Promoting Self-regulated Learning in Science: A Case Study of a Sri Lankan Secondary School Science Teacher

K. Prabha R. Jayawardena, Christina E. van Kraayenoord, and Annemaree Carroll

***Abstract*—The literature highlights the importance of self-regulated learning (SRL) in fostering students' achievement. The research to date has paid little attention on developing in-service secondary school science teachers' practices that foster SRL. This paper reports on part of a larger study of senior secondary school teachers' practices used to foster science achievement and an examination of how these practices related to SRL. In this paper, the case study of one senior secondary school science teacher is presented. Classroom observations and a semi-structured interview were used to collect data. The case study teacher used several practices to help students to develop aspects of SRL, such as goal setting, modeling, scaffolding, and developing learner autonomy. However, teaching practices that are advocated for the development of SRL such as problem-solving and critical thinking were not prominent in her teaching practices. It seems that the overloaded science syllabus, limited resources were barriers for her to use teaching practices that foster SRL.**

***Index Terms*—Secondary school, science, self-regulated learning, teachers' practices, case study.**

I. Introduction

There is a wide range of empirical evidence that SRL is important in students' academic achievement [1], [2]. SRL has been defined as the "processes that learners use to activate and maintain cognitions, emotions, and behaviours to attain personal goals" [1]. Researchers have identified that SRL is important because a major function of school is to encourage students to be autonomous and lifelong learners [3]. Teachers play a crucial role in promoting students' SRL. Self-regulatory processes or beliefs (e.g., goal setting, strategy use, self-evaluation) can be taught [4]. Teachers' use of modeling and scaffolding and acting as a mentor or coach promote SRL in classrooms [5]. Some researchers have emphasised the importance of teachers' knowledge about SRL [5]. One group of authors has suggested that a student's eventual level of expertise in SRL depends on how their own teachers elect to engage them in SRL-promoting experiences [6]. In the classroom situation, students are faced with new knowledge and skills that they want to learn or have to learn. If there is no external guidance from a teacher or others, students have to regulate their own learning processes [7].

Research indicates "unfortunately, not all learners are effectively self-regulating. Some students have difficulty gauging their learning strengths and weaknesses and how these interact with the demands of particular tasks" [7]. Many students, across a wide range of ages and contexts do not regulate their learning capacities in ways that are academically effective [8]. For these reasons teachers play a pivotal role in promoting SRL.

Research highlights the importance of SRL and the teacher's role in facilitating SRL [2], [9]. Although research findings strongly support the importance of students' use of self-regulatory processes, few teachers effectively prepare students to learn on their own [9], [10]. Even though SRL is important for teachers, research suggests that teachers lack knowledge about how much and what kinds of support they need to provide their students in order to enhance their SRL capacities [5], [10]. That is, many teachers lack the knowledge and skills to promote SRL to enhance their students' learning [9], [10].

Whilst considerable research about the development of SRL has been carried out at primary and middle school levels, only a few studies have involved secondary/senior secondary teachers (e.g., in language [11]; mathematics [12]. Despite the importance of secondary school teachers' promotion of SRL, studies of teachers' practices related to SRL in science have not been found. A larger study [13] therefore investigated senior secondary school teachers' practices used to foster students' science achievement and to examine how these practices related to SRL. This paper refers to a case study of a Sri Lankan senior secondary school science teacher from this larger study.

II. Method

A. Aim and Key Research Question

The aim of the case study was to examine the role of the teacher and her teaching in shaping her students' learning in science, and possibly their SRL. The key research question for the case study was: What practices does this teacher use to foster students' science achievement and which of these practices are related to SRL?

B. Participant

The case study teacher, MrsMalee (pseudonym) taught science to senior secondary students (Grades 10 and 11) at the Mathugama National School in the Kalutara district of Sri Lanka.

C. The Instruments

The instruments comprised the Classroom Observation Protocol and the Semi-structured Interview. The researcher

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developed the instruments based on the model fromVrieling, Bastiaens, and Stijnen [14].

D. The Procedure for Data Collection

The researcher observed two chemistry and physics lessons given by Mrs. Malee to her Grade 10 students during scheduled 40-min lessons. After conducting the two classroom observations, the semi-structured interview was conducted in the Sinhala language and recorded using a digital voice recorder. The interview was 65-minin duration. Quotes were later translated into English.

III. Data Analysis

The data collected from the classroom observations and interviews were analysed using inductive and deductive thematic analyses. Two sweeps of the data were undertaken during the analysis. In Sweep 1, the researcher used detailed readings of the data to derive themes, and then identified the commonalities and relationships amongst them. In Sweep 2, the key themes from both data sources were analysed using deductive thematic analysis in relation to some of the components of Pintrich and Zusho's (2007) model [15]. Triangulation and member checking were undertaken.

IV. Results

A. Understanding Mrs Malee and Her Teaching Practices

At the time of data collection, Mrs. Malee had spent all12 years of her teaching career at the school. She had taught science to Grade 10 and 11 students for two years. Before that she had taught science in Grades 12 and 13. She had a Diploma in Science from the Siyane National College of Education, Sri Lanka.

Four key themes relating to the goals of Mrs Malee's teaching are reported first. They were: 1) developing scientific learners; 2) developing students' science interests; 3) helping students to achieve their goals; and 4) developing students' independent learning. In addition the teaching practices used by Mrs Malee to develop these goals are presented.

B. Developing Scientific Learners

Mrs. Malee aimed to help her students to develop their scientific thinking. Three themes related to her teaching practices emerged from the data: i) practices to build knowledge; ii) practices to help students learn together; and iii) practices that assist students to retrieve knowledge.

C. Practices to Build Knowledge

In building students' knowledge, Mrs Malee used the practices of: i) assisting students to apply scientific knowledge to everyday life; ii) practices to activate the students' prior knowledge; iii) modelling and scaffolding; and iv) using visual representations. For example, Mrs Malee explained the way she activated students' prior knowledge.

Sometimes I ask questions related to their prior learning in Grades 7 to 8. For example, when I teach force, I ask the students how did you define "force" in Grade 7? Then, students define "force" according to their prior knowledge. I start the new lesson on the basis of their previous knowledge. (207-210).

She asked questions and allowed time for the students to think and recall their new knowledge based on their pre-existing knowledge. In the first observed lesson, Mrs. Malee used modelling and scaffolding to teach the functions and safe use of a Bunsen burner. When Mrs Malee modelled how to manipulate the flame of a Bunsen burner, she made suggestions about what the students could do, gave occasional hints to the students on what to do next, and asked metacognitive questions (e.g., "What would occur if you open the air hole fully?") which may help the students to develop their self-regulatory skills. She also referred to three practices related to visual representations that she used to build students' knowledge. They were the: i) visualization and illustration of science concepts; ii) use of graphs; and iii) use of models. For example, Mrs. Malee asked her students to draw and make their own sketches of the concepts being taught, labelling each part with the name and function in order to help visualization of the abstract concepts such as motion or force. Mrs. Malee also said that she often used models to develop students' understanding of other concepts (e.g., chromosome).

D. Practices to Help Students Learn Together

Mrs. Malee used group discussions and group experiments to help students learn together. In the first lesson that was observed she encouraged the students to conduct experiments related to factors affecting the rate of chemical reactions. She thought group experiments provided students with shared opportunities to develop their scientific thinking skills.

E. Practices That Assist Students to Retrieve Knowledge

Mrs. Malee also described several memory techniques that she thought assisted students to retrieve knowledge. For example, she encouraged students to create a glossary, engage in rote learning, and make their own notes. Another memorisation technique that she thought would assist her students to retrieve science concepts and theories were to write their own notes when they read their textbooks or classroom notebooks.

F. Developing Students' Science Interests

Mrs. Malee believed that science teachers played a key role in fostering students' initial interest in science. She thought a teacher's enthusiasm for science could influence students' own interests in the subject. In addition, she perceived that praising students for their achievements and encouraging students' talents and abilities were important in fostering their science interests. She also thought that a science teacher's use of a variety of practices that focused on student engagement (e.g., group discussion, hands-on activities) played a role in sparking students' science interests. She described how she used hands-on activities in her science class:

I ask students to make a model of the atom. Students talk about how to make the model with their peers and they have opportunities to see what they are doing, what they are going to be learning about in the lesson when they engage in hands-on activities (136-139).

She also encouraged the use of observation to tackle the students' lack of understanding about the natural environment. She organized fieldtrips to further address students' science interests. She encouraged students to inquire about phenomenon in their environment and to ask themselves questions about the relationship between what they saw and their experiences and their own lives. In addition, she believed that the use of technology such as science CDs, videos, and chemistry and physics software assisted her students to develop their science interests.

G. Helping Students to Achieve Goals

Mrs. Malee helped her students to set goals and helped them to achieve them. These goals related to: i) learning goals; ii) achievement in exams; and iii) future career goals. At the beginning of the first term, she helped her Grade 10 students identify their goals in science learning by asking them to list them. She noted that many of the students' goals were to obtain high grades in the General Certificate of Education (Ordinary Level) exam. She provided past exam papers to assist with revision and examination preparation. She believed that the perusal of examination papers from previous years and the answering of set questions helped her students become familiar with a range of questions and the patterns of questions, and also provided practice in managing time requirements. In addition, she directed students to identify their personal career goals and helped them towards these goals.

H. Developing Students' Independent Learning

Mrs Malee assisted students to develop their independent learning. She pointed to the importance of encouraging students to take responsibility in their learning. She described two ways in which she provided choice to the students. She provided the students with choice to: i) select their own topics and learning materials for assignments, and ii) select group members. She also promoted students' independence in their learning by allowing them to: iii) change the steps in an experiment and iv) seek knowledge by themselves (e.g., the Internet, science journals, and educational CDs).

Mrs Malee referred to several barriers that influence her teaching practice in science.

I. Barriers to Teaching and Learning

When discussing barriers that hindered Mrs Malee's science teaching, she spoke about the lack of time to complete the overloaded syllabus as the main barrier that limited the opportunities of her to use a range of teaching practices in science. She also commented on the lack of space, equipment, and chemicals to conduct group experiments as other barriers that influenced her science teaching.

V. Discussion

The findings showed that Mrs Malee engaged in a range of practices to develop students' achievement in science. They included activating students' prior knowledge, modelling and scaffolding, group discussions, providing hands-on activities, and using visual representations. When these teaching practices were examined to see if they were related to the development of SRL, there were several practices that fostered students' SRL. Specifically, as part of "developing scientific learners", Mrs Malee helped students to develop SRL through modelling and scaffolding. Several other studies suggest that the teachers' use of modelling and scaffolding promotes students' SRL [5], [16]. Similarly, when Mrs Malee modelled how to manipulate the flame of a Bunsen burner, she scaffolded the students' learning by asking metacognitive questions that helped the students to develop their SRL in science.

In "developing students' science interests", Mrs Malee used hands-on activities. Using hands-on activities to trigger high school students' science interests has been found in other studies [17], [18].

As part of "developing students' independent learning", Mrs Malee said that she allowed students to choose group members with whom they would complete their experiments. Providing choice to students when participating in learning activities has been found to foster independent learning (e.g., [7], [19]).

VI. Conclusion

Mrs Malee developed students' science achievement by using a variety of practices. She also engaged in some practices that developed SRL. However, a closer examination of Mrs Malee's teaching practices revealed that typically she focused more on the transfer of factual information associated with the lesson from herself to the students. This suggests that she was the main knowledge provider in the classroom and that her use of practices to develop SRL were limited. Teaching practices that are advocated for the development of several aspects of SRL such as problem-solving and critical thinking were not prominent in Mrs Malee's teaching practices. Perhaps the time constraints in covering the extensive science syllabus and the lack of resources (e.g., equipment, chemicals, and space) have hindered Mrs Malee to use teaching practices that foster SRL in science.

VII. Limitations of the Study

There are three limitations. The use of a single case study in this paper does not allow generalization to senior secondary school science teachers at large. The case study was limited in terms of grade levels (i.e., Grades 10 and11 only), and school type (i.e., a national school). Only two science lessons were observed for Mrs Malee and this affected any opportunities to observe changes (if there were any) in Mrs Malee's teaching practices.

VIII. Implications

Teachers need to have opportunities to acquire teaching practices that can be used to develop students' SRL. Mrs Malee could be encouraged to pursue professional learning that focuses on the development of her knowledge and skills related to SRL and applied in the context of students' science learning. It is important that the Sri Lankan Ministry of Education and it authorities provide such opportunities for

secondary science teachers.

IX. Directions for Future Research

Future research could be undertaken to examine the effects of professional learning that promotes teachers' knowledge and skills in fostering students' SRL in science. Furthermore, research could investigate the effects of particular teaching practices related to SRL on promoting secondary school students' science achievement.

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