Exploring Follow-up Effect of Scaffolding for Creative Problem Solving through Question Prompts in Project-based Community Service Learning

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Abstract

This paper is aimed to explore the follow-up effect of scaffolding for Creative Problem Solving (CPS) through question-prompts in project-based community service learning implemented in a freshmen's entry-level course on participants' learning in their subsequent STEM courses. Research subjects are those students who have participated in the required community service learning with the Scaffolding for Creative Problem Solving from a historical black university. While participating in community service learning during their freshman year, students were facilitated with question prompts on self-regulated learning and creative problem solving. These question prompts served as the scaffolding for creative problem solving and included metacognitive prompts, procedural prompts, elaboration prompts, and reflective prompts, as well as prompts for creative problem solving strategies. Sixty-four participants among those students were voluntarily recruited for interviews to explore the follow-up effect of Scaffolding for Creative Problem Solving at least one year later after they participated in the community service learning with the scaffolding. The findings from the interview reveal that students have adopted some strategies of self-regulated learning and creative problem solving and deemed the benefits from applying those strategies for their subsequent STEM studies. However, the extent to which students applied these strategies is not at the level as expected, which is indicated by the lower percentage of strategies applied by the participants, implying that there may still be a potential for improving students' learning in their STEM courses through instructors' efforts for prompting students' application of these strategies with adoption of novel instructional strategies. The limitations of current findings and suggestions for future research are discussed as well.

1. Introduction

Creative problem solving skills are referred to as the abilities to identify and solve problems creatively. They are critical skills required for engineering design, which is essentially a process of defining the problem, acquiring relevant knowledge and information, generating and selecting solutions, and testing and implementing the solution. The need and significance of developing students' creative problem solving skills have been widely recognized by many STEM faculty members. The approach and processes of engineering design have been adopted and introduced in engineering curriculum to help students to develop their creativity and creative problem solving skills [1,2,3]. Nevertheless, the findings from cognitive science research on developing self-regulated learning and creative problem solving skills may be not well known and utilized by the STEM faculty members to help their students develop these important skills. Therefore, there may be few opportunities for STEM students to learn the effective model or strategies of self-regulated learning and creative problem solving developed by cognitive scientists in their learning processes. Besides, in

traditional STEM courses, emphasis may only be placed on memorization of knowledge and method procedures rather than development of skills of self-regulated learning and creative problem solving [4]. As a result, most of students may not be particularly trained on how to develop those important skills by instructors in their STEM courses [5].

It has been recognized that the problem-based service learning (PBSL) can provide a particular opportunity for students to confront real world problems and solve them by applying what they learn to a great extent. Thus, PBSL may serve as an effective platform to foster students' skills of self-regulated learning and creative problem solving as compared with traditional learning. To help students acquire and develop necessary knowledge and skills for creatively developing the innovative solutions to the real world problems they identify in their PBSL, instructional scaffolding can be provided to students to facilitate their PBSL. Among accepted scaffolding methods, question prompts are typically considered as one of effective methods for guiding students' learning and problem solving process [6]. Rosenshine and Meister had indicated that prompts were able to direct students to pay their attention to important aspects of the problem, activate them to organize information and think of the relationships among information, elicit their explanations, and prompt them to self-monitor and self-reflect their learning and problem solving [7]. Davis and Linn also found that reflective prompts are able to prompt students' knowledge integration and encourage their reflection [8].

Other researchers have adopted scaffolding strategies to facilitate students to develop skills of self-regulated learning and creative problem solving. Blank et al. developed and implemented a Self-regulated Learning Assessment System as an intervention to help students majoring in electromechanical engineering technology better reflect on feedback about their learning, their learning performance, and effectiveness of problem-solving strategies they had applied [9]. Cook et al. implemented an intervention through providing the learning strategies through a 50-minute lecture in general chemistry classes [10]. Donawa offered critical thinking and cognitive tools to minority engineering students [11]. Girgis provided scaffolding through problem-based instruction in engineering mechanic course and indicated that the one-week long intervention worked out as planned with satisfactory results [12].

The authors of this paper had adopted the scaffolding for creative problem solving through question prompts for freshmen in an entry-level course - University Success 100 at the authors' institution. All students registered in this entry-level course were required to participate in community service. Through collaboration with the Community Learning Center at the authors' institution and instructors for the course University Success 100, students from selected sessions of the course were required to identify any problems that exist and need to be solved at their community service site, and then propose innovative solutions to the problems. They were also required to write a process journal and final project report to describe their reflection on their self-regulated learning and creative problem solving process and their final solutions to the problems. They were also provided with the process model of Self-Regulated Learning and Creative Problem Solving [13, 14] and scaffolding through question prompts to facilitate their creative problem solving. Those provided question

prompts can be categorized into metacognitive, procedural, elaborative, and reflective prompts, as well as creative thinking prompts based on findings from cognitive research. Metacognitive prompts were used to facilitate students to make plans for their next actions. Procedural prompts are utilized to guide students' efforts to complete a specific cognitive task and generate of solutions or ideas. Elaboration prompts are provided to help students to apply strategies and elaborate and articulate their reasoning and thinking process. Reflective prompts are aimed to provoke students to reflect on effectiveness of their past action and make the needed adjustment. Creative problem solving prompts are designed to facilitate students to generate creative solutions to the problems that they tackle. Details on the implementation procedures and the provided model and prompts can be referred to authors' previously published ASEE conference paper [13,14].

The authors' ASEE conference paper published in 2013 reported the certain correlations among students' application of question prompts and different components of their learning process and learning outcomes during their project-based community service learning [13]. Results from correlation analysis of available data revealed that the provided question prompts were positively correlated with major components of self-regulated learning process, and also positively correlated with important components of creative problem solving outcomes for their community service learning projects, indicating that scaffolding through question prompts may play an important role in self-regulated learning processes and creative problem solving outcomes. The authors' ASEE conference paper published in 2015 revealed the impacts of scaffolding for creative problem solving through question prompts on students' perception on creative problem solving, self-efficacy, identity, and application of creative strategies based on data collected from implementation at that time [14]. Results from analysis of available data indicated that scaffolding for creative problem solving might enhance students' self-efficacy and their interest in engineering and promote their learning and application of strategies for creative problem solving. The objective of this paper is to explore the follow-up effect of scaffolding for Creative Problem Solving (CPS) through question-prompts in project-based community service learning for freshmen in the entry-level course on students' learning in the subsequent STEM courses.

2. Methods and Data Collection

The follow-up study was carried out at a historically black university where approximately 90% of students are African Americans. It is aimed at answering the research question- Can students' skills of self-regulated learning and creative problem solving cultivated in their problem-based community service learning be transferred into their learning and problem solving in their subsequent STEM studies and lead to better academic performance. The first effort of the follow-up studies is to recruit students who participated in the aforementioned community service-learning project with scaffolding for creative problem solving for the follow-up interview, in which they are asked to answer questions and finish questionnaires about their reflections on their learning and application of relevant strategies during and after their community service learning projects, particularly during their learning in their subsequent STEM courses.

To complete this task, research assistants (RAs) searched and collected the information of candidates to participate in the follow-up interview in following four ways: collecting the former participants' e-mails in the available name lists and sending the recruitment invitation to them through e-mail, posting the recruitment advertisements or flyers on the bulletin boards in campus buildings, distributing the recruitment advertisement to students at the student center and library, increasing compensation for each interviewee and provide additional compensation to the interviewee who successfully recruit their friends or classmates qualified for the interview, as well as hiring two undergraduate interviewees as research assistants to recruit their friends and classmates qualified for the interview. In the recruitment advertisements or flyers, the qualification and compensation were clearly stated.

The project RAs totally distributed 350 recruitment advertisements or flyers and obtained consents for interview from 217 students. After receiving the consent response from students, RAs sent emails to schedule time slots for students to select proper one for the interview. However, once students arrived at the scheduled time, RAs found that most of responding students were not qualified because they did not participate in the community service learning project with the scaffolding for creative problem solving, and only 64 students were identified to be the qualified candidates who had participated in the community service learning projects with the scaffolding.

The interview was conducted in a structured manner with questions-and-answers session composed of oral questions and self-reported questionnaire composed of two open-ended questions, six categories of questions, one question on project journal and report, and one question on common mistakes, cognitive and metacognitive factors. The oral questions and those in self-reported questionnaires are presented in the next section with corresponding results. During the interview process, the candidates were asked to finish questionnaires first and then answer some questions orally. The oral answers were recorded during the interview for analysis. The entire interview process takes about 40 to 50 minutes.

Data from the self-report questionnaires during the interview were collected in form of the Likert-scale. They were input manually by RAs into Excel files and then were processed and analyzed by using the software SPSS. The interview audio records were listened to and rated by two RAs, who independently extracted key words and statistical data from answers of interviewees. The results from the two raters were averaged or summarized to reveal the general trends from data analysis as one part of the reported findings.

3. Results from analysis of collected data

3.1 Results from self-report questionnaires

Each student during the interview was asked to rank the usefulness of question prompts in each of six categories from the creative problem solving scaffolding for their learning and problem solving in their subsequent studies. The results from students' ranks are tabulated in Table 1, which is composed of six categories: Managing thinking, Generation, Exploration, Evaluation, Creative thinking strategies and Types of question prompts. It shows that the

most frequently used strategy by students in the Managing thinking category was "Goal setting", which was chosen by 32 students (50%). The highest frequency of choice in Generation category was "Retrieval", which was chosen by 28 students (43.8%), and "Knowledge application" in the Exploration category was also chosen by 28 students (43.8%). "Analysis" (42.25%) is the most frequently adopted strategy in the Evaluation category and "Divergent thinking" in the Creative thinking strategies ranked as the most popular one by 20 students (31.3%). While in terms of Types of question prompts, "Elaboration prompts" were the top choice selected by 22 students (34.4%).

Table 1：Frequency of 1st choice in 6 Categories (n=64)

	Frequency as the 1st strategy	Percentage as the 1st strategy
Category I - MANAGING THINKING		
A. Goal setting	32	50%
B. Switching	8	12.5%
C. Cognitive awareness	16	25%
D. Goal monitoring	8	12.5%
Category II – GENERATION		
A. Search	25	39.1%
B. Retrieval	28	43.8%
C. Association	4	6.3%
D. Contrast	0	0
E. Synthesis	3	4.6%
F. Transformation	1	1.6%
G. Analogical transfer	3	4.6%
Category III - EXPLORATION		
A. Knowledge Application	28	43.8%
B. Experimentation	12	18.8%
C. Attribute Finding	7	10.9%
D. Context Shifting	6	9.4%
E. Acknowledging limitations	11	17.1%
Category IV – EVALUATION		
A. Analysis	27	42.2%
B. Assessment	12	18.8%
C. Verification	5	7.8%
D. Trialing	3	4.7%
E. Criteria fulfillment	9	14.1%
F. Elimination	0	0
G. Comparison	2	3.1%
H. Selection	6	9.3%
Category V – CREATIVE THINKING STRATEGIES		
A. Metaphorical Thinking	7	10.9%
B. Analogical Thinking	18	28.1%
C. Combinatorial Creation	3	4.7%
D. Divergent Thinking	20	31.3%

E. Productive Thinking	16	25%
Category VI –Types Of question prompts		
A. Reflective Prompts	11	17.1%
B. Metacognitive Prompts	14	21.9%
C. Elaboration Prompts	22	34.4%
D. Procedural Prompts	17	26.6%

Students during the interview were also asked to reveal the process of their thinking and activities in eight perspectives (or items) while they were working on the assigned learning project. These perspectives and the results from students' ranks are tabulated in Table 2. The highest rate among 18 perspectives is given to the 11th item (i.e., when I do the project, I know how to identify the effective question prompts to help me solve the problems), while the 8th item gets the lowest score (i.e., I can self-evaluate the outcome of my project). The results show that students may still need to improve and practice self-evaluation skills for their learning, even though they may do very well in identifying the effective prompts to help them to solve problems. In general, most of rates on these 18 items or perspectives are above 3 and above average, implying that most of the students are having positive attitudes or correct strategies during the process of carrying out their assigned learning project.

Table 2：Questions and Results on Project Journal and Report (n=63)

Item	Questions	Mean	Std. Deviation
1	When I do my community service project, I have great motivation and interest to do it.	4.44	.87
2	In my project, I can identify problems by myself.	4.03	.84
3	In my project, I can identify problems with the help of others.	4.36	.88
4	In my project, I can plan time and manage effort very well.	4.20	.86
5	In my project, I can select useful and relevant strategies and apply them to my problem solving.	4.38	.70
6	In my project, I can generate ideas to solve problems.	4.44	.71
7	I can self- monitor every part of my project.	3.88	1.06
8	I can self-evaluate the outcome of my project.	3.78	.99
9	When I met problems in my project, I know how to seek help or resources to complete the project.	4.36	.82
10	When I do the project, I know how to evaluate the usefulness of all the strategies I thought of.	4.09	.79
11	When I do the project, I know how to identify the effective question prompts to help me solve the problems.	4.69	6.20
12	I know the correct form of writing a report of the project.	3.84	.93
13	In my writing report, I can describe the problems clearly.	4.13	.75
14	In my writing report, I can search the previous work or solution by others.	3.89	.89
15	In my writing report, I can find some innovative solutions as well as how it is built on the previous works.	4.08	.82
16	In my writing report, I will consider some alternative solutions and some different approaches.	4.08	1.00
17	In my writing report, I will consider how the innovation is initiated or what strategies are utilized for your innovative solution.	4.05	.84
18	In my writing report, I will consider the references I cited.	4.20	.99

In addition, student interviewees were asked to identify and reflect mistakes that may block their thinking of approaching the right solution in eight perspectives during their learning or problem solving in their study. These perspectives and results from students' responses are illustrated in Table 3. The most frequent mistake identified by students is the 6th item with average rate of 2.84, indicating that students are easy to be distracted by other things. The least frequent mistake revealed by students is the 4th item with average score of 1.38, i.e., not previewing a text before beginning a task. Overall, most of scores on all items in this survey is less than 3 or below the average, which may indicate these students make relatively less mistakes during their learning.

Table 3：Questions and Results on Common Mistakes (n=63)

Item	Questions	Mean	Std. Deviation
1	I don't think I can work it out successfully.	2.14	1.22
2	I have no time to read books, or to do homework.	2.16	1.16
3	My prerequisite knowledge is not enough.	2.17	1.08
4	There is no way to seek help.	1.38	0.73
5	There is no sufficient collaborative learning.	1.86	1.05
6	I am easy to be distracted by other things.	2.84	1.32
7	I am often absent-minded in class.	2.17	1.25
8	I like to do some other things in class, such as text, surfing internet, listening to music, etc.	2.30	1.24

To reveal factors in students' metacognitive or cognitive processes that may hinder their successful problem solving and learning, self-report questionnaires developed based on some accepted instrument were provided to students to seek their inputs in terms of the extent to which they apply metacognitive strategies and cognitive strategies. The input was on a scale of 1 to 5 and input by students for each survey item to indicate the extent varying from a positive to a negative status. There are 15 items for metacognitive processes or strategies and 14 items for cognitive processes or strategies (see Table 4).

Among these hindering factors as shown in Table 4, item 2 "not plan task sequence" has the highest score of 2.03, while item 12 "not determine how to learn best" has the lowest rate of 1.56 in metacognitive perspective. In cognitive perspective, item 14 "not remind unknown strategy" is ranked with highest scores of 2.83, while item 1 "not know how to collect, store, retrieve information" and item 2 "not know how to process to remember information" have the lowest rate of 1.55. Overall, the mean of scores of hindering factors reported by students for all items in the questionnaires are less than 3 or below the average, indicating that those students seem to have less hindering in their application of metacognitive and cognitive strategies in their study.

Table 4：Questions and Results on Metacognitive (mcf) and Cognitive Factors (cf) (n=64)

Item	Questions	Mean	Std. Deviation
mcf1	I do not set goals before beginning a task.	1.84	1.06
mcf2	I do not plan the task or content sequence before beginning a task.	2.03	1.11

mcf3	I do not plan how to accomplish the task or choose strategies before beginning a task.	1.69	0.81
mcf4	I do not preview a text before beginning a task.	1.94	0.87
mcf5	I do not check my progress on the task.	1.80	0.98
mcf6	I do not my comprehension on learning contents.	1.75	0.82
mcf7	I do not check the solution to the problem to see if it makes sense.	1.63	0.93
mcf8	I do not assess how well I have accomplished the learning task.	1.91	0.97
mcf9	I do not assess how well I have used learning strategies.	1.95	1.00
mcf10	I do not evaluate how effective the strategies were.	1.88	1.00
mcf11	I do not identify changes I will make the next time when I have a similar task to do.	1.69	0.97
mcf12	I do not determine how I can learn best.	1.56	0.85
mcf13	I do not arrange conditions that help me learn.	1.78	1.15
mcf14	I do not seek opportunities for practice.	1.69	1.01
mcf15	I do not focus my attention on the task.	1.63	1.03
cf1	I cannot know how to collect, sort, store, and retrieve information?	1.56	0.84
cf2	I cannot know how to receive, perceive, process, and remember information?	1.56	0.86
cf3	I can't concentrate on my learning.	1.68	1.04
cf4	I think I have a poor memory, which causes my learning not successful.	1.81	1.06
cf5	I cannot draw attention to learning a task through teacher's instruction or self-regulation.	1.89	1.09
cf6	I cannot maintain attention by connecting a concrete object or other cue to the learning task.	1.83	0.87
cf7	I cannot enhance problem-solving by connecting a concrete object or other cue to the learning task.	1.75	0.86
cf8	I cannot Practice (rehearsal) target information through verbalization, visual study, solving similar problems, or other means.	1.63	0.90
cf9	I cannot expand target information by relating it to other information (e.g. creating a phrase, making an analogy).	1.60	0.93
cf10	I cannot simplify target information by converting difficult or unfamiliar information into more manageable one.	1.77	0.99
cf11	I cannot transform target information by creating meaningful visual, auditory, or kinesthetic images of the information.	1.67	0.98
cf12	I cannot transform target information for easy memory by relating a cue word, phrase, or sentence to the target information.	1.66	0.88
cf13	I cannot categorize sequences or organizes information for more efficient recall and use.	1.59	0.81
cf14	I think questions in this survey remind me of some strategies that I have not thought of or have not used during my study, but could be helpful for my learning.	2.82	1.38

Results from analysis of available data collected from the interview indicate that the student interviewees prefer to use strategies such as goal setting, retrieval, knowledge application, analysis, divergent thinking and elaboration prompts. In the process of their working on the assigned learning project, it reveals that students know how to identify the effective question prompts to help them solve the problem and most of the students hold

positive attitudes or adopt correct strategies during the process of carrying out their assigned learning project. However, they are not doing comparatively good in self-evaluating the outcome of their project. Their most common mistakes are "easy to be distracted by other things," while the least mistakes are "no way to seek help." In addition, the low mean scores of mistakes or hindering factors in metacognitive and cognitive perspectives may indicate that scaffolding through question prompts could play an important role in self-regulated learning process and creative problem solving outcomes. Further research should explore structure models by using confirmatory factor analyses to confirm effects of the scaffolding through question prompts on self-regulated learning and creative problem solving skill development. The further efforts should also include collecting and accumulating more data from students' self-regulated learning process and creative problem solving outcomes.

3.2 Results from structured interview conservation

The follow-up interviews were audio-recorded and transcribed. To establish the validity of the rating scheme, an inter-rater reliability check was conducted. Two graduate assistants from College of Education at authors' institution, independently coded and scored all the grouped responses of the interviewees, based on the coding scheme developed by the authors. Key words or statistical data are extracted from these audios independently by two raters (see in Appendix) and then summarized or averaged. In order to discern the patterns, all the answers to the same question were grouped together.

Five dimensions concerning effects of Project-Based Community Service learning with scaffolding for creative problem solving were identified for data collection from the interview transcripts, including benefits and problem solving skills (Question 1), strategies (Question 2), understanding and interest in engineering (Question 3), creative strategies' influence (Question 4) and factors facilitate or hinder problem solving and learning (Question 5). The findings from analysis of those collected data from interview transcripts are reported as follows.

For Question 4 "Do you feel that the creative strategies help your learning and facilitate you to find right solutions to homework or exams?" (See Table 4A and 4B in Appendix), it can be noted that all the interviewees hold the positive attitude towards this question, indicating that the creative problem solving strategies may help their learning and facilitate them to find right solutions to homework or exams.

Based on students' response to Question 1, i.e., "what benefits you get from your project" (see Table 1A and Table 1B in Appendix), the average of accounts by both Research Assistant A and Research Assistant B indicate that about 14% of the participants believed that the community service learning with creative problem solving scaffolding can lead to better academic performance in their subsequent studies, such as "Helps me build work for the next semester" (Interviewee 2, 2015 Fall), "learn to study in a better way, be more accurate." (Interviewee 4, 2016 Fall), "Help studies…help me see different strategies that didn't known before and see different angles of questions." (Interviewee 24, 2016 Fall). The rest of students asserted CSL project benefits them in other dimensions more or less. For

example, some viewed community service learning as the experience of interacting or meeting with new people and making them happy. Some held the view that they become more experienced with children after the project. Moreover, on response to the question on whether you think your problem solving skills have been improved in the completion of project, all the respondents agreed that their problem solving skills have been improved or enhanced in the completion of the project, either for both Research Assistant A and Research Assistant B. This means that respondents held beliefs consistent with research studies showing a positive effect of the community service learning with creative problem solving scaffolding in their academic studies.

Table 2A and 2B in Appendix reveal the detailed responses from students to Question 2, i.e., "Have you used any strategies to solve problems met in your academic study? What are these strategies?" The results indicate that 60 (93.8%) students reported that they have adopted strategy or strategies to solve problems met in their academic study, only 4 (6.2%) students said they did not use any strategy during their academic study. According to Assistant A's data analysis, among 5 categories of creative problem solving strategies, the most frequently used strategy is "Creative thinking" (12.5%), followed by "Manage thinking" (10.9%) being the second, "Exploration" (4.7%) being the third. "Evaluation" (3.1 %) and "Generation" (3.1%) are both the least used strategies. These five strategies occupy only 34.3% of total strategies reported by students. However, for Assistant B's rating results, among the students who adopted strategies, 7.8% of them adopted Managing Thinking, 4.7% of them adopted Evaluation, 4.7% of them adopted Creative Thinking and 1.6 % of them adopted Generation. Other than these five strategies listed in the rubric, many students also mentioned that they use other strategies such as time management, visualization, group learning, taking notes, seeking help from instructors and other students, rehearsal, collaboration, divide tasks into small parts, or time management. These strategies do not belong to the aforementioned five categories of strategies or are the sub-dimensions, but they are mentioned in many participants' response.

In responses to question 3 (After the Community Service Learning Project, do you think that you have a deep understanding and great interest in engineering? Do you want to become an engineer after graduation?), majority of respondents (87.5 %) showed that they have a deep understanding and great interest in engineering after the community service learning project, compared to 4 (6.3%) who have no interest or deep understanding in engineering (both Assistant A and Assistant B have the same data results on this part). Further, with reference to the latter part of the question, Assistant A stated that 44(68.8%) students would like to become an engineer after graduation while 16(25%) students held the opposite opinion, which indicates respondents' great interest in engineering after implementation of the project. Assistant B found that 41(64%) students would like to become an engineer after graduation while 18(28.1%) students showed no interest in becoming an engineer in the future.

For question 5 (What factors in your cognitive and metacognitive process do you see as either facilitate or hinder your successful problem solving and learning? Please illustrate with an example), both of the raters illustrated that cognitive and metacognitive factors or

processes that could facilitate students' successful problem solving and learning processes include goal setting, being creative, concentration, seeking help, goal setting, priority setting and prior knowledge. In "goal setting", Assistant A rated 7.8% while Assistant B rated 6.2%. For the factor "being creative", they both rated 6.2%. However, those that could hinder their successful problem solving and learning mainly lie in distraction, over thinking, having difficulty remember things, do not understanding materials, not having enough time and resources, over confident and not feeling confident. The biggest barrier in hindering students successful problem solving and learning come from "distraction" (both rated as 14.1%) and "over thinking" (Assistant B rated 6.3% and Assistant A rated 4.7% respectively).

4. Summary and Conclusion

This paper explores the follow-up effect of scaffolding for creative problem solving through Project-Based Service Learning (PBSL) on students' learning in their susequent STEM courses. The self-reported survey inputs provided by student interviewees reveal that among five types of creative problem-solving strategies, the most used strategies in each category reported by the student interviewees are goal setting, retrieval, knowledge application, analysis, and divergent thinking respectively. Among the five different types of prompts, the elaboration prompts are reported by student interviewee as the most useful type of question prompts, outperforming other types of question prompts, such as reflective prompts, metacognitve prompts, procedural prompts, and creative problem solving prompts. The most reported activity in the processes of students' conducting their assignment is that they know how to identify the effective question prompts to help them solve the problem, while the least reported activity is that they are not doing comparatively well in self-evaluating outcome of their efforts.

As indicated by students interviewees, the most common mistake that they made in their learning and problem-solving processes is that they are "easy to be distracted by other things", while the least mistake is reported as "not seeking help". The metacognitive factors that may hinder students from successfully solving problems are reported mostly as "not plan task sequence", and the least reported metacognitive factor is revealed as "not determine how to learn best". In cognitive perspective, "not know how to collect, store, retrieve information" and "not remind unknown strategy" are reported as the most frequent factor that hinders students from success, while the least factor is described as "not know how to process to remember information".

From keywords extracted from the interviewees' audio records reveal that all participating interviewees feel that the creative problem-solving strategies provided in the scaffolding help their learning and facilitate them find the right solutions to homework or exam. They all think that their problem-solving skills have been improved after participation in and completion of the community service learning project with scaffolding for creative problem-solving.

Except for four students, all other students (93.0%) indicated that they have applied some strategies in their subsequent studies. The mostly used strategies by students include "creative

thinking" and "managing thinking". Majority of the students (87.5%) indicate that after participating in the community service-learning project with scaffolding for creative problem-solving, they have a deep understanding and great interest in engineering, and most of them (68.8%) want to become engineers after graduation. Some strategies that have been identified by students as factors that facilitate their successfully problem solving include priority setting, goal setting, concentration, being creative, prior knowledge, and seeking help. Some processes that have been identified by students as factors hindering their successful problem solving are distraction, having difficulty remember things, over thinking, over confidant, and not feeling confident.

Overall, findings from the analysis of data collected during the interview reveal that students mentioned and recalled that they have applied some creative problem-solving strategies and deemed the benefits from applying those strategies in their subsequent STEM learning. In addition,   the scores rated by students for using provided strategies are above 3 or over the average, while the scores on mistakes and factors that hinder them from success are less than 3 or below the average. All those indicate there may be some positive impact on students' subsequent learning from implementing community service learning with scaffolding for creative problem solving. Nevertheless, the extent to which students applied the creative problem solving is not very satisfactory as indicated by the lower percentage of application of these strategies.

Nevertheless, the reported findings from the interview may have their limits, because they are based on students' self-report assessment and may be objective to bias of interviewees. Even through each individual interviewee might try to be honest, they may not have the adequate introspective ability to offer an accurate response to questionnaires or questions. They may also have different interpretation or understanding of specific questions. The further research may look into the GPAs of students two years after they had participated in the community service learning with scaffolding for creative problem solving, and make comparison with those who participated in the community service learning without any scaffolding. This may provide more objective measurements on follow-up effect of scaffolding for creative problem solving through question prompts in project-based community service learning on participating students' learning in their subsequent STEM studies.

Acknowledgements

Reference

1. Ocon, R. (2006). "Teaching Creative Thinking to Engineering and Technology Students". Proceeding of 9th International Conference on Engineering Education.

2. Yashin-Shaw, I., (2003)."The effectiveness of the StrateGEE model for creative problem-solving as a tool for facilitating creative thinking", in Enriching learning cultures: proceedings of the 11th annual international conference on post-compulsory education and training: volume 3., ed. G University Faculty of Education Centre for Learning Research, Australian Academic Press, Brisbane, pp.190-197.

3. Cropley, D. (2005). "Engineering Creativity: A Systems Concept of Functional Creativity". In Kaufman, James C. & Baer, John (Eds). Creativity Across Domains: Faces of the Muse. Mahwah, NJ: Lawrence Erlbaum Associates Publishers 169-185.

4. Magee, C. L. et al. (2003). "Advancing Inventive Creativity through Education, the report of the LemelsonMIT Workshop on Advancing Inventive Creativity through Education". Retrieved in 2014, http://web.mit.edu/invent/n-pressreleases/downloads/education.pdf.

5. Barak, M. & Goffer, N. (2002). "Fostering Systematic Innovative Thinking and Problem Solving: Lessons Education Can Learn from Industry". International Journal of Technology and Design Education, 12(3), 227- 247.

6. Wirth,J., (2009). "Prompting self-regulated learning through prompts." Zeitschrift für Pädagogische Psychologie, 23(2), 91-94.

7. Rosenshine, B., & Meister, C. (1992). "The Use of Scaffolds for Teaching Higher-level Cognitive Strategies". Educational Leadership, 49(7), 26-33.

8. Davis, E. A., Linn, M. C. (2000). "Scaffolding Students' Knowledge Integration: Prompts for Reflection in KIE". International Journal of Science Education, 22(8), 819-37.

9. Blank, S., Hudesman, J., Morton, E.D., Armstrong, R., Moylan, A., White, N., and Zimmerman, B. (2006). "A Self-regulated Learning Assessment System for Electromechanical Engineering Technology Students." Proceedings of the National STEM Assessment Conference, Washington, D.C.

10. Elzbieta Cook, Eugene Kennedy, and Sandra Y. McGuire. (2013). "Effect of Teaching Metacognitive learning Strategies on Performance in General Chemistry Courses" Journal of Chemical Education. 2013, 90, 961-967

11. Annette Mallory Donawa. (2011). "The impact of Critical Thinking Instruction on Minority Engineering Students at a Public Urban Higher Education Institution." American Society for Engineering Education, 2011.

12. Morris M. Girgis. (2015). "A Scaffolding Case Study for Teaching Engineering Problem Solving to Underrepresented minorities." 122nd ASEE Annual Conference & Exposition, June 14-17, 2015

13. Zheng ,W., Wang, L.S. and Yin, J.J., (2013). "Correlation Analysis of Scaffolding Creative Problem Solving Through Question Prompts with Process and Outcomes of Project-Based Service Learning."

14. Zheng, W., Cao, Y. (2015). "Effects of Scaffolding Creative Problem Solving through Question Prompts in Project-Based Community Service Learning."

Appendix

Q1. What benefits did you get from your project? Do you think your problem solving skills have been improved in the completion of project?

Table 1A Benefits and Problem Solving Skills - Key words and statistical data from interview audio extracted by Assistant A

Interviewee 1	Learn more humble, more patient/ Yes
Interviewee 2	Helps me build work for the next semester
Interviewee 3	I enjoyed how younger children learn how respond to older students
Interviewee 4	Experiencing a learning from what they did wrong and right/ Yes
Interviewee 5	I have fun with the kids
Interviewee 6	Have fun, also learn things about other majors will be interested but I don't know about
Interviewee 7	Got interaction with a lot of freshmen and decide different opportunities and things/ Yes
Interviewee 8	Have people to go to ask questions, problem solving skills/ Yes
Interviewee 9	I tend to enjoy help people so seeing the results from the tutoring that I gave make me happy
Interviewee 10	People say thank you and appreciate after my work done, which makes me feel good
Interviewee 11	More people helping me with situation/ Yes
Interviewee 12	Learn more about problem solving strategies as well as learning more about service/ Yes
Interviewee 13	Yes, classifying papers, nothing complicated
Interviewee 14	Community service hours, for doing the project?
Interviewee 15	Yes, see problem differently now.
Interviewee 16	Yes, learn to study in a better way, be more accurate.
Interviewee 17	Yes, got the experience of working with different people and having strategize on which houses to go to
Interviewee 18	It helps me to meet new people and get in touch with the Jackson community, create new friendship with people
Interviewee 19	Different people try a different community which makes me feel so good

Interviewee 20	Problem service/ Yes
Interviewee 21	Yes, I need to remember the elementary stuffing so it is good for me to go back and having somebody else
Interviewee 22	Yes, it wasn't easy as it looked. We have to split up the team, set-up for strategies and implemented it.
Interviewee 23	Yes, problem solving skills increased
Interviewee 24	Yes, get my whole community become close with my classrooms and gets fun.
Interviewee 25	Yes, gain leadership, skills, also gain insight into how school teach students
Interviewee 26	I learn how to be more social and I learn how to benefit more about helping others
Interviewee 27	Been able to see how the animal's world, the type of food they need like what they like for the basic survive in the zoo.
Interviewee 28	Yes, able to improve my communication skills, helping students learn a lot of stuff. Trying to explain what I knew and I applied what I already know and into other people, helping them to understand
Interviewee 29	Working great people/ Yes
Interviewee 30	Yes, interaction skills improved, elaborate on my lab. How to solve different problems.
Interviewee 31	Got some experiences of how to code? Have fun/ Yes
Interviewee 32	Transfer my school become more….. meet with new people
Interviewee 33	Community service hours/Yes
Interviewee 34	Have benefits of leading children to do new things/Yes
Interviewee 35	A couple of connections to meet with new people. Yes.
Interviewee 36	Help studies…help me see different strategies that didn't known before see different angles of questions.
Interviewee 37	Learn a lot of things. I didn't know at first./ Yes
Interviewee 38	Help me see all the problem solving skills that I have and we're used them
Interviewee 39	Yes, my problem-solving working in a team
Interviewee 40	Yes, cognitive skills, time management and have improved.
Interviewee 41	Help somebody and changing somebody's life
Interviewee 42	Give a new light to show people that you don't need to have a lot, just to give someone problem-solving skills improved.
Interviewee 43	Solving-problem skills improved
Interviewee 44	Yes, learn a lot of strategies to work with patients to treat patients or sth. like that
Interviewee 45	Yes, multiple of terminologies and also show me that……
Interviewee 46	Yes, to have good teamwork skills, leadership skills and also push me to help the future generation and become a better person, in the future motivate them to be engineers. Improve my team work skills/ Yes

Interviewee 47	Receive problem solving skills, got experience with kids.
Interviewee 48	Have a opportunity to have a understanding of different study habits/Yes
Interviewee 49	Help me meet friend from different nationalities/ Yes
Interviewee 50	More patience with children, problem solving skills improved/Yes
Interviewee 51	Yes, look deep into the problem, work together in a group, help me on the test too.
Interviewee 52	It was nice working with our students and teaching, problem solving skills, people skills and has patience.
Interviewee 53	Feel happy, didn't do it for the money, did it for myself/ Not sure
Interviewee 54	Learn how to actually judge and evaluate project and problem solving skills improved a lot.
Interviewee 55	Yes/ Yes
Interviewee 56	Made world a better place/ Yes
Interviewee 57	Yes, we learn more about the systems, you can be volunteer at anytime and go back to tutor, problem solving skills improved
Interviewee 58	Keep smile on the faces, learn how to deal with different kids and speak a new language to some kids who learn a second language
Interviewee 59	I got to learn how to work better with people and parents and kids who CPR are artistic/ have behavior problems like ADHD
Interviewee 60	Become more aware how Jackson public education handing their students in privacy, became CPR certified/ problem solving skills not improved much
Interviewee 61	More experienced with the children and working in schools/ Yes
Interviewee 62	I was able to see there could be more problems solved in different areas.
Interviewee 63	Care for blind children and help them understand things, being able to make risk decisions/ Yes
Interviewee 64	Use team work quickly and efficiently

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.

Table 1B Benefits and Problem Solving Skills - Key words and statistical data from interview audio extracted by Assistant B

Interviewee 1	Yes, more humble, more patient
Interviewee 2	Yes
Interviewee 3	Yes, enjoy learning how young children respond to older students catering to their needs.
Interviewee 4	Yes, experience and learning from others
Interviewee 5	Yes, work with the kids

Interviewee 6	Yes, get lots of benefits, have fun, learning things about other majors
Interviewee 7	Yes, interact with freshmen; help them with different activities and events
Interviewee 8	Yes, meet with peers
Interviewee 9	Yes, enjoy helping people, see the results from tutoring that I gave make me happy
Interviewee 10	Yes, people appreciate our cleaning up
Interviewee 11	Yes, more people was helping me
Interviewee 12	Yes, learn more problem-solving strategies, worry more about service
Interviewee 13	Yes, classifying papers
Interviewee 14	Yes, receive community service hours, help me how I should look for sites where I can do community service
Interviewee 15	Yes, benefit from other classes, learn how to analyze problems differently and I see problems differently,
Interviewee 16	Yes, study in a better way
Interviewee 17	Yes, working with different people
Interviewee 18	Yes, meet new people, get familiar with the JSU community, and establish friendship with new people
Interviewee 19	Yes, different people try different communities
Interviewee 20	Yes, fulfillment of the service
Interviewee 21	Yes, remember the elementary stuff
Interviewee 22	Yes, it wasn't as easy as it is
Interviewee 23	Yes, problem s-solving skills are improved
Interviewee 24	Yes, get closer with my classmates, have fun
Interviewee 25	Yes, gain leadership skills, gain insight how the school runs and how to teach students
Interviewee 26	Yes, be more social, how to benefit more by helping others
Interviewee 27	Yes, being able to see how the animal's world, the type of food they need like what they like for the basic survive in the zoo
Interviewee 28	Yes, improve communication skills while helping students learn
Interviewee 29	Yes, working with different people
Interviewee 30	Yes, interaction skills are improved; help me how to solve problems
Interviewee 31	Yes, got experience, get familiar with how everything works
Interviewee 32	Yes, become more comfortable when working with new people
Interviewee 33	Yes, community service hours
Interviewee 34	Yes, leading children to do some things
Interviewee 35	Yes, connections to meet with new people
Interviewee 36	Yes, help others; see different strategies I don't know
Interviewee 37	Yes, learn a lot of things
Interviewee 38	Yes, help me see all the problem solving skills
Interviewee 39	Yes, problem solving skills were developed

Interviewee 40	Yes, cognition, time management skills are improved
Interviewee 41	Yes, help others and changing their life
Interviewee 42	Yes, seeing the satisfaction of the less fortunate, problem solving skills are improved
Interviewee 43	Yes, help others
Interviewee 44	Yes, get experience how to work with the patient and how to treat
Interviewee 45	Yes, learn medical terminologies, show me what is
Interviewee 46	Yes, good team work skills, leadership skill, help the future generation, motivate them to be engineer
Interviewee 47	Yes, gain hands-on experience working with people
Interviewee 48	Yes, having the opportunity to understand different leaning habits
Interviewee 49	Yes, meet people from other nationality
Interviewee 50	Yes, be more patient with children, problem-solving skills are improved
Interviewee 51	Yes, learn to look deep into the problem, work together in a group, help me on the test, work together with the team
Interviewee 52	Yes, be patient
Interviewee 53	Yes, feel happy
Interviewee 54	Yes, learning how to judge and evaluate projects
Interviewee 55	Yes
Interviewee 56	Yes, Feel happy, didn't do it for the money, did it for myself
Interviewee 57	Yes, learn more about the system of business
Interviewee 58	Yes, see the children's smile
Interviewee 59	Yes, got to learn how to work with other people
Interviewee 60	Yes, CPR Certify
Interviewee 61	Yes, more experience with children, more problem-solving skills
Interviewee 62	Yes, I was able to see there could be more problems solved in different areas
Interviewee 63	Yes, help them understand things
Interviewee 64	Yes, get the quickly and efficiently

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.

Q2. Have you used any strategies to solve problems met in your academic study? What are these strategies?

Table 2A Strategies Used in Academic Study - Key words and statistical data from interview audio extracted by Assistant A

Interviewee 1	Evaluation
Interviewee 2	Look up ……word and find out and build then I found out
Interviewee 3	Time management
Interviewee 4	Creative way Creative thinking

Interviewee 5	N/A
Interviewee 6	Online videos, self-tutoring
Interviewee 7	Set up tutoring sessions and study groups and find people who can help me opportunities and things （goal setting）Managing thinking
Interviewee 8	Literary research/ review Generation
Interviewee 9	Process note taking, specific steps for each problem
Interviewee 10	Talk to the professor/ academic advisor
Interviewee 11	Find the problem/ analyzing situation Generation
Interviewee 12	Set up my goals, elaboration (goal setting）Managing thinking
Interviewee 13	No strategies
Interviewee 14	The first strategy is that I think of the question I can ask before I start on it, make sure that I know who I can ask(goal setting）Managing thinking
Interviewee 15	Rehearsal, visual learning
Interviewee 16	Yes
Interviewee 17	Time management, social skills (working with different people)
Interviewee 18	On Sundays study subjects, like studying E subjects at least for an hour
Interviewee 19	Working with classmates
Interviewee 20	Whenever I have an academic challenge, I do not ask for my peers foe a help, I use time management strategy.
Interviewee 21	Go to see my professor for help
Interviewee 22	Sit down and develop a approach, some steps, plan, flowchart, step by step
Interviewee 23	Rework different problems
Interviewee 24	Take my time and go back and make sure I'm doing the right things.(switching) Managing thinking
Interviewee 25	Make sure that I am studying
Interviewee 26	The more my friends, the more to study a little bit more and to apply them in everyday life such as figure out certain problems
Interviewee 27	Brain-storming
Interviewee 28	I use the strategies that easier for the age of students to understand
Interviewee 29	Learn how to divide my work out with other people, collaboration
Interviewee 30	Organization, time managements
Interviewee 31	Set goals, switching at the moment (goal setting, switching) Managing thinking
Interviewee 32	Set my goals, time management (goal setting) Managing thinking
Interviewee 33	No
Interviewee 34	Evaluation and creative thinking strategies Evaluation, Creative thinking

Interviewee 35	Creative thinking Creative thinking strategies
Interviewee 36	No specific strategies, memorize, depends on the problem
Interviewee 37	See the question, (elimination) Evaluation
Interviewee 38	I used the same strategy that I used during project in my academic studies Creative thinking
Interviewee 39	Team-building
Interviewee 40	Critical thinking Creative thinking
Interviewee 41	Finding problems, rest to solve them Exploration
Interviewee 42	Group work, at least hours a day
Interviewee 43	Taking parts, dividing them and showing to people
Interviewee 44	Study with the group, like different websites, different videos and tutoring
Interviewee 45	Do easier parts first, see complex problems in parts (switching) Managing thinking
Interviewee 46	Gather information, linking solving problem in different situation and asking people to get the solution quickly (divergent thinking) Creative thinking
Interviewee 47	Use creative thinking skills Creative thinking
Interviewee 48	Analogies, try to remember things, study not in the classroom but also out of classroom, learn many times Creative thinking
Interviewee 49	visualization
Interviewee 50	Break down things, get a deep understanding.
Interviewee 51	N/A
Interviewee 52	Recall, go back and listen my classes, take a lot of notes (Knowledge Application) Exploration
Interviewee 53	In my spare time go to the library
Interviewee 54	Problem solving and analyzation skills Exploration
Interviewee 55	Read for myself
Interviewee 56	Time management
Interviewee 57	plan
Interviewee 58	Flashcards for words: word on one side, definition on the other side, then guess the meaning
Interviewee 59	In my health classes, I ask about CPR , I have to be CPR certified. I learn to do different stuffs with kids
Interviewee 60	Visual and action base, e.g.: making flashcards and games
Interviewee 61	Repetition, review
Interviewee 62	Break down, how they function
Interviewee 63	Fast-pace. I have to get all the information at one time
Interviewee 64	Minimize daily work hour to have more time for study.

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.

Evaluation: 2 (3.1%)

Creative thinking: 8 (12.5)

Managing thinking: 7 (10.9%)

Generation: 2 (3.1%)
Exploration: 3(4.7%)
No strategies: 4

Table 2B Strategies Used in Academic Study - Key words and statistical data from interview audio extracted by Assistant B

Interviewee 1	Yes, time management skills, goal setting, evaluation (Managing thinking) (evaluation)
Interviewee 2	Yes, Look up words and find out and build
Interviewee 3	Yes, Time management
Interviewee 4	Yes, young children want stuff done in a creative way so that they can get board as fast
Interviewee 5	No
Interviewee 6	Yes, online videos, help others understand, self-tutoring
Interviewee 7	Yes, set up tutoring sessions, study groups, networking to find people who can help me
Interviewee 8	Yes, literary reviews
Interviewee 9	Yes, process note-taking for math class. Write notes
Interviewee 10	Yes, seek help from professor and academic advisor.
Interviewee 11	Yes, find the problem, analyze the situation (evaluation)
Interviewee 12	Yes, goal setting (managing thinking)
Interviewee 13	No
Interviewee 14	Yes, think of how many questions I can ask before I start on it, make sure who to ask
Interviewee 15	Yes, rehearsal, visual learning
Interviewee 16	Yes, study certain subjects
Interviewee 17	Yes, time management, social skills
Interviewee 18	Yes, ask peers for help, time management
Interviewee 19	Yes, working with the classmates
Interviewee 20	Yes, persuading others to donate
Interviewee 21	Yes, go and see the professor
Interviewee 22	Yes, develop an approach
Interviewee 23	Yes, rework difficult tasks more times
Interviewee 24	Yes, take my time, don't overlook, do the right thing
Interviewee 25	Yes, studying and try to become a better student
Interviewee 26	Yes, figure out certain problems (managing thinking)
Interviewee 27	Yes, brainstorming
Interviewee 28	Yes, strategies for easier for students to understand
Interviewee 29	Yes, collaboration
Interviewee 30	Yes, organization and time management
Interviewee 31	Yes, goal setting, (Managing thinking)
Interviewee 32	Yes, set goals, time management skills, meet the requirements, (Managing thinking)
Interviewee 33	No strategy

Interviewee 34	Yes, evaluation and creative thinking
Interviewee 35	Yes, creative thinking (creative thinking)
Interviewee 36	No specific strategies
Interviewee 37	Yes, solve the problems in several steps
Interviewee 38	Yes, use the same strategy that I used during project in my academic studies
Interviewee 39	Yes, team-building
Interviewee 40	Yes, critical thinking, collaborate with classmates (creative thinking)
Interviewee 41	Yes, finding problems and solve them
Interviewee 42	Yes, group study, work longer hours
Interviewee 43	Yes, taking parts, diving them
Interviewee 44	Yes, study with the groups, learn from learning videos
Interviewee 45	Yes, divide tasks into small parts
Interviewee 46	Yes, gather information, think about solving problems in different situations
Interviewee 47	Yes, critical thinking skills (creative thinking)
Interviewee 48	Yes, analogy, acronyms (generation)
Interviewee 49	Yes, Visualization
Interviewee 50	Yes, the questions more and break down things to gain understanding of them
Interviewee 51	Yes, macroeconomics
Interviewee 52	Yes, recall classes
Interviewee 53	Yes, study at free time
Interviewee 54	Yes, problem solving and analyze (evaluation)
Interviewee 55	Yes, read, go over the materials
Interviewee 56	Yes, use my time more efficiently
Interviewee 57	Yes, plan
Interviewee 58	Yes, flash card, collaboration
Interviewee 59	Yes, ask about CPR
Interviewee 60	Yes, visual and action base
Interviewee 61	Yes, review
Interviewee 62	Yes, break the problem down
Interviewee 63	Yes, understand better
Interviewee 64	Yes, minimize daily social and have more time for study

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.

Q3: After the community service-learning project, do you think that you have a deep understanding and great interest in engineering? Do you want to become an engineer after graduation? (Y=YES, N=NO, N/A=NOT)

Table 3A: Understanding and Interest in Engineering- Key words and statistical data from interview audio extracted by Assistant A

Interviewee 1	Y	Y
Interviewee 2	Y	N
Interviewee 3	N	N
Interviewee 4	N	N
Interviewee 5	N	N
Interviewee 6	Y	N
Interviewee 7	Y	Neutral
Interviewee 8	Y	Y
Interviewee 9	Y	Y
Interviewee 10	Y	Y
Interviewee 11	Y	N
Interviewee 12	Y	N
Interviewee 13	Y	Y
Interviewee 14	Y	Y
Interviewee 15	Y	Y
Interviewee 16	Y	Y
Interviewee 17	Y	N
Interviewee 18	Y	Y
Interviewee 19	Y	Y
Interviewee 20	Y	N
Interviewee 21	Y	Y
Interviewee 22	Y	Y
Interviewee 23	Y	Y
Interviewee 24	Y	Y
Interviewee 25	Y	Y
Interviewee 26	Y	Y
Interviewee 27	Y	Y
Interviewee 28	Y	Y
Interviewee 29	Y	Y
Interviewee 30	Y	Y
Interviewee 31	Y	Y
Interviewee 32	Y	Y
Interviewee 33	Y	N
Interviewee 34	Y	Y
Interviewee 35	Y	Y
Interviewee 36	Y	Y
Interviewee 37	Y	Y
Interviewee 38	Y	Y
Interviewee 39	Y	Y
Interviewee 40	Y	Y
Interviewee 41	Y	Y
Interviewee 42	Y	Y
Interviewee 43	Y	Y

Interviewee 44	Y	Y
Interviewee 45	Neutral	Neutral
Interviewee 46	Y	Y
Interviewee 47	Y	Y
Interviewee 48	Y	Y
Interviewee 49	Y	Y
Interviewee 50	N/A	N
Interviewee 51	Y	Y
Interviewee 52	Y	Y
Interviewee 53	Y	Y
Interviewee 54	Y	Y
Interviewee 55	Y	N
Interviewee 56	Y	Neutral
Interviewee 57	Y	Y
Interviewee 58	Y	N
Interviewee 59	N/A	N
Interviewee 60	Y	Y
Interviewee 61	Y	Y
Interviewee 62	Y	Y
Interviewee 63	Y	Y
Interviewee 64	**N/A**	**N**

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.

Table 3B: Understanding and Interest in Engineering-Key words and statistical data from interview audio extracted by Assistant B

Interviewee 1	Y	Y
Interviewee 2	Y	N
Interviewee 3	N	N
Interviewee 4	N	N
Interviewee 5	N	N
Interviewee 6	Y	N
Interviewee 7	Y	Neutral
Interviewee 8	Y	Y
Interviewee 9	Y	Y
Interviewee 10	Y	
Interviewee 11	Y	N
Interviewee 12	Y	N
Interviewee 13	Y	Y
Interviewee 14	Y	Y
Interviewee 15	Y	Y
Interviewee 16	Y	Y
Interviewee 17	Y	N
Interviewee 18	Y	Y

Interviewee 19	Y	Y
Interviewee 20	Y	N
Interviewee 21	Y	Y
Interviewee 22	Y	Y
Interviewee 23	Y	Y
Interviewee 24	Y	Y
Interviewee 25	Y	Y
Interviewee 26	Y	Y
Interviewee 27	Y	Y
Interviewee 28	Y	Y
Interviewee 29	Y	Y
Interviewee 30	Y	Y
Interviewee 31	Y	Y
Interviewee 32	Y	Y
Interviewee 33	Y	N
Interviewee 34	Y	Y
Interviewee 35	Y	Y
Interviewee 36	Y	Y
Interviewee 37	Y	Y
Interviewee 38	Y	Y
Interviewee 39	Y	Y
Interviewee 40	Y	Y
Interviewee 41	Y	Y
Interviewee 42	Y	Y
Interviewee 43	Y	Y
Interviewee 44	Y	Y
Interviewee 45	Neutral	Neutral
Interviewee 46	Y	Y
Interviewee 47	Y	N/A
Interviewee 48	Y	Y
Interviewee 49	Y	Y
Interviewee 50	N/A	N
Interviewee 51	Y	Y
Interviewee 52	Y	N
Interviewee 53	Y	Y
Interviewee 54	Y	Y
Interviewee 55	Y	N
Interviewee 56	Y	Neutral
Interviewee 57	Y	Y
Interviewee 58	Y	N
Interviewee 59	N/A	N
Interviewee 60	Y	N
Interviewee 61	Y	N

Interviewee 62	Y	Y
Interviewee 63	Y	Y
Interviewee 64	N/A	N

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.

Q4: Do you feel that the creative strategies help your learning and facilitate you to find right solutions to homework or exams? (Y=YES)

Table 4A: Whether Strategies Help or Facilitate Learning- Key words and statistical data from interview audio extracted by Assistant A

Interviewee 1	Y
Interviewee 2	Y
Interviewee 3	Y
Interviewee 4	Y
Interviewee 5	Y
Interviewee 6	Y
Interviewee 7	Y
Interviewee 8	Y
Interviewee 9	Y
Interviewee 10	Y
Interviewee 11	Y
Interviewee 12	Y
Interviewee 13	Y
Interviewee 14	Y
Interviewee 15	Y
Interviewee 16	Y
Interviewee 17	Y
Interviewee 18	Y
Interviewee 19	Y
Interviewee 20	Y
Interviewee 21	Y
Interviewee 22	Y
Interviewee 23	Y
Interviewee 24	Y
Interviewee 25	Y
Interviewee 26	Y
Interviewee 27	Y
Interviewee 28	Y
Interviewee 29	Y
Interviewee 30	Y
Interviewee 31	Y
Interviewee 32	Y
Interviewee 33	Y

Interviewee 34	Y
Interviewee 35	Y
Interviewee 36	Y
Interviewee 37	Y
Interviewee 38	Y
Interviewee 39	Y
Interviewee 40	Y
Interviewee 41	Y
Interviewee 42	Y
Interviewee 43	Y
Interviewee 44	Y
Interviewee 45	Y
Interviewee 46	Y
Interviewee 47	Y
Interviewee 48	Y
Interviewee 49	Y
Interviewee 50	Y
Interviewee 51	Y
Interviewee 52	Y
Interviewee 53	Y
Interviewee 54	Y
Interviewee 55	Y
Interviewee 56	Y
Interviewee 57	Y
Interviewee 58	Y
Interviewee 59	Y
Interviewee 60	Y
Interviewee 61	Y
Interviewee 62	Y
Interviewee 63	Y
Interviewee 64	Y

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.

Table 4B: Whether Strategies Help or Facilitate Learning - Key words and statistical data from interview audio extracted by Assistant B

Interviewee 1	Y
Interviewee 2	Y
Interviewee 3	Y
Interviewee 4	Y
Interviewee 5	Y
Interviewee 6	Y
Interviewee 7	Y
Interviewee 8	Y

Interviewee 9	Y
Interviewee 10	Y
Interviewee 11	Y
Interviewee 12	Y
Interviewee 13	Y
Interviewee 14	Y
Interviewee 15	Y
Interviewee 16	Y
Interviewee 17	Y
Interviewee 18	Y
Interviewee 19	Y
Interviewee 20	Y
Interviewee 21	Y
Interviewee 22	Y
Interviewee 23	Y
Interviewee 24	Y
Interviewee 25	Y
Interviewee 26	Y
Interviewee 27	Y
Interviewee 28	Y
Interviewee 29	Y
Interviewee 30	Y
Interviewee 31	Y
Interviewee 32	Y
Interviewee 33	Y
Interviewee 34	Y
Interviewee 35	Y
Interviewee 36	Y
Interviewee 37	Y
Interviewee 38	Y
Interviewee 39	Y
Interviewee 40	Y
Interviewee 41	Y
Interviewee 42	Y
Interviewee 43	Y
Interviewee 44	Y
Interviewee 45	Y
Interviewee 46	Y
Interviewee 47	Y
Interviewee 48	Y
Interviewee 49	Y
Interviewee 50	Y
Interviewee 51	Y

Interviewee 52	Y
Interviewee 53	Y
Interviewee 54	Y
Interviewee 55	Y
Interviewee 56	Y
Interviewee 57	Y
Interviewee 58	Y
Interviewee 59	Y
Interviewee 60	Y
Interviewee 61	Y
Interviewee 62	Y
Interviewee 63	Y
Interviewee 64	Y

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.

Question5: What factors in your cognitive and metacognitive process do you see as either facilitate or hinder your successful problem solving and learning? Please illustrate with an example.

Table 5A: Factors Facilitate or Hinder Students' Problem Solving and Learning- Key words and statistical data from interview audio extracted by Assistant A

Interviewee 1	The way I solve problems can facilitate, the very way I spoken will hinder
Interviewee 2	Pay attention as sitting in the class and listen to the teacher
Interviewee 3	Involved in a lot of social activities
Interviewee 4	Not really understanding my goal
Interviewee 5	Just preparing what I'm going to my university
Interviewee 6	Set up the priority, do the most complicated question first
Interviewee 7	Very focused
Interviewee 8	Absent-minded
Interviewee 9	Can't concentrate, easily distracted, that hinders
Interviewee 10	Be creative person
Interviewee 11	Prior to knowledge (math, science, English) help solve problem better
Interviewee 12	Sensing the problem and then analyzing
Interviewee 13	Too much information, can't remember everything. It helps me find way around campus
Interviewee 14	Problem solving/ learning
Interviewee 15	Hinder: trying to remember all the strategies
Interviewee 16	The way that I study, do my homework
Interviewee 17	Everybody understand the problem that you are trying to solve
Interviewee 18	Goal monitoring, use more visual videos. Setting up your goals, writing up your goals, always check up goals.

Interviewee 19	Distraction
Interviewee 20	Overanalyze the situation
Interviewee 21	When and where to study, forming your own words, ask question.
Interviewee 22	I'm over-confident, in a rush.
Interviewee 23	Over thinking, creativity
Interviewee 24	Create your own way
Interviewee 25	Over thinking
Interviewee 26	On performing the project, my outcome of solving the problem has not been appreciated.
Interviewee 27	Feel confident
Interviewee 28	Go through the problem, step by step, following the necessary solving techniques
Interviewee 29	Exploration, evaluation,(facilitate)
Interviewee 30	Productive thinking, find multiple ways to solve the problem.
Interviewee 31	Monitoring, setting goals (facilitate) hinder: no
Interviewee 32	Hinder: distractions. Problem solving learning just understands the importance of my lessons
Interviewee 33	N/A
Interviewee 34	Distractions, just basic human problems
Interviewee 35	Distractions
Interviewee 36	Setting, switching over simplifying
Interviewee 37	Managing thinking, goal settings, switching community awareness and goal monitoring. Hinder: over blend my ideas
Interviewee 38	Hinder: anxiety
Interviewee 39	Not understanding the problem/ not pay attention to how to solve problem
Interviewee 40	Step by step learning
Interviewee 41	Being creative
Interviewee 42	Just thinking and trying to hinder
Interviewee 43	Taking step by step and using technology
Interviewee 44	Asking people who got more experience, try to find a different study then you'll get a lot of information about it.
Interviewee 45	Doing projects here and there
Interviewee 46	Not having a great strategy to solve problem and not having enough time and resource.
Interviewee 47	Hinder: just being afraid around. Facilitate: experience
Interviewee 48	Reading and understanding what the problem is, looking for different solutions, time management, aware of timeline.
Interviewee 49	People helps me solving problems and learning
Interviewee 50	Try to make some music and that would be distractions on the outside world. People put and input on how it sound, block my creativity
Interviewee 51	Problem-solving skills

Interviewee 52	Phone calls that messages, distractions
Interviewee 53	Facilitate: listening to music
Interviewee 54	Setting a goal, organize information, recording data
Interviewee 55	A lot of prompt can set back things
Interviewee 56	Waiting on others; hinder my problem-solving. Not sure for facilitate
Interviewee 57	Not taking my time
Interviewee 58	Remember stuff quickly so I get test everything
Interviewee 59	Fear in my brain keeps me from doing something.
Interviewee 60	Not having a lot of confidence
Interviewee 61	Focus on little day by day
Interviewee 62	Facilitate: going up early. Hinder: distractions
Interviewee 63	Being in a fast place hinder my performance
Interviewee 64	Brainstorming , write it down, go step by step (facilitate)

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.

Table 5B: Factors Facilitate or Hinder Students' Problem Solving and Learning- Key words and statistical data from interview audio extracted by Assistant B

Interviewee 1	The way solve problems facilitates, the very way I spoke hinders
Interviewee 2	Pay attention, focus on what the teaching says facilitate
Interviewee 3	Being involved in a lot of social activities hinders
Interviewee 4	Not really understanding hinders
Interviewee 5	preparing what I'm going to do in university
Interviewee 6	set priority, do the most complicated first facilitate
Interviewee 7	Distraction hinders
Interviewee 8	Perfectionism, focus on the questions, hard to back on track
Interviewee 9	can't concentrate, easily distracted
Interviewee 10	being creative
Interviewee 11	prior knowledge helped me learn better
Interviewee 12	sending the problem, analyzing
Interviewee 13	too much information, can't remember everything will hinder
Interviewee 14	problem solving
Interviewee 15	Remember all the strategies are difficult
Interviewee 16	the way that I study hinders my learning
Interviewee 17	Everybody understands the problem can enhance
Interviewee 18	Goal monitoring facilitate
Interviewee 19	?
Interviewee 20	over analyzing the situation hinders
Interviewee 21	understand the materials, if have questions, ask for help
Interviewee 22	Over confident hinders
Interviewee 23	O Cognitive and metacognitive skills can facilitate over thinking hinders

Interviewee 24	Create your own way
Interviewee 25	Over thinking hinders
Interviewee 26	Group project?
Interviewee 27	not feeling confident
Interviewee 28	Follow the necessary process, problem solving techniques, not understanding everything
Interviewee 29	Evaluation
Interviewee 30	multiple ways to solve problems
Interviewee 31	setting goals facilitate, no
Interviewee 32	distraction hinders
Interviewee 33	N/A
Interviewee 34	No
Interviewee 35	Distractions
Interviewee 36	Goal setting, switching, over simplifying sth
Interviewee 37	Managing thinking, Goal setting; Switching
Interviewee 38	Anxiety hinders
Interviewee 39	Not pay attention to the problem
Interviewee 40	step by step learning facilitates; no
Interviewee 41	Being creative
Interviewee 42	Just thinking and trying may hinder
Interviewee 43	Taking step by step and using technology
Interviewee 44	Asking people who are more experienced, try to find a different study then you'll get a lot of information
Interviewee 45	doing projects here and there
Interviewee 46	not having enough time and resources
Interviewee 47	Being afraid of being wrong hinders
Interviewee 48	Reading and understanding the problems, looking for different solutions and stay on tasks
Interviewee 49	people help me solve t he problem and learning
Interviewee 50	Try to make some music and that would be distractions in the outside world?? block my creativity
Interviewee 51	Strategies could facilitate
Interviewee 52	not paying attention hinders
Interviewee 53	Listening to music helps
Interviewee 54	list steps of solving the problem, recall information, collect data
Interviewee 55	A lot of prompts can set back things
Interviewee 56	Waiting on others
Interviewee 57	Not taking the time
Interviewee 58	Remember stuff,
Interviewee 59	fear of being wrong and pride may hinder
Interviewee 60	Not have enough confidence
Interviewee 61	Keep going with the project, stay on track
Interviewee 62	Distractions
Interviewee 63	No time to do it

Interviewee 64	Brainstorming

Note: Interviewee 1 to 12 were interviewed in Fall of 2015, Interviewee 13-50 were interviewed in Fall of 2016, Interviewee 51-64 were interviewed in Spring of 2016.