. Another challenge with these outdoor activities was the weather. For example, Pat, a teacher in the ninth and eighth grade Exploration classes, mentioned that the most difficult part of preparing for the class was the changeable weather. Lanyu is the only area in Taiwan that is classified as a tropical rainforest climate, and throughout the year humidity often reaches more than 90%. In summer, it is hot and rainy, and typhoons attack every year. In winter, Lanyu is affected by the northeast monsoon, the weather is changeable, and the rain is abundant. Therefore, teachers have to prepare a fallback plan for rainy days.

In addition, due to the outbreak of the COVID-19 epidemic, Taiwan was upgraded to Alert Level 3 on May 18, 2021, and schools were closed to distance learning. Students returning to tribes and families should be the most natural environment for learning culture, but not every family can provide students with these resources. For safety reasons, students cannot go to the fields by themselves. Therefore, in the last three weeks of the ninth-grade Exploration course, students were synchronously taking classes online in the google classroom. Lesson activities change from outdoor or hands-on to more static, such as report writing and video recordings that

are easier to perform at home. The sudden change also made teachers have to think about how Ethnic Education should be presented in the form of online courses.

Translated Curriculum

During the In Planned curriculum phase, participants discuss why and how to develop Ethnic Education. It is hoped that students can learn cultural knowledge and disciplines under the guidance of the elderly and teachers in the most natural learning environment and situation. Premised on this direction, what tensions did participants experience in translated curriculum stage when they actually designed and executed class lessons?

The millet lesson for the ninth grade Exploration class

One Wednesday afternoon, this was the usual weekly planning time for the ninth grade Exploration class. Two volunteer teachers, Emma and Echo, were behind the school library waiting for three other teachers, Mike, Pat, and Sam, to prepare for the Exploration class on Friday. But because there was a school meeting and a course development meeting for the whole school today, other teachers were participating in the meetings. Mike asked the teachers to put any ideas for the Friday class into the group chat. Mike suggested letting students cook millet in groups, write down the steps, and cook millet again for comparison after optimization and adjustment to the process. Emma wanted to focus on experimental observation and recording. This week, students cook the millet and observe the cooked characteristics of the millet. Next week, students can bring the ingredients for the millet dishes they want to make. From the perspective of a science teacher, Echo proposed that if cooking millet is an experiment, the purpose of the experiment should be to understand the characteristics of millet and the ratio

required and variables to cooking millet, such as the amount of millet, the amount of water, time, and heat. The concept of experimental design can be integrated, such as dividing the millet into an experimental group and a control group, picking up some millet every five minutes during the cooking process to observe, and discussing whether soaking the millet in water before cooking affects the cooking time of the millet. Students can apply the control, independent, and dependent variables learned in science class to the experiment of cooking millet. As usual, Pat and Sam had no comment.

After Emma and Echo waited for half an hour, the other teachers were still in the meeting. These two volunteer teachers first began to discuss the worksheets recorded in millet experiments and the details of the lesson plan. They asked other teachers to review after the meeting to see if there were any problems. In the group chat, Mike shared an article about the millet culture of the Tao ethnic group, which covered the origin and use of millet, the seasons of sowing and harvesting, and the traditional cooking methods of millet. Mike also shared with the group that the cultural instructor (Elder) provided the ratio of cooking millet and water from her life experience, as well as the steps and ethnic language of cooking the millet. Emma said, "This time I want to use homework to teach the Tao language, leaving class time for experiments and writing reports." Mike agreed. Mike and Emma used their spare time to try cooking millet and uploaded their millet experiment results to the group.

Figure 4. 15

Mike's Cooking Millet Experiment Results

Note. During the process of cooking millet, take out some millet every five minutes and observe the changes and characteristics of the millet

In the group, Mike, Emma, and Echo discussed the details of the experimental process of cooking millet, such as how much millet was added? How much water was added? Did they stir the millet? Finally, they concluded how many grams of millet and other required materials and tools they should give students to conduct this experiment. During the course design process, only Mike, Emma, and Echo participated in the discussions. Pat just asked where students should be taking classes. Because Sam is a science teacher, Mike asked him to help explain the design of the millet cooking experiment, the concept of variables, and the writing of the experiment report.

When it came to class time on Friday afternoon, Emma, Mike, and Echo went to the classroom to explain today's class agenda and group list. Sam and Pat were late. Mike took the students to pick up the equipment for cooking millet. Finally, Mike explained the experimental

record worksheets, the cooking method of millet, and the steps and how to fill in the experimental worksheets and reminded students how to use the equipment and precautions. Echo and Emma added timely supplementary explanations, such as reminding to explain the variables and reminding that the soaking time should be fixed. Pat helped to write the key points on the blackboard and manage the class order while other teachers were explaining.

The original plan was that students could find the best conditions for cooking millet based on the results of the experiment this week and then repeat the experiment the next week to confirm that the students could grasp the concept of variable factors. However, due to the impact of the epidemic, all courses from May 18 to the end of the semester were online classes. Therefore, in the second week of the millet lesson, students completed millet experimental reports in the Google classroom. Sam was responsible for reviewing the experimental results, and Echo took care of the experimental steps. Pat and Mike examined parts of the lab equipment. Emma was in charge of the discussion and reflection section. In the middle of this, there was an episode. When Sam was reviewing the students' experiment report, he accidentally mixed up the control variable and the independent variable, which caused the students confusion because it was different from what Echo taught. When teachers have different instructions or requirements in the same class, students will not know which teacher to listen to. For example, when collecting student reports, Pat asked students to finish writing before submitting them, while Emma asked students to submit them first, explaining that they could revise their report in the next class.

This is a typical case of curriculum design and implementation. Some of these tensions can be seen from this description.

I really don't know what to teach!

As shown in Table 4.2, the Ethnic Education curriculum has only themes, but no learning content, standards, and learning objectives. Therefore, teachers can discuss and decide what content should be taught in the course according to the theme in the co-planning meetings. For example, the theme of the seventh grade Exploration course was millet of Lanyu, the eighth-grade Exploration was planting of millet, and the ninth-grade Exploration was Methods of Proceedings Millet. These three themes were all related to millet, and the teaching in three grades was to hope that students could deepen and broaden their knowledge of millet.

But if there is no communication between teachers, or if the new teacher does not know what the students have learned and what prior knowledge they have, the students may learn the same content for three years. Therefore, teachers refer to the course records left by the teachers of the previous year to decide the class content. However, the ninth grade Exploration course was implemented in the first year, and there was no previous course content that could be referred to. Because there are no standards, teachers do not know what the learning objectives of the subject are. Is it that students have the ability to distinguish between different varieties of millet? Or do students need to know the method and month of growing millet, or can students speak the steps of cooking millet in the Tao language?

When Emma and Echo were preparing to explore the Methods of Proceedings Millet lesson in the ninth grade, because Emma had participated in the seventh and eighth grade Exploration courses, they knew that the students had experience in cooking millet porridge and planting millet. Emma planned the learning focus of the ninth-grade Exploration class on writing the experimental report, hoping that the students could observe and record the process of cooking millet. For the science teacher Echo, the observation record is only part of the experiment, and

the focus should be the question and design of the experiment. The taste of millet is relatively secondary information. So, she wanted to incorporate the concepts of experimental groups, control groups, and variables that students had learned in seventh-grade science class.

Because there are no cultural and disciplinary standards to rely on, the direction of the course and which subject content to integrate is up to the teachers in the class. This approach makes the course very flexible, and the teachers have a lot of room to develop, but at the same time, the teachers may also feel overwhelmed and have no direction. For example, teachers like Polly and Emma, who participated in the first year Ethnic Education courses, said that preparing for the class in the first year was very stressful. Teachers often looked at each other and did not know what to teach.

Can we break taboos?

When designing the Methods of Proceedings Millet lesson for the ninth grade Exploration course, teachers wanted students to thresh and hull millet. But the Elders said this is the job of grown men. Therefore, the teacher ended up not arranging this activity for the class. In Tao culture, the division of labor between men and women is very clear, and women and children are responsible for the easier and safer tasks of the workforce. For example, managing taro fields and collecting shellfish in the intertidal zone is the job of women, while men are responsible for the heavy work of fishing, reclamation, and building houses. This kind of social division of labor and cooperation, each performing their respective duties and hard work, is the attitude of Tao People in life. This social division of labor stems from valuing and protecting women, who play an important role in raising the next generation. More dangerous jobs such as sailing and catching fish are men's duties.

But these protections for women have also led to many taboos, such as not allowing women to touch the *Tatala* (traditional Tao boat). Therefore, when designing courses related to *Tatala*, teachers would try their best to cooperate with Tao customs to avoid conflicts. The teacher arranged the class activity that girls would touch the *Tatala* after the flying fish season; for example, during the activity where students experienced paddle boats to explore scientific principles like buoyancy.

However, schools tend to have greater flexibility and tolerance in breaking taboos. The Elders would say with understanding, "It's okay; you are still learning." Because of these taboos, teachers have some restrictions and more thinking when designing courses. For example, Echo hoped that students could experience burning shells during the Exploration class in middle school because students had learned chemical reactions in the eighth grade. Students could apply what they have learned in the Tao traditional burning shells technique. This technique can be regarded as calcium carbonate ($CaCO_3$) to decompose it into calcium oxide (CaO) and carbon dioxide (CO_2). Therefore, students can view science concepts through their own cultural lenses. But the activity of burning shells is age-restricted, so it can only be used in the high school curriculum, although students can learn chemical reactions in middle school. Furthermore, many students will go to high schools on Taiwan's main island, where they will miss this activity experience.

On the other hand, sometimes there is some ambiguity about these "can't dos." It often happens that one Elder says yes, and another says no. For example, Leo, the project assistant of Ethnic Experimental Education, and Pat, the teacher of the Exploration class, two Indigenous Tao mentioned that they originally hoped to have lessons in making traditional Tao fishing nets, fishing gear, and spear guns. Some Elders said that these skills are too difficult for students to do,

and some Elders said that students could do it at this age. “Can you do it at this age” will vary according to the life background of the Elders. Some Elders whose parents passed young, who had to learn this skill earlier, would think that students at this age can do it.

Leo’s point was that if students are too young to be allowed to learn these things in the Ethnic Education courses at this time, they may not have the opportunity, access, or exposure to these traditional skills and cultural knowledge after they leave school study or work elsewhere. He said:

> They [Elders] said that it is too difficult for middle school to cultivate the land. However, if they [students] are not allowed to do so in high school, will they still go to reclaim the land after they graduate? I don’t know. (Leo, personal communication, June 30, 2021)

Leo believes that these constraints need to take into account the historical context. In the past, cultivating fields was the job of adult men, but modern adult men may take up other jobs, such as service industry, tourism, etc., or leave Lanyu for other places. It is better to let students have formal courses at the school stage to experience these jobs that originally only adults can do.

Besides the taboo factors, such as girls cannot participate in catching flying fish, there were very few lessons on sea area activities in the Ethnic Education class. This is out of consideration for the protection and safety of students. Taking students to sail or engaging in seaside activities is extra pressure for teachers and schools. Therefore, while Tao is a marine ethnicity and lives on an island, students can only do activities in the intertidal zone except for the maritime safety lessons and swimming tests.

Are we learning cooking millet or are we learning designing the scientific experiments?

During interviews, the participants agreed that Ethnic Experimental Education should include both cultural knowledge and subject knowledge but wondered how it should be integrated and how the degree of integration be judged. There are four levels in Banks' multicultural education model (2008) that can enhance the cultural awareness of any curriculum. Its function and purpose categorize each level. According to the degree of connection, it can be divided into (1) Contribution Approach: in the current curriculum and teaching materials, the symbolic of non-mainstream ethnic groups, such as characters, rituals, cultural characteristics, etc., are used to make learners appreciate the culture of different ethnic groups; (2) Additive Approach: refers to adding the characteristics, concepts, or themes of non-mainstream ethnic groups without changing the mainstream framework; (3) Transformative Approach: the curriculum undergoes restructuring and redesign to reflect the perspective of individuals within the culture, so that students have the ability to explore concepts, events and issues from the perspectives and thinking modes of different ethnic groups; and (4) Social Action Approach: Encouragement of students to criticize and participate in social transformation, while at the same time empowering. Educators must embrace their role of increasing ethnic diversity and commitment to educating from a community and social perspective.

Using the four levels of Banks' multicultural education model to examine seven units performed by ninth grade Exploration course students, there are some units that achieve a Transformative Approach level, such as the Kuroshio Current Fish Lesson. Students used the Tao perspective and scientific perspective to explore the concepts of taxonomy. But some units are still at the Additive Approach level, such as the Methods of Proceedings Millet lesson. Students learned Tao language and cultural knowledge about millet in the classroom. For

example, they learned why millet is called *avat no inawan* (lifesaving), the vozok (black millet) native to Lanyu, and the two traditional ways of eating millet, one is called *oggogen* (millet porridge) and the other is *amain* (millet ball).

However, the proportion of cultural knowledge only accounts for one class, and millet is only a theme for students to learn scientific experiment design, and it can be replaced with other themes. In addition, in the last three weeks of the course, students spent most of their time on writing the millet experiment report. Part of this was because static activities are easier to operate in online courses and the other part was because the students' experimental reports were very immature and incomplete. The focus of the units shifted from millet cultural knowledge to the writing of scientific experimental reports.

Table 4. 8

Use Banks' multicultural education model to analyze the degree of integration of cultural and scientific knowledge in unit content

Topic	Cultural Knowledge	Scientific subject knowledge	Banks' multicultural education model
Survival in the Wild	Traditional knowledge of wild vegetable	Plant classification	Transformative Approach
Traditional commonly used tree species	Traditional knowledge of canoe building	Density of wood of different tree species	Transformative Approach
Ritual plant planting	Planting methods of *Soli* (Taro), *Patan* (lesser yam), and *Wakey* (sweet potato)	1. Plant structure 2. Vegetative reproduction	Transformative Approach
Record family water	Water source location	1. Unit conversion 2. Latitude and longitude.	Additive Approach

source and distribution			
Kuroshio Current fish	Traditional knowledge of Kuroshio current fish and taxonomy of Tao culture	1. Scientific research and report format 2. Fish structure 3. Identification keys	Transformative Approach
Manmey (Taro cake)	Traditional knowledge and Tao language of taro fields, planting Taro and making Taro cake.	1. Plant cultivation 2. scientific report	Additive Approach
Methods of Proceedings Millet	Tao language about millet and millet culture.	Scientific experimental design, including variation, experimental group and control group.	Additive Approach

In addition, The Alaska Science Consortium, the Alaska Rural Systemic Initiative (AKRSI), and the Alaska Department of Education collaborated on developing standards-based, culturally relevant science curricula that integrated Indigenous Knowledge and Western Science Knowledge (Stephens & Alaska Univ., 2001). These documents suggest that to develop culturally relevant science curricula, teachers should consider four factors: (1) Cultural relevance, (2) Standards-Based, (3) Best Practices, and (4) Assessment.

Using the AKRSI Unit Building Assessment Rubric to evaluate the Methods of Proceedings Millet unit for the ninth grade Exploration course, cultural knowledge was apparent and cultural experts were involved in the Cultural Relevance Parameter. However, cultural experts were not a significant and critical part of the unit implementation. The role of Elders in curriculum design was as counselors of cultural knowledge. The teacher asked the Elders about the cultural knowledge of millet and then passed it on to the students, instead of the Elders directly teaching it. However, cultural values and skills were identified in this unit. For example, there was a class discussion about why millet is called a lifesaver in winter. There was also an

emphasis on the Tao language of cooking millet process— (1) *mangwat so cinwat* (boil water), (2) *nokomboaz o cinwat* (water boiled), (3) *pasbongen o kadai* (put in millet), (4) *oggogen o kadai* (stir millet with liquids), (5) *amain o kadai* (stir millet until all liquids are reduced and absorbed, (6) *araon o kadai* (scoop up), and (7) *memehen o kadai* (knead into millet balls)

Before designing this unit, the national science standards were not identified, but the knowledge or skills that students would learn were listed, including the design of experiments and the method of writing experimental reports. The unit includes an adequate number of appropriate activities, such as the millet cooking lab.

For the Best Practices section, teachers were committed to enabling students to understand and apply knowledge, concepts, and processes of inquiry, and apply scientific experimental design concepts to explore the variables of cooking millet. The activity included student investigation, but it was mainly led by the teacher, so the teacher still maintained most of the learning responsibility and authority. After the end of the unit, there was no formal assessment for scientific knowledge and inquiry. The millet experimental report and the video that students created to present their report were used as the learning evaluation. It only measured students' understanding of cultural knowledge of millet, and only measured the factual knowledge. For example, students read aloud the process of cooking millet in the Tao language.

Table 4. 9

Use AKRSI Unit Building Assessment Rubric to evaluate the Methods of Proceedings Millet unit for the 9th grade Exploration course

Parameter	
Cultural Relevance How well does the unit examine topics of cultural significance, involve cultural experts, and address cultural standards?	**Level 3** Cultural knowledge is appetent
	Level 3 Cultural experts involved

	Level 2 Cultural values, skills, and standards suggested or implied
Standard Based How well does unit identify an appropriate number of state/ national science standards; describe specifically what is to be learned about those standards; and provide an adequate number of properly sequenced opportunities that lead students to a deeper understanding of the standards?	**Level 1** Standards not identified **Level 3** Skills and knowledge to be gained are identified. **Level 3** Includes an adequate number of appropriate activities.
Best Practices How well does the unit incorporate strategies which focus on student understanding and use of scientific knowledge, ideas, and inquiry process; guide students in active and extended scientific inquiry; and support a classroom community with cooperation, shared responsibility, and respect?	**Level 3** Strategies include some attention to student understanding and use of knowledge, ideas, and inquiry process. **Level 3** Activities include some active student investigation **Level 2** Teacher maintains responsibility for learning
Assessment How does the unit engage in ongoing assessment of student understanding of highly valued, well-structured knowledge; student skill development and reasoning ability; diverse representations of understanding.	**Level 2** Students were tested at the end of the unit on factual understanding that can be easily measured. Assessment of deep scientific, mathematical or cultural understandings or skill development is absent.

Through the use of Banks' multicultural education model and the AKRSI Unit Building Assessment Rubric to examine the ninth-grade Exploration curriculum, the results showed that although the curriculum content included both cultural knowledge and scientific knowledge, there was room for improvement in the degree of integration of cultural knowledge and scientific knowledge. The value of cultural knowledge should not just provide context to learn scientific knowledge. The curriculum needs to be strengthened in terms of standards and assessments.

Which knowledge is more important? — Prioritization of Knowledge

When designing the Methods of Proceedings Millet unit, the teachers started from the cultural theme and decided that the cultural knowledge in this lesson was the technique and the cultural connotation of cooking millet. Then, the science teacher came up with the scientific knowledge that could be integrated with cooking millet. The class time for the ninth grade Exploration course formerly belonged to physical education and health education. Logically speaking, the content of these integrated subjects should be presented in the form of ethnic courses, and the knowledge content of physical education and health education courses should be integrated into ethnic classes. However, the Methods of Proceedings Millet unit did not present what physical education and health education should teach. Which disciplines should be given priority for integration into Ethnic Education? Pat, the co-teacher of the ninth grade Exploration class, was also a physical education teacher and rarely gave advice on curriculum design and co-preparation. On the one hand, it was because she was not the leading teacher of the class. Moreover, if the P.E. teacher did not indicate what physical education knowledge could be incorporated, likewise, teachers of other specialties did not know how to incorporate physical education knowledge. Therefore, the process of students walking to the field was often viewed as an integration of physical education.

Another example is that teachers themselves often did not know what subject knowledge could be integrated. For example, health education in Orchid High School is taught by teachers of other subjects. Due to the small number of classes in the school, the number of health education classes in the whole school is not enough to hire a full-time teacher with expertise in health education. However, are these out-of-field teachers able to identify Health science knowledge and integrate it into Ethnic Experimental Education? For example, the unit of millet

can be combined with the nutrition concept of health education, like what macronutrients and micronutrients millet can provide to the human body. If the teacher of the subject does not or cannot speak for the subject knowledge, the subject knowledge will not be integrated into the Ethnic Experimental Education.

Although the time for science courses is not included in the Ethnic Experimental Education curriculum, the reality is that science is a subject that students take in the high school entrance examination. Scientific knowledge has the value of examinations. When science teachers proposed that students learn the concept of experimental design and variables through the process of cooking millet with cultural skills, the idea was quickly accepted. But it could also lead to another phenomenon - turning Ethnic Education courses into another science course. For example, in the four weeks of the Methods of Proceedings Millet unit, students spent at least three weeks writing lab reports. When too much subject knowledge occupies most of the content of the ethnic class, the cultural core of the ethnicity class will be reduced.

In the limited class hours, how should teachers consider the priority of knowledge teaching? For example, in the traditional commonly used tree species unit in the ninth-grade Exploration class, students measured the density and hardness of wood samples of different tree species and then chose which tree species to use as the keel according to their experimental results. This echoed the cultural knowledge of *Tatala* (traditional Tao boat) construction. Tao people put denser wood on the bottom of the boat, the keel is wear-resistant, the center of gravity of the boat is low, and the boat is less likely to overturn. Students have already learned about the concept of density in eighth-grade science classes, so teachers have designed this unit with density as prior knowledge and expect students to apply the scientific knowledge they've learned to cultural contexts in the Exploration course.

However, when students measured the density of wood, some students had problems with the data, the density of wood they calculated was greater than 1g/cm^3. Anyone who is familiar with the concept of density should know that the density of wood should generally be 1g/cm^3 less than that of water because wood floats on the water. But the students did not notice the anomaly in the data. When choosing which tree species to use for the keel, the students did not refer to the experimental data but made decisions based on experience. Therefore, the teachers believed that the students were not clear about the concept of density. In the case of insufficient time for Ethnic Education classes, should teachers clarify the concept of density first, or should they focus on the cultural knowledge that should be included?

Teachers as learners

On the other hand, not every co-teacher was familiar with the concept of density because teachers came from different professional backgrounds. For instance, when designing the traditional commonly used tree species unit, Emma, a former English teacher, confused mass and weight, and wrote the wrong density formula on the worksheets. Or in the Methods of Proceedings Millet unit, PE teacher Pat said she did not know what control, dependent, and independent variables were. Therefore, when teachers implemented culturally relevant science lessons in ninth-grade Exploration courses, teachers were also learners of non-specialized domain knowledge. For example, Emma and Mike both tried the experiments before teaching the experiments of cooking millet, testing the conditions such as the time and amount of water needed to cook millet. Teachers also asked the Elders about the traditional method of cooking millet, as well as the knowledge of ethnic languages and cultures. Teachers had to spend extra time studying and preparing for lessons.

When preparing for and teaching culturally relevant science classes, Mike said the biggest dilemma is that he does not have a solid understanding of the science content of the lesson. Because science is not his area of expertise, he only learned it ahead of students when preparing the lessons. He had a hard time answering other extended questions from students. For example, In the Kuroshio fish unit, he learned about the identification keys and taxonomy, but he did not know the purpose of classification.

However, this could also be an advantage because Mike might be more likely to think from the student's point of view. Math teacher Mike said that for learning science, he and his students are at the same starting point. If he has problems, the student probably will too. So, they can study together and ask other teachers who can answer. The best case is that if all teachers are willing to use such an open mind, they can learn knowledge outside their professional fields in Ethnic Education classes.

Whose knowledge is correct? —Your fruit is not my fruit!

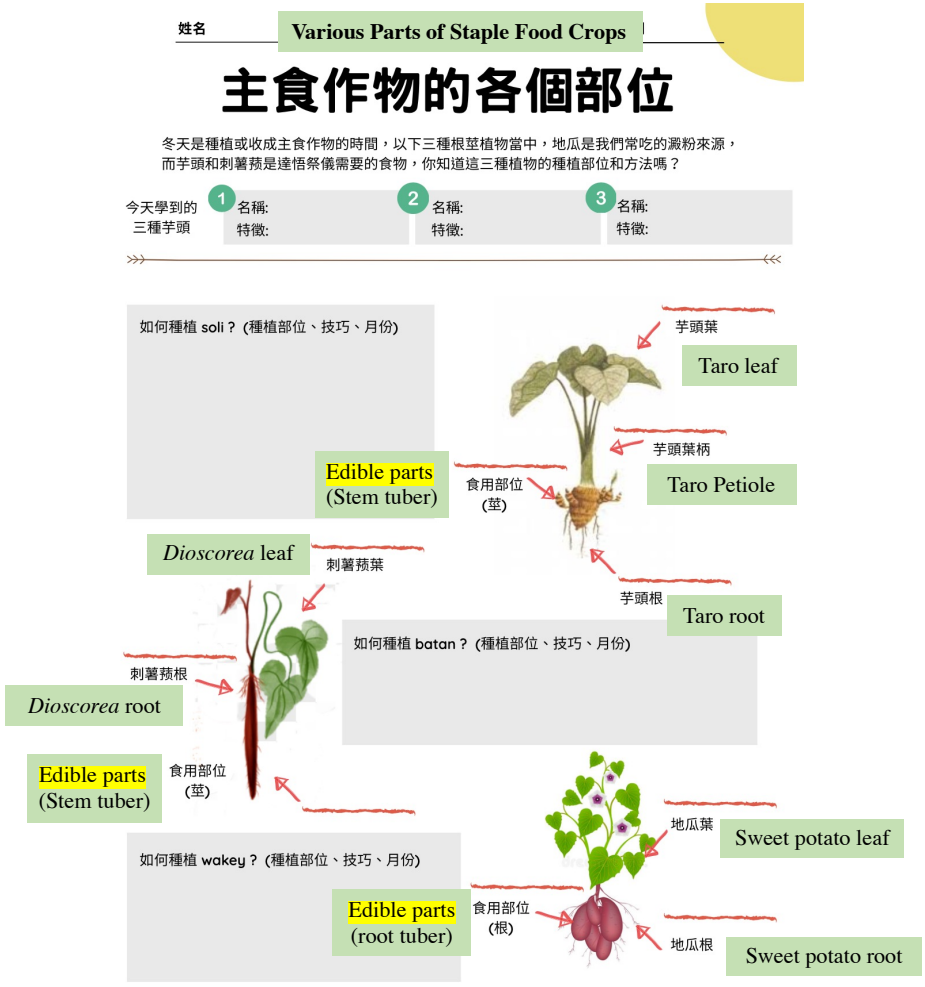
Ethnic Education integrates different disciplines, hoping to cross the boundaries of different knowledge systems and allowing students to interpret culture from different perspectives. However, in the process of integrating knowledge, different opinions sometimes arise.

For example, when preparing for the Ritual Plant planting unit, the Elder was teaching teachers how to plant ritual plants, including taro, millet, and *Patan* (*Dioscorea*, lesser yam). Luna, the cultural instructor, held the *Patan* and said "we plant the 'fruit' in the ground..." However, from the perspective of plant science, *Patan* is not a fruit; it is a stem tuber like a potato. This lesson incorporated what students learned in science class about vegetative reproduction and the use of plant vegetative organs such as leaves, stems, and roots to produce

new plants. Science teachers were concerned that the Elder's use of the word 'fruit' would confuse students or cause misconceptions. Therefore, after the discussion, the teachers asked the Elders to use Tao language calling this part *'asi'* instead of 'fruit' in Chinese. On the worksheet, the teachers also referred to *'asi'* as 'the edible part.' But that's not entirely true either because the leaves and petioles of taro are also edible.

Figure 4. 16

Ritual Plant Planting Unit Worksheet

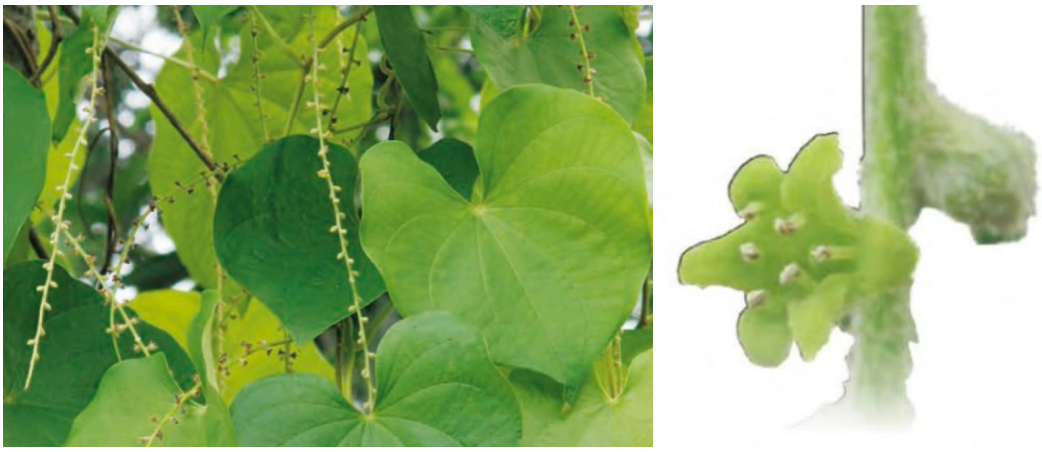


Note. Introduce the knowledge of various parts and planting of staple crops. The words on the green background are English translations, not on the original worksheet.

Furthermore, the science teacher suggested that the students could observe and record the flowers and other structures of the *Patan* when they went to the field. The Elder said, "*Patan* has no flowers. I have never seen its flowers." Although the science teacher had never seen the flowers of *Patan*, according to the classification of the plant, *Patan* (lesser yam) is an angiosperm (flowering plant), which should have flowers. Therefore, the science teacher researched the appearance of the flower of *Patan*. As shown in Figure 4.18, the flowers of *Patan* are tiny green spikes, unlike the general public's colorful impression of flowers. It is understandable for Elders to think that *Patan* will not bloom.

Figure 4. 17

Small green flower spikes of Patan (lesser yam)



Note. From *台灣民族植物圖鑑* [Taiwan Ethnobotanical Encyclopedia*]* (p. 384), by Zhong, M. Z. & Yang, Z. K., 2002, Morning Star Publishing Inc. Copyright 2002 by Zhong, M. Z. & Yang, Z. K.

Indigenous knowledge is based on lived experience and is characterized by qualitative oral records and local confirmation. But each person's life experience may be different, which in

turn develops the diverse and dynamic nature of traditional knowledge. Each tribe, and even each family, may have different practices in terms of knowledge and skills. Such differences in cultural knowledge and language among tribes are another challenge for teachers accustomed to the universal mindset of Western science.

How many times do I have to go to the taro field to learn how to plant taro? — Indigenous way of knowing

In the ninth grade Exploration course, students spend one month each semester reclaiming taro fields, digging canals, diverting water, planting taro, and weeding. Every field class took a lot of time. Regarding the arrangement of class time, Pat, a new generation Tao teacher, believes that the school spends too much time on cultural classes. However, Elder Luna wants the students to spend more time in the fields. She said:

> Growing taro is not about knowing it, but about doing it. And not just once, but many times. …Growing taro is not that simple. After it grows, you have to manage it. If you don't take care of it, there is no way to get the taro (Luna, personal communication, June 30, 2021).

Western science emphasizes categorized, decontextualized knowledge and classrooms, so curriculum design includes pre-determined concepts and objective assessments (Stephens & Alaska Univ., 2001). For example, the reproduction method of taro is the core idea, and after students understand the concept of asexual reproduction, the goal is for them to verify this knowledge through a one-time off-campus field trip in the taro field. Students experience planting taro and using vegetative organs to reproduce the next generation. Finally, students take an objective test to assess whether they know the steps of vegetative reproduction and growing

taro. This approach essentially regards knowledge as a product that is then transferred to students. Therefore, the method of evaluation is to measure whether students acquire this knowledge.

For the Elder, growing taro is not a one-time cultural experience class. She said, "You should go to the fields more, know the fields, and bless the fields." Tao people hang weathered shells in the taro fields to pray for a good harvest, conveying their respect for nature. Knowledge is not a product but a relationship; the relationship builds with the taro field. Even though Indigenous people around the world have different cultures, there is one common worldview they share. From their viewpoint, Traditional Ecological Knowledge (TEK) is viewed as "the process of participating (a verb) fully and responsibly in such relationships, rather than specifically as the knowledge gained from such experiences" (McGregor, 2008, p.145). As Tao's Elders often said, "You have to go to the sea and the mountain often so that the sea and the mountain will know you and remember you." However, how should this 'relationship' be taught in the school system? How should it be evaluated?

Figure 4. 18

Weathered shells hang in a taro field

The depth and breadth of school curriculum culture can be viewed through Edward T. Hall's (1989) "cultural iceberg" analogy. The interpretation of culture in the current school ethnic curriculum mostly stays in the explicit culture and material culture rather than the spiritual aspects such as co-prosperity, sharing, and equality. For example, Tao people sing while harvesting millet in the millet field. Students can also learn this traditional song in the classroom, but without the context, it's just a song, not a human-to-human communication.

Figure 4. 19

Students harvested millet in the millet field

Note. Eleventh-grade students harvested millet in the tribe field under the leadership of the tribe Elders in May.

Values, beliefs, attitudes, and perceptions are implicit cultures. For example, when going up the mountain, the Elders told the students that the firewood stacked in a particular way was owned by others and could not be taken. During the flying fish season, the Elders tell students

not to fish for bottom-dwelling fish (bottom-feeder fish) and allow the ecology to recover. When catching land crabs, they remind students not to catch female crabs holding eggs. When catching fish, don't catch too small fish, etc. These unobservable aspects of the cultural iceberg are difficult to assess.

Students' reflections on the Exploration course of Ethnic Experimental Education

In order to understand the ninth-grade students' responses and thoughts about the Exploration course of Ethnic Education, teachers asked students to fill out the survey questionnaire at the end of the Fall 2020 semester. In the last class of Spring 2021, the teacher had the students review the curriculum and photo records of the three-year Exploration class. Students selected the photos taken in the Exploration courses of Ethnic Education in the past three years and used google slides to create course feedback in groups.

Fall 2020 Semester

The questionnaire in the Fall 2020 semester was created through the Google form webpage, and students filled in the online form through the link. There were 29 responses, and deducting the duplicates, 27 surveys were adopted. The survey was a required part of course participation; it was not a research activity. Researchers just asked to analyze the surveys for research purposes.

The survey contains Class, seat number, and four questions:

1) Score yourself for this semester? Why?

2) Which unit did you like this semester? Why?

3) Which unit of the curriculum do you think needs improvement? How to improve?

4) What are your expectations for the next semester?

Score yourself for this semester? Why? (How students comment on their learning)

The average grade of self-evaluation that students gave themselves was 86 points out of 100. One student gave himself 45 points because he felt that he was not working hard enough in the class. Three students gave themselves 60 points because they thought their class performance was not particularly bad or good. Four students who gave themselves a score of 70-79 thought that they had participated in the course, but their enthusiasm or learning attitude could be improved. Four students who gave 80-89 points and six students who gave themselves 90-99 thought that they were actively participating in most of the classes, but a fly in the ointment was sleeping in one of the classes or complaining about the unit they didn't like. Eight of them gave themselves 100-101 points, believing that they were willing to participate and were fully engaged in classes, and they had learned a lot.

The result shows that the basis for students' self-assessment is mainly based on their participation in the course and their attitude towards learning, rather than a summary assessment, such as how much I know about this content knowledge.

Which unit do you like this semester? Why?

In the Fall 2020 semester, students learned the units about Survival in the Wild (6 weeks), Traditional commonly used tree species (3 weeks), Ritual plant gardening (6 weeks), and Record family water source and distribution (3 weeks).

Eight students like ritual plant gardening because they could be close to the natural environment and learn how to plant. Eight students liked swimming lessons because they had fun and enjoyed the classes. Four students liked to pick wild vegetables because they could go to the field to learn how to survive in the wild and identify the edible wild vegetables. Three students liked camping lessons because they could learn camping skills such as setting up a tent, making a

fire, cooking a meal in the open (air), and working with senior students. Two students said that they liked all the outdoor classes, but there was one student that did not like the off-campus classes because they had to walk a long distance to the field. Apart from this student, most of the students liked outdoor courses.

However, only seven students mentioned learning knowledge or practicing skills. Most of the students emphasized their feelings about the course, such as fun, interesting, experience, or being close to the natural environment. The affective domain is one of the three domains in Bloom's Taxonomy for identifying, understanding, and addressing how people learn. It involves our feelings, emotions, and attitudes. David Krathwohl et al. (1964) proposed a taxonomy to systematically classify the types of human affective responses. They analyzed the emotions, thinking styles, attitudes, values, etc., described in the goals of affective education as representative behavioral components, and students' responses to the affective field represent the learning evidence generated by the teaching results.

The taxonomy is presented in five stages:

1) Receiving: the perception of a certain phenomenon and stimulus, and then choosing the stimulus to be paid attention to
2) Responding: actively paying attention, that is, actively participating in the response, but not committed to keeping or dedicating
3) Valuing: perceiving the value existing in a phenomenon, thing, or behavior, and then attaching importance to its value
4) Organization: the system that internalizes value into self

5) Characterization by value or value set: internalizing the value of the organization level, becoming a part of the personality, and raising it to the level of the philosophy of life, that is, the concept. Individuals act according to their ideas

According to students' feedback, students have reached the stage of Responding by expressing positive feelings toward Ethnic Education courses but have not yet emphasized the value of Ethnic Education, such as mentioning the importance of traditional cultural knowledge or what scientific knowledge they have learned.

Which unit of the curriculum do you think needs improvement? How to improve?

There were 12 students who thought there was no need to modify the course. Five of them gave positive feedback such as "great courses" and "great teachers." One student said there were some lessons that he was not interested in, but overall, the course was very good depending on whether the students had a willingness to learn. Five students hoped to increase off-campus courses and students' independent time. Seven students made suggestions for the safety, convenience, and comfort of the course environment. For the activities that required family cooperation, such as looking at the family's water source, students noted that their families might not be able to cooperate in time. They also mentioned that outdoor courses could be taken when the weather is warmer or sunny. Some students raised doubts about the safety of field activities.

Spring 2021 Semester

In the last class of Spring 2021, students used the sharing function of google slide to complete the production and sharing of the three-year Exploration course review briefing. Their presentation contained:

1) What were the course units that most appeal to you (the most practical, the most meaningful, the most learned, the easiest to understand)?
2) What did you do in this unit, or what happened?
3) What did you learn?
4) Other things you want to share (course suggestions, gratitude)

There were six groups of students in groups of four. Five groups chose the unit that most appealed to them, Taro Cake, and one group chose to observe the five senses they had learned in the seventh grade Exploration course. The reasons students cited for choosing taro cake were mostly because this unit was the most practical. They could see the product and have a sense of achievement. Students also mentioned that this was the most meaningful unit because it contained cultural knowledge.

When answering the knowledge learned in the Exploration class, the students mostly focused on traditional skills and knowledge, such as the making of taro cakes, the utensils of taro cakes, their mother tongue, etc. Some students also mentioned that they learned a lot about the form and writing of formal reports in the ethnic class. At the end of the experience sharing, the students shared their feelings about the course. For example, the seventh grade Exploration class learned the traditional cooking method of millet and how smoke made people cry. In the five senses experience unit of the seventh grade Exploration class, trying different foods blindfolded was scary, and so on. Students also suggested that they could learn more traditional etiquette, and they also hoped to have more outdoor courses and seaside activities. One student said:

> Thank you for your teaching over the past three years. We learned a lot about our culture from the Exploration courses. From seventh grade to now, we have learned how to grow

staple foods, how to cook local food, ethnic languages, and how to write reports. I have learned a lot in the three years of middle school. Thank you, teacher.

CHAPTER 5

DISCUSSION AND IMPLICATIONS

Introduction

The Education Act for Indigenous Peoples was enacted in 1998. The term "Indigenous schools" began to appear in 2004, emphasizing the study of traditional national culture. However, education usually still focuses on general education, and the knowledge of Indigenous people is only incidental. It was not until the Experimental Education Act was passed in 2014 that the Indigenous knowledge system was substantively transmitted through the Ethnic Experimental Education School, emphasizing education truly centered on the value and beliefs of Indigenous people. Through participation in the design of the Ethnic Experimental Education curriculum, this action research looks at the experiences of Orchid High School teachers in developing and implementing Ethnic Experimental Education, integrates scientific subject knowledge and inquiry into the Ethnic Experimental Education curriculum, and explores the possibility of Ethnic Experimental Education bridging students' life culture and school science.

This chapter is divided into three sections. The first section, "Should Ethnic Experimental Education be continued?" discusses participants' beliefs and what they gained in Ethnic Experimental Education. The second section is entitled "What needs to be overcome in continuing Ethnic Experimental Education?" The last section describes "Recommendations of the Future Action." It includes Implications for science teacher education, professional development of in-service teachers, developing deeper cultural dimensions and standard-based

curriculum, and establishing community-based network resources to allow Elders to have more leadership and participation in curriculum development and implementation.

Should Ethnic Experimental Education be continued?

Orchid High School has experienced many different voices and tensions since the official implementation of Ethnic Experimental Education in 2018. Ethnic Experimental Education is not a fixed template. Under ever-changing parameters and conditions, the school is always looking for a more comfortable and acceptable dynamic balance.

The question of whether or not Ethnic Experimental Education should continue is a question that cannot be answered only a yes or no dichotomous way. Among the respondents, some people agree with Ethnic Education, but they do not agree with the methods implemented at this stage. Some teachers do not participate in the Ethnic Experimental Education courses but teach Ethnic Knowledge in their professional subjects in a culturally responsive way. Some teachers believe that Ethnic Education should be taught by families and communities, and the implementation of Ethnic Experimental Education in schools is only a compensatory policy for past assimilative education.

In the face of so many difficulties and backlashes, why should Ethnic Experimental Education continue? Erin, Director of Academic Affairs, said it was a declaration of sovereignty. From the period of the Japanese occupation to government by the government of the Republic of China the implement action of compulsory national education in Lanyu is like the cultural colonization of foreign regimes. The younger generation of Tao people entered the school to learn foreign knowledge taught by foreign teachers. Some voices of cultural hegemony even

said, “They [the Indigenous people] are finally progressing now, and Ethnic Education has brought them back to a backward culture.”

Ethnic Experimental Education allows schools to make changes, empower a group of people, and invite Elders, Knowledge Keepers, and community members to participate in discussions about what schools should teach. As stated in the United Nations Declaration on the Rights of Indigenous Peoples, Article 14(1): “Indigenous peoples have the right to establish and control their educational systems and institutions providing education in their languages in a manner appropriate to their cultural methods of teaching and learning.”

This change does not only affect schoolteachers and students, but the entire ethnic group and people exposed to Ethnic Education. Especially after two generations of assimilation education, many teachers or assistants in their 20s and 30s have lost their mother culture. Because of their participation and exposure to Ethnic Experimental Education, they can re-learn and recognize their own Ethnic culture and make up for the cultural gap. As Erin said:

> Ethnic Experimental Education is precious, including the young assistants who are back. I saw them working as assistants, following the class, and speaking about what they saw. I just feel its value, not just the matter of these three years’ classes. It has a lot of influence, as long as the exposed people will think about it. Even people who disagree with it may have the opportunity to think because of this, whether they are too arrogant or they can see the knowledge, wisdom, and ability of each ethnic group (Erin, personal communication, July 11, 2021).

In addition, the transformation and growth of students in Ethnic Experimental Education is apparent from the feedback of teachers. The progress of grades may not measure the

achievement and value of Ethnic Education. Students' identification with culture may not be manifested in a short period of time. However, Ethnic Experimental Education returns the right to students to recognize their own culture, and students have more opportunities to be exposed to cultural practices. The teachers and Elders took the students to the fields to grow taro, sweet potato, millet, etc. After class, students still continued to care for their crops and demonstrate pride in their harvests. Students also shared that they went to the fields to weed with their parents during the weekend, and their mother taught them about weeds that were not mentioned in the classroom. Based on anecdotal stories it was evident that students started to care more about the land, and were more involved and familiar with ethnic rituals. These values are difficult to measure with standardized tests because Ethnic Education is the practice of life, not a discipline.

Ethnic Experimental Education has also changed the previous teacher-centered teaching method. Students no longer take passive simply sitting in the audience and listening to lectures, but rather are cultural executors. For example, more than half of the classes are held outside of school in the ninth-grade exploration course. Based on feedback from teachers and students, the proportion of students sleeping in Ethnic Experimental Education courses class is lower than in other general education subject courses. In addition, the students like the Ethnic Experimental Education courses. Although students' expressed reason might be "it's fun to go outside school," this also means that the field of learning is no longer limited to schools and classrooms. Students' abilities that were suppressed or had no chance to show in the traditional general education have also been released in Ethnic Experimental Education. Ethnic Experimental Education provides students with another stage in which to learn science. As the principal said, "I see that students can express themselves to the fullest, learning confidently and happily."

The change in the teaching mode of Ethnic Experimental Education has also brought added value besides cultural awareness. For example, many classroom outcomes in the ninth-grade exploration class require students to make posters or presentations to share and integrate their learning. With constant practice, even students with poor academic performance in the class were willing to stand on stage with confidence. The students themselves have noticed these improvements. In the past, students who used to talk on stage with their heads lowered and spoke to the floor can now do presentations confidently. From the process of students' learning and dissemination of culture, their ability to express themselves has also improved.

Teachers also learned and gained from participating in Ethnic Experimental Education. There are no ready-made textbooks and teaching materials for Ethnic Experimental Education, and all courses need to be discussed and designed cooperatively by teachers. The curriculum is adjusted annually based on the expertise of the teachers and the needs of the students. It also improves teachers' ability to design lessons. Ethnic Experimental Education is a co-taught course. Teachers also learn teamwork, which naturally forms an informal mentors-mentees system led by experienced teachers in service with novice teachers. Via the collision of different teaching methods, expertise, and perspectives, teachers see other possibilities for education. As the principal said:

> As far as I'm concerned, some of my thoughts, opinions, and values have changed since I came [to Orchid High School]. I no longer think that things can only be handled in one way as before. In fact, coming here really gave me a different outlook on life."

Some teachers see the educational philosophy they want to achieve in Ethnic Experimental Education. As Emma said:

> "I feel a sense of accomplishment. In the past, we might criticize that education is how to get students out of nature (environment), or we seem to train students to become consumers in the industrial and commercial society. We may have these criticisms. But when doing Ethnic Education, we are talking about methods of growing plants, land ethics, and systematic thinking. These things seem to be ideal. Ethnic Experimental Education is very similar to the kind of education we have to do."

Among the participants, some substitute teachers decided to go to graduate school to study in a teacher education program after teaching at Orchid High School. In addition, they hope to bring the concept of Ethnic Experimental Education back to their tribe. Furthermore, because most of the teachers are not Indigenous, developing the Ethnic Experimental Education curriculum provides an opportunity for teachers to learn to teach. Teachers can learn Indigenous knowledge in appropriate contexts and in multiple ways, especially in the local communities. They can explore and develop Indigenous knowledge in a rich, dynamic educational context that combines the Indigenous Knowledge System and school subject knowledge systems. These changes are by-products that were not expected at the beginning of the Ethnic Experimental Education.

Ethnic Experimental Education aims to preserve the Indigenous Knowledge and worldview passed down from generation to generation, which is not only meaningful to a single ethnic group but beneficial to the survival of all humanity. Like the concept of Biodiversity, the variability that exists among living organisms (both within and between species) and the ecosystems of which they are part, in a biologically diverse ecosystem, this complexity allows organisms to adapt to continually changing environmental conditions and to maintain ecosystem

functions (Food and Agriculture Organization of the United Nations (FAO), 2019). In the face of future uncertainties and challenges, such as climate change and the Covid-19 pandemic, when everything humans take for granted is disrupted, preserving cultural and intellectual diversity is the way to survive. For instance, in June 2021, due to the COVID-19 level 3 epidemic prevention alert in Taiwan, the passenger ships to Lanyu were suspended. In addition, due to the strong southwest monsoon, the sea conditions around the island were not good, resulting in no freighters for half a month. The staple merchandise on the island had long been snapped up, and even the most basic groceries such as vegetables, fruits, and eggs were not available. But Elders said, "As long as the mountains, fields, and sea are still there, the people of Lanyu will not starve to death." The disappearance of an ethnic language, knowledge, and culture is not only a pity but also a loss to all humankind.

The preservation of Indigenous knowledge and worldview echoes biocultural diversity, expressing the link between biodiversity and human diversity (Cocks, 2006). Examples of how "Indigenous" and "local" peoples worldwide protect individual species and entire habitats have sparked interest in biocultural diversity.

Western science ignores spirituality and emotion, but there is not only one way to get along with natural surroundings. When the environment changes, human beings have to think about other wisdom and ways of living. For instance, the traditional Tao residence, semi-basement house, is Tao people's countermeasures against the typhoon that hits Lanyu every summer. They build the house under the ground, with only the roof above the ground. However, there are new building materials, and everyone builds reinforced concrete homes now. Then why do schools still teach the knowledge of semi-basement houses? For another example, now everyone uses motorized boats to go fishing, why should students learn to build *Tatala*

(traditional Tao boat)? However, Ethnic Education is not about restricting the Indigenous way of life, not requiring students to live in semi-basement houses, or forbidding them to use motorized boats. They can choose the way they live. Ethnic Education hopes to continue the excellent meaning behind Traditional Ecological Knowledge (TEK) and culture, such as restraint fishing even with motorized boats, so that biological resources can be sustainable.

What needs to be overcome in continuing Ethnic Experimental Education?

The difficulties that Orchid High School needs to overcome to continue promoting Ethnic Experimental Education include both external and internal issues. External issues are the broader education system, outsider attitudes, and resources that the school cannot change based on its power and ability alone. The internal issues are the problems that the school or the teachers themselves still have to overcome even if the external problems are solved, such as the teachers' attitudes, awareness, and cultural competence.

External issues

School system (Teacher recruitment)

Orchid High School is a county school, and teacher recruitment is based on the joint selection of public schools. It means that regular teachers are ranked by test scores, selecting schools in descending order of test scores. Therefore, the regular teachers who finally come to the school do not necessarily agree with the school's concept of promoting Ethnic Experimental Education.

In addition, because of the Act for Education Development of Schools in Remote Areas (Act for Education Development of Schools in Remote Areas, 2017), the qualified, full-time, regular teachers, who are employed by the placement of government-funded student teachers or

recruitment specifically for schools in remote areas, should serve at least six years of actual service before the teacher may apply for transfer to a school in a non-remote area. Such teachers are mainly passive, negative, or opposed when participating in Ethnic Experimental Education. Therefore, regular teachers cannot leave the school even if they disagree with Ethnic Experimental Education unless they re-sit for recruitments of the regular teachers or use remote schools as a springboard, applying for transfer as soon as the six-year deadline is up.

More than half of the teachers at Orchid High School are substitute teachers, but the position of substitute teacher is not stable. Although the school can independently recruit for vacancies among substitute teachers according to its philosophy, if there are unsuitable substitute teachers, they may not renew the contract. However, it is difficult to recruit people in remote areas. Sometimes the school could not find substitute teachers when classes have already started for the year. And there is no salary during the summer vacation, so the turnover rate is very high. In addition, more than 70% of the teachers are foreigners. With the different stages of teachers' life development and personal career choices, they will leave Lanyu eventually. How to face personnel changes and maintain an effective workforce troubles school leaders and teachers. In the case of unstable teachers, it is challenging to develop an Ethnic Experimental Education curriculum steadily

Admissions system (Examination system)

To reduce exam stress for students and solve the problem of determining students' futures and opportunities based on only a single exam, Taiwan's government has proposed many educational reforms in the admissions system in recent years. Two examples are the Policy of University Multiple Entrance Program from 2000 and the non-exam-based Admission to Senior Secondary and Vocational High Schools from 2014. Although the proportion of students using

these alternative admission increases, the entrance examination is still the key to determining students' further education. The focus on examination-oriented pedagogies is not likely to disappear any time soon in Asian countries (S. Martin, 2017).

The literature review found that secondary schools that run Ethnic Experimental Education all carry out dual-track curricula to maintain students' academic skills, and the courses are divided into General Education and Ethnic Education. The general subjects are the entrance examination subjects, including Chinese, mathematics, natural science, and social studies. Although Panan Tribe Elementary and Junior High School changed the name of natural science class to land science and put it into the curriculum of Ethnic Experimental Education. The land science class is still taught independently, integrating some Indigenous cultural themes and elements.

What is the impact of Ethnic Experimental Education on subject examinations? Some teachers believe that the students' good learning attitude in the Ethnic Education class should positively affect the students' learning attitudes in other general subjects. Some teachers also believe that the curriculum of Ethnic Experimental Education is not integrated into the content of general subjects, and even if it has no positive effect on subject examinations, it will not have a negative impact. Orchid High School began Ethnic Experimental Education in 2018 and implemented a dual-track system. However, in 2021, the first group of ninth-grade students who took three years of Ethnic Experimental Education participated in the Comprehensive Assessment Program for Junior High School Students, and the results were not satisfactory. The student's academic performance did not meet the teacher's expectations.

Many reasons affect students' performance in exams. Some teachers think that the curriculum preparation burden of Ethnic Experimental Education is too heavy, so teachers do not

have the energy and time to prepare their academic subjects teaching. Even though teachers have a positive attitude, they are also busy with teaching and administrative affairs, which exhausts their energy. It makes the teacher shortage even more critical. On the other hand, how should the success and failure of an experimental education be defined? Ethnic Experimental Education looks forward to the day when students can put ethnic culture into practice and build relationships with land, sea, mountains, and community because knowledge is the relationship. Therefore, the significance and value of Ethnic Experimental Education may not be reflected in subject examinations.

Although subject learning is not the primary purpose of Ethnic Education, if teachers can better understand students' ethnic culture through Ethnic Education and use it in Culturally Relevant Pedagogy (CRP), they can integrate subject knowledge into Ethnic Education or incorporate cultural knowledge into general disciplines. It can provide an appropriate context to engage students in learning subjects in their way of knowing and might lead to academic success. But this may not be a short-term outcome. The Alaska Science Consortium and Alaska Rural Systemic Initiative (AKRSI) and the Alaska Department of Education took five years to develop a standards-based, culturally relevant curriculum (Barnhardt et al., 1998; Hill et al., 2000; Stephens & Alaska Univ., 2001). It effectively integrates Indigenous and Western knowledge around science topics. It has produced increases in student achievement scores, the number of rural students attending college, the number of Native students choosing to pursue science, math, and engineering, fields and a decrease in Alaska dropout rates.

Experimental education takes time, as the slow science movement (Salo & Heikkinen, 2018; Stengers, 2018) advocates – science needs time for thought, reflection, making mistakes, and more time correcting those mistakes. Learning also needs time, and schools are not factories

that focus on the efficiency of knowledge production. Ethnic Experimental Education planted a seed that needs to be internalized and waited for, expecting it to germinate one day

Attitudes of Parents and the Outside World

Examination culture also affects how the outside world views and comments on Ethnic Experimental Education. Some parents have a positive attitude toward Ethnic Experimental Education, believing that schools are beginning to care about the community. For example, teachers ask students to ask their parents or grandparents how to make taro cakes or where the family's water source is located. Because of the Ethnic Experimental Education, the school is more open, allowing the knowledge of the community to enter the school, and the school and the community have more opportunities for communication. However, most parents and the outside world, including government educational institutions, are most concerned about students' test performance and whether students can get into their ideal school. If Ethnic Experimental Education cannot have a satisfactory effect in this regard, it will be challenging to win the support of the parents and the outside world.

On the other hand, subjects are divided into General Education and Ethnic Education, reflecting the hierarchy of knowledge (Beane, 1997). The disciplines appearing in the examinations reflect the high culture, the knowledge, and topics of concern to the social and academic elites. Ethnic culture and popular cultures that people care about, such as daily life and social issues, are excluded from exames. To practice equity of knowledge, it is necessary to integrate the general subjects and ethnic knowledge.

Resources

Lack of systematic database

Of the six secondary schools that conduct Ethnic Experimental Education, three serve Tayal people. Tao people are mainly distributed on the small island of Lanyu. The independent geographical environment creates a unique culture and isolates many external resources. Unlike Tayal experimental schools' system, Orchid High School does not have a relatively complete curriculum development organization system composed of teachers, Knowledge Keepers, Cultural Advisors, curriculum professional education partners and scholars, and the County Government Education Office team, and the community. Because there is no systematic cultural database, teachers at Orchid High School spend a lot of time collecting data, checking the accuracy of the data, digesting the content, and then converting it into a curriculum.

No stable curriculum development group

Human resources are also an issue. Even though the school requires teachers to keep the course materials, the specialties of teachers who teach Ethnic Education may be different every year. Last year's lessons couldn't be used intact, and the new teachers didn't know how to implement them. Therefore, the Ethnic Experimental Education course involves co-taught, led by experienced teachers with inexperienced teachers, such as the informal mentoring system. However, this mentor may only have one year of experience – are they capable enough to lead a team?

In addition, because there is no stable curriculum development group, the lead teacher in the team will also feel at a loss because the direction of the entire curriculum is determined by lead teacher alone. Apart from high teacher turnover, part of it is the education system -

substitute teachers are not paid during the summer. The summer vacation before the start of each school year is the best time to reflect, revise and integrate the curriculum, but more than half of the teachers in Orchid School are substitute teachers. Therefore, it is often necessary to wait until the start of the school year, when the teachers are all in place, before classes can be planned.

External resources and assistance do not meet school needs

Suppose that the government educational institutions, collaboration centers, and scholars at universities do not understand the local culture and have no real-world experience with the school's situation. In that case, their advice and help is detached and likely to be relatively useless. For example, some teachers mentioned that the collaboration center suggested the lesson plan format or developed board games and other teaching materials. Still, in fact, they did not seem to know how to help the actual teaching, and they could not solve the current urgent problems of the school.

Disconnection between community and school

In addition to the teacher, Knowledge Keepers from the community are essential elements in the curriculum development group. When teachers from other places come to Lanyu, they all work and live in the school. Most teachers socialize only with their school colleagues. On weekends, they either stay at school to rest or go sightseeing and return home to Taiwan's main island for long breaks and holidays. The school is like a colonial base – there always seems to be a distance between community and school. There are no other Elders to ask for when teachers need cultural resources except the school's cultural instructor. Also, it is challenging to present local viewpoints in designing courses without an in-depth understanding of the place and

interaction with the local people. What often happens is that very superficial cultural elements are emphasized, and it is difficult for teaching to respond to students' ethnic cultures.

Internal issues

Teacher's attitude

Teachers play a crucial role in promoting Ethnic Experimental Education because they play the role of curriculum planners, facilitators, implementers, and modifiers. Therefore, teachers' beliefs and attitudes affect the development and outcomes of the curriculum. In a 2011 survey of 1,005 teachers in primary and secondary schools in Indigenous areas across the country, less than half of non-Indigenous teachers believed that courses on "the mission of revitalizing the culture of Indigenous peoples" should be added (Z. L. Chen, 2011). In an analysis of the current situation of experimental education in Indigenous schools in the Taitung area after ten years, the teachers at the Ethnic Experimental Education School have a positive attitude toward the current curriculum planning. However, there are still teachers who have limited knowledge of Indigenous culture because they do not know or understand, or reject or fear, the concepts or attitudes. In particular, regular teachers with previous teaching experience have more backlash because it is different from what they learned in their teacher education or past teaching experience.

A teacher mentioned that in Ethnic Education classes, he felt "Students know more than me." It may make the teacher think that the authority of knowledge in the classroom is being challenged. However, student-centered learning should use funds of knowledge (Brown, 2017; Moll et al., 1992) —using what students know as a starting point. Teachers should not use "it's not my culture, I don't know what their culture is" as the excuse but should enrich their own

cultural connotation. A teacher with 20 years of teaching experience is different than a teacher who had the same experience for 20 years. Many teachers have forgotten their learner identity before they developed a teacher identity. The implementation of Ethnic Experimental Education forced teachers to jump out of their comfort zone and use different teaching methods, such as cooperative teaching, subject integration, learning ethnic culture, etc. The attitude of the teacher also affects the connection with the community. The extent to which a teacher is willing to go out of the campus, enter the tribe, and have a deeper understanding of this place and people depends on the teacher's mindset.

Lack of knowledge about the Tao culture and subject knowledge

Increased awareness of the importance of ethnic cultures in the education field is reflected in education policies. 12-year basic education requires school curricula incorporate "multicultural and Indigenous education issues" and the number of Ethnic Experimental Education schools increased from 7 in the 2016 school year to 32 for the 2020 school year. However, when schools implement Ethnic Experimental Education, they usually separate it from general education. Students have to navigate between two cultures on their own. To help students cross cultural boundaries, teachers must have cross-cultural awareness and the ability to bridge cultures. The biggest challenge in implementing culturally relevant science teaching in Ethnic Experimental Education courses is teachers' lack of knowledge about the Tao culture and subject knowledge.

The third space theory (Bhabha, 2012) is used in the theoretical framework of this study. The third space is the dialogue between two cultures through the nature of shared knowledge. If Ethnic Experimental Education is established in the third space, it means that teachers should be

able to speak the language of both cultures. However, most of the teachers are not Tao people, and they are still in the stage of understanding and learning about the local culture. On the other hand, the school has only two science teachers, one is not involved in the Ethnic Experimental Education curriculum, and the other is a passive participant. Because of the class arrangement, the teachers who teach Ethnic Education are different every year. For example, in the 2020-2021 school year, a science teacher participated in the ninth-grade exploration class, but not in the 2021-2022 school year. The original ninth-grade exploration course was designed to guide students in interpreting culture from a scientific perspective in the first year. But when non-science teachers teach it in the second year, it's like having teachers teach their third language in their second language. For example, a math teacher in a ninth-grade Exploration class said he could learn about the science content knowledge related to the unit when preparing for the lessons. Still, he struggled to respond if students asked other extended science-related questions in class.

Recommendations of the Future Action

For Teacher Educator

Theoretical Implications

As mentioned in the previous paragraph, the third space is the overlapping space of the first space and the second space, which can be a compatible worldview or a newly formed worldview. This corresponds with Phase 4 in the Worldview Oriented Learning Framework (WOLF) developed by Fu (1999)—Form a new worldview and present the concepts of related subject knowledge and Phase 5: Connect the Indigenous worldview with the worldview of disciplines. Worldviews can coexist and are dynamic. It is also a reflection of the foreign cultural

influence mentioned in Chapter 2, Christianity is deeply embedded in Tao people's life. Christian monotheism and Animated in the Indigenous world may seem incompatible, but Tao people have formed a new approach. For example, they believe in the god of flying fish and follow the custom and taboo taught by the god of flying fish: they also pray to the God of Christianity in *mivanwa* (flying fish summon ritual) to bless the harvest of the flying fish season.

Likewise, science is not untouchable, science learning is a process of transforming worldviews (Fu, 1999), not the process of discarding incompatible worldviews. In Ethnic Education classes, even taboos that cannot be explained by science can be discussed in class. The point is not to judge right or wrong, but to generate cross-cultural conversations.

Cultural border crossings theory states that learners will encounter cultural borders from home culture into classroom science culture through that of western science in their learning of science (Aikenhead, 1996). The difference in this study is that the action of crossings does not occur in science classes but attempts to take place in Ethnic Education classes. When the bridge between Indigenous culture and school science is built, knowledge exchange and cultural dialogue should be two-way.

Moreover, in Ethnic Experimental Education, it is not only students who need to navigate the cultural borders, teachers also engage in border crossing. In the process of developing and implementing Ethnic Experimental Education, teachers must cross local culture, ethnic culture, school culture, subject culture, and teaching method boundaries. Aikenhead (1996) pointed out that learners needed help for resolving any cultural conflicts so that they navigate and negotiate their border crossings. Likewise, teachers also need help to navigate these borders. Teacher educators and schools should be aware of this.

Implications for Science Teacher Education — Are teacher education programs ready for Ethnic Experimental Education?

Responding to culture and making it sustainable is one of the goals of Ethnic Education, in which teachers play a crucial role. Culturally responsive teaching emphasizes that if teachers can understand students' communication patterns, cultural content, and life experiences, it will help students learn (Gay, 2018). Both Indigenous and non-Indigenous teachers should pay attention to the subjectivity of students, cultural identification, and cultural sustainability, including having considerable professional ability in cultural acquisition, cultural integration teaching, Ethnic Education curriculum design, ethnic language skills, and the cultural activity practice.

Teacher development in Indigenous and general education currently appears to proceed along two parallel lines. The Teacher Professional Development section in Curriculum Guidelines of 12-Year Basic Education states that "Teachers for Indigenous Education should enroll in Indigenous cultural education courses to enhance their professionalism" (p. 50). However, when teachers take teacher education courses, they do not even know that they will teach in Indigenous schools in the future and are not prepared for it. Many regular teachers at Orchid High School came there with no other option. When first entering the educational field, they have not yet realized the importance of culture to students' learning.

In particular, science teacher education rarely mentions culture. Many science educators believe multicultural education has no place in science pedagogy because science is a neutral, objective field of study without cultural understanding and assumptions (Atwater, 2010). This small group of teachers did not or could not see the need for culturally relevant science teaching in their classrooms. Even though teachers expressed the importance of culturally relevant science

teaching for teaching their Indigenous students and emphasized the importance of using the place as a context for teaching science, these teachers used this pedagogical approach without explicit cultural connections.

Taiwan should refer to the practice of British Columbia in Canada and put "First Peoples Principles of Learning" into the Curriculum Guidelines. Whether or not serving in Indigenous areas, all preservice and in-service teachers must understand the Indigenous Learning Principles and incorporate them into their teaching. In addition, the New Zealand government's Education and Training Act 2020 also mandates that schools must ensure their curriculum reflects local tikanga Māori (culture, Māori concept incorporating practices and values) and mātauranga Māori (traditional Māori knowledge) (Matthews, 2022). Incorporating examples and contexts of Māori culture into bicultural science education in school science curricula not only does not ignore any scientific concepts and skills, but also enhances students' interest in learning (McKinley et al., 1992).

Ethnic Education is a space that integrates disciplines and cultures. However, the traditional school course design and teacher education program are deeply influenced by conventional discipline-based courses. The professional identity of general teachers is also subject-based. Asking these teachers to participate in and integrate the curriculum is asking them to rebuild their professional self-concepts (Beane, 1997). The current teacher educators also adopt the teaching method of the subject-based and disciplinary skills to cultivate future teachers. However, the preservice teacher has not experienced an integrated curriculum in the teacher training process. How can they demonstrate curriculum integration in their future teaching? As a science teacher, Sophie mentioned that she thinks the biggest challenge is how to interpret culture through her subject knowledge. She believes that teachers should learn Place Pedagogy

and have the ability to understand the nature of local culture. Therefore, the basic concepts of cultural anthropology should be incorporated into teacher education programs to develop teachers' ability to investigate and understand places and people to establish place-based education further.

Professional Development of Inservice Teachers

Some in-service teachers are unwilling to participate or passively participate because they do not understand Ethnic Experimental Education since it is a different way of teaching than what they are familiar with, or it requires teachers to step outside the comfort zone of their professional field. At the same time, teachers who are willing to explore and participate in Ethnic Experimental Education should get more support through workshops, learning communities, visiting other schools, or cooperating with teachers who have participated in Ethnic Experimental Education. For example, Panan Tribe Elementary and Junior High School invited professors from the National Taichung University of Education to share nine Indigenous teaching methods' concepts and practical possibilities during school teacher preparation meetings, including, 1. Land-based teaching, 2. Non-linear teaching method, 3. Storytelling, 4. Mind mapping, 5. Non-verbal instruction, 6. Symbol image teaching, 7. Community Connections, 8. Deconstruction and reconstruction teaching method 9. Multimodal teaching method.

Orchid High School has organized workshops and teachers have visited other ethnic experimental schools, but these are voluntary. Teachers are overwhelmed by teaching and administration on weekdays. They need to rest on holidays and have no energy to participate in the workshops on the weekends. On the other hand, some teachers are reluctant to try integrating

the Ethnic Experimental Education curriculum, mainly because they are worried about affecting students' performance in academic subjects of examinations.

Beane pointed out that fear of the integrated curriculum is due to teachers' unwillingness to participate in such laborious teaching and to share the power of collaborative projects with others (Beane, 1997). However, Ethnic Experimental Education itself is inherently a form of long-term professional development and learning process. Both active and passive participants can learn students' ethnic knowledge through Ethnic Education. Moreover, they might use Ethnic Knowledge to enrich their professional subject teaching. Through the teacher's profession-Indigenous teaching methods, even foreign teachers can find their role in Ethnic Experimental Education and enhance their cultural identity.

For future participatory research with Indigenous populations:

Methodological Implications and Limitations

Action Research, Participatory Action Research, and Action Learning are the most common terms used to describe the research challenges of the hierarchical relationship between the researcher and the "researched" in a traditional study (Kindon et al., 2007). The goal is that researchers and participants can cooperate to transform the flexibility of academic production, empower the participants in the research, and share knowledge and apply the research results to action. However, Action Research is more focused on social action or reform. It can but does not necessarily engage participants directly in the research process. In contrast, Participatory Research and Participatory Action Research emphasize the cooperation with marginalized or "vulnerable" others to embody "a democratic commitment to break the monopoly on who holds knowledge and for whom social research should be undertaken (Kindon et al., 2007, p.11)."

Therefore, building relationships with participants is crucial in PAR. For example, in one of the interviews, when the lead researcher asked the interviewee, “What is your personal opinion on Ethnic Education?”, the interviewee looked reluctant and said “Uh...” The lead researcher said, “if you feel this question is too sensitive, you don't need to answer it.” “Because I trust you, I can answer,” the interviewee said. She expressed that when people ask her about her views on Ethnic Education, she usually only answers “very good”. But because of her trusting relationship with the lead researcher, she was willing to share and discuss her real thought in greater depth. This evidence shows the importance of building relationships with participants.

However, the Covid-19 outbreak has hindered relationship building. In the second week of the lead researcher's arrival on Orchid Island, the school started remote learning, and some teachers went back home to Taiwan's main island directly. The epidemic prevention policy also restricted the communication between people, and the lead researcher did not have the opportunity to establish relationships with more teachers. During the search for interviewees, two teachers did not accept interviews. One was expressing “no interest” in Ethnic Education, and she feared that the interview would only turn into complaining. The lead researcher believes that if there was no epidemic, there could have been more communication and understanding with teachers who she did not know previously, and teachers might be more willing to open their hearts and share their true feelings, even if they were complaints or negative thoughts.

On the other hand, PAR emphasizes sharing ownership, and participants’ voices being heard. However, sometimes participants need courage to make their voice be heard. Especially in a unique place like Orchid Island, the community is small, and it is difficult to guarantee the anonymity of participants; it brings risks to revealing participants’ voices. Teachers, for example,

may not want to risk letting their supervisors or principals know that they are dissatisfied with the Ethnic Experimental Education in school.

PAR also commits to collective knowledge production where analysis is not only conducted by experts or researchers. In PAR, the analysis processes participants may participate in collaborative negotiation and interpretation more so than in traditional and qualitative modes. However, not all participants or co-researchers can or are willing to conduct analysis. For example, non-researchers usually do not receive IRB training or take professional data analysis courses. In addition, the participating teachers are usually very busy, and the lead researcher cannot ask them to do more work. Therefore, participants would join in stages of the process to varying degrees, such as verifying the findings or being fully involved in a collective research team.

In the days when the lead researcher lived in Lanyu, she met many scholars who came to Lanyu to do research, including flying fish research, cetacean research, plant research, education research, and anthropological language research, etc. However, not all Tao people have a positive attitude toward foreign researchers. In a conversation with a friend of the lead researcher, the friend said, “They came here to do research, took the things from our place, and then left. What research did they do? What are the findings or results? What is the benefit to us? What is the feedback?” Some research has not only failed to benefit Indigenous communities, but it has also even harmed them. For example, a research project— Linkage Analysis of Schizophrenia with Positional Candidate Genetic Markers in Tao Aboriginal Families (Ko, 2001), subsidized by the National Science Council, assumed that the Tao people are an isolated ethnic group, which were isolated due to cultural, environmental and other major factors in the past, and intra-ethnic intermarriage had prevailed for a century. Since the genes for susceptibility

are prone to appear as a result of intermarriage, the hypothesis is that genes are associated with a high proportion of psychiatric disorders. Such victim-blaming research is not only de-historical, it also lacks Indigenous subjectivity and stigmatizes Tao people.

Some scholars who conducted research in Lanyu criticized what the other local people needed from the perspective of outsiders, thinking that they were helping this place, but did not take into account the local needs and practical considerations. Elder Verna Kirkness and Barnhardt (1991) advocate four R's in education — Respect, Relevance, Reciprocity, and Responsibility. Likewise, Indigenous research and Indigenous education should respect people for who they are, relevant to their view of the world, offer reciprocity in their relationships with others, and help them exercise responsibility over their own lives. Researchers should work with Elders and the community members, respect the values of each other, recognize the contribution that everyone can make, and look to engage with participants in a more give and take relationship.

For Orchid High School and teachers:

Developing Deeper Cultural Dimensions and Standard-Based Curriculum

Orchid High School's current Ethnic Experimental Education curriculum only has a theme outline, and the co-teaching teachers develop the teaching content according to their majors and themes. For example, teachers want students to use scientific reporting methods to study various Kuroshio fish, link lessons to taxonomic concepts, or discuss the origin of the Kuroshio name. It is up to the teacher to decide. The advantage of this is that the teacher has a lot of room for creativity, but it may also make the teacher feel overwhelmed. Schools should develop a standard-based, culturally relevant curriculum.

The curriculum jointly developed by the Alaska Science Consortium and Alaska Rural Systemic Initiative (AKRSI) and the Alaska Department of Education has clear cultural and Science/Math standards. Teachers can clearly know what each topic expects students to learn including specific cultural knowledge and skills. For instance, cultural standards in the Snowshoes unit include practicing their traditional responsibility to the surrounding environment and acquiring in-depth cultural knowledge through active participation and meaningful interaction with Elders. In addition, students should be able to know which types of snowshoes are appropriate for which conditions, demonstrate traditional weaving techniques and integrate with tessellation, show how to take care of snowshoes properly, and develop respect for Elders and others who have traditional knowledge and skills. In addition to factual knowledge, the curriculum also contains deeper cultural dimensions such as belief and value, such as cherishing what you have and respecting others.

Curriculum development of cultural knowledge and subject integration should be imperative. Its value is not just as an educational method but as the affirmation and recognition of Ethnic knowledge. Eva (a Tao teacher) said:

> It would be very efficient from a modern point of view because you are doing two systems at a time. You are using Tao culture to teach Western knowledge acquisition. If I were not a Tao person, I would find this very efficient because the example you used combines two important things with your method. Very Efficient. But because I'm from Lanyu, I won't say that. I think it's a very precious union. I will look at it with a more sacred attitude.

It is difficult to do with the power, competence, and resources of schoolteachers alone. Since the Indigenous Schools Act has not yet been enacted, many regions can only break through the framework with "experimental schools" to impart Indigenous culture and knowledge. If the Indigenous Schools Act draft is passed, it will achieve the same status as the Compulsory Education Law. In the future, Indigenous peoples will be more able to lead the planning of Indigenous schools, at all levels, that meet the needs of ethnic groups.

Establishing a Community-based Network of Resources to Allow Elders to Have More Leadership and Participation in Curriculum Development and Implementation

The turnover rate of teachers in Orchid High School is high, and more than half of the teachers are substitute teachers. In addition, because there is no systematic cultural database, each teacher spends a lot of time collecting, reviewing, and integrating data. The lengthy preparation time and burden left teachers exhausted and less willing to stay. The instability of teachers also makes the Ethnic Education curriculum, which is very dependent on the development of teachers, face new challenges every year.

On the other hand, the roles of the Elders and cultural instructors in Ethnic Experimental Education is that of passive advisors. After the teachers determined the units' content and direction, they then asked the cultural instructor about cultural knowledge and skills. Since Elders and cultural instructors are not certified staff, they will only show up when asked to, such as demonstrating how to plant taro. Elders do not have the primary decision-making power over the direction of the curriculum and what students should learn.

Ethnic Education is place-based education and should be built on a rock, and the community is that rock. Even when schoolteachers come and go, the community is always there.

Therefore, schools can cooperate with community foundations, institutions, and groups such as the Lan An Cultural and Educational Foundation and build community-based network resources together, so that these tribal institutions can serve as a pathway between schools and communities. They could let the community, parents, and Elders have more leadership and participation in the curriculum development and implementation, thus also sharing the pressure currently placed on teachers. Furthermore, the establishment of an Indigenous knowledge database has the function of preserving knowledge and culture and allows teachers to compare materials and curriculum design(Ya Wen Kuo, 2012). Teachers who lack relevant cultural knowledge of Indigenous people can follow up rather than take data collection as an additional burden.

Indigenous peoples traditionally acquired knowledge from direct experience with the natural world, understanding the particular as a whole, and validating the laws of existence. Rather than learning about a place, Indigenous people are learning within a place. They emphasize skills and practical application of knowledge because it is about their survival or extinction. Learning is connected to life, seasons, and the environment. They observe the natural cycle and adjust survival patterns. Children learn by watching Elders' demonstrations, listening, seeing, and doing – sharing knowledge through modeling, storytelling, and innovation. Even in different forms, these are all science learning. As written in *A Framework for K–12 Science Education*:

> All science learning can be understood as a cultural accomplishment. Children and adults the world over explore their surroundings and converse about the seeming causes and consequences of the phenomena they observe, but they are raised in environments with

varied exposures to activities (e.g., fishing, farming, computing) that relate to different science and engineering domains. What counts as learning and what types of knowledge are seen as important are closely tied to a community's values and what is useful in that community context. (National Research Council (NRC), 2012, p. 284)

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