The Development of a Rubric to Assess Science Teachers' SRL Knowledge and Application

Xiaorong Zhang [1], Anastasia Kitsantas [1], Erin E. Peters-Burton [1], Timothy J. Cleary [2], Kimberly McLeod [1], and Jacqueline Slemp [2]

George Mason University [1] and Rutgers, The State University of New Jersey [2]

ABSTRACT

The purpose of the present study was to describe the development and provide initial psychometrics of a rubric designed to evaluate science teachers' self-regulated learning (SRL) knowledge and application in the context of computational thinking. Specifically, the goal of this rubric was to assess science teachers' SRL knowledge and application across several dimensions including breadth, depth, strategy use, and action plan in implementing SRL. Participants included 20 in-service high school science teachers. SRL data were collected before and after a week-long professional learning workshop using open-ended questions and a vignette. Following systematic coding of the data, the newly developed rubric was found to be a useful tool for measuring gains in teachers' knowledge and application of SRL. A high level of inter-rater reliability was obtained for most of the dimensions. Educational implications were discussed.

INTRODUCTION

Self-Regulated Learning in Science Education

- SRL refers to the process where learners self-generate thoughts, feelings, and behaviors oriented to attaining goals (Zimmerman, 2000).
- Research has suggested the importance of incorporating SRL in science education (DiBenedetto & Zimmerman, 2013; Peters-Burton, Cleary, & Kitsantas, 2018; Schraw, Crippen, & Hartley, 2006)

Instruments Measuring Teacher SRL

A number of instruments existed in the literature assessing teachers' SRL. Examples include:

- Teachers' own use of SRL (Motivated Strategies for Learning Questionnaire by Pintrich et al. [1993] in Buzza &Allinotte, 2013)
- Teachers' beliefs about SRL (e.g., Self-Regulated Learning Teacher Belief Scale in Lombaerts et al., 2009)
- Teachers' application of SRL in class (e.g, self-report scale by Adagideli et al., 2017)
- Teachers' knowledge of SRL (Dignath-van Ewijk &van der Werf, 2012)
  - Coded as student autonomy vs. learning strategy

However, none of these measures thoroughly evaluate teachers' knowledge of SRL that is fundamental in teachers' application of SRL (Dignath-van Ewijk & van der Werf, 2012).

Thus, the purpose of this study was to develop a rubric to evaluate science teachers' SRL knowledge and application.

METHODS

Participants

- 20 in-service secondary science teachers (16 females, 4 males; 17 Caucasians, 3 Asians) from a suburban public school district in the Mid-Atlantic region of the United States.
- The four subjects of focus included: Biology (10 teachers), Physics (4 teachers), Earth Science (2 teachers), and Chemistry (4 teachers).

Data Collection

- Part one assessed science teachers' SRL knowledge through an open-ended question, asking teachers to define and describe SRL as specifically and comprehensively as they understood it.
- Part two included a vignette describing a struggling student's lack of SRL strategies in his science learning. At the end of the scenario, science teachers were asked to list specific things they could do to help the struggling student improve his SRL and to explain their thinking.
- These data collection instruments were administered before and after a one-week professional learning workshop that aimed to promote science teachers' knowledge and application of SRL.

Data Analysis

- Two trained graduate students used this rubric to code 20 teachers' pretest and posttest responses individually.
- They then met to discuss and resolve all the disagreements.
- Teachers' knowledge and application in the pretest and posttest were compared.

Table 1. SRL Phases and Strategies

SRL Phase	Forethought	Performance	Self-Reflection
SRL Examples/ Techniques	. Task analysis ◦ Goal setting ◦ Strategic Planning . Self-motivation beliefs ◦ Self-efficacy ◦ Outcome expectations ◦ Task interest/value ◦ Goal orientation	. Self-control ◦ Task strategies ◦ Regulatory strategies . Self-observation ◦ Metacognitive monitoring ◦ Self-recording	. Self-judgment ◦ Self-evaluation ◦ Causal attribution . Self-reaction ◦ Self-satisfaction/affect ◦ Adaptive/defensive inferences

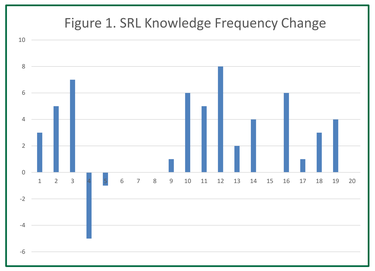
The SRL Knowledge and Application Rubric

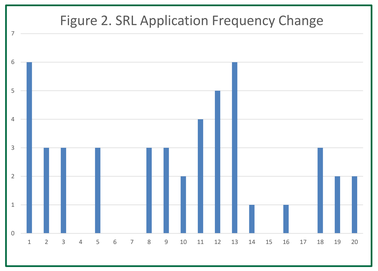
- The SRL Knowledge and Application Rubric was developed based on the key components of SRL that had structured the professional learning session (Zimmerman, 2000).
- The rubric included a general frequency section and a quality section.
  - In the frequency section, the incidence of key SRL components was identified from teacher responses either as Yes (1) or No (0; see Table 1).
  - The quality section for SRL knowledge consisted of three dimensions: **breadth** (the inclusion of SRL phases and strategies), **depth** (the level of detail in the response), and **iterative cycle** (mention of iterative loop).
  - The quality section for SRL application was comprised of three dimensions: **breadth** (the inclusion of SRL phases and strategies), **strategy explanation** (level of explanation in terms of the strategies recommended), and **action plan** (level of robustness of the action plan and justification provided).
- Each dimension was evaluated by a 1-3-point scale (see Table 1). Scores were added up for knowledge and application separately, ranging from 3-9. Responses to the quality section for both knowledge and application were categorized into one of four categories based on the following descriptors (total scores): No Basis (3); Beginning (4 or 5); Developing (6 or 7); and Proficient (8 or 9).

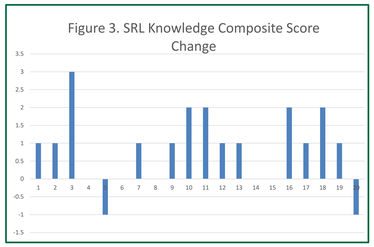
Table 2. SRL Knowledge and Application Rubric

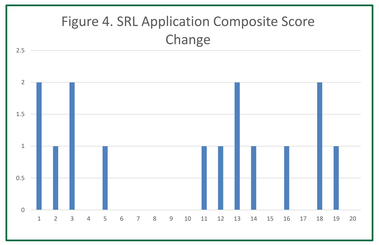
	Dimensions	1	2	3
SRL Knowledge	Breadth To what extent do the strategies mentioned fall across the three phases	0 phases	1 or 2 phases	3 phases
	Depth The level of detail/ explanation the respondent provided	Not explained (no examples, description, or elaboration on phases provided)	Partially explained through a definition. Explanation is vague or incomplete, demonstrating some understanding of SRL.	Full in-depth explanation or multiple examples. Explanation is clear and complete, demonstrating good understanding of SRL.
	Iterative cycle	No mention of the SRL cycle/loop	Mention of cycle/loop with no integration	Mention of cycle/loop with integration between at least two phases
SRL Application	Breadth To what extent do the strategies mentioned fall across the three phases?	0 phases	1 or 2 phases	3 phases
	Strategy explanation Level of detail/explanation the respondent provided in strategies recommended	None of recommended strategies have adequate explanation	1-2 recommended strategies have adequate explanation	More than 2 of the recommended strategies have adequate explanation
	Action Plan Level of robustness (i.e., specificity, actionability, and justification) the respondent provided in the action plan of the highest quality	No specific, actionable step(s) that can be directly implemented by the student	Specific, actionable step(s) that can be directly implemented by the student	Specific, actionable step(s) that can be directly implemented by the student. It also includes a justification for how/why it targets that specific strategy.

RESULTS









RESULTS AND DISCUSSION

- Results showed that teachers' SRL knowledge and application improved after the PD (N=17).
  - The number of strategies identified in teachers' SRL knowledge and application responses increased in all individual teachers except for four(see Figure 1 and 2).
  - The quality of the response in the teacher knowledge improved in all three dimensions following the PD program. Specifically, the number of "No Basis" and "Beginning" responses greatly decreased and that of "Developing" and "Proficient" responses largely increased. All but five teachers had an increase in their composite score (see Figure 3).
  - In terms of the quality of teachers' SRL application, five teachers did not change following the PD program, and all the other teachers had an increase in their composite score (see Figure 4).
  - Initial analysis of interrater reliability between two independent coders revealed adequate reliability at pretest for knowledge and application, but mixed result for the posttest.
- In summary, the present rubric appeared to be a helpful tool in evaluating teachers' SRL knowledge and application.
- Additional research is needed to further refine the rubric, evaluate the psychometric properties of the rubric (e.g., using class videos to document teachers' implementation of SRL), and establish its utility evidence.

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