Exploring STEM Students’ Perceived Self-Efficacy and Attitudes in General Chemistry

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Abstract
The study explored the perceived self-efficacy and attitudes of Grade 12 Senior High School students under Science, Technology, Engineering and Mathematics (STEM) strand in general chemistry. Specifically, it sought to describe their confidence in performing varied learning tasks in general chemistry and their attitudes towards the subject. A convergent parallel mixed methods research design was employed to gather both quantitative data and qualitative data of students’ self-efficacy in general chemistry. The sample of the study consisted of two intact sections of Senior High School students (n=87) enrolled under STEM strand at one of the Philippine high schools. The quantitative data were gathered using the Chemistry Attitudes and Experiences Questionnaire (CAEQ) as the research instrument while focused group discussion was employed to gather qualitative data. Descriptive statistics such as weighted arithmetic mean and standard deviation were used to analyze the quantitative data while thematic analysis was used to analyze the qualitative data and confirm the quantitative analyses. Results showed that the overall weighted arithmetic mean is 3.13, and standard deviation is 0.10, indicating that the participants had neutral responses in most of the items (15 out of 19) in the questionnaire while they were slightly confident in the remaining four (4) items implying that they have low level of self-efficacy in general chemistry. These results were confirmed by the emerging themes derived from the thematic analysis were students gave slightly confident and neutral responses since their confidence in the subject depends on its level of difficulty. Contributing factors on the resulted self-efficacy level such as congested curriculum guide, class duration, teacher’s content knowledge and modes of instruction used were also identified. The said factors provided significant implications relevant to teaching approaches and alternative modes of instruction that can enhance STEM students’ self-efficacy in general chemistry. It is recommended in the study that the said factors be addressed in general chemistry course.

Keywords
General chemistry
Self-efficacy
STEM students

INTRODUCTION
Self-efficacy is the person’s belief about his or her capabilities on a specific task (Bandura, 1997). It can influence an individual’s decision to attempt to do a task. If self-efficacy is low, then a task that is perceived as difficult may be avoided (Bandura, 1997). If a difficult task is confronted with limited assistance, and the individual succeeds at the task, then self-efficacy towards the challenging task will improve (Bandura, 1986).

Meanwhile, four factors were proposed to shape self-efficacy and these include enactive mastery experience, vicarious experience, verbal persuasion, and physiological and emotional states (Bandura, 1986, 1997). An individual’s past situations that include success or failures are internalized, and applied to future situations. These past experiences can either improve, or lower self-efficacy, and are known as an inactive mastery experience (Bandura, 1986, 1997). On the other hand, vicarious experiences result in comparisons between peer groups of similar intellectual ability. If peers are

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successful then the observer’s self-efficacy will increase, and failures by the peer will lead the observer to gain less self-efficacy. The exposure to several role models who are successful can also lead to higher self-efficacy (Bandura, 1986, 1997).

The third factor is verbal persuasion which is exemplified when a teacher delivers encouragement, verbal feedback, or evaluation. Persuasion must be genuine, as it can negatively impact self-efficacy beliefs of the individual. Lastly, physiological state describes if performance impairment or a fear of failing contributes to a hyperactive state. In this case, a hyperactive state on a physiological level can lead to a “flight” or “fight” response raising heart rate, rate of breathing, and sweating. Emotional states are positive or negative moods that can fluctuate in the individual during given tasks (Bandura, 1986, 1997). Self-efficacy is a deciding factor for individuals’ approach to participate or decline in approaching a given task.

Studies have shown that students with a higher self-efficacy typically choose more challenging tasks and persist longer on challenging tasks than students with lower self-efficacy (Aktürk & Delen, 2021; Aslan, 2021; Dalgety, Coll, & Jones, 2003). Likewise, students with a high self-efficacy will show more effort when pursuing a challenging task and will generally perform higher on that given task than students with low self-efficacy (Akturk, 2014; Crippen & Earl, 2007; Kozcu Cakir, 2020).

According to Ebbing and Gammon (2010), chemistry is “the science of the composition and structure of materials and of the changes that materials undergo”. Chemistry is a complex science that helps not only explain the world around us, but also helps to explain processes in many other STEM fields such as biology, physics, environmental science, and medical sciences. There are many different types of chemistry; there is organic chemistry, biochemistry, thermochemistry, physical chemistry, theoretical chemistry, experimental chemistry, chemical engineering, etc. The term “general chemistry” is used to describe an introductory course (either at the secondary or postsecondary level) that seeks to introduce critical chemistry concepts that are important to all types of chemistry and related subjects to give an overview or introduction to chemistry.

Moreover, general chemistry curriculum consists of concrete and abstract concepts, which force students to think analytically, spatially, and mathematically. Students in a general chemistry course must have a basic understanding of mathematical procedures, especially manipulation of algebraic expressions. This knowledge is the most important prerequisite to general chemistry. According to the American Chemical Society’s (ACS) Guidelines and Evaluation Procedures (2008), an introductory general chemistry course should provide students with the knowledge of “basic chemical concepts such as stoichiometry, states of matter, atomic structure, molecular structure and bonding, thermodynamics, equilibria, and kinetics” (p.9). Every concept listed as “basic chemistry knowledge” is used in many other STEM fields to help prepare STEM professionals. To fully understand this basic knowledge, students must be able to think abstractly about an atomic structure they cannot see, they must be able to think spatially in order to understand molecular structure and bonding, and they must be able to think concretely to convert units using stoichiometry. These are only the ways in which students must think. This list does not include the memorization of elements, ions, and basic equations and constants. It does not include the interpretation of graphs and data. It does not include the structure of the periodic table, predicting products of reactions, or determining the heats of formation and reaction. In addition, the ACS Guidelines and Evaluation Procedures (2008) also include a list of skills that students should gain from a general chemistry course such as problem-solving skills, chemical literature skills, communication skills, team skills and ethics.

Furthermore, general chemistry is a complex and challenging course, but the skills and knowledge learned in that course are essential and mandatory for almost every STEM discipline (Luzzo et al., 1999). At the college level, a general chemistry course often consists of freshmen and sophomores who are completing the course as a pre-requisite for some further study of science, technology or engineering. Accordingly, students with a high self-efficacy toward chemistry will be more likely to take on the challenge of chemistry and persist through the courses. In addition, research suggests that self-efficacy accounts for “a little over 25% of the variance in vocational and academic interests”
(Brown & Lent, 2006) and that academic interests influence our subsequent career decisions or intentions (Dalgety & Coll, 2006; Hebebci, 2019; Hebebci & Usta, 2017). Consequently, STEM students who wish to pursue STEM careers in physics, biology, environmental science, medicine, engineering, pharmacy, etc. must have high level of self-efficacy in chemistry.

Theoretical Framework

Self-efficacy serves as the guiding concept for this study, which reflects the view of Bandura (1997) in his social cognitive theory. An individual’s sense of efficacy presumably will influence one to recognize and understand problems that are associated with a particular task at work or other situations. Bandura posits that in order for an individual to be innovative and creatively productive and participate in discovery of new knowledge in any particular domain, the individual has to have a high sense of efficacy in that domain.

Perceived self-efficacy is a fundamental component of Bandura’s (1986) social cognitive theory, which emphasizes the role of observational learning and social experience in the development of personality. Social cognitive learning theory attributes learning to the occurrence of transactional relationships between behaviors, environmental factors and personal factors that consist of cognitive, affective and behavioral processes (Bandura, 1986). A personal sense of efficacy will propel individuals to move forward in the face of difficulty and be assured that they are capable of tackling challenging tasks within a particular domain of knowledge. In fact, Zimmerman (1995) posits that individuals’ self-efficacy beliefs in many cases can predict performance more accurately than can actual ability. Research findings support the important role of self-efficacy, indicating that an individual’s perceived sense of efficacy is an accurate predictor of skill acquisition, rate of performance, expenditure of energy, persistence, goal setting, and self-monitoring of goals (Bandura, 1997).

There are a number of differences between high-efficacy and low-efficacy students. As compared with students who have a lower sense of efficacy, students who have a higher sense of perceived efficacy are more likely to exert effort physically, endure in challenging tasks, and engage in instrumental help-seeking behaviors (Akturk & Ozturk, 2019). Students with high self-efficacy are also more likely to choose academically oriented peer groups than individuals with low self-efficacy, again resulting in higher academic achievement (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996). As such, it can be concluded that self-efficacy promotes and facilitates academic achievement.

The Study

In view of the current study, general chemistry is one of the subjects taken by senior high school students under the STEM strand in the chosen Philippine high school. Students who will be graduating from STEM are expected to enroll in engineering courses and other science-related careers in different universities. As such, Philippine universities and colleges offer both civil and electrical engineering courses. The said courses also include chemistry as one of its course requirements, thus making chemistry essential for STEM students’ academic success in college. This also implies that their academic achievement in general chemistry they are taking in senior high school is crucial for their success in college level chemistry.

Several studies have been documented on the role of self-efficacy to the academic success of students in chemistry or generally in science. Results of the study conducted by Cook (2013) showed that students’ self-efficacy and attitude towards Chemistry are both significant and can predict students’ intentions to take future courses. Moreover, study done by Louis and Mistele (2012) concluded that students’ level of self-efficacy in mathematics and science classrooms can influence their academic achievement in math and science implying the significant role played by self-efficacy on the academic achievement of students in the said subjects. Also, results of the study conducted by Larson et al.
Capanzana (2014) showed that the STEM students’ self-efficacy in mathematics and science significantly predicted their academic success like graduating with a bachelor’s degree 4 to 8 years later after controlling for prior performance and aptitude. Another study by Kan and Akbas (2006) concluded that students’ attitude and self-efficacy in chemistry influence their chemistry achievement. Similarly, Villafañe-Garcia (2015) in her study concluded that students’ chemistry self-efficacy beliefs were linked to students’ achievement and students with stronger self-efficacy are more likely to try challenging tasks and persist in them. The results of the studies cited above about the crucial role played by self-efficacy to the academic achievement in general chemistry prompted the researcher to conduct a study on self-efficacy of STEM students in general chemistry. Specifically, this study sought to investigate on the following questions:

1. What is the level of STEM students’ perceived self-efficacy and attitudes in general chemistry?
2. What are the factors contributing to the STEM students’ level of self-efficacy in general chemistry?
3. What teaching approaches and alternative modes of instruction can enhance STEM students’ self-efficacy in general chemistry?

METHOD

Design of the Study

A convergent parallel mixed methods research design was employed to gather both quantitative data and qualitative data of STEM students’ self-efficacy in general chemistry.

Sampling and Participants

Purposive sampling was employed in choosing the sample of the study which is consisted of two intact sections of senior high school students (n=87) enrolled under STEM strand at a Philippine high school.

Data Collection Procedure

After having sought the approval of the concerned education institution and consent of the participants and their class advisers, individual copies of the Chemistry Attitudes and Experiences Questionnaire (CAEQ) as the research instrument were distributed to the participants to determine the level of students’ self-efficacy in general chemistry. Students’ responses to the said questionnaire were treated as the quantitative data. Meanwhile, 10 students were randomly selected to engage in focused group discussion to gather qualitative data.

Data Analysis Procedures

Descriptive statistics such as weighted arithmetic mean and standard deviation were used to analyze the quantitative data while thematic analysis was used to confirm the quantitative analyses of the students’ self-efficacy in general chemistry.

Ethical Considerations

In relation to the objective of the study, the researcher secured the safety and protection of the participants and the research locale. The researcher sought the approval of the concerned institution before conducting the study to ensure that the study adhered to the ethical standards and guidelines in research of the said institution. The data that were collected in this study were treated with utmost
anonymity and confidentiality since the researcher respects the rights of the participants for privacy and confidentiality. In terms of providing complete information to the research participants regarding the nature of the study, the researcher included a short description of the nature and purpose of the study in the survey-questionnaire. In view of scientific honesty, the researcher made proper citations of original works that were included in this study.

RESULTS AND DISCUSSION

Level of Self-Efficacy of STEM Students in General Chemistry

Table 1. Weighted Arithmetic Mean (WAM) and Interpretation of CAEQ Items

<table>
<thead>
<tr>
<th>Items in the CAEQ</th>
<th>WAM</th>
<th>Verbal Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Achieving a passing grade in a chemistry course</td>
<td>3.27</td>
<td>Slightly confident</td>
</tr>
<tr>
<td>2. Reading the procedures for an experiment and conducting the experiment without supervision</td>
<td>3.36</td>
<td>Slightly confident</td>
</tr>
<tr>
<td>3. Designing and conducting a chemistry experiment</td>
<td>3.21</td>
<td>Neutral</td>
</tr>
<tr>
<td>4. Tutoring another student in a first-year chemistry course</td>
<td>2.51</td>
<td>Neutral</td>
</tr>
<tr>
<td>5. Determining what answer is required from a written description of a chemistry problem</td>
<td>2.95</td>
<td>Neutral</td>
</tr>
<tr>
<td>6. Ensuring that data obtained from an experiment is accurate</td>
<td>3.30</td>
<td>Slightly confident</td>
</tr>
<tr>
<td>7. Proposing a meaningful question that could be answered experimentally</td>
<td>3.18</td>
<td>Neutral</td>
</tr>
<tr>
<td>8. Explaining something that you learnt in this chemistry course to another person</td>
<td>3.38</td>
<td>Slightly confident</td>
</tr>
<tr>
<td>9. Choosing an appropriate formula to solve a chemistry problem</td>
<td>3.18</td>
<td>Neutral</td>
</tr>
<tr>
<td>10. Knowing how to convert the data obtained in a chemistry experiment into a result</td>
<td>3.23</td>
<td>Neutral</td>
</tr>
<tr>
<td>11. After reading an article about a chemistry experiment, writing a summary of the main points</td>
<td>3.03</td>
<td>Neutral</td>
</tr>
<tr>
<td>12. Learning chemistry theory</td>
<td>3.17</td>
<td>Neutral</td>
</tr>
<tr>
<td>13. Determining the appropriate units for a result determined using a formula</td>
<td>3.09</td>
<td>Neutral</td>
</tr>
<tr>
<td>14. Writing up the experimental procedures in a laboratory report</td>
<td>3.08</td>
<td>Neutral</td>
</tr>
<tr>
<td>15. After watching a television documentary dealing with some aspect of chemistry, writing a summary of its main points</td>
<td>3.08</td>
<td>Neutral</td>
</tr>
<tr>
<td>16. Achieving a passing grade in a general chemistry course</td>
<td>3.21</td>
<td>Neutral</td>
</tr>
<tr>
<td>17. Applying theory learnt in a lecture for a laboratory experiment</td>
<td>3.14</td>
<td>Neutral</td>
</tr>
<tr>
<td>18. Writing up the results section in a laboratory report</td>
<td>3.18</td>
<td>Neutral</td>
</tr>
<tr>
<td>19. After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person</td>
<td>2.92</td>
<td>Neutral</td>
</tr>
<tr>
<td>Overall</td>
<td>3.13</td>
<td>Neutral</td>
</tr>
</tbody>
</table>

Legend: Totally Confident (4.01 – 5.00), Slightly Confident (3.26-4.00), Neutral (2.51-3.25), Slightly Not Confident (1.76 – 2.50), Totally Not Confident (1.00 – 1.75)

Table 1 presents the WAM and its corresponding verbal interpretation to indicate the level of self-efficacy of STEM students in general chemistry using the CAEQ as the research instrument. Among
the items in the said questionnaire, item 8 stating “Explaining something that you learnt in this chemistry course to another person”, got the highest WAM of 3.38 which corresponds to “slightly confident” as the level of students’ self-efficacy. On the other hand, item 4 stating “Tutoring another student in a first-year chemistry course, got the lowest WAM of 2.51 corresponding to “neutral” response. Moreover, among the 19 items in the questionnaire, items 1, 2, 6, 8 got WAM values which correspond to “slightly confident” responses while the remaining items got WAM values which indicated “neutral responses”. These results imply that the students gave neutral responses on most of the items in the questionnaire on their level of self-efficacy in general chemistry.

<table>
<thead>
<tr>
<th>Items in the CAEQ</th>
<th>WAM</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Achieving a passing grade in a chemical hazard course</td>
<td>3.27</td>
<td>0.79</td>
</tr>
<tr>
<td>2. Reading the procedures for an experiment and conducting the experiment without supervision</td>
<td>3.36</td>
<td>1.11</td>
</tr>
<tr>
<td>3. Designing and conducting a chemistry experiment</td>
<td>3.21</td>
<td>1.07</td>
</tr>
<tr>
<td>4. Tutoring another student in a first-year chemistry course</td>
<td>2.51</td>
<td>1.14</td>
</tr>
<tr>
<td>5. Determining what answer is required from a written description of a chemistry problem</td>
<td>2.95</td>
<td>0.92</td>
</tr>
<tr>
<td>6. Ensuring that data obtained from an experiment is accurate</td>
<td>3.30</td>
<td>0.79</td>
</tr>
<tr>
<td>7. Proposing a meaningful question that could be answered experimentally</td>
<td>3.18</td>
<td>0.95</td>
</tr>
<tr>
<td>8. Explaining something that you learnt in this chemistry course to another person</td>
<td>3.38</td>
<td>1.01</td>
</tr>
<tr>
<td>9. Choosing an appropriate formula to solve a chemistry problem</td>
<td>3.18</td>
<td>0.96</td>
</tr>
<tr>
<td>10. Knowing how to convert the data obtained in a chemistry experiment into a result</td>
<td>3.23</td>
<td>1.09</td>
</tr>
<tr>
<td>11. After reading an article about a chemistry experiment, writing a summary of the main points</td>
<td>3.03</td>
<td>0.88</td>
</tr>
<tr>
<td>12. Learning chemistry theory</td>
<td>3.17</td>
<td>0.94</td>
</tr>
<tr>
<td>13. Determining the appropriate units for a result determined using a formula</td>
<td>3.09</td>
<td>0.83</td>
</tr>
<tr>
<td>14. Writing up the experimental procedures in a laboratory report</td>
<td>3.08</td>
<td>0.87</td>
</tr>
<tr>
<td>15. After watching a television documentary dealing with some aspect of chemistry, writing a summary of its main points</td>
<td>3.08</td>
<td>0.89</td>
</tr>
<tr>
<td>16. Achieving a passing grade in a general chemistry course</td>
<td>3.21</td>
<td>0.94</td>
</tr>
<tr>
<td>17. Applying theory learnt in a lecture for a laboratory experiment</td>
<td>3.14</td>
<td>0.82</td>
</tr>
<tr>
<td>18. Writing up the results section in a laboratory report</td>
<td>3.18</td>
<td>0.86</td>
</tr>
<tr>
<td>19. After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person</td>
<td>2.92</td>
<td>0.96</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>3.13</strong></td>
<td><strong>0.10</strong></td>
</tr>
</tbody>
</table>

Table 2 shows the weighted arithmetic means and SD of students’ responses on the CAEQ as the research instrument to measure the level of students’ self-efficacy in general chemistry. The overall WAM and SD are 3.13 and 0.10, respectively implying that on the average students gave neutral responses on the questionnaire and their responses were not spread out as indicated by low SD value since most of their responses were neutral.

In addition to employing descriptive statistics such as WAM and SD for quantitative data analysis, thematic analysis was also applied for qualitative data analysis to confirm the results derived from quantitative data analysis.

Table 3. Emerging Themes on STEM Students’ Self-Efficacy
Table 3 presents students’ responses and emerging themes on their level of self-efficacy in general chemistry based from the focused group discussion conducted among them. Students’ answers on the first question showed their perception on general chemistry as a broad subject containing confusing and difficult topics. In the second question, the students described themselves slightly confident, neutral and not confident based on their performance in general chemistry. Lastly, in the third question, students had neutral responses on their attitude towards general chemistry. These qualitative results confirmed the quantitative results presented in Table 1 and 2.

Moreover, these results indicate that students have differences in their level of self-efficacy in general chemistry. Similarly, results in the study by Morsy (2018) shows the differences in the level of self-efficacy.
efficacy in science between Egyptian students and American students which have been affected by factors which include classroom environments that promoted cultural expectations aligned with gender norms and other factors such as social persuasion and mastery experiences, the nature of teacher-student relationships, and limited and ineffective professional development and on teaching practices such as an emphasis on didactic modes of science teaching and innovative instructional approaches and creating safe learning spaces.

Furthermore, students’ lower level of self-efficacy shown by results could be attributed to their interest on the subject. This is supported by the results of the study by Ferrell (2016) that showed the relationship among students’ interest, self-efficacy and effort beliefs towards general chemistry wherein factors such as family influence and personal experiences affect students’ effort beliefs were also identified. Another factor that could explain the results is the academic engagement by the students which was affected by other factors. This can be supported by the study of Miller (2006) concluding that classroom factors such as academic engagement greatly influenced students’ self-efficacy in science which implies that academic engagement is crucial in improving the self-efficacy of students in science.

Overall, the results showed that students had lower levels of self-efficacy in general chemistry. These may have significant implications relevant to the contributing factors on students’ self-efficacy in general chemistry.

**Implications of the Study**

*What are the factors contributing to the STEM students’ level of self-efficacy in general chemistry?*

Additional relevant information obtained based on the students’ responses from the focused group discussion led the researcher to identify some factors that contributed to students’ self-efficacy in general chemistry. Time has been a great factor since they had limited time for having classes in general chemistry due to their 80-hour work immersion as another course requirement which is compulsory for senior high school students. Similarly, students stressed that the 1-hour class period was not sufficient for them to finish the lesson and understand its underlying concepts. In relation to time constraint, students also pointed out that many of the topics found in the curriculum guide of general chemistry were not covered.

Several studies have cited different factors affecting students’ self-efficacy in general chemistry. Results in the study of Bonafield-Pierce (2018) showed that emotionally safe learning community, sense of trust and belonging, on-the-job learning and the teacher’s positive “noticing” and commitment to the students are key factors in developing academic self-efficacy. Also, in the study of Olave (2014), results indicate the importance of the three variables – attitude towards science, perspective of laboratory and self-efficacy in chemistry learning among students. This could support the implication of the current study that teachers play an important role in developing the said variables and could be a suggestive statement to revisit the curriculum guide of General Chemistry in senior high school to see possible modifications of it especially for the laboratory part.

Moreover, O’Connor (2018) indicates in his study that there is a significant positive relationship between science self-efficacy and school climate, and among attitude towards math, school climate and self-efficacy in science. It is interesting to note here that school climate is a significant factor that we can consider for enhancing students’ self-efficacy. This suggests significant implication on the role of the school climate or environment in the students’ self-efficacy in science. Another significant factor is the attitude towards math which could also suggests that positive attitude in math may improve students’ self-efficacy in science which could be possibly explained by the nature of some sciences which use mathematical content like equations and formulas in studying them like Physics and Chemistry.
On the other hand, the students also identified the teacher’s method as a factor that could have influenced their level of self-efficacy in general chemistry which pose significant implication on classroom management.

What teaching approaches and alternative modes of instruction can enhance STEM students’ self-efficacy in general chemistry?

Several studies have documented varied teaching methods and alternative modes of instruction which are found to have a positive effect on students’ self-efficacy. According to the results of the study conducted by Gormally et al. (2009), inquiry-based learning can improve students’ confidence or self-efficacy in science implying that inquiry-based learning can be one of the teaching strategies that can be employed by the participant’s chemistry teacher as a way of increasing their self-efficacy in general chemistry. Similarly, study done by Winkelmann et al. (2014) shows that inquiry-based, research-inspired modules in General Chemistry laboratory classes improved the inquiry skills and self-efficacy of students implying that the said use of general chemistry modules can be one of the additional instructional materials for the said subject since there is a lack of materials especially for the lab classes in the study site. Also, MacPhee, et al. (2013) concluded in their study that underrepresented STEM students’ self-efficacy can be improved through ways like mentoring and can produce significant changes in their academic performance.

On the other hand, Okonkwo (2014) concluded in his study that STEM students’ self-efficacy in science predicts their innovative behavior pertaining to science and technological advancement. This is an interesting result which is relevant to countries like the Philippines where poverty is still persisting in many of its provinces. This result could be a recommendation for future studies since STEM students’ future careers could contribute on the alleviation of poverty through science, math and engineering advancements. Also, results in the study of Bergey (2014) indicated that higher self-efficacy was associated with fewer procedural questions and more questions that reflected smaller knowledge deficits implying the role of self-efficacy in increasing the knowledge acquisition by students. Moreover, Bryant (2017) identified in his study some sources of self-efficacy as perceived by students in terms of how successful or unsuccessful they had been in school relating to all four mastery sources (mastery, vicarious, persuasion, physiological and affective).

Other alternative modes of instruction were cited in the studies of Gess (2015) indicated that design process significantly impacts both students’ self-efficacy and content knowledge in STEM track of learning; Mataka (2014) concluded in his study that Problem-Based Learning (PBL) has a potential for improved students’ outcomes in the attitude towards chemistry and self-efficacy beliefs implying that PBL as a teaching strategy can enhance students’ self-efficacy; and Jordan (2014) indicating that an intervention showing videos of upperclass engineering students significantly improved the self-efficacy of underrepresented minority students.

CONCLUSION AND RECOMMENDATIONS

STEM students’ responses on the CAEQ and from the focused group discussion showed that they have relatively low level of self-efficacy in general chemistry as indicated by slightly confident and neutral responses they made based on quantitative analysis. These are confirmed by the results of qualitative analysis indicating their perception in general chemistry as a difficult subject and their neutral attitude towards general chemistry indicating that their attitude on the said subject depends on how easy or difficult it can be. Accordingly, contributing factors such as congested curriculum guide, class duration and teaching methods have been identified to influence students’ self-efficacy which have significant implications relevant to factors which can enhance students’ self-efficacy in general chemistry such as employment of varied teaching approaches and alternative modes of instruction in the said subject. In view of these implications, it is recommended that a revisit on the curriculum guide be employed by concerned curriculum developers for modifications on the number of topics
included in order to decongest it and school administrators and senior high school coordinators may reconsider the planning of work immersion without affecting the class duration of STEM students taking general chemistry. It is also recommended that varied teaching approaches and alternative modes of instruction may be employed in teaching general chemistry.

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