

# Upgrading Scientific Capability and Learning Enrichment Program: A Proposed Professional Development Model for Non-Biology Major Science Teachers

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**ABSTRACT :** The integrated approach in Science curriculum for basic education has brought several challenges to teachers' instruction. This study examines the challenges encountered by the non-biology major Science teachers in teaching Biology to High School students and their needs in a professional development program. Utilizing a qualitative responsive evaluation approach, the six non-biology major Science teachers were selected and asked in a semi-structured online interview. The questions are open-ended to explore their views and ideas on the challenges they encounter, professional development needs, and perceive achievement in teaching career. The responses are coded and analyzed using QDA-Miner Data Analysis. There are several themes generated for the challenges and professional development needs. The respondents emphasized the need to have an in-depth knowledge on difficult topics in biology; and trainings on how to teach these topics effectively. Based on the findings, the Upgrading Scientific Capability and Learning Enrichment (UpSCaLE) Program model was proposed to address the professional development (PD) needs of the respondents. The result of this study may serve as a basis for designing and developing the PD program for non-biology major Science teachers and a springboard to further study.

**Keywords** - biology education; non-biology major; professional development; Science teacher; challenges

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## 1. INTRODUCTION

Teacher's knowledge and competencies on scientific concepts and principles is crucial to create meaningful learning experience among learners. Science teachers should be able to design and execute instructional materials and strategies that could develop scientific literacy, scientific attitude, and scientific awareness among their students. They should enhance students' science process skills and increase students' interest and engagement in learning science to keep pace with global needs. Biology is one of the core subjects needed for various professional courses such as medicine, biotechnology, nursing, and agriculture among many other courses. It is crucial for learners to comprehend biological concepts meaningfully to encourage them to pursue science-related courses. It is also essential for individuals to be knowledgeable in various biological processes as living organisms inhabiting the Earth that sustains life.

To keep up with the changing needs and standards, the Philippine Basic Education system implemented the K to 12 program by the virtue of Republic Act 10533 last 2013. This program has changed the curriculum of basic education to keep up with the global demands. It includes the science curriculum which is designed with three

domains: “understanding and applying scientific knowledge in local and global context; performing scientific processes and skills; and developing and demonstrating scientific attitudes and values (Department of Education, 2012). One distinct change in the science curriculum is the spiral progression approach where science concepts are integrated rather than discipline-based. This is one of the challenges for science educators especially those who graduated in discipline-based education courses. Conceptual understanding, misconceptions, and confidence in teaching biology topics may be a challenge for non-biology major science teachers. Misconceptions among teachers may adversely affect the conceptual understanding of their students (Chavan & Patankar, 2018). Furthermore, concerns regarding lack of content knowledge (Kunene et al., 2015); lack of basic tools in teaching biology (Friedrichsen et al., 2016); traditional method of teaching; lack of motivation for teachers; lack of facilities; time allocations for biology; low performance in National Achievement Test; and least emphasis in the affective domain by teachers have long been identified when it comes to secondary biology education (Buot, 2008). These issues and concerns are still evident as suggested in the study of Rogayan (2019) that science education program in state universities should enhance the curriculum in relation to content knowledge, pedagogy, and learning environment; and should strengthen the capacity-building programs of the pre-service science teachers.

Hence, professional development programs such as formal education, specialized training, or advanced professional learning is essential to improve their knowledge, skills, and competence (Hidden Curriculum, 2013 as cited in Morales et al., 2019). Sakib and Obra recommended that teachers should be provided with enhancement trainings on their least mastered competencies; and should be guided with the execution of instructional materials. This supported the suggestion of Friedrichsen et al. (2016) that biology teacher’s teaching practices, professional development needs, and content knowledge should be assessed. They should be provided with professional development workshops that allow them to use real scientific data and research, and be able to explore various supplementary materials and laboratory resources. With reference to published scientific data and media, engaging to independent research projects; and employing practical work such as experimental activity and practical laboratory skills could also improve students’ conceptual understanding and improve attitudes to STEM education and careers (Fadzil & Saat, 2020; Reiss, 2018).

There are limited studies when it comes to the professional development programs for non-biology major teachers teaching biology concepts. Most of the studies only include pre-service teachers and in-service teachers who are biology majors. In this view, this study aims to determine the professional development needs of the non-biology major teachers teaching Science in Basic Education. It will seek to understand the challenges they encountered and what do they expect in pursuing for advance learning. The result of this study may help the researcher to develop program that could enhance the knowledge, competencies, and skills of teachers in teaching Biology. It may also provide insights on improving the course offered in the master’s degree program pursued by the participants.

#### *Statement of the Problem*

This study aims to determine the challenges encountered by non-biology major in teaching Biology subjects to students and the needs of these teachers to further develop their knowledge and skills through professional development.

Specifically, this study seeks to answer the following questions:

1. What are the challenges encountered by the non-biology major teachers in teaching Biology to High School students?
2. What are the professional development needs of the participants to enhance their knowledge and skills in teaching Biology?
3. What are the indicators of achievement in your teaching career?

## 2. METHODOLOGY

This study utilized a qualitative research method aligned to responsive program evaluation approach. Responsive evaluation allows eliciting the personalization of the evaluation process by having direct contact with the people in the program and having firsthand learning on the stakeholders' perspective, experiences, and concerns (Patton, 2015). This approach focuses on the needs and views of the participants in the program activities which could help in determining the professional development needs in teaching biology.

### *Participants*

The respondents of this study are purposively selected based on two criteria: 1) non-Biology major teaching Science with at least three years of teaching experience; and 2) had taken some professional development course and training. Table 1 shows the profile of the respondents. There are six respondents for this study. Four of them are graduate of Bachelor of Science in Secondary Education major in General Science and the other two respondents took Bachelor of Technical Teacher Education major in Chemistry, and Physics, respectively. The respondents have a teaching experience ranging from 3 to 12 years. Two of the respondents are teaching in Junior High School; three are teaching both in Junior and Senior High School; and one is teaching in Senior High School only.

Table 1. Profile of Respondents

Respondent	R1	R2	R3	R4	R5	R6
<b>Sex</b>	female	male	male	female	female	male
<b>Undergraduate Course</b>	B.S. in Secondary Education major in General Science	B.S. in Secondary Education major in General Science	B.T.T.E. major in Chemistry	B.S. in Secondary Education major in General Science	B.T.T.E. major in Physics	B.S. in Secondary Education major in General Science
<b>Years of teaching experience</b>	12	7	3	9	3	11
<b>Participating classes (grade)</b>	7 <sup>th</sup> , 11 <sup>th</sup>	10 <sup>th</sup>	11 <sup>th</sup> , 12 <sup>th</sup>	9 <sup>th</sup> , 11 <sup>th</sup>	7 <sup>th</sup> , 10 <sup>th</sup>	7 <sup>th</sup> , 11 <sup>th</sup>
<b>Type of School</b>	public	public	private	private	private	public

### *Instrument*

This study used a semi-structured interview guide to elicit the teachers' views on their challenges in teaching Biology and expectations in a profession development training program. The interview lasted from 30 to 50 minutes. There are eight open-ended questions to seek the views of the teachers on the challenges they encounter in teaching biology, and expectations in taking further studies and seeking professional development. These may be followed by sub-questions depending on the flow of responses. The open-ended questions used during the interview are shown in Appendix A.

### *Procedure*

The respondents are emailed with letter of invitation. The copy of the interview guide was also provided. The respondents were asked of their convenient and most available time for the online interview. The researcher conducted an online interview using Zoom and the responses were recorded. Using the open-ended questions, the participants were allowed to explored ideas and views about their challenges in teaching and views in seeking further professional development to biology teaching. The responses were analyzed by content analysis. The collected data was be organized by data coding approach. The similarities and differences of the codes emerged in during the interview was be categorized in themes. The data was analyzed inductively to understand the teachers' perception and be able to generate the main themes using grounded theory. The response frequencies and category percentage was be calculated and analyzed using QDA Miner-Data Analysis.

### 3. RESULTS

#### *Challenges encountered of the non-biology major teachers*

The challenges encountered by the respondents in teaching Biology topics are shown in Table 2. It was revealed that the respondents have difficulty in teaching some abstract concepts (100%) to the students. The teachers revealed that several biological processes are difficult to teach due to is abstract and molecular nature. This biological concepts and processes include Krebs cycle, photosynthesis, cellular respiration, DNA replication, and protein synthesis. It also includes several terminologies (83.3%) that are needed to learn this concepts and processes which is one of the challenges for the teachers. Then, this is followed by lack of student interest, lack of in-depth knowledge, and time-management and congested topics (66.7%). The teachers explain that due to the nature of Biology, the students find it boring. Also, the non-biology major teachers expressed that they lack in-depth understanding on some topics in Biology though they encountered in their program. This would require them more time to read and research to study the lesson. Lack of retention on prior knowledge among students; difficulty in connecting and applying lessons; and lack of tools for teaching (50%) are also found to be challenges among the teachers in teaching Biology topics. Due to the spiral progression approach, the teachers mentioned that the students tend to forget the topics that were discussed in the previous grade level which is essential to understand the current topic. The students also find it difficult to find connection on the biological processes to other concepts within the discipline and to other areas. They also are questioning the application of the seemingly abstract biological process to real life situations. Lack of laboratory equipment and educational resources is also a challenge for teachers to enhance their teaching strategies and stimulate the interest of their students.

Table 2. Sample quotes from the respondents on their challenges encountered in teaching biology

Theme	Quotes
<b>Difficult and abstract concepts (100%)</b>	<p><i>“the time that K to 12 curriculum started, there are many difficulties that we are experiencing as teachers like in biology. It is hard for us to make our students understand the lessons for example they are learning about the parts of the cell, the function of organelles. It is difficult if our part to make them learn the topic” – R2</i></p> <p><i>“I really do not know the process for example NADPH though I encounter the term I do not have an in-depth understanding about it. I cannot recall. I am understanding one term and then other term will be given and I cannot follow. So for me, discuss the terminologies first so that in the chart (process) I will not be confuse because I know the use of the terms”- R5</i></p> <p><i>“Biology seems to be impossible to be imparted; it is quite really challenging to impart that molecular part of biology especially when it comes to teaching concepts like DNA. It is very hard to balance the ration between the hard concepts and the simplification foo the concepts” – R6</i></p>
<b>Too many terminologies (83.3%)</b>	<p><i>“they (students) are not yet prepared on the terminologies that they need to learn. There are too many terminologies that they encounter the first time...and is difficult for us to make them understand” – R2</i></p> <p><i>“I have difficulty in biology especially in teaching biology. There are terminologies that are difficulty to understand ...more readings are needed which is my weakness” – R3</i></p> <p><i>“some process in biology most of the time are the topics that I really tend to have a hard time teaching or explaining because that don’t know the terms, they don’t know the words, what are the abbreviations, what is this for” – R5</i></p>
<b>Lack of student interest (66.7%)</b>	<p><i>“in grade 8 biodiversity which seems to be boring for the students like for example the different kingdoms and the terminologies involved”-R2</i></p> <p><i>“teaching biology is more boring for them (students) because it is wordy and some of the terminologies are hard to understand” – R4</i></p> <p><i>“they would just sleep in the class. They wouldn’t learn. I want to get the interest of my students” – R5</i></p>

<b>Lack of in-depth knowledge (66.7%)</b>	<p><i>“since I am not a biology (major) teacher so I don’t have in-depth understanding on other topics for example in genetics, botany, organ system. I have some knowledge but not too broad.”- R3</i></p> <p><i>“In higher level of biology like for example Krebs cycle, it is really hard for me because I need to study all the terms in the cycle, I watched videos in YouTube on how it is going to be taught for them to easily understand the Krebs cycle as well as some concepts in biology... also one of the most challenging for me is heredity because I learned that I need to learn more and read more books and watch videos before I’ll just going to face my students and teaching that kind of lesson” – R4</i></p> <p><i>“I find it hard to teach (biology) because it is not my major and also there are topics that I lack mastery of. That is why I do usually overtime of there would be a topic the next day to teach and it would be biology because it is hard for me to understand really that much” – R5</i></p>
<b>Time management and congested topics (66.7%)</b>	<p><i>“in grade 10, we are not able to reach some parts of the lesson because of too many lessons that needs to be covered, this is also one of our difficulties where the topics are too congested in the grade levels and we are not able to finish all the lessons in one grading period” – R2</i></p> <p><i>“actually one of my problem in teaching biology is time. I handle too many sections and I have difficulty preparing. The preparation and time for the topic is difficult in my first year of teaching. I have four teaching preparations so I find it difficult to prepare lessons on different levels” – R3</i></p>
<b>Lack of retention on prior knowledge among students (50%)</b>	<p><i>“there are gaps in the lessons found in curriculum guide which is difficult. There is a gap from grade 7,8,9, and 10. They tend to forget the topics connected from one grade level to the next” -R2</i></p> <p><i>“long processes because they need prerequisite knowledge. In junior high school, science is taught spirally like for example for grade 7 fourth quarter is biology and then for grade 9 biology is for third quarter. When you teach them the next part of the lesson, they lack when it comes to retention so you need to review again in the last topic that you has when they were in grade 8. So for me the difficulties would be retention of the students when it comes to the topics of the lesson. Biology requires a lot of prior knowledge and a lot of retention when it comes to the processes, terminologies, systems” –R5</i></p>
<b>Difficulty in connecting and applying lessons (50%)</b>	<p><i>“(students) have difficulty in connecting the lessons, understanding the concepts and its importance and application” – R2</i></p> <p><i>“they really need to understand the topic for them to proceed to another topic because it is interconnected. So teaching biology is like building puzzles, when you miss one part of the lesson and then you move to the next part of the lesson probably the students would be having a hard time interacting or connecting the two lessons. We want to apply it in real life scenario but how will we apply it in a real life scenario that makes sense. At times the students take it very literal that they don’t understand the meaning of the lesson itself.” – R5</i></p> <p><i>“since science requires the understanding of various interrelated fields, for me it is quite challenging as it requires a lot of concepts to understand some concepts being taught. Teaching biology also requires sustained interest. It is quite hard to sustain the interest if the students especially to concepts that are quite high for them. Although, you try your best to achieve that sense of need...biology is seemingly hard and quite a chunk of knowledge to be taken by the students” – R6</i></p>
<b>Lack of tools for teaching (50%)</b>	<p><i>“conducting an experiment which lead to using equipment...in our school, we have limited equipment that can be used in the laboratory experiment in biology” – R4</i></p> <p><i>“before, biology is taught in a story like manner...back then, there was no television sets. We only rely on black board and cartolina and mostly diagram, tarpaulins and</i></p>

*some painted materials. For me teaching biology is challenging, in the sense that you have to gain, to raise the imagination of the students due to lack of interactive videos”-R6*

### *Professional development needs of the non-biology major teachers*

The themes and sample quotes for the professional development needs of non-biology major science teachers is shown in Table 3. There are five themes generated for the professional development needs of the respondents: in-depth content knowledge (100%); develop skills and strategies in teaching (100%); develop laboratory skills and improvisation (83.3%); new technologies and open resources (50%); and develop confidence in teaching (50%). Due to different field of specialization in their undergraduate program, the respondents would like to have in-depth content knowledge training. The teachers seek an emphasis on some of the difficult topics in the Biology to gain more knowledge and upgrade their skills. Aside from content knowledge, the teachers also seek to develop their pedagogical skills. They want to enhance their teaching strategies to be able to sustain the interest of the students in learning biological concepts and processes. The teachers also seek to develop their teaching strategies so that their students can easily understand the biological concepts and processes. This also includes the development of their laboratory skills and be able to use improvised tools in doing laboratory activities. The teachers mentioned that conducting experiments is effective in catching students’ attention and interest on the subject matter. Also, being able to access different technology and open educational resources could provide teachers various resources that they could use to innovate their teaching strategies. The respondents find this useful to cater the needs of the 21<sup>st</sup> century learners and to equip teachers in our current distance learning set-up. The respondents also revealed that they need to develop confidence in teaching the subject matter. They felt that since Biology is not their field of specialization, they are not fully confident to provide deeper insights and address some questions asked by their students.

Table 3. Sample quotes from the respondents on their need for professional development

Theme	Quotes
<b>In-depth content knowledge (100%)</b>	<p><i>“I think I need to develop in-depth concepts to be taught to students and teach correctly. Since I am a General Science major I don’t have in-depth knowledge to biology concepts”-R1</i></p> <p><i>“to refresh our knowledge on the content of biology as it is progressing and so what we have learned before might change now” –R2</i></p> <p><i>“I know that in public school, spiral approach is used. So I need to develop skills which I find as weakness. I need to gain more knowledge” – R3</i></p> <p><i>“now the education is evolving so as a teacher I also need to evolve or to upgrade my skills the way I taught the subject in order for them to catch or get the lesson” – R4</i></p>
<b>Develop skills and strategies in teaching (100%)</b>	<p><i>“more on strategies on how to teach biology and how to develop activities that are suitable for students” – R1</i></p> <p><i>“strategies and techniques on how to make the lesson easier for students, how they can better understand the lesson to get their interest in learning biology. New techniques that could keep the interest of the students nowadays” –R2</i></p> <p><i>“seminars and trainings that will get the attention of the students regarding teaching biology in order for them to easily understand it and not easily get bored” – R4</i></p>
<b>Develop laboratory skills and improvisation (83.3%)</b>	<p><i>“usually when I attend workshops or seminars it is about the concept of new technology or new techniques but there is no hands-on on how to use the technology. Having hand-on activity on how to use the technology so that we can see how we can use it as part of our subject matter” – R2</i></p> <p><i>“conducting more experiments or laboratory activities that I can share to my students for them to really understand the application of biology and other fields of science through experiment or activity” – R4</i></p>
<b>New technologies</b>	<p><i>“teaching biology in the 21<sup>st</sup> century and the distance learning... latest tools like for</i></p>



<b>and open resources (50%)</b>	<i>example electronic microscope and how to handle it... using different kinds of latest innovation in equipment” – R4</i> <i>“consulting with videos, visiting a lot of presentations available from the internet aside from coming up with your own...I always go to watching videos from credible sources like Khan academy whenever I have time. I try to view videos from time to time to further enhance my knowledge” – R6</i>
<b>Develop confidence in teaching (50%)</b>	<i>“I am not confident for myself that I can. I want mastery because it is fulfilling when the students ask questions that I can answer properly and I can answer in the right way. I usually say that I don’t want to answer you with false hopes. So when I don’t know the answer, I try to research it and I will answer later. I (want) to learn something so that others learned also. So I can go into conversation that I can also give my insights and answer the questions with regards to the topic” – R5</i> <i>“it is difficult to gain confidence in teaching the subject...it is like your soul if you say that it is your major...somehow you blanket yourself with that sense that you are familiar with the topics. But then when you are called to teach subjects that you were only able to touch in college, it is as if you are challenge again” – R6</i>

*Indicators of achievement in teaching career*

In their teaching career, the respondents expressed their indicators of achievement as Science teachers as shown in Table 4. There are five themes generated: career development (100%); contribute to improvement in learning system (66.7%); students’ feedback on learning the lesson (50%); winning scientific competitions (50%); and students pursuing science related courses (33.3%). The respondents revealed that one of their success indicators in their teaching careers is professional development. Respondents are seeking professional development programs through attending seminars and trainings; and enrolling in advanced education to upgrade and update their knowledge and skills. This also includes promotion and salary increase. Aside from career development, the teachers also expressed that they want to contribute to the improvement in the learning system. Being able to share their knowledge to their co-teachers, improving the performance of the students in science exams, and conducting research are ways on how the respondents want to contribute in improving the learning process. The teachers also find it an achievement if their students provide feedback that they understand the lesson well and that they are also able to use it in their college course. Also, when their previous students are taking science-related courses are also indication of achievement among the teachers. Lastly, the teachers consider winning in scientific competitions as one of their major achievement. This may include competitions in science quiz bee; instructional material making; and even when the students they coach won the competition.

Table 4. Sample quotes from the respondents on their perceive success indicators as teachers

<b>Theme</b>	<b>Quotes</b>
<b>Career development (100%)</b>	<i>“Of course personally for promotion and professional growth then to share my knowledge to my co-teachers” – R2</i> <i>“to upgrade my knowledge un science and for my professional growth and development... then for salary increase” – R4</i> <i>“I believe that set of experiences that I will encounter in the course will contribute to steps closer to my expertise. If you have professional growth, you are added with professional responsibility and it is a bit of a challenge. I want not just a promotion but an update to myself again, to explore my skills, to enhance and teach in higher level” – R6</i>
<b>Contribute to improvement in learning system (66.7%)</b>	<i>“I want to contribute to change in our learning system. Because we know that based on studies in science, we have a very low performance. So I really hope to make a way to help to improve our educational system” – R1</i> <i>“to focus on research that will help them also to become globalized or to share their skills to other Asian countries and presenting the research that they conduct” – R4</i>

<b>Students' feedback on learning the lesson (50%)</b>	<p>"one of my achievement in teaching science is when my students inform me that all of the things they learned from what I've taught them is that they really used it in their college lessons or it helped them cope up with their college lesson"-R4</p> <p>"for me achievement is when my students learn the lesson especially when it is hard for example process and terminologies in biology because these are topics that students really find a hard time swallowing the lesson or understanding the concept" – R5</p>
<b>Winning scientific competitions (50%)</b>	<p>"during science month when I became coach in quiz bee and I can see that many students are winning is one of my achievement. Also, in my part, I join contest such as Strategic Intervention Material (SIM) contest which is one of my achievement as teacher." – R2</p>
<b>Students pursuing science related courses (33.3%)</b>	<p>"when I see my students pursuing courses related to science and are still remembering the lessons that I taught them." - R2</p> <p>"they are informing me that I am the one who lead them to take the course of education major in chemistry or in biology" – R4</p>

*Proposed model of professional development program for non-biology major teachers*

Based on the generated themes, the proposed model for professional development (PD) program for the non-biology major science teachers is shown in Figure 1. The model for the program is called Upgrading Scientific Capability and Learning Enrichment (UpSCaLE) program. The program has four sides which are Input, Intervention, Outcome, and Impact. *Input* serves as the base of the program as the needs of the non-biology major teachers are considered. It involves conceptual understanding to difficulty topics in Biology, pedagogical knowledge in teaching biology, and technological and scientific skills for Biology.

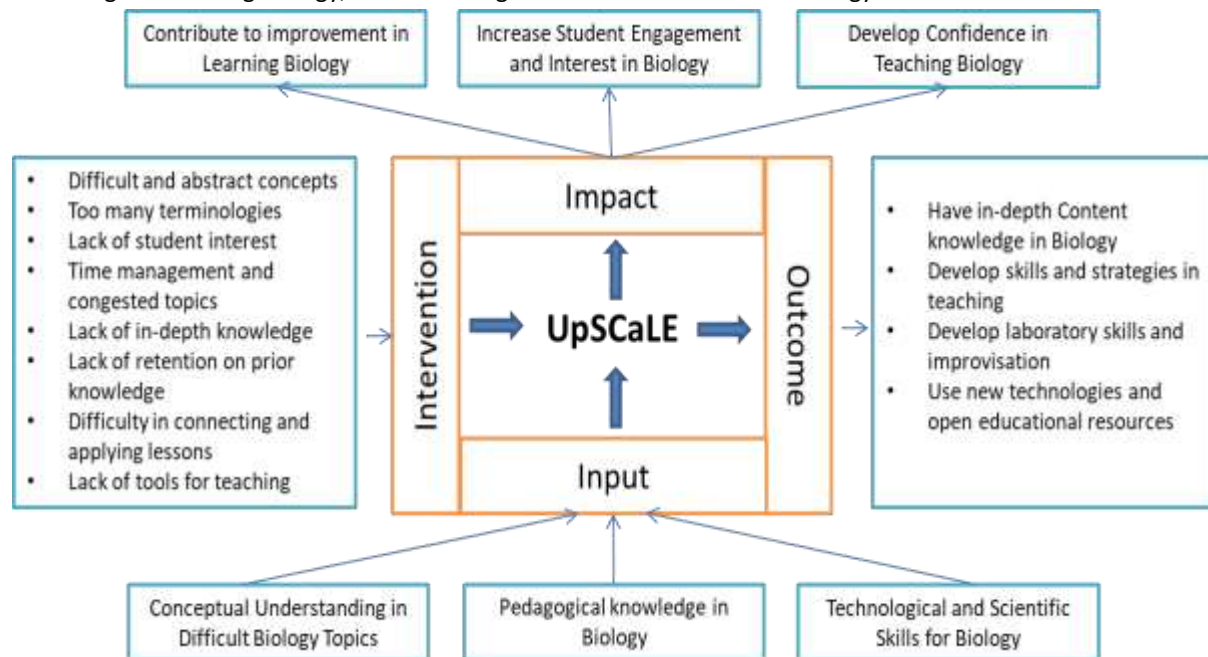


Figure 1. Upgrading Scientific Capability and Learning Enrichment (UpSCaLE) Program for non-biology major Science Teachers

The UpSCaLE program would ensure that there would be an emphasis on the difficult and abstract topics in biology with suitable teaching strategies and technological tools and equipment fit for the teachers and students use. The UpSCaLE program would serve as an *intervention* to address challenges of the teachers as shown in the leftmost box. It would provide in-depth discussion on difficult topics in biology and to give ideas and learning exemplars on various teaching strategies, technology, and resources that can be used in teaching those topics. For the *Outcome*, the program aims to increase the content knowledge and conceptual understanding of the non-biology major teachers to Biology concepts and processes; and to enhance their



pedagogical and technological knowledge and skills. As an *impact*, the program would improve the participants' knowledge and skills in teaching biology which may contribute to transformation in learning biology and increase students' engagement and interest. It may also boost the confidence of the non-biology major science teachers to teach biology even in different grade levels. The UpSCaLE program model aims to build the scientific capability of non-biology major science teachers by providing various techniques, strategies, and laboratory skills that they could use to support their teaching in Biology topics. Upon building the content, pedagogical, and technological knowledge and skills of the teachers, its long-term goal is to upgrade not only the skills of the teachers but also their motivation and confidence to teach biology that could inspire their students to engage in active and meaningful learning experience.

#### 4. DISCUSSION

Based on the results, the non-biology major teachers revealed that some of the topics in biology are difficult and abstract and includes too many terminologies. There are also numerous topic involved in the subject matter that makes it difficult to manage time for discussion. The complex and abstract nature of the biology develop a negative attitude among students (Cimer, 2012). This also affected the retention of prior knowledge among students which is crucial for spiral progression approach. These findings are similar to Shernoff et al. (2017) with regards to dealing with students' lack of interest and engagement and gaps in understanding as a challenge for teachers. The students find it difficult to realize the application and connection of the biological concepts and processes to real life situations. This is in contrast with the goal of STEM education which calls the students to integrate the discipline of science, technology, engineering, and mathematics as well as with the other core subjects. The STEM education aims to produce students who can innovate, create solutions, and engage in project-based approach to pursue STEM related careers (Stohlmann et al., 2012 as cited in Shernoff et al., 2017). Biological concepts and processes should not only be applied to real life situations but should be connected with other core subjects. This requires teachers to be able to design instruction that integrates biology with the other disciplines to provide holistic development of the 21<sup>st</sup> century skills and develop solutions to global challenges.

In this view, the teachers are aware that their needs to have an in-depth understanding about biology; and to gain more knowledge on different teaching techniques. This is aligned with the study of Shernoff et al. (2017) that teachers seek support on having "more resources and technology support; more professional development; and deeper backgrounds and greater interests in topics among students". It was also revealed in their study that teachers are not familiar on how to effectively integrate the lesson in STEM areas. The teachers seek for more professional development programs on how to connect STEM disciplines and integrate technology. In accordance to Owens et al. (2018), upon the conduct of Biology Faculty Explorations in Scientific Teaching (Biology FEST), the participating teachers engaged in the program to improve their teaching skills. The teachers are interested to learn various teaching strategies to increase student engagement and interest in learning biology. This includes skills on doing different laboratory experiments aligned to the topic. As Fadzil and Saat (2020) revealed that their biology teacher-respondents had difficulty in designing and planning effective practical lessons with experiments and that they need to be trained and updated. The teachers are also keen on exploring different open educational resources and technological tools that they can use in teaching biology. Cimer (2012) discussed that the students suggested the use of visual materials, practical works, and varied strategies to make teaching interesting and effective.

With regards to professional development program, Cofre et al. (2017) examined the effectiveness of the PD program on teachers' understanding of nature of science and evolution. It was found that PD program had a positive impact on improving the participants understanding of nature of science. The pedagogical approach used in the program is based on active learning approach where participants engage in data analysis of scientific findings; case studies; and inquiry-based laboratory activities. Corlu and Corlu (2012) used Learning Cycle for Inquiry Concept and Learning Cycle for Conceptual Inquiry for their PD model which includes "planning of inquiry concepts and skills for conceptual understanding; learning, developing and investigating actions that improve inquiry concepts; and evaluating and creating new plan for deeper understanding." It aims to develop the conceptual inquiry skills, critical thinking skills; and conceptual high level learning of the content knowledge. It was found that content knowledge in not enough for effective implementation of the

scientific-inquiry based PD model but pedagogical content knowledge is more essential. In similar vein, the researcher observed that the result for the professional development needs of the teachers is aligned with the Technological Pedagogical and Content Knowledge (TPACK) model. Technology integration is found to be essential in making pedagogical strategies with strong content knowledge (Koehler & Mishra, 2009 as cited in Morales et al., 2019).

Aside from knowledge and skills, the teachers are also interested from the other benefit that they could gain from the program such as authorship, promotion, tenureship, and some monetary compensation (Owens et al., 2018). The teachers also express the desire to contribute to the improvement of the learning system. This includes having a good rating in national and international achievement tests; and being able to conduct relevant research work. The teachers also value the feedback of their students. It as an achievement if their students pursue science-related course or if their students mentioned how their lessons on the subject matter has helped them. Having an in-depth knowledge and being able to give insights and answer students' questions in Biology give confidence to non-biology major science teachers. Hence, to be able to design and develop a PD program to address the challenges and needs of the teachers is essential to transform the learning experience of students in Biology.

The limitation of this study may be the number of respondents which may not well-represent different non-biology major science teachers. The results of the study are based on their perceptions. The responses were categorized based on the researcher's judgment which may include bias. Hence, having a larger group of respondents may help to represent teachers with different backgrounds and teaching experience. Also, having other researchers to review the generated themes, and evaluate the responses may increase the validity of the result.

This study provided a venue to elicit the challenges faced by non-biology major Science teachers who are teaching biology as part of the K to 12 Science curriculum. The teachers need a professional development program that could help them increase their conceptual understanding on biological concepts and processes and to improve their teaching and laboratory skills. This may pave a way to develop a professional development program that fit the needs of the non-biology major Science teachers. It is important to have these preliminary findings to be able to develop specific expectations for a professional development program (Withcomb et al., 2009). With the proposed UpSCaLE program, the model may be used in developing PD program for the teachers. The identification of the least mastered topics among the non-biology major Science teacher is a crucial baseline data to design the UpSCaLE program. Also, process of how to measure the effectiveness of the program based on the change on the teaching of the faculty and on the learning development of their students should be considered. Having a support from the administration and conducting follow-up activity is essential to determine the outcomes and impact of the proposed program to the participating teachers. Hence, building a leaning community for the teachers is needed to sustain professional development (Owens et al., (2018).

## 5. CONCLUSION

The result of this study could serve as a basis for the development of a professional development program that is aligned to the needs of the non-biology major Science teachers. There is limited literature regarding professional development programs in STEM education and for teachers. This would enable future research on designing a PD program that would enhance the content knowledge and pedagogical skills of the teachers in teaching biology based on their challenges faced by the teachers. Upon designing and developing the program, consultation with experts in the field of biology, biology education, and science education is essential to provide an effective professional development program. Also, measuring the effectiveness of the program is necessary by assessing the conceptual understanding and teaching practices of the participating teachers in Biology. Likewise, this should further be manifested among their students by assessing the scientific literacy, engagement, and motivation in learning Biology.

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