AC 2012-3808: SELF-REGULATED LEARNING STRATEGIES OF GRADES 9-12 STUDENTS IN DESIGN PROJECT: VIEWED FROM PERFORMANCE AND GENDER PERSPECTIVES

Dr. Oenardi Lawanto, Utah State University

Oenardi Lawanto is an Assistant Professor of the Department of Engineering Education at Utah State University. Lawanto holds B.S. and M.S. degrees in electrical engineering and a Ph.D. in human resource education. His research interests include areas in cognition, learning, instructions, engineering design, and e-learning. Currently, he is working on two research projects that investigate students' cognitive and metacognitive activities while learning engineering. Both projects are funded by the National Science Foundation (NSF).

Dr. Wade H. Goodridge, Utah State University

Wade Goodridge, Principal Lecturer in the Department of Engineering and Technology Education at Utah State University, instructs Solid Modeling, CAD, Introductory Electronics, Surveying, and Introductory Engineering courses at the Brigham City Regional campus. Goodridge has has been teaching for the Utah State College of Engineering for more than eight years. He holds dual B.S degrees in industrial technology education and civil engineering from Utah State University, as well as an M.S. and Ph.D. in civil engineering from Utah State University. His research interests include metacognitive processes and strategies involved in engineering design using solid modeling, learning style impacts upon hybrid synchronous broadcast engineering education, and team teaching in broadcast environments.

Self-Regulated Learning Strategies of Grades 9-12 Students in Design Project: Performance and Gender Perspectives

Abstract

Exploring self-regulated learning skills in grades 9-12 students' design activities promotes a better understanding of how students deal with problem solving. This study focuses on students' understanding of task demand and Self-Regulated Learning (SRL) strategies including planning, and cognitive and monitoring/fix-up strategies. A mixed-methods approach to research was applied to gather comprehensive and valid information about students' SRL strategies. The objectives of this preliminary study were to investigate high school students' design activities that reflect their understanding of task demand and SRL strategies to accomplish the design task from the perspective of design performance (i.e., high- and low- performing students) and gender. A better understanding of these issues will specifically benefit technology and pre-engineering educators as well as the high school curriculum developer.

Students at a high school in Colorado participated in this preliminary study (n = 29); 22 students participated in a robotics project and 7 students conducted an architecture project. Based upon a data review process, the researchers accepted 27 data sets for data analysis. Butler and Cartier's SRL model was used to frame a survey questionnaire and design journal. Because SRL is contextual, Dym and Little's prescriptive model of design process was also used to frame the questionnaire items for this study. Two subsections of survey questionnaire were used at the early and middle stages of the design projects, respectively. Each subsection assessed different SRL strategies. The SRL mean values of each design sub-phase were calculated and compared between high- and low-performing students, and also between males and females. For the design journal, participant responses were categorized and tabulated according to SRL features. The class instructor was asked to score the students' journal based upon clarity and specificity of the journal writing. The findings of the design journal were used to confirm the results of the questionnaire analysis.

The results suggested that high-performing students exhibited a better awareness than did low-performing ones on task interpretation, cognitive strategies, and monitoring/fix-up strategies during the design project. On the other hand, the low-performing students performed very well on planning strategies. From a gender perspective, while males reported a good awareness on task interpretation and planning strategies, females showed a good awareness on cognitive and monitoring/fix-up strategies. The analysis of the design journals confirmed that high-performing students outperformed the low-performers. The findings from design journals also revealed that female students had a good awareness in understanding task demand, executing plans and monitoring and regulating their strategies. In addition, limitations and suggestions for further work on this study will also be discussed.

1. Introduction

A report published by The National Academy of Sciences, National Academy of Engineering, and Institute of Medicine entitled *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* recommends improvement in mathematics and science education on the K-12 level [1]. This needs to be realized to maintain the U.S. competitiveness in the global economy. In line with this publication, the Committee on K-12 Engineering Education suggested that K-12 engineering education should emphasize engineering design [2]. Through the engineering design process "students not only know the mathematics and science but also actually understand why they need to know it" [3]. In addition to the needs of engineering and technology, metacognition is essential in both mathematics and science [4]-[7].

This study focuses on Grade 9-12 student task understanding and its relation to planning and self-regulated learning strategies in engineering design activity. Students' understanding of task demand, or also often called task interpretation, is one of the metacognitive features and the heart of the self-regulated learning (SRL) model insofar as it shapes key dynamic and recursive self-regulating processes. Butler found that having a good understanding of a presented learning activity grounded in productive metacognitive knowledge about tasks is associated with students' thoughtful planning, self monitoring, and selection of appropriate strategies to accomplish task objectives [8].

In this research, students engaged in design activities in an authentic school learning environment; the teacher created the design projects. Their understanding of the task interpretation was collected and evaluated through survey questionnaire and design journal. Many studies suggest that metacognitive skills are important determinants of successful learning. Besides learning achievement issues, previous studies showed the lack of diversity in engineering education. A study from Anderson and Gilbride found that boys were significantly more interested than girls in pursuing engineering careers [9]. However, there is still limited study investigating self-regulated learning strategies in the stage process of engineering design and how the strategies differ between male and female students.

2. Literature Review

2.1. Metacognition in Self-Regulated Learning Context

Extensive research has been done evaluating the importance of metacognition in learning, especially in problem-solving ability. Flavell described metacognition knowledge as "one's knowledge concerning one's own cognitive processes and products or anything related to them" (p. 232) [10]. He also identified three different types of metacognitive knowledge: person (the knowledge one has about him or herself and others as cognitive processors); task (the knowledge one has about the information and resources needed to undertake a task); strategy (knowledge regarding the strategies which are likely to be effective in achieving goals and undertaking tasks) [11].

In another study, Paris and Winograd offer a more comprehensive view in which metacognition can be observed through two essential features of metacognition: cognitive self-appraisal (CSA) and cognitive self-management (CSM) [12]. Lawanto & Johnson noted that CSA and CSM are distinct, easy to identify, and place the learner as the central part of the metacognition issue [13]. CSA refers to learners' personal judgments about their ability to meet a cognitive goal. On the other hand, CSM refers to learners' abilities to make necessary adjustments and revisions during their work.

The dynamic and iterative interplay between metacognitive and cognitive activity is described by Butler and Cartier in a SRL model, which characterizes SRL as a complex, dynamic, and situated learning process [14]-[17]. This model involves six central features that interact with each other: layers of context, what individuals bring, mediating variables, task interpretation, SRL processes, and cognitive strategies. This study focuses primarily on student task interpretation, which is analogous to student understanding of design activity, planning strategies, and cognitive strategies. Planning strategies are required to guide students completing the design systematically. Cognitive strategies refer to any cognitive actions used to complete the project. Cognitive strategies are contextual and specific to each activity; reading, writing, solving mathematical problems, or solving engineering design have specific cognitive action. Although the researcher emphasizes three SRL features, it is also important to understand how the students monitor their activities during design activity. A student with good metacognitive skills and awareness uses these processes to oversee his or her own learning process, plan and monitor ongoing cognitive activities, and compare cognitive outcomes with internal or external standards [11].

2.2. Engineering Design

The Accreditation Board for Engineering and Technology (ABET) defined engineering design as "the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs (p. 3) [18]." Jain and Sobek and Dym, Agogino, Eris, Frey, and Leifer stated that increasing emphasis over the last several decades has been placed on design as the focus for engineering curricula [19][20]. Design is a distinguishing activity of engineering and is a vital part of an engineer's preparation. At the K-12 level, Douglas, Iversen, and Kalyandurg reported that the engineering community has identified the need for teaching engineering at this level, and it has been supported by the American Society of Engineering Education [21].

The nature of engineering design can be explained through the structure phase. Based on the structure, engineering design is divided into two categories: well-defined and ill-defined problem design. Ill-defined problems are more difficult to solve since they require more cognitive operations than simpler, well-defined ones [22]. Although the phases identified as engineering design differ among authors. Dym and Little proposed that the design process consists of five main phases: problem definition, conceptual design, preliminary design, detailed design, and design communication (see Table 1) [23]. This study used Dym and Little's five-stage prescriptive model to categorize and code engineering design strategies and to evaluate students' metacognitive activities during problem definition and conceptual design phases.

The engineering design process, as noted by Sheppard, Macatangay, Colby, and Sullivan, "is not linear: at any phase of the process, the engineer may need to identify and define sub-problems, then generate and evaluate solutions to the sub-problems to integrate back into the overall process" (p. 104) [24]. Sheppard et al. summarized the design process to include three broad areas: defining the problem, generating candidate solutions, and evaluating and implementing candidate solutions. In addition, communication, teamwork, time management, and project management were essential broader professional skills requisite to success.

Table 1. A five-stage prescriptive model of the design process

Problem Definition	**Preliminary Design**
Co –Clarify objectives	Ma –Model and analyze chosen design
Emo –Establish metrics for objectives	Te –Test and evaluate chosen design
Ic – Identify constraints	
Rp – Revise client's problem statement	
Conceptual Design	**Detailed Design**
Ef –Establish functions	Rod –Refine and optimize chosen design
Er –Establish requirements	Afd –Assign and fix design details
Emf –Establish means for functions	**Design Communication**
Ga –Generate design alternatives	Dfd –Document final design
Ram –Refine and apply metrics to design alternatives	
Cd –Choose a design	

2.3. Academic Performance and Gender Issues in Design Activities

Zimmerman and Pons found that consistency in employing self-regulated learning strategies is highly correlated with student achievement [25]. Schoenfeld argued that an unsuccessful problem-solving effort may result from the absence of assessments and strategic decisions [26]. Students with good task interpretation skills make effective planning activities which lead to better academic performance [11]. Task interpretation is the heart of the SRL model insofar as it shapes key dynamic and recursive self-regulating processes. When confronted with academic work, students draw on information available in the environment, and on knowledge, concepts, and perceptions derived from prior learning experiences, to interpret the demands of a task [14-16].

Furthermore, another topic in engineering education includes issues concerning gender. Selected data for women shows that they are underrepresented in engineering disciplines (e.g., proportion of bachelor's degrees in engineering, tenured/tenure-track appointments on U.S. engineering faculties, and employed as engineers) [2]. Although that is the case, other studies found that basically both of them have equal opportunity to participate. Eccles and Harold argued that gender-based level participation is not due to biological reason; rather it is triggered by individual's perception, task value, and participation [26]. Schreuders, Rutherford, Cox, and Mannon in their study found that in general there was no gender difference for biological and agricultural engineering [28]. Limited studies have been conducted to clarify gender related issues in terms of attitudes and learning strategies in engineering education [29] [30], and not on how students deploy their self-regulated learning during design activity. This study aims to provide initial understanding on this issue.

3. The Study

The main objective of this study was to describe the task interpretation of students engaged in a design activity and determine the extent to which they translated their understanding of the design task into planning and cognitive strategies. Two research questions guided this exploratory study: (1) How did low- and high-design-performing students differ in interpreting tasks and deploying their SRL strategies?, and (2) How did male and female students differ in interpreting tasks and deploying their SRL strategies? Low- and high- performers were categorized based on students' project grades reported by the teacher.

3.1. Study Participants
Twenty-nine students participated in the study: 7 students (5 females and 2 males) were in the Architectural Design class and 22 students (3 females and 19 males) were in the Robotics Design class. Two considerations were used to select one high school in Colorado to participate in this study: (1) it provides a comprehensive set of engineering/ technology-related courses, and (2) the school is recognized as one of the best schools in the U.S. [31].

3.2. Context of the Design Activities
The teacher of the classes created the requirements of the Robotics and Architectural design projects. A brief description of these two final projects is presented below.

3.2.1. Robotic Design
Robotic design students worked in a team of two or three to design and build a robot capable of operating under a tele-operated mode to navigate inside a 4' x 8' table with 2"-high walls populated with 12 balls (two colors). Students were asked to fully assembly a robot, including a drive train and actuator, using SolidWorks™ before eventually building and competing with it in four successful matches. The grading criteria were established based upon the SolidWorks™ model, robot performance, team participation, and design journal writings.

3.2.2. Architectural Design
Students were asked to design and build a miniature of a new library to be built in a small town with a population of 25,000. As in the robotic design project, the architectural design students were required to solve a design task as their final design project. The library was to be built on a square corner lot measuring 150’ x 150,’ needed to include various facilities such as meeting rooms, performance space, a computer access area, an outside garden or reflection area with benches, a circulation desk, a staff office or break space, and restrooms, and was required to be handicap accessible.

3.3. Instrumentation
Data from the survey were collected at the early and middle stages of the design project, respectively through an online survey tool. In the early stage, the survey assessed students’ mediating variables, task interpretation, and planning strategies. In addition, in the middle stage, the survey assessed their cognitive and monitoring/fix-up strategies. The questionnaire was adapted from the Inquiry Learning Questionnaire [14] [15]. Measurement scales of the survey ranged from 1 to 4 (i.e., 1 = *never*, 2 = *sometimes*, 3 = *often*, and 4 = *always*). The students completed the survey at those three different stages of the project in class and it was administered by the teacher (see Table 2 for a sample of the survey items). An exploratory factor analysis was conducted to identify the internal reliability of EDQ. Table 3 shows that all dimensions under Task Understanding and Self-Regulating Strategies have very high Cronbach’s Alpha scores.

3.4. Data Collection and Analysis
Two sources including a self-regulated survey for engineering design and a Web-based engineering design notebook were used in data collection. The survey questionnaire was used to capture students’ mediating variables, task interpretation, perceptions of planning, cognitive, and self-regulating strategies. To confirm data gathered from survey, data on task interpretation and use of planning, cognitive and self-regulating strategies were also collected through a Web-based

engineering design notebook. Here students were asked to report their activities on projects twice-a-week using a Moodle™-based application.

Before analyzing data, collected surveys were first evaluated for irregularities. Specifically we looked for anyone who responded to each survey item with the same answers (e.g., marked "4" for all items or blocks of items). There were two suspiciously completed surveys that required us to further investigate the validity of the responses. As a result of those findings, we excluded the two surveys from our data pool and, therefore, ended up with 27 surveys to be analyzed.

The analysis process involved evaluating both quantitative and qualitative data. Quantitative data collected from the survey were analyzed by first calculating the mean values of the SRL features and then comparing them across the two design phases. Second, due to the small sample size and ordinal data, non-parametric tests were conducted in this study. Qualitative data collected from students' design journals were first categorized according to the SRL features and then coded using Dym and Little's [23] conceptual model. This approach allowed us to identify how SRL features were identified within design phase. Students wrote their engineering design journals guided by four different prompts for each entry that reflect the SRL features. The teacher gave a score for each answer of the four questions. Similar to the work of Butler [8], the scores used for journal scoring ranged from 0 to 3; a highest score represents a clear and specific answer. Although the students were not required to write design journal every day, they wrote their journal entries whenever they were making progress. Second, comparison between groups across SRL features were represented in graphical views.

Table 2. SRL features and examples in the context of defining the design project

Feature	**Statement example**
Task Interpretation	*When I am asked to work on a design task like the one I am about to solve, I am being asked to…* • Get a good overview of the design objectives. • Understand the action or goal for which my design must perform
Planning Strategies	*Before I begin to work on the design task, I…* • List ways to identify design objectives. • Identify the measures that make a good design performance.
Cognitive Strategies	*When working on this kind of design task, I…* • Read the design description (or brief). • Establish a way to measure how well I am reaching the design objectives.
Monitoring & Fix Up	*During my work on my design task, I* • Look back at the design description (or brief). • Make sure whether a good understanding of the design objectives was achieved.

Table 3. Exploratory Factor Analysis

General Category	**Dimensions**	**# of Items**	**Cronbach's Alpha**
Task Understanding	Task Interpretation	9	.80
Self-Regulating Strategies	Planning Strategies	9	.77
	Cognitive Strategies	25	.91
	Monitoring & Fix Up	20	.91

4. Findings

4.1. Demographics Information and Mediating Variables

Twenty-nine students participated in this study. However, only 27 valid data sets were used in the analysis. Six students (4 females and 2 males) were in the Architectural Design class and 21 students (3 females and 18 males) were in the Robotics Design class. Eighteen of the participants (67%) identified themselves as Caucasian, with the next highest demographic being Asian-Pacific Islander with five students (19%). The Grade Point Average (GPA) was almost normally distributed around the mid-3 range. Most participants were freshmen in high school (56%), followed by sophomores (37%), then seniors (3.5%), and juniors (3.5%). Fifty-six percent of the students claim to be considering engineering or technology schooling, whereas 44% claim to not be interested. Furthermore, Table 4 reports the highest level of math course students have taken.

Table 4. The highest level of math course

No	Answer	Response	%
1	Algebra 1	9	33 %
2	Algebra 2	7	26 %
3	Geometry	10	37 %
4	Trigonometry/Pre-Calculus	1	4 %
5	Calculus	0	0 %
6	AP Calculus	0	0 %
7	None	0	0 %
	Total	27	100%

Furthermore, each student has different mediating variables when dealing with the design activity. Mediating variables refer to their perceptions about the task and prior knowledge related to the task. When starting the design task, 44% of the participants claimed to have a decent grasp on the background knowledge regarding the design task that they were about to solve, 33% claimed to have a small amount of knowledge regarding the background of the design task, and 23% claimed to have a lot of background knowledge. None of the students claimed to know nothing about the background knowledge related to the task. Furthermore, when asked to rate the complexity of the design task, the majority (17 participants, 63%) thought the design task was pretty complex and 9 participants stated that the task was a little bit complex. Regarding their confidence in completing the design task, most of the students were enthusiastic with 52% claiming “very much” confidence and 41% claiming “somewhat” confidence.

4.2. Research Question 1: *How do low- and high-design-performing students differ in interpreting and deploying SRL strategies?*

Students were clustered into relatively low and higher performers based on project grades reported by the teacher (see Figure 1). The researchers decided to not use students’ overall GPA and final course grade because they consists of other courses’ grades that may not be necessarily related to engineering design performance. Overall the mean grade across students was 91.07% (SD = 4.62). We identified high-performing students as those whose scores were at least ¾ of an SD above this mean (scores ≥ 94.5; n = 12), and low-performing students as those whose scores were at least ¾ of an SD below the mean (scores <= 87.6; n = 7).

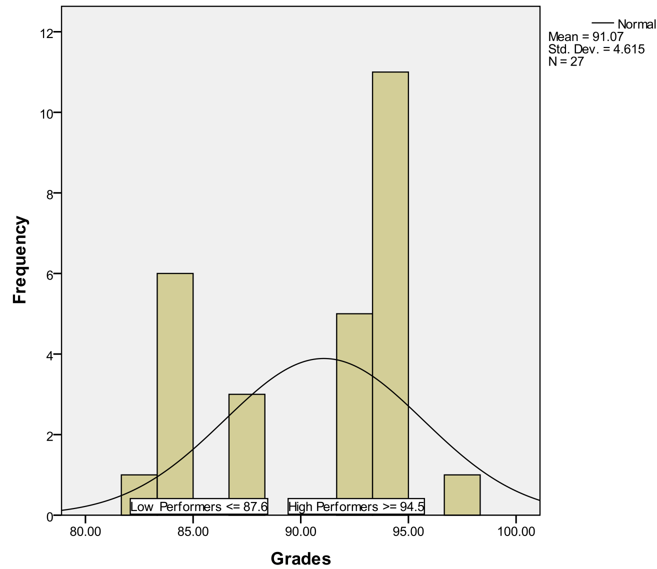

Figure 1. Histogram of grades distribution between high- and low-performer students

The data analyses employed to answer this research question were conducted in two phases. First, we compared SRL scores between the two groups of students. Second, we analyzed the relationship among SRL scores within each group, and then compared those patterns across the two groups to see if there were any important differences.

First, Table 5 reports our findings from the survey comparing mean scores across problem definition and conceptual design phases for the two groups of students. What can be observed here is high-performing students reported high awareness on task interpretation and reported use of cognitive and monitoring-fix up strategies, compared to low-performing students. It was the lower-performing students who reported greater use of planning strategies. We interpreted this result to suggest that, while lower-performing students may have high awareness on their plans, survey results suggested they were not more likely to translate those plans into action.

Table 5. Comparison of SRL scores for high- and low-performing students (N = 19)

SRL Feature	**High-performing students** ***M (SD)***	**Low-performing students** ***M (SD)***
Task interpretation (TI)	3.10 (.44)	3.03 (.52)
Planning Strategies (PS)	2.56 (.61)	2.81 (.48)
Cognitive Strategies (CS)	2.80 (.34)	2.71 (.24)
Monitoring/Fix-up Strategies (M/F)	2.96 (.42)	2.93 (.14)

Second, a series of Mann-Whitney tests indicated that, on average, high-performing students scored higher than low-performing students on task interpretation and cognitive strategies. On task interpretation, high-performing students had an average rank of 10.17, while low-performing students had an average rank of 9.71. In addition, on cognitive strategies, high-performing students had an average rank of 10.46, while low-performing students had an average rank of 9.21. Low-performing students outperformed the high-performing students on planning and monitoring strategies. In addition, the tests were not significant on all SRL strategies (see Tables 6 and 7).

Table 6. Mann Whitney Tests: *Ranks*

SRL Feature	Group	*N*	Mean Rank	Sum of Ranks
Task Interpretation	Low-performing students	7	9.71	68.00
	High-performing students	12	10.17	122.00
	Total	19		
Planning Strategies	Low-performing students	7	11.86	83.00
	High-performing students	12	8.92	107.00
	Total	19		
Cognitive Strategies	Low-performing students	7	9.21	64.50
	High-performing students	12	10.46	125.50
	Total	19		
Monitoring Strategies	Low-performing students	7	10.21	71.50
	High-performing students	12	9.88	118.50
	Total	19		

Table 7. Mann Whitney Tests: *Test Statistics*

	Task Interpretation	Planning Strategies	Cognitive Strategies	Monitoring Strategies
Mann-Whitney U	40.50	29.00	36.50	40.50
Asymp. Sig. (2-tailed)	.87	.27	.64	.90

While differences between higher- and lower-performing students were not pronounced in the survey findings, analysis of journal writings did reveal important differences across the two groups (see Figure 2). Results show that the mean scores of SRL features using journal scoring confirm the results of survey questionnaire. On overall, the high-performing students scored higher than low-performing students on all SRL features. It means that high-performing students provided more clear and specific answers than low-performing students.

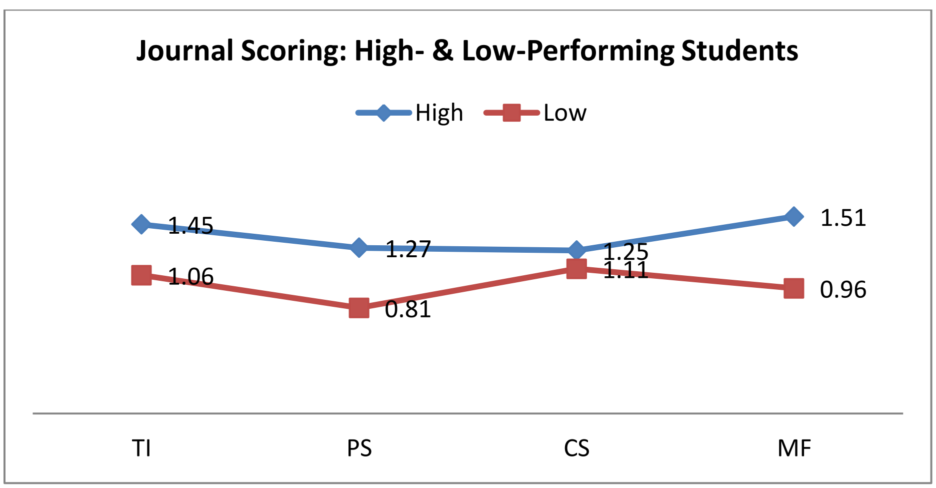

Figure 2. Comparison of journal scores for high- and low-performing students (*N* = 19)

4.3. Research Question 2: *How do male and female students differ in interpreting and deploying SRL strategies?*

Eight female and twenty-one male students were identified from students participated in the study. Since we only used 27 sets of data, it was identified that there are six female students and twenty-one male students. There are two steps we used to answer the research question. First, comparing mean scores across problem definition and conceptual design for the two groups of students (see Table 8). What can be observed here is that male students outperformed female students on the understanding of task demand and planning strategies. We interpreted this result to suggest that, while male students may have been more given to planning, survey results suggested they were not more likely to translate those plans into action. Furthermore, it was found that female students performed higher awareness on cognitive strategies and monitoring/fix-up strategies compared to male students.

Table 8. Comparison of SRL scores for male and female students ($N = 27$)

SRL Feature	**Male students (n=20)** ***M (SD)***	**Female students (n=7)** ***M (SD)***
Task interpretation (TI)	3.17 (.48)	3.02 (.34)
Planning Strategies (PS)	2.81 (.67)	2.60 (.36)
Cognitive Strategies (CS)	2.71 (.38)	2.77 (.22)
Monitoring/Fix-up Strategies (M/F)	2.82 (.46)	2.90 (.33)

Second, a series of Mann-Whitney tests indicated that, male students scored higher than female students on task interpretation and planning strategies. On task interpretation, male students had an average rank of 14.75, while female students had an average rank of 11.86. In addition, on planning strategies, male students had an average rank of 15.40, while female students had an average rank of 10.00. However, female students outperformed male students on cognitive strategies and monitoring strategies. In addition, the tests were not significant on all SRL strategies (see Tables 9 and 10).

Table 9. Mann Whitney Tests: *Ranks*

SRL Feature	**Group**	***N***	**Mean Rank**	**Sum of Ranks**
Task Interpretation	Male students	20	14.75	295.00
	Female students	7	11.86	83.00
	Total	27		
Planning Strategies	Male students	20	15.40	308.00
	Female students	7	10.00	70.00
	Total	27		
Cognitive Strategies	Male students	20	13.65	273.00
	Female students	7	15.00	105.00
	Total	27		
Monitoring Strategies	Male students	20	13.50	270.00
	Female students	7	15.43	108.00
	Total	27		

Table 10. Mann Whitney Tests: *Test Statistics*

	Task Interpretation	**Planning Strategies**	**Cognitive Strategies**	**Monitoring Strategies**
Mann-Whitney U	55.000	42.000	63.000	60.000
Asymp. Sig. (2-tailed)	.405	.120	.698	.579

Slightly different with survey findings, analysis of notebook writings did reveal important differences between male and female students (Figure 3). Notebook writing found that female students outperformed male students on clarity and detail for all SRL features.

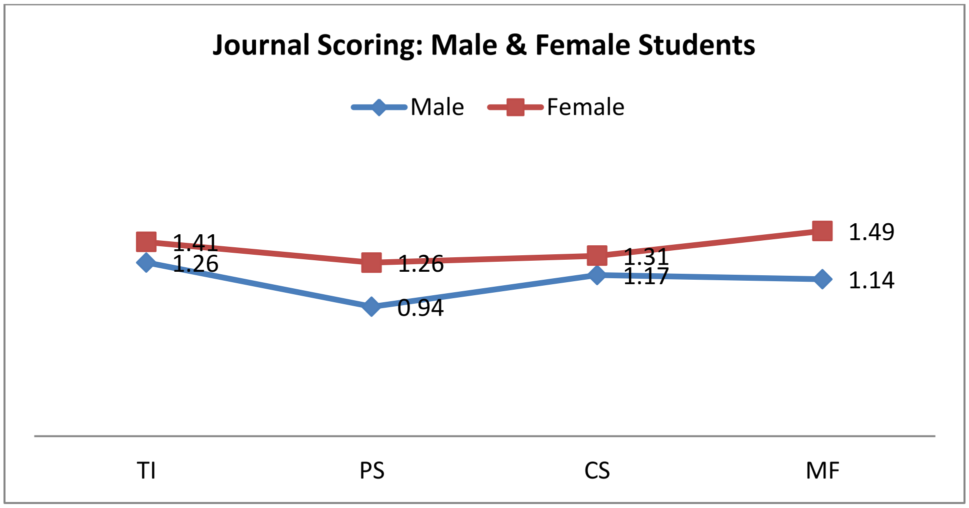

Figure 3. Comparison of journal scores for high- and low-performing students (N = 27)

5. Conclusions and Discussion

The results of this study provide clear understanding how high school students deal with engineering design activity from self-regulated learning perspectives. The findings suggest that the level of understanding of the task were high. It can be concluded from the mean value which is higher than 3.00. In contrast, students were found to be lacking in the area of planning, cognitive strategies, and monitoring and fix-up strategies.

Other intriguing results are the comparisons between high- and low-performing students, and also between male and female students. Descriptive statistics and journal analysis scoring reported that high-performing students outperformed low-performing students on all SRL features. Furthermore, when investigating how male and female students differ in interpreting and deploying SRL strategies, descriptive statistics and Mann-Whitney tests reported that female students outperformed male students in cognitive and monitoring/fix-up strategies.

Data analysis from survey questionnaire and journal writing also revealed the similar result: students had the highest score in task interpretation compared to other SRL features. It means that the students had a very high awareness in understanding the task demand. This finding is consistent with a study conducted by Atman, Kilgore, and McKenna [32]. In their study, "Understanding the Problem" is the most important design activity, not only for first- and fourth-year students, but also for experts. In addition, there was a lack of ability to transform task interpretation to planning strategies. Based upon the findings, the researcher assumes at least there are two factors influenced the way students approached the design task. First, most participants were freshman and sophomore in high school. Second, the majority thought the design task was pretty complex. These facts show that the students had lack of experiences to engage in design projects.

Future research endeavors will emerge from this work, as efforts to improve high school students' understanding of engineering are coupled with a body of literature focused on uncovering the elusive cognitive thought processes employed by students as they practice engineering design activities. As an exploratory study, this study will lead to another study which is to investigate student complex metacognitive practices during engineering design project. The future study will not only help enhance the body of knowledge on metacognition used in technology/engineering related design activities, but it also helps us understand how metacognition matures over time (from secondary to post-secondary education levels). In addition, the researcher plans to involve a higher number of participants in order to minimize attrition level and increase the statistical power. This effort will improve the generalizability of the results of the study.

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