A CASE STUDY OF SCIENCE TEACHERS' TEACHING EXPERIENCES TO ENGLISH LANGUAGE LEARNERS (ELLs)

A Thesis

by

SYAHRUL AMIN

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Chair of Committee,	Bugrahan Yalvac
Committee Members,	Trina Davis
	Jeffrey Liew
Head of Department,	Michael de Miranda

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ABSTRACT

A number of studies have shown that teaching science to the English Language Learners (ELLs) remains a challenge faced by many science teachers around the world. The purposes of this study were to explore and document science teachers' experiences in teaching Science to ELLs at a National Plus School (NPS) in Indonesia. The NPS is known to be a bilingual school that offers both national and international curricula in tandem. Science is one of the subjects that are taught both in Indonesian and in English. The school serves for mostly Indonesian students whose first language is not English. An instrumental and multiple case study design was employed to explore the experiences of the science teachers in the school. Four science teachers were recruited using convenience and purposeful sampling strategies. The primary data were collected through semi-structured interviews. The interview conversations were audio-recorded. The researcher transcribed the recordings verbatim. He employed constant comparative method and implemented open, axial, and selective coding strategies. In analyzing the data, the researcher first performed the within-case analyses where each case was analyzed one at a time and the reports for each case were generated separately. Next, the researcher performed the cross-case analyses where the cases were compared and contrasted with one another and a report in which the differences and similarities among the cases were reported. Five themes emerged from the data analyses: (1) Teachers perform double duty as they are teaching science to ELLs, (2) A non-lecture learning environment is well-suited for science teachers, (3) Computational science vs narrative science, (4) Language acquisition is important but not a sole determining factor in learning science, and (5) ELLs in upper grades are susceptible to not learning science in English.
Keywords: *Science Teaching Experience, Science Education in International Context, English Language Learners (ELLs), National Plus School (NPS), Bilingual Education*

DEDICATION

First and foremost, I would like to express my sincere gratitude to God for pouring down His endless blessings on me for the past twenty-eight years. I thank God for giving me prosperity and tremendous strength to get through the day every day. I am dedicating this thesis to my mother who is continuously praying for me and supporting me each and every day of my life. To my father, whose memories I always cherish, even though you are no longer of this world. I know that you would have prayed for me, supported me and you would been proud of my achievements. May you rest in peace in paradise, Dad!

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The data collected for Chapter 3 was provided by Syahrul Amin, and the analyses depicted in Chapter 4 were also conducted by Syahrul Amin. All other work conducted for the thesis was completed by Syahrul Amin, the student, independently.

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NOMENCLATURE

ELLs	English Language Learners
NPS	National Plus School

TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF TABLES

Page

CHAPTER I

INTRODUCTION

Background of the Study

In Indonesia, a National Plus School (NPS) referred to a school that offered education beyond the minimum requirements of the national Indonesian accreditation authorities. The school utilized both the Indonesian curriculum and International curriculum. The most common international curricula used by the National Plus Schools were International Baccalaureate (IB) and Cambridge International Examinations (CIE) (Indonesia International Standard School, 2010). The students took the courses both in Indonesian and English languages (Association of National and Private Schools of Indonesia, 2014). Generally, Science, Mathematics, and English courses were taught in English. Even in English, the courses were taught differently according to the international curriculum the school follows (Living in Indonesia, 2014). For example, an International curriculum from England differed from that of Western Australia.

Typically, NPSs were different from any International Schools in terms of their students' characteristics. The NPSs served primarily Indonesian students. In Indonesia, English was considered as the nation's second or third language, hence, the student body of NPS was populated by the English Language Learners (ELLs). Science, Mathematics, and English teachers at the NPSs were Indonesians, who were proficient in both Indonesian and English languages. Majority of the teachers shared the same culture with the students. However, some of the teachers were originally from various countries around the world (The Jakarta Post, 2017).

As aforementioned, science was one of the subjects taught in English at the NPSs. Teaching science to ELLs could be very challenging because not only the teachers must have possessed excellent linguistic skills (e.g., students' home language, science language as well as

English language skills) but they must also have been well-equipped in science content itself. Sharing the same native language with the ELLs might have been beneficial for the teachers in guiding the ELL's mastery of science content.

A synthesis of literature by Oliveira, Weinburgh, McBride, Bobowski, & Shea (2019) reported that the literature regarding science teachers' linguistic knowledge was less clear and lacking. They affirmed that on one hand, some studies have shown that having an extensive knowledge in ELLs' native language could be beneficial for science teachers. Teachers could provide additional support for their students, particularly in science content mastery because not only "science teachers can make more effective use of translanguaging, but they also could promote high-quality pedagogy (p. 7). Translanguaging is similar to a term called code-switching. Morrison (2017) defined code-switching as a process in which a person switches from one linguistic code (L1) to another linguistic code (L2), depending on the context of the conversation. Morrison provided the instance of code-switching use where it was initially studied in U.S. classroom in which the students could shift Spanish to English and vice versa in the context of second-language acquisition. Park (2013) extended that translanguaging was a more recent term used in line and relatively similar to code-switching but used systematically within the same learning activity through strategic classroom language planning. Park (2013) argued "both code-switching and translanguaging were still understood broadly and practiced limitedly" (p. 51).

On the other hand, Oliveira, Weinburgh, McBride, Bobowski, & Shea (2019) noted some studies have shown that having an extensive knowledge or sharing the same language with ELLs did not determine whether a teacher was effective in teaching science to ELLs or not. They highlighted findings from studies conducted in Southeast USA in which the effective science

teachers for ELLs "know only basic conversational Spanish and strategically limit their use of it to instructional moments when providing L1 [speaker's first language] support to ELLs is critical, as well as before and after school (e.g., to communicate with parents)." (p. 6-7)

In a recent study on the language ideologies in science education, Lemmi, Brown, Wild, Zummo, & Sedlacek (2019) highlighted the need for more research addressing what science teachers thought about language and how their language ideologies impacted their teaching practices. Lemmi et al. identified two ideologies amongst their science teacher participants; an inclusive language ideology and an exclusive language ideology. Lemmi et al. argued that "if teachers can become aware of their own ideologies about language and examine them critically, they may be better positioned to change their practices in ways that are beneficial for students." (p. 872) Lemmi et al. (2019) emphasized the issues with the use of translanguaging in science classrooms.

The research conducted in science teachers' linguistic knowledge, especially in the NPSs in Indonesia, is scarce. We do not know about the experiences of the Indonesian science teachers who share the same native language with the students in the NPSs. Knowing the Indonesian science teachers' experiences will shed light on the science teachers' linguistic knowledge and the characteristics of their interactions with their students. Who takes the lead in a science group project, who presents the conclusion of a scientific inquiry conducted by a team of students, etc. could have been decided based on the students' English language proficiency. The characteristics of the students' interactions in a classroom where the medium of instruction is in a language other than the students' native language are not well explored. In addition, science teachers in the NPSs are discouraged to speak Indonesian with their students in the science classrooms. When students have questions, they often do not ask their questions to their teachers in class because of

the likelihood that they will not be understanding the answers when the teacher speaks to them in English. Students become quiet and do not participate. This trend has also been observed in college level (Alpaslan & Yalvac, 2017).

Students in the NPSs attend two different science classrooms. In one of them English is the medium of communication and the international curriculum is followed. In the other classroom students' native language is spoken and the Indonesian curriculum is followed. International curriculum and Indonesian curriculum have commonalities and differences in terms of the scientific content being presented, the resources being provided, and the teaching practices being recommended. Science teachers in the NPSs are often puzzled in figuring out an effective way to teach science to ELLs in the international curriculum and when the medium of instruction is in English. In this study, I explored the science teachers' experiences in teaching science to ELLs where the school offered two different curricula in Indonesia.

The Purpose of the Study

In this study, my research purposes were to explore and document science teachers' experiences in teaching ELLs at a National Plus School in Indonesia. The focus was on four selected science teachers who possessed two or more years of teaching experience at a National Plus School in a province in Indonesia during the academic year 2019-2020.

Research Questions

Central Question of the study was:

What were the lived experiences of Indonesian science teachers in teaching science to the ELLs who shared the same native language?

Sub-questions of the study were:

1. What were the challenges the science teachers encountered in teaching science to the ELLs whose native language was Indonesian?
2. What were the teaching strategies the science teachers found effective in teaching science to the ELLs whose native language was Indonesian?

To answer the two sub-questions, I conducted individual interviews with the selected participants.

Significance of the Study (Rationale)

In this study, I provided fresh and new insights about the role of teachers in teaching science to the ELLs who shared the same native language in a school that offered two different curricula. First, a study similar to this was not yet conducted in this particular setting where the school required students to take two science courses taught in two different languages. The exploration of the science teachers' experiences in this context added new evidence to teaching science to ELLs (e.g., teachers' views in students' home language and culture and whether they took those aspects into account in their teaching or not, whether it was challenging or not to teach students who had to learn two science subjects in different languages with different curricula, and how feasible it was to help students excel in science content mastery in English because the school expected the students to be able to have excellent mastery of science in English). Second, the study was expected to vividly inform other teachers, researchers, curriculum developers, and policy makers about the teachers' experiences in teaching science to ELLs in which the schools required students to excel science in both native language [national curriculum] and English [international curriculum].

The findings of the present research served as resources for designing professional development activities for science teachers who teach in a similar school setting. Exploring the challenges that the teachers had encountered helped inform the best teaching strategy(ies) on teaching science to ELLs. Understanding the common themes emerged from science teachers' experiences helped inform policy makers in assisting science teachers tackle the challenges in the future.

CHAPTER II

LITERATURE REVIEW

Teaching Science to English Language Learners (ELLs)

Teaching science to English Language Learners (ELLs) has been found to be very challenging for many teachers. Abundant research has been conducted in teaching science to ELLs over decades. When one types on google scholar with the keywords "teaching science to ELLs" to look for journal articles from the past ten years, over 16,700 hits show up, ranging from 2009 to 2019. This denotes that many scholars and researchers have focused on researching science teaching to the ELLs. One of the prominent scholars in this field is Okhee Lee, who has been researching about science teaching to the ELLs issues for over twenty years and has found myriad research findings.

If many scholars have found various findings in teaching science to the ELLs issues, what makes this field still worth researching? Is there any research gap that must be closed in the field? A prompt answer is, yes, there are still gaps that are worth exploring and the possible findings will address those gaps in the literature. In this chapter, I reviewed and reported several research findings generated from studies conducted over ten years, ranging from 2009 to 2019, even though some findings were drawn from older literature. Most of the research conducted was U.S. oriented. The scholars, who conducted research in this area have been trying to mitigate the issue among the US teachers because the number of ELLs in US classrooms have been the fastest growing subset of the student population in US (National Center for Education Statistics, 2018).

Findings generated from the research conducted in the U.S. might or might not have applied to the ELLs in other countries. Studying similar research in a different country would

add new findings and perspectives to the existing literature. I conducted this study in one of Southeast Asian countries, Indonesia, where the school required science teachers to teach science to their students (whose native language is Indonesian Language) in English language as part of the school's curriculum. Science teachers' experiences in the school shed light on the existing gaps in the literature due to the different demographics between the US and Indonesia.

Main Findings and the Gaps in the Literature

Science Teachers and ELLs

Science teachers are challenged with varied issues when it comes to teaching science to ELLs. Lee & Buxton (2013) reported that ELL science teachers face the double challenge of promoting English language and literacy development, as well as academic achievement across subject areas (e.g., science and English language). Cho & McDonnough (2009) suggested what challenged the science teachers the most when teaching ELLs were the language barriers and ELLs' lack of science foundational knowledge. A recent study by Williams, Pringle, & Kilgore (2019) emphasized that science teachers were expected to be effective in providing experiences that would promote the development of ELLs' literacy skills to do science and engage in scientific activities.

Science teachers are persistently challenged to not only teach the science content but also to make the science content accessible for ELLs. Nutta, Bautista, & Butler, (2010) contended that meeting the needs of ELLs could be challenging for all science teachers given the text-dependent nature of content areas. For example, the language used in the curriculum was too abstract and included complex concepts calling for students' higher-order thinking skills.

In order to successfully teach science to ELLs, science teachers are expected to have more positive attitudes towards the ELLs. This is another challenge being faced by science

teachers. A recent study by Huerta, Garza, Jackson, & Murukutla, (2019) stipulated that science teachers who were Bilingual or multilingual showed more positive attitudes towards ELLs than science teachers who were monolingual [English speaking teachers]. Previously, Fradd and Lee (1999) argued that science teachers who shared their students' languages and cultures were likely to relate in more meaningful ways to their students' prior experiences, while Tolbert and Knox (2016) contended that bilingual teachers were more prone to promote contextualized science instruction in science classrooms.

In contrast, different studies have reported that effective science teachers were not required to share the same native language with ELLs as long as the teachers knew ELLs' basic conversational language (González-Howard & McNeill, 2016; Swanson, Bianchini, & Lee, 2014). More research needs to be conducted in this area because the evidence is lacking, and new findings will strengthen the existing findings.

A number of studies have been conducted to inform science teachers how to teach ELLs. Williams, Pringle, & Kilgore (2019) affirmed that the Spanish-English cognate was a viable tool in bridging the language differences in science classrooms. Even though the cognate instructions are proven to be a viable teaching strategy, it will be difficult to implement this type of instruction if the students' native language does not have common roots with English. Williams, Pringle, & Kilgore (2019) acknowledged this to be the limitation of the cognate instruction in science classrooms. Nonetheless, cognate instruction is less likely to work effectively in science classrooms in Indonesia due to the fact that Indonesian language is not related, even remotely, to English (Quinn, 2001).

Bautista & Castañeda (2011) laid out a number of strategies that science teachers could do to overcome the challenges: (a) providing accessible language of instruction to the students,

(b) providing opportunities for students to interact with their classmates, and (c) in terms of assessing the students' work, teachers were encouraged to lower the language barriers in the assessment and provide the students with performance-based assessment "(e.g., using data collected via observations to generate inferences) and a product (e.g., creating a model of a thermos while studying thermal conductors and insulators)" (p. 39). Lee & Buxton (2013) emphasized that effective science teachers were those who extensively promoted communication of science ideas using various modes of representation, for example, gestural, pictorial, graphic, and textual. Those strategies might not be easily attainable for the science teachers, but they are still feasible. Bautista & Castañeda (2011) claimed that the strategies they offered "will allow teachers to provide meaningful science learning experiences for all students, but particularly for ELLs" (p. 39).

Lee (2019) asserted that there needed to be a call for collaboration between English Language Education and content areas (e.g., science education) to ensure ELLs achieve academically rigorous content standards while developing their language proficiency. Correspondingly, Meskill & Oliveira (2019) conducted a study in response to the current challenges in teaching science to ELLs by pairing science and English teachers in science classroom. They argued that "a language/content pairing model with emphasis on multimodal teaching strategies is recommended as an effective means for meeting the challenges of linguistically diverse science classrooms" (p. 1025).

The aforementioned studies suggested that teaching science to ELLs remains an issue in science education field. Despite having been researched multiple times by various scholars, this area is still worth researching, particularly from the teachers' lived experiences and perspectives. If there is a call for collaboration between two fields (English Education and Science Education)

as recommended by Lee (2019) and Meskill & Oliveira (2019), to address the persistent issue in teaching science to ELLs, a study which intends to explore science teachers' experiences in teaching science to ELLs in a school that offers a dual-curriculum will give new insights to the existing literature and new evidence for future research.

Understanding Science Teachers' Experiences

Exploring science teachers' experiences is not uncommon in science education research. Some studies I have come across with, employed qualitative research methods in which semi-structured interviews, observations, or any other techniques were used to explore science teachers' experiences. Data drawn from any methods employed by the researcher are essentially used to answer specific research questions. Some studies provided significant findings about how studying about science teachers' lived experiences could be valuable to address the various issues in science education.

In a recent study, Rushton & Reiss (2019) explored UK-based secondary science teachers' experiences who actively participated in science research projects. The researchers employed semi-structured interviews to collect data about the lived experiences of 17 science teachers. They asked questions that could be categorized in three main parts; the background information, the impact of the research on the participant's experience of the subject taught; and the experience of teaching and their sense of self. The recorded interviews were then transcribed and analyzed using the six phases of Thematic Analysis outlined in Braun and Clarke (2006). The data analysis employed in the study was an inductive and semantic approach that allowed the theory to emerge from the data. Rushton & Reiss (2019) found that through participating in research projects, science teachers developed a multi-faceted sense of professional identities that included the roles of teacher, scientist/researcher, mentor, and coach. They highlighted that

exploring and documenting science teachers' lived experiences have been critical to understand their challenges and provide solutions.

In another study, McDonald (2017) explored twelve pre-service secondary science teachers' views and decisions to pursue teaching as a career. The primary data source was semi-structured interviews comprising two sections. In the first section, the researcher sought biographical information from participants. In the second section, the researcher sought to ascertain their views about science and science teaching. The study participants were asked about their STEM-teaching experiences in high school. By exploring the participants' experiences through interviews, the researcher documented the lived experiences of the participants that were transcribed, coded, and analyzed at the conclusion of the study. The coding process was initiated as the researcher read through all twelve transcripts and generated a set of categories that encompassed all responses. The researcher found three broad categories that represented the central themes that emerged from the data. The study findings were organized around those identified themes. From the data analysis, McDonald (2017) identified two key factors influencing science teachers' decisions, including their perceptions and experiences in high school as well as a lack of opportunities in STEM-related fields such as personal and lifestyle factors. It can be implied that exploring the participants' views and experiences through a qualitative approach (e.g., semi-structured interviews) provide evidence and help answer the main research questions being asked.

Similarly, Kier & Lee (2017) explored 20 pre-service science teachers' experiences in which they employed semi-structured interviews. The researchers explored participants' experiences to identify the role of identity in teaching science. The researchers interviewed the participants using a scripted protocol over Skype or Whatsapp. The interviews lasted about 30

minutes. While all participants were asked the exact same questions, different probes were used to encourage elaboration on various questions. The development of the interview was exploratory in nature. The researchers "wanted to know what experiences led students to the program, how students reflected upon their science identity in the context of the concentration and how they thought of their science teacher identity relative to their future" (p. 203).

Bo, Fulmer, Lee & Chen (2018) emphasized the use of semi-structured interviews in exploring secondary science teachers' experiences. The researchers sought to explore twelve secondary school science teachers' perspectives of interactive simulation as well as their practical experiences with simulations implemented in science classroom. The data collected from the interviews were analyzed using thematic analysis as recommended by Miles and Huberman (1994). The researchers found that "most teachers mainly had the experience of adopting simulations for demonstration purposes in teacher-led instruction" (p.558). However, "despite teacher training and technical support, the implementation of interactive simulations was perceived by the grade 7–12 science teachers to be difficult" (p. 562). Based on the abovementioned study, it can be inferred that the researchers managed to lay out various findings that were generated from the interview transcript data of science teachers' experiences in using the interactive simulation in teaching science.

Correspondingly, Manning (2017) conducted a study that explored four urban science teachers' experiences by using semi-structured interviews and observation. In the study, Manning (2017) interviewed four urban science teachers and then transcribed the interviews. The transcriptions then were coded. The study was a longitudinal study in which the participants were interviewed multiple times over a period of four years. However, the teachers were only observed at one occasion. Manning (2017) sought to explore the day-to-day experiences of the

four urban science teachers and how the teachers' experiences and role construction influenced their teaching practice. In the study, Manning (2017) found that some urban science teachers were able to acknowledge the factors contributing to a situation and take appropriate action to address the challenges, while others did not appear to be able to either recognize or act, or both in the same way.

In sum, based on all abovementioned studies it is clear that exploring science teachers' experiences can provide significant findings in the realm of science education research. Qualitative research method is mainly employed by the researchers in order to provide rich and in-depth data regardless of the instrumentation of data collection. The underlying assumptions embedded in any lived experience of either pre- or in-service science teachers and these assumptions influence their thinking and teaching. In my study, the literature I have reviewed so far highlighted the importance of in-depth and qualitative approaches to studies of science teacher learning through their lived experiences. The studies emerged from the qualitative research paradigm illuminated the nuance and complexity of science teachers' lived experiences and perspectives.

CHAPTER III

METHODS

In this study, I explored science teachers' experiences in teaching science to English Language Learners (ELLs) at a National Plus School located in one of southeast Asian countries. It has been affirmed that teaching science to ELLs remains an issue, not only in the U.S. but also worldwide. This chapter is divided into several sections addressing the research context, research designs, participants selection, data collection procedures, instrumentation, data analysis and ethical considerations.

Research Context

The School System in Indonesia

Regardless of public or private schools, the types of schools in Indonesia were categorized to national, national plus, and international schools. All those three types served different students with different curricula. A national school was typically a public school that employed a national curriculum from the government and served Indonesian students. The language of instruction across all subjects in this school was Indonesian language. An international school was a school that employs international curriculum and served only international students across the globe. Rarely, native Indonesians attended this type of school because the language of instruction across all subjects in this school was English.

In contrast, a National Plus School (NPS) was a school that attempted to bridge national school and international school systems. Not only this type of school employed national curriculum by the Indonesian government, but it also offered an International curriculum. Hence, the NPS was often considered as dual-curriculum school. Manurung (2015) affirmed that in National Plus School, the national curriculum was brought to the whole other level, enriched in

content, delivery method in students' native language as well as sustained by the international curriculum. Rinaldi & Saroh (2016) emphasized that when international curriculum was brought into a National Plus School system, the language of instruction in the curriculum is English and the school promoted learning in English language so that the students had more access for the knowledge communicated in English. Having to have access for a broader resource to learning, students in a National Plus School are highly encouraged to speak both Indonesian and English (as their second or third language).

Correspondingly, students were offered with courses from National curriculum as well as courses from the International curriculum. Students took courses in science and mathematics taught in English as well as science courses in Indonesian language (IPA) and mathematics in Indonesian language (matematika). Typically, the instructors who taught those courses were not the same teachers due to the different language of instruction, the resources (e.g., course books, exercise books), the assessment types of those subjects were different. Teachers who taught science and mathematics in English were typically Indonesian teachers whose English Language Proficiency (ELP) level was warranted. Some teachers were also from different countries from all over the world (The Jakarta Post, 2017).

Bilingual Science Education in Indonesia

Given the fact that Indonesia fell to number 70 out of 78 countries on its 2019 PISA science scores, science education in Indonesia is still facing numerous challenges that need to be addressed (Tommy Kurnia, 2019). Revina (2019) reported that the main reasons for this problem were the low quality of teachers and low science literacy in Indonesian schools. In most schools in Indonesia, science courses were offered in Indonesian language which followed the National curriculum as mandated by the government. However, a number of private and public schools

offered a few courses taught in English such as science and mathematics (Santoso, 2006). Bilingual Education was rapidly growing in Indonesia because the test scores of science and mathematics from such schools were proved to be better than those of monolingual schools (James & Merrill, 1986). Santoso (2006) asserted that bilingual education provided students with various resources to nurture their understanding without neglecting the role of students' native language. Moreover, nowadays, the reliable resources to support students are available in English. Consequently, if the school is able to expose students to all those resources, students will have a better chance to learn science better. Nababan (1991) reported that most of the scientific materials and books, including reference materials in many libraries in Indonesia were available in English language.

Unfortunately, bilingual education in Indonesia was still fraught with challenges and stereotypes. The main stereotype among Indonesian people was that speaking English is too westernized and students should be proud of speaking their own native language, instead of speaking English. Given the fact that most learning resources, especially in science courses were available only in English, bilingual education offered by schools could be the answer. Santoso (2006) contended that bilingual education did not necessarily mean ignoring completely students' native language. Instead, students' native language was enriched by the addition of English language.

Apart from the stereotype, the main challenge faced by bilingual education-based schools was the teachers. It was difficult to hire teachers who were able to teach courses in English without possible cultural constraints. Santoso (2006) laid out one strategy to overcome this challenge which was the need of a collaboration between English native speakers with

Indonesian teachers. He argued that recruiting Indonesian teachers who graduated from overseas to teach science was one way to overcome the human resources issue.

Sari (2012) emphasized that Indonesia still lagged the science and technology literacy and one of the biggest contributing factors is the quality of science teacher quality, followed by the Indonesian government policy in education. Indonesian science teachers were still challenged by their teaching to which whether they took into consideration the application of the science concepts into student daily life. Mulyani & Julianto (2019) identified two major problems that caused the poor science teaching in Indonesia. First, the lack of awareness of the importance of science in daily life. Second, the lack of application of local culture by the community. Mulyani & Julianto (2019) emphasized that teachers, parents and government did not pay more attention to the integration of those two components, hence, science education in Indonesia was deteriorating. Suastra (2010) asserted that a culture-based science teaching could be used to develop basic competencies in science and values in local wisdom in Indonesian science classrooms.

Integrating students' culture and language into teaching might have been challenging for science teachers, especially for those who taught in a National Plus School or other bilingual education settings. Science classrooms in the NPSs were very diverse and students brought their own cultures and language into the classroom. Science teachers should not only have been culturally inclusive, but they also should have been able to teach science context in students' second or third language which is in English. Marcellino (2015) reported that the success of English teaching in Indonesia could not be freed from the students' cultural backgrounds, values, customs, and beliefs as well as the political standpoint of the government regarding this foreign language. Even though science courses were offered in both Indonesian and English, science

teachers who teach science in English felt more pressure to teach science content to the ELLs. Science teachers must be qualified in science content mastery, linguistic skills, as well as culture awareness. In terms of language acquisition, Marcellino (2015) emphasized that the substantial unconstructive influence of the students' cultures and the non-conducive language environment affected students' ability to comprehend the content of the subject being taught.

Given the diversity in Indonesia, Mayasari (2017) argued that the diversity could be used as teaching resources for science teachers by connecting the relevant topics with students' cultures. Suardana (2014) also emphasized that the integration of science content and students' home culture was effective for guided inquiry in science classrooms. Prasetiyaningsih, Diantoro & Kusairi (2013) reported that the integration of science, students' home culture and English language showed high student satisfaction and more positive feedback.

However, Manara (2014) argued that most teachers who taught in English in the country continued to struggle in the complexities of the interconnectedness between the local as well as global perspectives. Consequently, Manara (2014) affirmed the urgency of critical evaluation on the current trends on bilingual pedagogy and reimagination of the role of English for the learners and English language pedagogy in Indonesia today. Given all the challenges, science teachers in the NPSs should have been well-equipped to teach students who came from a very diverse background, did not speak English as their first language and at the same time, were expected to have science content mastery.

Research Design

The design of this study was case study. It is a synthesis of experience in which a researcher is a key instrument. Creswell and Poth (2018) defined case study research as "a qualitative approach in which the investigator explores a real-life, contemporary bounded system

(a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information and reports a case description and case themes" (p. 96). Ideally, a case study research begins with the identification of a specific case which can be described within certain parameters (e.g., certain people involved in the case).

The intent of the case study was to seek a better understanding of the problem, relying on more than one sources of data collection. The data analysis approach may differ from one case to the other cases. Identifying case themes is essential to generate the description of the case, and a qualitative researcher often concludes the case study with conclusions about general meaning yielding from the case. In this study, I, as the investigator, explored the lived experiences of science teachers who taught science at a school which offered national and international curricula in tandem in Indonesia through detailed and in-depth data collection such as semi-structured interviews.

The case under investigation was a science teacher's experience in teaching science to the ELLs in the National Plus School. This study was an instrumental multiple case study (Stake, 2005) with four cases. It was instrumental because the findings from one case informed the potential findings from other cases that were similar. It was multiple because there were four cases in which four science teachers' experiences were explored.

Participant and Their Recruitment

Four secondary science teachers were selected and invited to join Skype/Whatsapp interview for 30-120 minutes. Prior to being selected as a participant of this study, the potential participants were sent a recruitment email and the copy of the university's Institutional Review Board (IRB) approved information sheet. They were able to access the recruitment email and the

information sheet from their personal email. The recruitment email script as well as the information sheet have been approved by the IRB (*see Appendix A and Appendix B*).

Participant Selection Strategies

Participants were selected based on non-probability sampling techniques. First, I employed convenience or accidental sampling. According to Creswell and Poth (2018), convenience sampling would "save time, money, and effort, but at the expense of information and credibility." (p. 158). Ritchie and Lewis (2003) affirmed that convenience sampling "... constitutes the most common form of qualitative sampling, based on the misunderstanding that small sample sizes do not permit statistical generalization and therefore it does not matter how cases are chosen" (p. 81). Hence, in the next participant sampling strategy, I employed a criterion based or purposive sampling strategy. This sampling strategy casts for cases that fit some criteria, as well as applicable for quality assurance (Creswell and Poth, 2018). Ritchie and Lewis (2003) asserted that "The sample units are chosen because they have particular features or characteristics which will enable detailed exploration and understanding of the central themes and puzzles which the researcher wishes to study" (p. 78).

In this study, all participants were selected by criterion-based sampling in which they were required to possess at least two years of teaching experience in the field and also shared the same native language with the ELLs. Participants who were not native Indonesians were excluded from this study.

Study Instrument

The data of this study were collected via interviews with the participants. For the exploration of the central phenomenon of this research, a semi-structured interview design with open-ended questions was deemed most appropriate. Creswell (2005) & Ohman (2005) affirmed

that open-ended questions allow the participants to freely voice their experiences and minimize the influence of the researcher's attitudes and previous findings. Hence, to assist the researcher to conduct the interview, a semi-structured interview protocol was designed by the researcher (*see Appendix C)*. The interview protocol has been approved by the IRB.

Data Collection and Management

At the time of data collection, participants were not physically available in the U.S. The interviews were conducted via Skype/WhatsApp. As back-up storage, I used an iPhone audio recorder and/or a Laptop audio recorder to audio record the whole video conference. The recorded data of the interview were stored in both my personal laptop and google drive. The interviewer saw the faces of the participants and heard their voices through laptop/smartphone screen as well as audio and video recorded the entire interview session. The interviews were conducted based on the questions listed on the interview protocol (*see Appendix C*). The participants were allowed to answer the questions at their pace and convenience and take as much time as they needed. As needed, I asked emerging questions.

Data Analysis

Based on philosophical assumptions, the approach of this study followed what was recommended by Robert Stake. Stake (1995) affirmed that case study research approach is for research that seeks happenings not causes. The goal of the case study research is understanding, with interpretations being the primary method of understanding. My study sought to understand science teachers' experiences in teaching science to the English Language Leaners (ELLs). The primary data source was mainly generated from the interviews. The data collected from the interviews were transcribed in text. I analyzed the transcriptions using the constant comparative method suggested by Glaser (1965). Glaser suggested that there were four stages that described

the constant comparative method in qualitative research. First, start by coding each incident in the data in as many categories of analysis as possible, while coding an incident for a category, then compare it with the previous incidents coded in the same category. Second, integrate the categories and their properties. Third, delimit the theory. This stage occurs at two levels which are the theory and the original list of categories proposed for coding. Lastly, write the findings. At the end of this process the researcher has coded data, a series of memos, and a theory. The discussions in the memos provide the content behind the categories, which are the major themes of the theory as written in papers or book. Furthermore, the most relevant concepts being integrated to form a theoretical framework which is the final product of the study.

In other words, in the first time reading my transcriptions, I performed an open coding strategy in which I assigned codes to the incidents described by the participants. In the second time reading my transcriptions, I did an axial coding in which I combined the codes with similar incidents under the same code name and created the main themes and categories that had more than one code in them. In the third time reading my transcriptions, I did a selective coding in which I deleted the codes that did not make sense or were not meaningful within the main themes or categories and organized the codes under the main themes and categories for reporting purposes. I added, modified, or deleted codes during any one of these three different phases before I began writing my findings. I spent multiple days to perform all three coding stages: I performed one stage in one day and then slept over and performed the second stage the next day and then slept over and performed the third stage in the third day.

Because this study was an instrumental and multiple case study, I conducted the within-case and the cross-case analyses. In the within-case analysis, I analyzed each teacher's interview conversation separately and provided a report per teacher about their lived experiences and

perspectives. There were four the within-case analyses that I employed. In the cross-case analysis, I compared and contrasted the cases with one another and provided a summary of commonalities and differences across the teachers' lived experiences and perspectives. The cross-case analyses were reported in one single section.

Ethical Considerations

This study was deemed to be one of minimal risk to participants and that the probability and magnitude of harm or discomfort anticipated in the research was not greater than any ordinarily encountered in daily life, or during the performance of routine physical or psychological examinations or tests. The researcher made sure that the participants understood the nature of the study and the fact that their participation was voluntary. Participants' confidentiality was maintained at all times and the identification of participants was kept confidential during or after the study. All data collected were anonymized by replacing the participants' names and the research site with pseudonym. Participants were informed that they could withdraw from the study at any time without questions being asked. Given the fact that the data of this research were collected from International participants, a letter of cultural evaluation was submitted to the IRB and has been officially approved. All other required documents requested by the IRB have also been approved. Thus, the IRB has issued the letter of determination for this study (*see Appendix D).*

CHAPTER IV

FINDINGS

Four science teachers participated in this study. I interviewed each science teacher regarding their firsthand experience in teaching science in English to English language learners (ELLs) at a National Plus School. I analyzed the transcriptions of the interviews conducted with each science teacher one at a time and reported the findings in the within-case analyses. After reporting individual cases one by one, I performed the cross-case analyses. I reported the findings afterwards.

I explored each participant's experience, coded their responses, and interpreted the incidents that they described (Creswell, 2017) from my perspective. By sharing their teaching experience with me, participants provided their very own perspectives about teaching science in English to ELLs. At the time of the interviews, I asked the participants about how long they have been in the field, and which subject(s) and what grade(s) they taught. The demographic information I collected about the science teachers presented in Table 1.

Table 1

The Study Participants' Teaching Demographics

Name	**Year(s) of Teaching Experience**	**Subject(s) & Grade(s) Taught**
Galilahi	Six years	Integrated Science and Physics (Middle and high school)
Jacira	Seven years	Integrated science and Biology (Elementary, middle, and high school)
Nahuel	Three years	Chemistry and Physics (Middle and high school)
Urpi	Ten years	Integrated Science, Chemistry and Biology (Middle and high School)

The Within-Case Analysis

Case One (Participant 1: Galilahi)

Galilahi taught science for six years. Galilahi taught integrated science and biology to middle and high school students. Most of Galilahi's students were English language learners (ELLs). I revealed four themes based on my analyses of Galilahi's teaching experiences in teaching science to ELLs: science teacher performs double duty in teaching science to ELLs, A non-lecture learning environment is well-suited for teaching science to ELLs, computational science versus narrative science, and language acquisition is important but not a sole determining factor in learning science.

Science Teacher Performs Double Duty in Teaching Science to ELLs

Galilahi portrayed teaching science to ELLs as a double duty for a couple of reasons. First, Galilahi argued that science textbooks were often served to students with a complex language. Science textbooks were filled with myriad of scientific terms that most students struggled to understand. Second, due to the complex language use in the textbooks, the science teacher had a difficult time teaching science to the students. Science teacher needed to explain both the science concepts and the meaning of the complex science terms. Consequently, the science teacher ended up performing *double duty* in teaching science to the ELLs.

Galilahi asserted that they had to tailor the language used in the science textbook into a language that their students could understand. Galilahi (personal communication, January 25, 2020) stated that "I tried to use simpler language, the most common English language and not the textbook one." Galilahi added "I had to change my language to a common [simpler English] language, so from there, students were able to understand it [science] and would slowly use the science language."

When I asked why teaching science in English to the ELLs was a double duty, Galilahi explained that:

> It took twice the effort that I have to put into it because first one I tried to get them to understand about the lesson [science content]. The second one I tried to teach them English language. So, it was like teaching two subjects in one day that required twice the effort from me. Sometimes, I have to explain same things over and over again. Oftentimes, half of the class still did not understand what I said. (Personal communication, January 25, 2020)

Students in the science classrooms were expected to be able to speak English and able to understand science concepts. As the science teachers, they were expected to be able to nurture their students' language skills and science content understanding. Galilahi admitted that they forced their students to speak English in science class. Galilahi reasoned that:

> Students have to get used to English. If I speak Indonesian even only once, it is like giving them permission to speak Indonesian in the classroom. I know it is kind of mean to force them to speak English but by doing that, I know eventually they will get used to it and will understand more about the language. (Personal communication, January 25, 2020)

Students in Galilahi's science classroom were under pressure to learn science and English at the same time. The strategy that Galilahi described above appeared to work well. Galilahi extended their concern regarding the strategy in nurturing the English environment in science class and affirmed that:

> I force them to speak English in the classroom and then to get additional English lessons outside of school. Outside the classroom, I allowed them to mix their English language

with Indonesian. They are allowed to speak Indonesian to me, but I still respond in English. (Personal communication, January 25, 2020)

It appeared that Galilahi used the method called translanguaging in which ELLs were allowed to mix their native language and English.

A Non-Lecture Learning Environment Is Well-suited for Teaching Science to ELLs

Galilahi (personal communication, January 25, 2020) highlighted that "Every single time I try to teach, I see the students' faces changing because they didn't understand what I was talking about". Galilahi experienced this frequently because the students did not understand the science content being taught and also did not make out the language use in science classroom. Henceforth, a variety of facial expressions were observed in the science classroom.

To minimize the occurrences of myriad students' facial expressions, Galilahi reduced the use of complex science terms in their science classroom and replaced them with more common language that students can understand. Partially to avoid using complex science terms, Galilahi used hands-on activities and experiments and avoided using lectures. Galilahi (personal communication, January 25, 2020) said that "I have offered more experiments in our science class and tried to find fun experiments and turned out there was a fun experiment in nuclear chain reaction in physics." When I inquired if Galilahi's students preferred the hands-on science activities (e.g., science experiment), Galilahi reported "I am still trying to give them the best learning experience and evidently most students prefer science experiments that I provided for them rather". Galilahi also reported that "my students lacked imagination that they preferred to conduct the real experiments and see more of applications of the science concepts."

Computational Science Versus Narrative Science

Galilahi reported that Indonesian science curriculum was predominantly computational whereas the International science curriculum was predominantly narrative science, Galilahi explained their perspective as follows:

> Regarding teaching science in English, I needed to teach more about the concepts or the narrative of the science concepts. That was the most important thing in science. I had to make sure they really understand the concept of science because in Indonesian curriculum, there were a lot of calculations. For example, in physics taught in Indonesian language, everything is mainly calculations. So, in students' mind, physics is all about calculations. But in the International curriculum, it's more about science concepts and where are the formula are derived from. For examples, there are ten questions in physics test and all nine questions heavily measures students understanding science concepts and only one question is related to the calculation in physics. (Personal communication, January 25, 2020).

According to Galilahi, science in Indonesian curriculum was taught in a more computational discourse rather than a narrative discourse, which was contextually relevant to the students. For science teachers who taught science in International curriculum, the computational discourse of Indonesian curriculum added another burden to their teaching. Galilahi expressed their concern as follows:

> "So, I want to focus on the narrative science and my students in the class thinks it's boring because I focus more on the conceptual science rather than the calculations as they were taught in Indonesian curriculum. Even the smartest students would comment why do they have to study the theories [narrative science] and ended up commenting like I do

> not like to learn about concepts and theories [narrative science] and prefer calculations [computational science]. Actually, if students understand the concept, it would be very easy for them to solve the questions. That's another challenge for me in the classroom because they have already been taught science in Indonesian curriculum". (Personal communication, January 25, 2020).

Galilahi (personal communication, January 25, 2020) pointed out that "I notice that the questions for science tests were all required calculations and less conceptual understanding. Hence, in the students' mind, science is all calculations [computational science] not the concepts [narrative science]".

Language Acquisition Is Important but Not A Sole Determining Factor in Learning Science

When I asked about whether or not English language acquisition was important in science classroom, Galilahi, for one, contended that:

> In science class, English language skill is important but not a determining factor in learning science in English because it really depends on students' passion. If students do not have any passion in science even though you get an A+ in English, it is useless compared to the Indonesian students [ELLs] who studied harder and were passionate about science. They [ELLs] acquired a better understanding because they [ELLs] have studied at home and read science constantly and reviewed everything at home compared to those students who already know English [English native speaker students] but they did not like science in the first place. (Personal communication, January 25, 2020)

When inquired about whether or not they have had English native speaker students in their classroom, Galilahi (personal communication, January 25, 2020) reported that:

> Every year I have at least one English native speaker student in my class and their science grades are always lower than a smart passionate student from Indonesia [ELL]. So, it is evident that it does not matter where you are from or what language you speak. It is all about passion. (Personal communication, January 25, 2020)

According to Galilahi, passion in learning science played a significant role in determining whether or not ELLs can improve their science achievement in science class.

Case Two (Participant 2: Jacira)

Jacira, a science teacher who has seven years of teaching experience at both National Plus School and International School. Over the course of seven years, Jacira has taught science to elementary students, junior high school students as well as high school students. Having taught science for all grades, Jacira affirmed that every level had its own challenge. Based on Jacira's teaching experience analyses, I revealed four themes: ELLs in upper grades are susceptible to not learning science in English, a non-lecture learning environment is well-suited for teaching science to ELLs, language acquisition skill is important but not a determining factor in learning science in English and lastly, computational science versus narrative science.

ELLs in Upper Grades Are Susceptible to Not Learning Science in English

Jacira highlighted that students who are in upper grades (e.g., high school students) had tendency to resistance to learning science. Jacira asserted:

> I think for the lower level students, it is easier for them to understand science but for senior high school students, they already have their own thoughts about what they like including the teacher, the subject, what they want to be in the future like they want to be a businessman, a scientist. Oftentimes, this kind of thought affects their interest in science. (Personal communication, January 27, 2020).

Jacira claimed that teaching science to ELLs in upper grades was very challenging, especially when the students had their own perspectives of what they wanted to be in the future that they tended to gravitate towards those perspectives. Correspondingly, Jacira reported the following:

> My students said that they wanted to be a doctor that they were only interested in learning biology or chemistry. But then, if they wanted to be a businessman, they did not want to put too much attention in learning science. Even some students told me that next year they were going to run their father's business, and they did not need science after all. (Personal communication, January 27, 2020).

Having faced the challenges in teaching science to ELLs in the upper grades, Jacira encouraged their students to put more effort into learning science regardless of their interests in the future. Jacira illustrated:

> I told my students that whether or not you were going to be a lawyer, a businessman, or a doctor you needed to pass science course so then you could graduate high school. You are free to be whatever you want in the future and you are free follow your passion. But for now, you need the science course more than anything. So, I would always encourage them to learn science But, still I would give more freedom to my students to decide what they want to be in the future. But I know they all need my support to learn science and at the end of the day, it would always be their own decision to make. (Personal communication, January 27, 2020)

Jacira pointed out that a constant encouragement towards the ELLs in the upper grades to learn science was very crucial. Apart from keeping the students from thinking science is not

important, another challenge in teaching science to ELLs in the upper grades was the language barriers. Jacira highlighted the following:

> For senior high school students, some of them had language barriers issue. So, I translated some specific terms in science into Indonesian language. As a science teacher, I also needed to put in 100% effort in order to heighten the students' interests, so both of us can grow together. Some of the teaching materials for lower grades were okay but for upper grades, we used a lot of different and difficult scientific words. So, for me as their teacher, I needed to dig more before teaching, so it would be easier for me to deliver the lesson to my students. (Personal communication, January 27, 2020)

Jacira affirmed that employing the best teaching strategy that fits the students' needs before delivering the lesson was one way to reduce further frictions in the science classroom.

A Non-Lecture Learning Environment Is Well-suited for Teaching Science to ELLs

Given the numerous challenges faced in the science classroom, Jacira highlighted that providing students with more concrete activities related to the science concepts was the best way to teach science to ELLs. With their language barriers issue, lecturing was not the best teaching strategy in science classroom. Jacira pointed out:

> Normally, I would first introduce them with the science concepts in the classroom. Departing from their understanding for the concept, I would then ask my students to experience science in the real world. Having them outside the classroom was mostly freeing them from the boredom and inviting them to enjoy and learn the science concepts with hands-on activities. One of my projects was about calculating the number of specific bugs in certain area at school and it was an outdoor science learning experience for the

> students. I believe ELLs learned science better with hands-on activities. (Personal communication, January 27, 2020)

Jacira contended that project-based learning was one way to teach science to ELLs because students could learn science better by experiencing the science in real world. The students needed to see the concrete representations of the science concepts that were taught in the classroom. Jacira also found out that most students in the science classroom were bored that they needed a new learning environment in which they would enjoy and learn science at the same time.

Jacira mentioned that having students to learn science outside the classroom was good for their learning and their well-being. Jacira (Personal communication, January 27, 2020) reported "learning science outside the classroom was not as noisy as in the classroom because of the open space. Also, the psychology of the students was better in receiving the lesson because they could understand the science concept by doing teamwork with their friends in the open space." Regarding the teamwork in learning science, Jacira further commented "sometimes for my students, they understand science better when they get the explanation from their friends. They are more receptive when their friends explain it."

Language Acquisition Is Important but Not A Sole Determining Factor in Learning Science

Jacira explicitly mentioned that language barriers were one of the challenges in teaching science to ELLs. Yet, Jacira conceded that language acquisition skill was substantial but not the only factor that determined the ELLs' ability in learning science in English. Jacira reported:

> I believe every student is the same regardless of their willingness to speak English, but it all depends on their interests in science. The most important thing is not about the language acquisition but more of interest or passion of the students. Regardless if they

> speak English or not, if they have passion in learning science, you could actually teach science in English to the students. (Personal communication, January 27, 2020)

Jacira believed that student passion in science was also a contributing factor in determining whether or not ELLs would success in the science classroom. Jacira implied that ELLs' language acquisition skill can be gradually developed if ELLs have willingness to learn science in the first place. Jacira further argued that another factor that could affect ELLs' ability in learning science in English was the way science teachers manage the science classroom. Jacira found out that classroom management has always a big challenge in teaching science to ELLs. Jacira asserted:

> One main challenge was the classroom management because I taught alone in the classroom. I had to face 30 students in the classroom with 30 different characters, 30 kinds of problems and of course it was very challenging. Classroom management was the most challenging part of teaching because I needed to understand how to teach science to different kind of characters of ELLs in my science class. (Personal communication, January 27, 2020)

Given the circumstances, Jacira pointed out that teaching science to ELLs was more than how acknowledging that students' language acquisition skills mattered and heightening students' interests in science was crucial. Jacira believed that the way science teachers deal with classroom management could also affect the way ELLs learn science in their science classroom because Jacira had to acknowledge the fact that each ELL in their science classroom had their own character and each character should have been nurtured accordingly.

Computational Science Vs Narrative Science

Having taught science at a National Plus School for a number of years, Jacira noticed that there was an underlying difference between the science course taught in English and the science course taught in Indonesian language. Jacira highlighted that the fundamental difference that disintegrated those two science courses at a National Plus School. Jacira (Personal communication, January 27, 2020) reported that "science taught in English that follows International curriculum was much deeper in terms of science concepts that that of science taught in Indonesian curriculum." Jacira added that "science taught in Indonesian curriculum was more compact but not very specific in terms of explaining the science concepts [narrative science]".

Besides the main difference in science content-wise, Jacira argued that those two science courses also differed in other things. Jacira pointed out:

> In terms of teaching resources such as videos or recent papers, science teacher has to a lot of resources in teaching science in International curriculum. This made the students we had in this particular science classroom had a lot of science exposure compared to those who were in science taught Indonesian curriculum. Some of my students went to university abroad and it was very helpful for them to study science content taught in International curriculum as they wanted to begin their studies at the university abroad. (Personal communication, January 27, 2020)

Even though those two science courses shared a handful of underlying differences between one another, Jacira asserted that those two science courses were not that different in terms of chapters being taught. Jacira emphasized:

> Both science courses are not that different in terms of the science chapters in the textbooks, but science taught in International curriculum was more specific [narrative

> science]. But I think in Indonesian curriculum, a lot of chapters in science were not very specific and deep and there were a lot of calculations [computational science]. (Personal communication, January 27, 2020)

Jacira clearly pointed out that despite both science courses shared the commonalities in terms of chapters provided in the textbooks, both science courses had a fundamental difference regarding their science teaching approaches as being either narrative or computational.

Case Three (Participant 3: Nahuel)

Nahuel was a science teacher with three years of teaching experiences who taught Chemistry and Physics for middle and high school. I generated four hemes based on my analyses of Nahuel's science teaching experiences as follows: science teacher performs double duty in teaching science in English, computational science versus narrative science, language acquisition is important but not a sole determining factor in learning science, A Non-Lecture Learning Environment Is Well-suited for Teaching Science to ELLS.

Science Teacher Performs Double Duty in Teaching Science in English

Nahuel put forward some cogent reasons for affirming that teaching science to ELLs is a double-duty task for science teachers. First, Nahuel argued that teaching science concepts in students' native language was already a challenge, let alone teaching science concept in English. Prior to landing on teaching physics and chemistry in English, Nahuel had an opportunity to teach physics in Indonesian language. Nahuel (Personal communication, January 27, 2020) pointed out that "Even when I taught physics in students' native language [Indonesian language], not all my students understood the science concepts". Nahuel further commented:

> I could not leave them [students] behind because they were all my students. I know it was pretty difficult being a science teacher at a National Plus school. It was a double work. I

did not teach English. I did not only teach physics or science concepts, but I taught both science concepts and the English language itself. (Personal communication, January 27, 2020)

Second, Nahuel argued that in science classroom, all students must have spoken English regardless of their language acquisition skill. This left Nahuel with no choice but requiring the ELLs to speak English in the science classroom. Nahuel prohibited students from speaking Indonesian language in science classroom. He reasoned:

> If you force yourself or if you give permission to yourself to do something, you'll keep continuing to do that. So, if I say no to speaking Indonesian language in my science classroom and required the students to speak English only, their brain would always find a way out how to express their thoughts in English (Personal communication, January 27, 2020)

Even though teaching science to ELLs was highly challenging, Nahuel emphasized that the double duty that the science teacher faced was actually a learning opportunity for both the science teachers and the ELLs. Nahuel reported the following:

> For me as a teacher, it was a challenge that I had to face. Somehow, it benefited me as well as my students because at the same time we both learned the science concept and the language itself. Besides, in this globalization era, I think it is very important to make both students and science teachers understand science in English. (Personal communication, January 27, 2020)

Nahuel highlighted the importance of learning science in English despite the challenges faced by both science teacher and the ELLs in science classrooms. In addition, science teacher and the ELLs can use the challenges and difficulties as ways to grow together as co-learners in

science classrooms. So, both science teachers and the ELLs are ready to face the globalization era.

Computational Science Versus Narrative Science

As aforementioned, Nahuel had experiences in teaching science in both Indonesian and International curriculum. Nahuel shared the fundamental differences between teaching science in Indonesian curriculum and teaching science in International curriculum. Nahuel asserted the following:

> I think science in Indonesian curriculum was more complicated compared to science in English. For example, in calculations, science in Indonesian curriculum used a very complex math [computational science]. But after teaching science in Cambridge [International] curriculum, I got to use very simple calculations yet solved the science problems [narrative science]. **(**Personal communication, January 27, 2020)

When further asked about the underlying difference between science in Indonesian curriculum and science in International curriculum. Nahuel highlighted:

> Students who were in my Indonesian science classroom were really good at calculations [computational science]. They were able to solve questions that involved formula and equations [computational science]. However, there was something that they missed, which was the critical thinking and conceptual understanding [narrative science]. (Personal communication, January 27, 2020)

Nahuel explained that science in Indonesian curriculum was densely taught in computational way whereas science in International curriculum was taught in narrative way. Nahuel affirmed that:

> The good thing about science in International curriculum was less calculations and more concepts. I would try to find the theory behind the equations and relate it to student daily life. My students did not get this [narrative science] in science course taught in Indonesian curriculum. (Personal communication, January 27, 2020)

Language Acquisition Is Important but Not A Sole Determining Factor in Learning Science

Nahuel mentioned that the main challenge in teaching science to ELLs was the language barriers. Nahuel (Personal communication, January 27, 2020) pointed out that "the main challenge in teaching science to ELLs was understanding the scientific terms in English. At times, the terms in English are very different than those in Indonesian". Nonetheless, Nahuel argued that language was not the sole factor that determined students' success in learning science in English. Nahuel highlighted:

> Having the ability to speak English would certainly help ELLs in learning science. It would be pretty easy for them to be attentive in the science classroom if they could understand English. But when it comes understanding the science concept, ELLs would need more than understanding English. (Personal communication, January 27, 2020)

Nahuel then provided the example where there were times the ELLs could have scored better than the native speaker students. Nahuel illustrated the following:

> There were times when My ELL students whose native language is Indonesian could grasp the point of the science concept even better than the English native speaker students. So, basically, language can support but does not solely determine their ability in learning science in English. (Personal communication, January 27, 2020)

Nahuel explained that there were other factors that determine ELLs' success in science classroom. Nahuel reported:

> The most important thing in learning science for ELLs is their ability to understand the science concepts. Hence, the ELLs need the willingness to learn, the ability to engage and collaborate, also being cooperative with the teacher and their peers in the classroom. It is true that language acquisition skill is a support but the ability to learn the science concept is dependent upon the person [student]. (Personal communication, January 27, 2020)

Nahuel explicitly highlighted that ELLs need more than the ability to speak English in the science classroom. Their willingness to learn science, their ability to engage and collaborate in science classroom, as well as being able to cooperate with science teacher and other students in science classroom were other factors that could have determined their success in learning science in English.

A Non-Lecture Learning Environment Is Well-suited for Teaching Science to ELLs

Nahuel highlighted that teaching strategy was an important component in teaching science to ELLs. Nahuel asserted as follows:

> In my science classroom, I taught using active learning strategy. I would normally ask my students to engage with me in the learning process. For example, when I asked science questions in English, I would encourage them to give their responses using simple English words. I would want them to speak up in English even though they felt like they did not know much how to explain the answers in English. (Personal communication, January 27, 2020)

When asked if it was difficult to provide the best teaching strategy for students to learn science in English, Nahuel illustrated the following:

> It was pretty challenging but as a teacher, I found that I needed to find ways to make the students become interested in learning physics in English. The most effective teaching

> strategies were Active learning strategies where the students were active and engaged in science activities, and the second one was experiments. (Personal communication, January 27, 2020

Nahuel (personal communication, January 27, 2020) reasoned that "I noticed that the students were excited and understood science concept better in experiments or active learning activities compared to the conventional teaching strategy." Nahuel believed that teaching science was not all about teaching them the formula and how to use calculations to solve every science problem. Instead, Nahuel emphasized:

> I taught science concepts with experiments and hands-on activities and that is what we should do as a science teacher, not only teaching all about calculations. Instead, I taught my students how to get to the big science concept by doing experiments or hands-on activities. (Personal communication, January 27, 2020)

Case Four (Participant 4: Urpi)

Urpi, a science teacher who possessed ten years of experiences in teaching science to ELLs. Urpi taught Integrated science, Biology and Chemistry over the course of ten years. Based on my analyses of Urpi's teaching experiences, I revealed four themes: science teacher performs double duty in teaching science in English, computational science versus narrative science, a non-lecture learning environment is well-suited for teaching science to ELLs, language acquisition is important but not a sole determining factor in learning science.

Science Teacher Performs Double Duty in Teaching Science in English

Urpi acknowledged that teaching science to ELLs was not an easy task. Urpi argued that teaching science to ELLs was a double duty because of two things. First, the language barriers that the students were having and second, the need to find extra resources that fit the ELLs'

needs in science classroom. Regarding the language barriers in science classroom, Urpi elaborated:

> Most of the time the students did not understand the science terms that are different from Indonesian language. It means I needed to explain those science terms constantly using simpler language so that they would understand. So, the language barriers were one of the challenges for me in teaching science to ELLs. (Personal Communication, March 20, 2020)

Urpi emphasized that even though they had to minimize the language barriers in science classroom, Urpi still needed to introduce students to the difficult science terms. Urpi (Personal Communication, March 20, 2020) reported "I used English all the time, but I choose simpler words when it came down to teaching ELLs the difficult terms. I simplified the terms or tried to find words with similar meaning. Still, I had to introduce them to difficult words eventually." When asked about the way Urpi kept the students to speak English all the time in science classroom, Urpi (Personal Communication, March 20, 2020) illustrated "I would force my students to speak English all the time even though their vocabularies were very limited." Urpi then reasoned that "if I did not force my students to speak English, they did not get used to speaking English and it would be harder for them to understand the lesson." If the students in Urpi's science class refused to use English, Urpi claimed "I would subtract their points just to show them how important it was to speak English constantly in my class."

Another challenge for Urpi in teaching science to ELLs was the limited teaching resources. Urpi (Personal Communication, March 20, 2020) highlighted "I had limited sources of information in the forms of books which means I had to rely on the sources on the internet and it was hard to get free resources. That was another barrier for me." Urpi elaborated "I usually tried

to find free ebooks on the internet. The thing was I needed to sort them out and tailored whatever I found on the internet based on my students' needs." If Urpi could not find any good resources on the internet, Urpi would reach out to other science teachers who teach science in Indonesian curriculum. Urpi (Personal Communication, March 20, 2020) illustrated "I would always consult with the science teachers who teach science in Indonesian curriculum." Urpi reasoned:

> Because occasionally, science in Indonesian curriculum share similar science content with science in International curriculum. I would try to accommodate by matching the teaching timeline between science in Indonesian curriculum and science in International curriculum. Because my students would more likely to understand science in English better if they had learned it in Indonesian curriculum. So, at some point, it was very helpful for me as a science teacher. (Personal Communication, March 20, 2020)

Computational Science Versus Narrative Science

Even though Urpi asserted that at some point, science in Indonesian curriculum and International curriculum complement each other, Urpi (Personal Communication, March 20, 2020) affirmed that "science in International curriculum has totally different syllabus than that of the Indonesian one." Urpi explained "the Indonesian curriculum usually talks about the calculations and the Singaporean [international curriculum] primarily talks about concepts." Urpi then elaborated "the International curriculum mainly focuses on the basic science concept and advance that science concepts even further [narrative science] while the Indonesian curriculum focuses on calculations [computational science]."

Given those underlying differences between the two science curricula, Urpi did enjoy teaching science International curriculum to ELLs. They contended:

> I really liked teaching science because by teaching the [science] concepts, it means I could provide my students with many activities that are not computational. I had more freedom in teaching the science concepts. I would not know what to do if I had to teach science in Indonesian curriculum. (Personal Communication, March 20, 2020)

A Non-Lecture Learning Environment Is Well-Suited for Teaching Science to ELLs

As challenging as it might seem to teach science to ELLs in International curriculum, Urpi enjoyed designing learning activities for the students. Urpi (Personal Communication, March 20, 2020) elaborated "International curriculum aims my students to learn independently. It means I have to design the activities where my students can learn science with teacher as a facilitator, but at the same they understand the science concepts." However, Urpi affirmed that it was not easy to take the students out of their comfort zone. Urpi argued "my students were used to the system where teachers teach more and students just listen, but the International curriculum encourages teachers to become the facilitator. For me, to change the students' mindset in this regard was very difficult."

For this reason, Urpi would have designed the activities that were well-suited to the students' needs as well as to the science concepts being taught. Urpi (Personal Communication, March 20, 2020) elaborated "The activities I design depend on the topic I teach. If we needed outside activities, I would ask them to do the activities outside of the classroom and if it had to be conducted in the lab, I would ask them to go to the lab and conduct the experiment there." Urpi contended that "it seems like the students were more passionate in learning with hands-on activities compared to just listening to my lectures in the classroom." Urpi reasoned "Most of the time, my students enjoyed the experiments. I would ask them to do some practical work and this

was not usually common in Indonesian curriculum and they really liked to do practical activities."

Language Acquisition Is Important but Not A Sole Determining Factor in Learning Science

As previously mentioned, Urpi's main challenge in teaching science to ELLs was the language barriers. Urpi explicitly mentioned that if students were able to speak English, it would not have been so hard for them to understand science. Urpi (Personal Communication, March 20, 2020) reasoned "For most cases, my students who were from English native speaking country, they understood science better. Even Indonesian students who were capable enough to speak English, they did not have any problem in understanding science in my class."

Further, Urpi argued that ELLs' language acquisition skill affected their ability to learn science. When asked about the ELLs' capabilities in learning science, Urpi (Personal Communication, March 20, 2020) highlighted "I feel like my students were capable enough to learn science, but it all depends on their English capability. If they were good in speaking English, they would do good in science. But if not, it would be difficult for them." Urpi then illustrated "when my students came from elementary or middle school that taught them science in English, they had better capability than those who came from a public or private school that did not teach science in English."

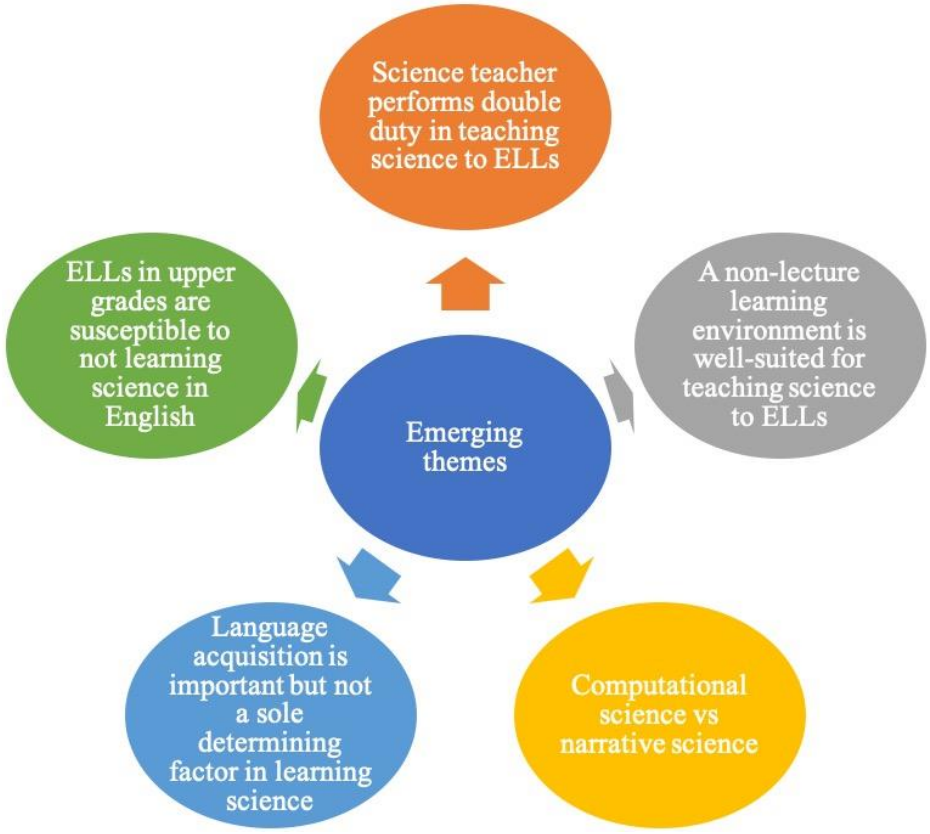
From the instances above, it is clear that Urpi believed that the more the ELLs were exposed to learning science in English when they were in lower grades, the easier for them to understand science in the upper grades. Of course, the language acquisition skill plays an important role in learning English, but Urpi argued that it was the only factor that determined ELL's success in science classroom. Urpi emphasized that teacher role was also as important. Urpi (Personal Communication, March 20, 2020) elaborated:

If my students just learned from the textbooks, I would say, only no more than 30% of them understood what they read regardless of how good their English was. As their teacher, I would need to explain the whole science concepts with much simpler and common words that they were familiar with. I would need to give them some explanations. I do not think my students would completely understand science just by relying on their English ability to understand science concepts."

From the reasoning above, Urpi inferred that science teacher role played as important role as the ELLs' English language acquisition skills in learning science taught in International curriculum at a National Plus School. Figure 1 shows the schematic representation of five themes emerged from the data.

Figure 1

The Five Themes that Emerged from the Data



The Cross-Case Analysis

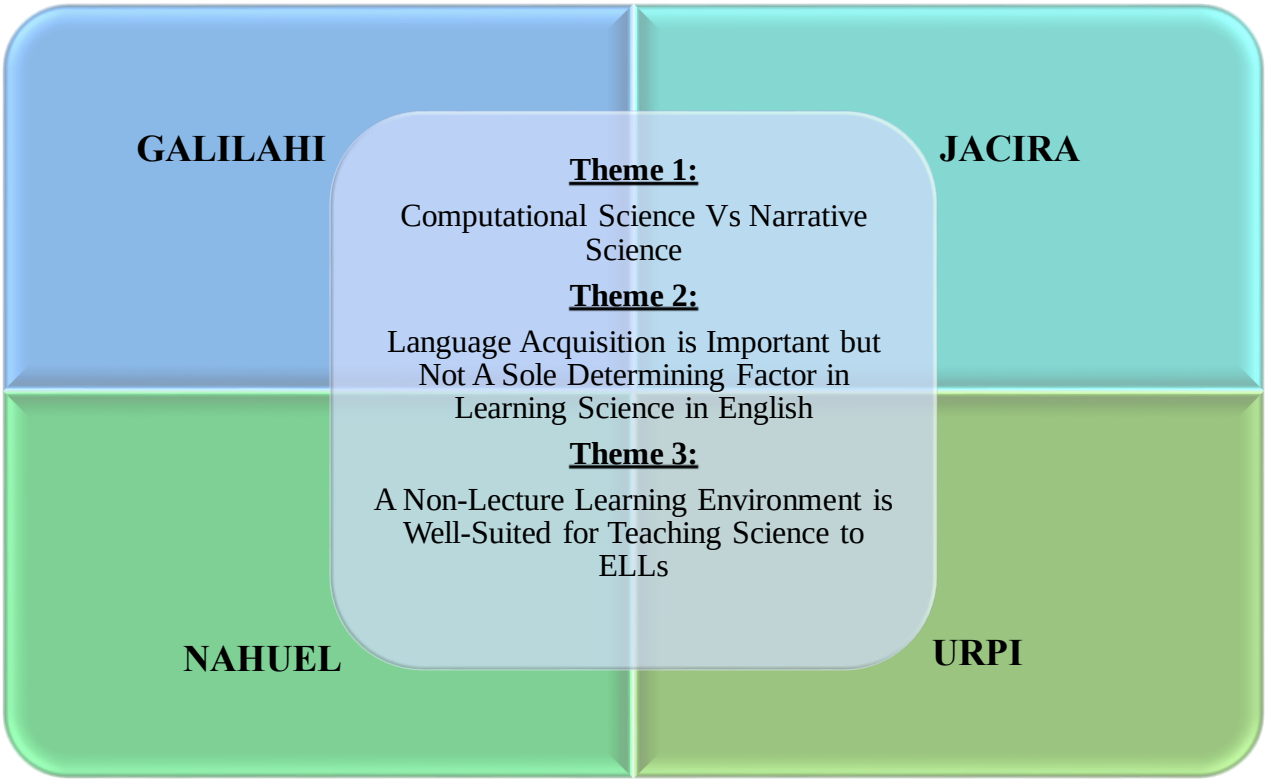
I analyzed all study participants' teaching experiences respectively by comparing and contrasting all four cases. Next I investigated the commonalities and differences across all four cases. In this section, I reported the cross-case analysis which referred to my analyses and findings that connected the elements found in specific cases to those found in other cases. In this section I described both the common themes and the individual themes.

The Common Themes

I analyzed and reported the commonalities that all study participants shared in common regarding their experiences in teaching science to ELLs at a National Plus School (NPS). The common themes across all four cases presented below.

Figure 2

The Common Themes Shared Across All Four Cases



From Figure 2 above, Galilahi, Jacira, Nahuel and Urpi shared three common themes: computational science vs narrative science, language acquisition is important but not a sole determining factor in learning science in English, and a non-lecture learning environment is well-suited for teaching science to ELLs. All four study participants reported all those three common themes regarding their experiences in teaching science to ELLs. Furthermore, I presented the incidents that were mentioned by all four study participants during the data collection in Table 2 below.

Table 2

The Incidents Described by the Study Participants

Study Participants	***Quote***		
	Theme 1	**Theme 2**	**Theme 3**
Galilahi	I needed to teach more about the concepts or the narrative of the science concepts. That was the most important thing in science. I had to make sure they really understand the concept of science because in Indonesian curriculum, there were a lot of calculations.	If students do not have any passion in science even though you get an A+ in English, it is useless compared to the Indonesian students [ELLs] who study harder and are passionate about science.	My students lacked imagination that they preferred to conduct the real experiments and see more of applications of the science concepts.

Table 2 (Continued)

Study Participants	*Quote*		
	Theme 1	**Theme 2**	**Theme 3**
Jacira	Science taught in International curriculum was more specific [narrative science]. But I think in Indonesian curriculum, a lot of chapters in science were not very specific and deep and there were a lot of calculations [computational science].	I believe every student is the same regardless of their willingness to speak English, but it all depends on their interests in science. Regardless if they speak English or not, if they have passion in learning science, you could actually teach science in English to the students.	Having them outside the classroom was mostly freeing them from the boredom and inviting them to enjoy and learn the science concepts with hands-on activities. I believe ELLs learned science better with hands-on activities.
Nahuel	Students who were in my Indonesian science classroom were really good at calculations [computational science]. They were able to solve questions that involved formula and equations [computational science]. However, there was something that they missed, which was the critical thinking and conceptual understanding [narrative science].	There were times when My ELL students whose native language is Indonesian could grasp the point of the science concept even better than the English native speaker students."	It was pretty challenging but as a teacher, I found that I needed to find ways to make the students become interested in learning physics in English. The most effective teaching strategies were Active learning where the students were active and engaged in science activities, and the second one was experiments.

Table 2 (Continued)

Study Participants	*Quote*		
	Theme 1	**Theme 2**	**Theme 3**
Urpi	The International curriculum mainly focuses on the basic science concept and advance that science concepts even further [narrative science] while the Indonesian curriculum focuses on calculations [computational science].	As their teacher, I would need to explain the whole science concepts with much simpler and common words that they were familiar with. I would need to give them some explanations. I do not think my students would completely understand science just by relying on their English ability to understand science concepts.	It seems like the students were more passionate in learning with hands-on activities compared to just listening to my lectures in the classroom.

Note. Theme 1 refers to computational science vs narrative science. Theme 2 refers to language acquisition is important but not a sole determining factor in learning science in English. Theme 3 refers to a non-lecture learning environment is well-suited for teaching science to ELLs.

The Individual Themes

In this section, I presented the unique themes shared by all four study participants. Despite sharing the commonalities, all four study participants' teaching experiences also varied from one another.

From comparing and contrasting all four cases, I found out that three out of four study participants reported that teaching science to ELLs was a double duty while one study participant did not report the same experience. Galilahi, Nahuel and Urpi reported that teaching science was a double duty because they had to teach both science concepts and the language at the same time due to the complex scientific terms. Meanwhile, Jacira did not report the same experience.

Instead, Jacira reported that he had difficult times teaching science to ELLs in the upper grades. Jacira affirmed that ELLs in upper grades were susceptible to not learning science compared to those in the lower grades because the ELLs in the upper grades tend to have their own thoughts about what they like including the teacher, the subject, what they want to be in the future. Jacira reasoned that this kind of thought can potentially affect their interest in science.

Even though all four study participants shared the same experiences regarding the fact that student language acquisition skill is not a sole determining factor in learning science in English, Galilahi, Jacira, Nahuel and Urpi pointed out their own thoughts on what other factors that could have potentially affected ELLs in learning science.

Galilahi reported that even though student language acquisition skill was important, student passion in learning science also played a very significant role in learning science in English. Galilahi reasoned that the ELLs who studied harder and were passionate about science would acquire a better understanding in science compared to those who had incredible ability in speaking English but did not have passion to learn science.

Jacira reported that even though student language acquisition skill played a significant role in determining their success in learning science in English, ELLs must also show their interest in learning science. Jacira further explained that the ELLs grade level could also affect their understanding in science because the higher the grade level, the more difficult the science would be. Jacira highlighted that if the ELLs have interest in science, they would acquire science understanding easily regardless of their grade level.

Nahuel reported that ELLs' willingness to learn science, their ability to engage and collaborate with their friends, and their willingness to be cooperative in science classroom would have helped them acquire a better science understanding regardless of their ability to speak

English. Nahuel highlighted that the language acquisition skill could have supported ELLs in learning science, but it was not the only element that determined whether or not ELLs would have succeeded in learning science in English at a National Plus School.

Urpi reported that science teacher's role in delivering the lesson to the ELLs was another important element that could affect the ELLs' understanding in science class. Urpi affirmed that language acquisition skill played a very significant role in determining the ELLs' success in learning science in English. Urpi constantly mentioned that ELLs who possess excellent ability in speaking English would do a great job in science. Still, Urpi revealed that teacher role is extremely important in assisting and facilitating the students in the science classroom.

I presented the individual themes revealed by all four study participants in Table 3.

Table 3

The Individual Themes Portrayed by the Study Participants

Individual Theme	**Participant 1 (Galilahi)**	**Participant 2 (Jacira)**	**Participant 3 (Nahuel)**	**Participant 4 (Urpi)**
Science Teacher Is Doing Double Duty in Teaching Science in English	Mentioned	Not Mentioned	Mentioned	Mentioned
ELLs in Upper Grades Are Susceptible to Not Learning Science in English	Not Mentioned	Mentioned	Not Mentioned	Not Mentioned
Other factor(s) that determine ELLs' success in learning Science in English	Student passion in learning science	Student interest & grade level in science	Student willingness & collaboration skill in science	Science teacher's role in science classroom

CHAPTER V

CONCLUSIONS

In this chapter, I provided the summary of this study, discussed the findings in the light of the existing literatures, and lastly, provided the implications of this study for future practice and nature and limitation of the study.

Summary of The Study

I conducted this study to explore and document science teachers' experiences in teaching ELLs at a National Plus School in Indonesia. I selected four selected science teachers who possess two or more years of teaching experiences at a National Plus School (NPS) in a province in Indonesia during the academic year 2019-2020. The main research question I asked in the study: What were the lived experiences of Indonesian science teachers in teaching science to the ELLs who shared the same native language?

To answer the research question, I asked the study participants to talk about the challenges that they faced when they were teaching science to ELLs and also talked about the teaching strategies that they employed in their science classrooms to help them overcome those challenges. Prior to collecting data for the study, the Institutional Review Board at Texas A&M University approved it. I invited four science teachers to volunteer participating in the study. All four science teachers agreed to join the study. At their convenience, I conducted individual interview with them via Skype and/or Whatsapp.

Once I completed the data collection, I transcribed the interviews and analyzed the transcriptions qualitatively. I delved into all four study participants' experiences by reading the transcriptions, assigning the codes to the incidents, and revealing the emerging themes. I performed the within-case analyses where I analyzed each case one at a time and reported the

findings of each case respectively. I performed the cross-case analyses by comparing and contrasting all four cases and reported the common themes as well as the individual themes of all four study participants.

The findings from the within-case analyses revealed that each science teacher in this study experienced challenges in teaching science to ELLs. Each study participant reported that teaching science to ELLs was very challenging that they required to work extra hard to make sure their students acquire a better science understanding. All science teachers in this study pointed out that they had to find better teaching strategies to mitigate the issues in their science classrooms. They leaned active learning strategies in which they provided concrete representations of the science concepts. They provided their students with various hands-on activities and experiments, but they still took control of the classroom.

The findings from the cross-case analyses revealed that all science teachers in this study shared common experiences in teaching science to ELLs at NPS. Galilahi, Jacira, Nahuel and Urpi reported three common themes. First, a non-lecture learning environment is well-suited for teaching science to ELLs. Second, ELLs' language acquisition skills were important but not a sole determining factor in learning science in English. They all pointed out that ELLs' passions in learning science were equally important as the language. Lastly, there were two different versions of science courses taught at NPS. The one taught in Indonesian curriculum was a computational science that focused on calculations and the other one taught in International curriculum was a narrative science that focused on conceptual science.

In contrast, the study participants also shared their own individual experiences that differ from one another. There were a couple of individual themes mentioned by the study participants that stand out. First, science teacher perceived that teaching science in English to ELLs as

double duty because they taught the science concepts and the language of science in English in tandem. Second, ELLs in the upper grades were more susceptible to not learning science in English because the upper grades ELLs had their own perspectives of what they wanted to be in the future that they tended to gravitate towards those perspectives.

Discussions

In this section, I assessed the meaning of the study findings by evaluating and interpreting in the light of existing literatures for comparison and contrast with the results. All speculations are deemed reasonable, firmly justified and subject to test. The main focus of this study was to explore and document science teachers' experiences in teaching science at a National Plus School (NPS).

The study findings showed that most of the science teachers who were involved in this study found teaching science to ELLs was a double duty. They did not only have to teach their students the science concepts, but they also had to diminish the language barriers. In order to tackle the challenge, some of the science teachers forced their students to constantly speak in English in their science classroom. They reasoned that by forcing them to speak English, students would get used to speaking English and eventually be able to acquire science understanding. If they no longer encountered the language barriers in their science class, students would have been comprehending the science concepts. Drawing on sociolinguistics research, Lemmi *et al.* (2019) affirmed that in this regard, science teachers employed a language ideology in science education called *language-exclusive ideology.* A language-exclusive ideology refers to an ideology that believes only certain forms of language are expected in a science class, while others are deemed inappropriate.

Lemmi et al. (2019) reported that language-exclusive ideology in science education could either benefit or hurt ELLs in understanding of science concepts. On one hand, it could benefit the ELLs because this approach has the potential to enhance ELLs' use of scientific language and bridge the language gaps in a multilingual community by providing everyone a systematic method of communication. On the other hand, the language-exclusive ideology has potential to hurt ELLs' science understanding because students feel excluded if science teachers do not value their ways of communication in their native language and only prioritize certain types of language (e.g., English language). This could negatively impact the ELL's understanding of science concepts.

Given that National Plus School requires students to take two different versions of science courses (i.e., one science course in Indonesian curriculum, and the other one is in International curriculum), it may be true that the language-exclusive ideology might work better for ELLs in this regard. Students learn science in their native language in one science course and learn science in English in the other science course in tandem. After all, it is dependent on the type of science courses being offered by the school and the science content being taught in International curriculum. At times, both science courses do not even go hand in hand, and this makes it even harder for science teachers to teach their students.

Some science teachers reported that they allowed ELLs to use their native language and English in tandem in science classrooms. They affirmed that they allowed their students to use both languages because it was more important for them to understand the science concepts than memorizing the definition and explanation of the concepts. Lemmi et al. (2019) referred this approach as *a language-inclusive ideology* where multiple forms of language use are acceptable in science class. Lemmi et al. (2019) affirmed that language-inclusive ideology is a form of

translanguaging. They asserted that the use of translanguaging in science classroom is yet to be researched, especially how it might impact student science learning. They recommended that more research in science education should focus on this area.

Mazak & Herbas-Donoso (2015) reported in their study that translanguaging practices in an undergraduate science course at a bilingual university (i.e., Spanish and English). They revealed that the "translanguaging was strategic, dynamic, and woven through the presentation of academic content. In addition, translanguaging served to apprentice the Spanish-dominant students into English for scientific purposes." (p. 698). Karlsson, Nygård Larsson & Jakobsson (2019) and Poza (2018) reported similar findings in their studies where translanguaging was found to be effective to develop ELLs' ability to contextualize the science concepts and develop critical awareness to target the language of science.

Furthermore, the study participants argued that sharing the same native language and culture with the ELLs and having an extensive knowledge about Indonesia helped them teach science concepts to their students. Some science teachers revealed that sometimes they tailored the science content in the International curriculum to their students' daily life and culture to support their understanding of science concepts. They elaborated that if science teachers did not have an extensive knowledge about Indonesia and did not know anything about their students' culture and native language, the science teachers would not have been able to tailor their teaching and failed to support their science understanding. Two of the study participants reported that the science teachers who were English native speakers, who did not share the native language and culture with the students, taught the students poorly. Yet, Oliveira, Weinburgh, McBride, Bobowski, & Shea (2019) reported in their synthesis of literature that the science education literature was less clear in addressing whether or having an extensive

knowledge, or even sharing the same native language with ELLs can be helpful for science teachers. Further, Oliveira, Weinburgh, McBride, Bobowski, & Shea (2019) asserted that "knowing science, language, and culture well, ELL science teachers also need to have pedagogical knowledge-familiarity with variety of pedagogical strategies shown to be effective through research and/or practice." (p. 10).

All science teachers in the study affirmed that their best teaching strategy to teach science to ELLs at this particular NPS was providing a non-lecture learning environment for their students. In their individual interview sessions, the study participants agreed on one proposition regarding their teaching strategy that worked best for teaching ELLs in their science classrooms. They withheld from giving too much lectures to the students and cultivated a more diverse learning environment where students learned science with more concrete applications. The science teachers preferred the active learning teaching strategy in which they provided the ELLs with hands-on activities and conducted the experiments as needed in learning science concepts.

As aforementioned, the study participants focused more on providing ELLs with myriad of science activities in which they did not involve too much lectures. They reported that the school emphasized on using active learning strategies in which students were able to see the concrete representations of the science concepts being taught. From there, science teachers developed students' English language acquisition skill gradually towards the abstractions of the science concepts. Ryoo (2015) reported that science teachers should first use students' everyday language, develop a coherent understanding of abstract science concepts by providing them with concrete representations of the concepts then introduce the language of science gradually. Ryoo (2015) affirmed that "by integrating students' everyday language in science instruction, it is

possible for all students including ELLs to acquire both the content and language of science." (p. 29).

According to developmental learning theory, when science teachers teach science, they must take into considerations the following factors: subject matter/science content, representation type (inscriptions), and the learners. First, science teachers should be aware of the highly abstract science content. If they encounter the highly abstract content that is not easily visualized or not a physical object, science teachers must figure out the way they represent the content to the students. They are expected to represent the science content from more concrete representations and move gradually towards more abstract. This way, the students should be able to visualize the science concepts. Science teachers should also take into considerations the learners' age and experience. Students' age and experience can shape how well students understand abstractions. Developmental learning theory is where concepts are most easily learned when concrete representations precede abstractions.

According to Lawson (1979), learning cycle is one teaching approach that science teachers can utilize that let "spontaneously inquire, raise questions, and seek solutions, while at the same time introducing a coherent and significant number of meaningful concepts." (p. 513). This approach can be employed by science teachers, especially in teaching science to ELLs. Instead of providing students with science content that are abstract, science teachers can employ the learning cycle approach where ELLs can explore, invent, and discover. Lawson (1979) asserted three phases of learning cycle: exploration where students work with a phenomenon, concept development where teachers work with students to make sense of their experience and move their thinking to the science concept and lastly, concept application where students use the new knowledge to do a different concrete task in their daily life.

Because the NPS required their students to take two different science courses, science teachers revealed that science course that they taught in English was different than the science course taught in Indonesian language. They reported that, on one hand, both science courses complemented one another. Some of the science teachers in this study affirmed that both science courses taught at NPS shared some commonalities in terms of science content being taught. When students learned science in Indonesian curriculum, they acquired science concepts understanding in their native language. Later, when they studied science in English about the same concepts, they generally had the idea what the concepts were all about.

On the other hand, some of the study participants reported that at times, both science courses did not go hand in hand most of the time. Science teachers were not able to share the same teaching materials that they were not able to teach the science concepts subsequently. The study participants affirmed that science in Indonesian curriculum heavily focused on calculations. I referred it as *a computational science.* In contrast, science taught in International curriculum mainly focused on understanding the science concepts. I referred it as *a narrative science. S*tudents in science class taught in Indonesian curriculum perceived science as calculations that involved only numbers and required mathematical approach.

Consequently, when asked with questions or provided with science problems that required critical thinking and conceptual understanding, students often failed to work the problems out. Given the circumstances, science teachers had to facilitate their students with concrete representations of science concepts and had to establish the relevancy of those science concepts and tie them up to their students' daily life. Tearing down the students' mindset about computational science and helping them establish the new mindset about narrative science was not an easy task for science teachers. One science teacher in this study asserted that the students

lacked the critical thinking and conceptual understanding due to the lack exposure of narrative science in Indonesian curriculum.

Furthermore, science teachers in this study reported that even though language barriers were one of the main challenges in their science classrooms, there were other significant factors that impacted their students' science understanding. Most of the science teachers pointed out that students' passion to learn science was equally important for students to succeed. Science teachers were encouraged to ignite students' passion in their science class. To address this issue, science teachers focused more on designing various science activities that could heighten students' passion in learning science, rather than focusing on their English language acquisition skills. Once students were stimulated to engage in science activities, their passion in learning science could be gradually restored. When students showed their passion in learning science, science teachers then slowly diffused a science learning environment in which the students were expected to speak English. This might have impacted students' attitudes towards science.

A study conducted by Oliver & Venville (2011) revealed that there was a breadth of literature that discussed about students' attitudes towards science. In contrast, there was almost no research on what students' passion for science might look like and how it might be manifested into changing students' attitudes toward science or vice versa. Oliver & Venville (2011) reported that their science program was the one that transformed students' positive attitudes towards science into passion for science. Regarding the manifestation of the students' passion in science, Oliver & Venville (2011) argued that "students' feelings of immersion, extension, emotion, inclusion, achievement, mastery and identity that collectively can be considered to represent what passion for science might look like." (p. 2318)

From the aforementioned study, it is clear that science teachers are expected to provide the learning environment where the students can raise their attitudes towards science from positive to passionate. Karnes & Riley (1999) reported that students' passion in science can also be manifested through students' motivations, persistence, inventiveness, and natural curiosity. Further, Karnes & Riley (1999) suggested to maximize the student involvement and participation in science, science teachers can begin the journey toward the development of students' passion for science. They argued that passion for science must be developed and nurtured. "The earlier this appetite for science is developed and enhanced, the sooner we will begin to see change occur." (p. 36)

The Implications of the Study for Future Practice

In this section, I discussed the potential practicality of the study findings. I do not wish to suggest that my recommendations are inherently favorable, and others' recommendations are poor and intangible. All the potential usefulness aspects of the study were genuinely generated from my analyses of all four study participants. I certainly hope that these implications are cogent that they would benefit other science teachers who teach science to ELLs as well as inform other researchers, curriculum developers and the policy makers to better assist the ill-prepared science teachers in teaching science to ELLs, particularly in National Plus School other schools with similar setting where their science classrooms are populated by English Language Learners (ELLs).

Culturally responsive science teachers

Science teachers reported that having an extensive knowledge about their ELLs' cultures and sharing the same native language with their students benefited them to teach science in their class. Further, they asserted that tailoring the science concepts to their students' daily life

experiences was a way to assist and facilitate their students in acquiring a better science understanding. Science teachers provided numerous real-life examples of science concepts in which they students could relate and even apply it in their daily life. This way, the students felt like science was more than concepts in the textbook or utter calculations that they could not apply and experience anywhere else but in their classrooms.

To make science matter and relevant to ELLs, science teachers should acknowledge and take into consideration their students' culture background as well as their native language when they come into their science class. Disregarding all those factors can potentially hurt their science understanding. Hence, science teachers should be aware of the different background of their students. If science teachers are ill-prepared and insensitive towards ELLs' different culture background and language, students feel excluded and the learning goals in science class are no longer attainable. Thus, culturally responsive science teachers are eminently important and in demand, especially in teaching science to ELLs.

Conceptualization of science concepts

Science teachers are often faced with myriad challenges in which they have difficulties in teaching the science content to ELLs due to the complex language use in the science. ELLs' inadequate language ability in speaking English hinders them to comprehend science concepts. Science teachers must be able to mitigate and address this particular problem in their science class. When science teachers teach science, they should take into consideration three important aspects: the subject matter or science content, the representation type of the science content, and their students' age and experience. If science teachers are well informed about those three important aspects in teaching science, they should be able to orient their students towards a better science understanding.

Once they take into consideration the ELLs' experience, age, as well as the level of abstraction of the science content, science teachers can gravitate their teaching towards more concrete representations of the science content. In other words, science teachers are encouraged to conceptualize the science concepts. They are expected start teaching science concepts from concrete representations towards more abstract science concepts and avoid using too much lectures because most ELLs encounter language barriers. Refraining science teaching from focusing heavily on using language of science can result in a more nurturing science learning environment for the ELLs. This way, ELLs can feel safe to express their ideas in science classroom.

Collaborations among teachers teaching different versions of science courses

Science teachers reported that sharing their teaching experiences with other science teachers enhanced their teaching. Occasionally, both International and Indonesian science curricula shared the commonalities, especially in the science contents. Science teachers sometimes tried to pair up the interchangeable science contents and they took this opportunity to align the timelines of the science contents. Normally, science teachers who taught in Indonesian language would have taught first and subsequently followed by science teachers who taught in English. They reported that in some cases, this strategy worked because when the students learned and understood the science concepts in Indonesian language, they already seemed familiar with the science concepts and science teachers who taught in English would only enhance the ELLs' understanding in English language.

When both versions of science courses are perfectly aligned, science teachers teaching different curricula can and should mirror their teaching. A collaboration between all science

teachers should be highly encouraged and promoted. Especially, those who teach science in a school where there are two or more different versions of science courses are offered.

Nature and Limitation of the Study

In this study, I followed a qualitative research approach, involving the use of the semi-structured interview as the primary method. I interviewed four study participants at one NPS because of the time constraints involved in interviewing and subsequent data analysis. Teachers at the same NPS or teachers at the other NPSs in Indonesia might have provided different responses. The common themes might have differed.

The participants were located in Indonesia while the researcher was located in USA at the time of data collection. The interviews took place on Skype/Whatsapp. The quality of the interactions and the nature of communications between the researcher and the participants might have been negatively impacted because of not talking face to face.

My experiences as a teacher in similar setting might have impacted my interpretations of the data. Another researcher whose teaching experiences differed from my experiences could have generated different themes. However, these different themes would not diminish the importance of the present study findings, yet they would complement them.

REFERENCES

Alpaslan, M. M., & Yalvac, B. (2017). Exploring the anxiety state of the science majoring international graduate students with conditional acceptance in the united states. *International Journal of Research in Education and Science, 3*(2), 614-623.

Bautista, N., & Castañeda, M. (2011). Teaching science to ELLs, part I. *The science teacher*, *78*(3), 35.

Bo, W. V., Fulmer, G. W., Lee, C. K. E., & Chen, V. D. T. (2018). How do secondary science teachers perceive the use of interactive simulations? The affordance in Singapore context. *Journal of Science Education and Technology*, *27*(6), 550-565.

Cho, S., & McDonnough, J. T. (2009). Meeting the needs of high school science teachers in English language learner instruction. *Journal of Science Teacher Education*, *20*(4), 385-402.

Creswell, J. W. (2005). Educational research: Planning, conducting, and evaluating quantitative and qualitative research. Upper Saddle River, New Jersey: Pearson Education, Inc.

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Thousand Oaks, CA. Sage publications.

Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry & research design: Choosing among five approaches. Thousand Oaks, CA. Sage publications.

Fradd, S. H., & Lee, O. (1999). Research news and comment: Teachers' roles in promoting science inquiry with students from diverse language backgrounds. *Educational Researcher, 28*(6), 14-42.

Garza, A. (2013) When science should be taught in English only: Spanish language use in a dual language classroom for science biliteracy development, *Identity*, *3*(12), 20.

Glaser, B.G. (1965). The constant comparative method of qualitative analysis. *Social problems*, 12(4), 436-445.

González-Howard, M., & McNeill, K.L. (2016). Learning in a community of practice: Factors impacting English-learning students' engagement in scientific argumentation. *Journal of Research in Science Teaching, 53*(4), 527-553.

Heineke, A. J., Smetana, L., & Carlson Sanei, J. (2019). A qualitative case study of field-based teacher education: one candidate's evolving expertise of science teaching for emergent bilinguals. *Journal of Science Teacher Education*, *30*(1), 80-100.

James, C., & Merrill, S. (1986). Bilingualism in education: Aspects of theory, research and policy.

Karlsson, A., Nygård Larsson, P., & Jakobsson, A. (2019). Multilingual students' use of translanguaging in science classrooms. *International Journal of Science Education, 41*(15), 2049-2069.

Karnes, F. A., & Riley, T. L. (1999). Developing an early passion for science through competitions. *Gifted Child Today, 22*(3), 34-36.

Kier, M. W., & Lee, T. D. (2017). Exploring the role of identity in elementary preservice teachers who plan to specialize in science teaching. *Teaching and Teacher Education, 61*, 199-210.

Lawson, A. E. (1979). The developmental learning paradigm. *Journal of Research in Science Teaching, 16*(6), 501-515.

Lee, O. (2019). Aligning English language proficiency standards with content standards: shared opportunity and responsibility across English learner education and content areas. *Educational Researcher*, *48*(8), 534-542.

Lee, O., & Buxton, C. A. (2013). Integrating science and English proficiency for English language learners. *Theory into Practice*, *52*(1), 36-42.

Lee, O., & Buxton, C. A. (2013). Teacher professional development to improve science and literacy achievement of English language learners. *Theory into Practice, 52*(2), 110-117.

Living in Indonesia. (2014, June 23). National Plus Schools. Retrieved from https://livinginindonesia.info/item/national-plus-schools/

Lemmi, C., Brown, B. A., Wild, A., Zummo, L., & Sedlacek, Q. (2019). Language ideologies in science education. *Science Education*, *103*(4), 854-874.

Manara, C. (2014). That‘s what worries me: Tensions in English language education in today‘s Indonesia. *International Journal of Innovation in English Language Teaching and Research, 3*(1), 21-35.

Manning, A. (2017). Urban Science Teachers: Exploring how their views and experiences can influence decisions to remain in post or not. *Doctoral dissertation*. London, UK: King's College London.

Manurung, A. D. (2015). The Influence of Parents' self-concept toward the decision-making process in choosing national or national plus school in Jakarta. International Journal of Applied Business and Economic Research, 4691-4701.

Marcellino, M. (2015). English language teaching in Indonesia: A continuous challenge in education and cultural diversity. *TEFLIN journal*, *19*(1), 57-69.

Mayasari, T. (2017). Integrasi budaya Indonesia dengan pendidikan sains. In *Prosiding SNPF (Seminar Nasional Pendidikan Fisika), 2527*(6670), 12-17.

Mazak, C. M., & Herbas-Donoso, C. (2015). Translanguaging practices at a bilingual university: A case study of a science classroom. *International Journal of Bilingual Education and Bilingualism, 18*(6), 698-714.

McDonald, C. V. (2017). Who is teaching science in our high schools? Exploring factors influencing pre-service secondary science teachers' decisions to pursue teaching as a career. *Teaching Science*, *63*(4), 33.

Meskill, C., & Oliveira, A. W. (2019). Meeting the challenges of English learners by pairing science and language educators. Research in Science Education, 49(4), 1025-1040.

Miles, M. B., Huberman, A. M., Huberman, M. A., & Huberman, M. (1994). *Qualitative data analysis: An expanded sourcebook*. Los Angeles, CA: Sage Publication.

Morrison, C. D. (2017, May 30). Code-switching. Retrieved January 15, 2020, from https://www.britannica.com/topic/code-switching

Mulyani, M., & Julianto, J. (2019). Pembelajaran sains berbasis budaya lokal sebagai bentuk integratif pendidikan karakter. *EduStream: Jurnal Pendidikan Dasar*, *2*(1), 35-42.

Nababan, P. W. J. (1991). Language in education: The case of Indonesia. International Review of Education, 37(1), 115-131.

Nutta, J., Bautista, N. U., & Butler, M. B. (2010). *Teaching science to English language learners*. New York, NY: Routledge.

Ohman, A. (2005). Qualitative methodology for rehabilitation research. *Journal of Rehabilitation Medicine*, 37(5), 273-280.

Oliver, M., & Venville, G. (2011). An exploratory case study of Olympiad students' attitudes towards and passion for science. *International Journal of Science Education, 33*(16), 2295-2322.

Oliveira, A. W., Weinburgh, M., McBride, E., Bobowski, T., & Shea, R. (2019). Teaching science to English language learners: current research and practices in the field of science education. In L.C. de Oliveira (Ed.), *The Handbook of TESOL in K-12*, (277-290). Hoboken, NJ: Wiley-Blackwell.

Park, M. S. (2013). Code-switching and translanguaging: Potential functions in multilingual classrooms. *Studies in Applied Linguistics and TESOL (SALT),13*(2). 50-52

Poza, L. E. (2018). The language of ciencia: Translanguaging and learning in a bilingual science classroom. *International Journal of Bilingual Education and Bilingualism, 21*(1), 1-19.

Prasetiyaningsih, A., Diantoro, M., & Kusairi, S. (2013). Pengembangan bahan ajar IPA terpadu model connected berbahasa Inggris dengan basis kontekstual pada materi energy, nutrient and molecule untuk siswa SMP kelas VIII (Tesis). *DISERTASI dan TESIS Program Pascasarjana*. Malang: Universitas Malang.

Quinn, G. (2001). The learner's dictionary of today's Indonesian. New South Wales, Australia: Allen & Unwin.

Rinaldi, I., & Saroh, Y. (2017). The rise of national plus school in Indonesia–education for parents and government. *Lingua Didaktika: Jurnal Bahasa dan Pembelajaran Bahasa*, *10*(2), 194-205.

Rushton, E. A., & Reiss, M. J. (2019). From science teacher to 'teacher scientist': Exploring the experiences of research-active science teachers in the UK. *International Journal of Science Education, 41*(11), 1541-1561.

Ryoo, K. (2015). Teaching science through the language of students in technology-enhanced instruction. *Journal of Science Education and Technology, 24*(1), 29-42.

Santoso, T. (2006). The benefits of bilingual education and its applications in Indonesia. *Jurnal Pendidikan Penabur*, *5*(6), 42-45.

Sari, M. (2012). Usaha mengatasi problematika pendidikan sains di sekolah dan perguruan tinggi. *Al-Ta'lim Journal, 19*(1), 74-86.

Sekolah International. (2010, October 24). Membedah sekolah nasional plus. Retrieved from https://web.archive.org/web/20110404171348/http://www.sekolahinternasional.com/

Shintia Revina. (2019, November 19). Skor siswa Indonesia dalam penilaian global PISA melorot kualitas guru dan disparitas mutu penyebab utama. Retrieved from http://theconversation.com/skor-siswa-indonesia-dalam-penilaian-global-pisa-melorot-kualitas-guru-dan-disparitas-mutu-penyebab-utama-128310

Stake, R. E. (1995). The art of case study research. Thousand Oaks, CA: Sage Publications.

Stake, R. E. (2005). Case studies. In N. K. Denzin, & Y. S. Lincoln (Eds.), Handbook of Qualitative Research (443-454, 3rd ed.). Thousand Oaks, CA: Sage Publications.

Suardana, I. N. (2014). Analisis relevansi budaya lokal dengan materi kimia SMA untuk mengembangkan perangkat pembelajaran inkuiri terbimbing berbasis budaya. *JPI (Jurnal Pendidikan Indonesia)*, *3*(1), 337-347.

Suastra, I. W. (2010). Model pembelajaran sains berbasis budaya lokal untuk mengembangkan potensi dasar sains dan nilai kearifan lokal di SMP. *Jurnal Pendidikan dan Pengajaran, 43*(1), 8-16.

Swanson, L.H., Bianchini, J.A., & Lee, J.S. (2014). Engaging in argument and communicating information: A case study of English language learners and their science teacher in an urban high school. *Journal of Research in Science Teaching, 51*(1), 31-64.

The Association of National and Private Schools (ANPS). 2014. Advancing the interests of national and private schools throughout Indonesia. Retrieved from https://anps-bi.org/information

Tolbert, S., & Knox, C. (2016). 'They might know a lot of things that I don't know': investigating differences in preservice teachers' ideas about contextualizing science instruction in multilingual classrooms. *International Journal of Science Education*, *38*(7), 1133-1149.

Tommy Kurnia. (2019, September,12). Skor terbaru PISA: Indonesia merosot di bidang membaca, sains, dan matematika. Retrieved from https://www.liputan6.com/global/read/4126480/skor-terbaru-pisa-indonesia-merosot-di-bidang-membaca-sains-dan-matematika

Williams, R. T., Pringle, R. M., & Kilgore, K. L. (2019). A practitioner's inquiry into vocabulary building strategies for native Spanish speaking ELLs in inquiry-based science. *Research in Science Education*, *49*(4), 989-1000.

APPENDIX A

THE RECRUITMENT EMAIL SCRIPT

Dear Potential Participant,

We are writing to invite you to participate in a research study titled "*A Case Study of Science Teachers' Experiences to English Language Learners (ELLs)*" and has been approved by the Institutional Review Board of Texas A&M University, College Station, TX. If you agree to participate, you will be asked to engage in a conversation with one of the researchers and answer a list of interview questions about your experiences in teaching science to English Language Learners (ELLs).

We are conducting this study and interviewing teachers to increase our understanding of science teachers' teaching experiences in teaching English Language Learners (ELLs) at a school that employs both national and international curricula in which the languages of instructions are Indonesian and English. As a science teacher, you are in an ideal position to give us valuable first-hand information from your own lived experiences.

The interview will take between 30-120 minutes and it will be semi-structured. You can take as much time as you will need to complete the interview session. This is going to be a conversation on Skype/Zoom/Facetime/Whatsapp since the interviewer and the interviewees are not physically located in the same country. Our goal is to capture your thoughts and perspectives on being a science teacher at this particular school. During the interview, we will record the conversations for the purpose of transcribing them for analyses. Your responses to the questions we ask will be kept confidential. We will know your identification, but we will not share it with anyone. When we report our findings, we will report fake names for any of your identifications to protect the confidentiality of your responses. Each interview will be assigned a number code to help ensure that personal identifiers are not revealed during the analysis and write up of findings.

There is no compensation for participating in this study. However, your participation will be a valuable addition to our research and findings could lead to greater public understanding of science teaching and English Language Learners (ELLs) and the people in the field.

If you are willing to participate, please find attached the information sheet about this study. Please go over the information sheet prior to conducting the interview. After you have read it, feel free to send your questions or concerns back to me as a reply to this email. In addition, please suggest a day and time that suits you and we will schedule a meeting over Skype/Zoom/Facetime/Whatsapp with you in advance. Also, please send me your

Skype/Zoom/Facetime/Whatsapp account so I can reach out to you before conducting the interview. If you have any other questions, please do not hesitate to ask.

Thank you in advance for your valuable time and perspectives.

APPENDIX B

INFORMATION SHEET

Title of Research Study: *A Case Study of Science Teachers' Experiences to English Language Learners (ELLs)*

Investigators*: Bugrahan Yalvac and Syahrul Amin*

Why are you being invited to take part in a research study?

You are being asked to participate because you are a science teacher at a National Plus School in Indonesia and you have two or more years of teaching experience at the time of data collection, that is, the academic year 2019-2020. Your experiences in teaching science to English Language Learners (ELLs) in Indonesia will inform the goal of this research study and help answer the research questions.

What should you know about a research study?

- Someone will explain this research study to you.
- Whether or not you take part is up to you.
- You can choose not to take part.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the research team by sending email to Mr. Syahrul Amin at s.amin1@tamu.edu or Dr. Bugrahan Yalvac at Yalvac@tamu.edu and/or talk over skype or call via +19796767232

This research has been reviewed and approved by the Texas A&M Institutional Review Board (IRB). You may talk to them at 1-979-458-4067, toll free at 1-855-795-8636, or by email at irb@tamu.edu., if

- You cannot reach the research team.
- Your questions, concerns, or complaints are not being answered by the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research participant.

- You want to get information or provide input about this research.

Why is this research being done?

Teaching science to ELLs can be very challenging because not only the teachers must possess excellent linguistic skills (e.g., students' home language, science language as well as English language skills) but also, they must excel in science content itself.

The purpose of this study is to explore and document science teachers' experiences in teaching ELLs at a National Plus School in Indonesia.

The study findings will provide fresh and new insights about the role of teachers in teaching science to the ELLs who share the same native language in a school that offers two different curricula. The report of this study will be a good resource for professional development for science teachers who teach in a similar school setting. Exploring the challenges that the teachers have encountered will help inform the best teaching strategy(ies) on how to teach science to ELLs. Understanding the common themes that emerged from numerous science teachers' experiences will help inform policymakers on how to help teachers tackle the challenges in the future.

How long will the research last?

We expect that you will be in this research study for a maximum 120 minutes.

How many people will be studied?

We expect to enroll several teachers in this research study.

What happens if I say "Yes, I want to be in this research"?

If you say "Yes, I want to be in this research", you will be invited to join a Skype interview and asked several questions about your teaching experience in teaching science to ELLs. As a participant of this research, you will be audio-recorded, and your interview will then be transcribed before the researchers analyze the information collected during your interview. The interview will not be a face-to-face session due to the location of the interviewer and the interviewee. You will be reached out to join the Skype interview after the end of January 2020. The duration of the study is around 120 minutes.

What happens if I do not want to be in this research?

You can leave the research at any time and it will not be held against you.

What happens if I say "Yes", but I change my mind later?

You can leave the research at any time and it will not be held against you. We will delete the data collected from you and will not use them in our analyses.

Is there any way being in this study could be bad for me?

No

Will being in this study help me in any way?

We cannot promise any benefits to you or others from your taking part in this research. However, possible benefits include this study will help you make sense of your teaching experience and the

findings of this study will help you and your peers understand the commonalities and differences that you share together. In this way, you can find alternatives to teach science better to ELLs.

What happens to the information collected for the research?

Efforts will be made to limit the use and disclosure of your personal information, including research study and other records, to people who have a need to review this information. We cannot promise complete privacy. Organizations that may inspect and copy your information include the TAMU HRPP/IRB and other representatives of this institution.

The data will be retained until the completion of the research and be destroyed afterwards. The data will be stored physically at 422 Harrington Tower, Texas A&M University and only researcher will have access to the data.

APPENDIX C

SEMI-STRUCTURED INTERVIEW PROTOCOL

[Interviewer fills the following information prior to conducting the interview]
Time of interview:
Date:
Media: Skype or Zoom
Interviewer:
Interviewee:
Position of interviewee:
[Briefly describe the project]
Main goal: To see things the way you see them, more like a conversation with a focus on your experience, your opinions and what you think or feel about the topics covered. This gives the interviewee gist information about what the study is all about and why interviewer thinks it is very important to conduct research in this area.
[Verbal consent]
Q: Would you like to participate in this interview?
Verbal Consent was obtained from the study participant
Verbal Consent was NOT obtained from the study participant
[Background information]
Main goal: To invite the interviewee to talk about him/herself: General information and background, for example, name, age, origin, current occupation, etc. Then proceed mostly about the interviewee's teaching experience. If the interviewee openly identifies certain experiences which may lead to his/her current experiences in science teaching, probe with the next questions or emerging questions.
[After describing the project and receiving verbal consent and sufficient background information, the interviewer begins asking the following questions as well as emerging questions as needed].

According to Ritchie and Lewis (2003), "In semi-structured or semi-standardized interviews, the interviewer asks key questions, in the same way, each time and does some probing for further information, but this probing is more limited than in unstructured, in-depth interviews" (p. 111). The following questions will be asked during the interviews with the participants.

Questions for the study participants:

1. What are your experiences teaching science to English Language Learners (ELLs) whose native language is Indonesian?
2. What percentage of your students in your science class are English Language Learners (ELLs) whose native language is Indonesian?
3. What difficulties did you come across in teaching science to English Language Learners (ELLs) whose native language is Indonesian?

4. What did you do to overcome the difficulties?
5. What did you think about your students' understanding of and/or learning of science?
6. What did you feel about yourself in teaching science taught in English to the English Language Learners (ELLs) whose native language is Indonesian?
7. What did you feel about your capabilities in teaching science taught in English to the English Language Learners (ELLs) whose native language is Indonesian?
8. How did you feel about your students' capabilities in learning science taught in English?
9. What did you think about the students in your class whose first language is English and whose first language is not in English? Were the English Language speaker students able to understand the science content better than the English Language Learners (ELLs) whose native language is Indonesian?
10. What did you share about your teaching experiences with your peers (with other science teachers)?
11. What could you mention as one main challenge in teaching science to English Language Learners (ELLs) whose native language is Indonesian and why?
12. What other comments do you have about your experiences in teaching science to English Language Learners whose native language is Indonesian in your classes?

[Interviewer thanks the interviewee in this interview and assures him or her of confidentiality or responses and potential future interviews]

APPENDIX D

THE LETTER OF EXEMPTION DETERMINATION FROM THE IRB

DIVISION OF RESEARCH

TEXAS A&M UNIVERSITY

EXEMPTION DETERMINATION
(Common Rule –Effective January, 2018)

January 09, 2020

Type of Review:	Submission Response for Initial Review Submission Form
Title:	Understanding Science Teachers' Experiences in Teaching English Language Learners (ELLs) at a National Plus School (NPS) through a case study
Investigator:	Bugrahan Yalvac
IRB ID:	IRB2019-1063
Reference Number:	104309
Funding:	
Documents Reviewed:	IRB Application (Human Research) - (Version 1.1) Rul_Email Script_Final - (Version 1.0 Approved on 01/09/2020) Rul_Social - Behavioral Consent_BY - (Version 1.1 Approved on 01/09/2020) Letter of Cultural Evaluation - (Version 1.0) Rul_The Interview Protocol - (Version 1.0 Approved on 01/09/2020) Syahrul's citiCompletionReport8025738 - (Version 1.1)
Review Category	Category 2: Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: i. The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; ii. Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or iii. The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by .111(a)(7).

Dear Bugrahan Yalvac:

The HRPP determined on 01/09/2020 that this research meets the criteria for Exemption in accordance with 45 CFR 46.104.

750 Agronomy Road, Suite 2701
1186 TAMU
College Station, TX 77843-1186

Tel. 979.458.1467 Fax. 979.862.3176
http://rcb.tamu.edu

This determination applies only to the activities described in this IRB submission and does not apply should any changes be made. If changes are made you must immediately contact the IRB. You may be required to submit a new request to the IRB.

Your exemption is good for three (3) years from the Approval Start Date. Thirty days prior to that time, you will be sent an Administrative Check-In Notice to provide an update on the status of your study.

If you have any questions, please contact the IRB Administrative Office at 1-979-458-4067, toll free at 1-855-795-8636.

Sincerely,
IRB Administration