Studies in Educational Evaluation 50 (2016) 1–13

Contents lists available at ScienceDirect

Studies in Educational Evaluation

journal homepage: www.elsevier.com/stueduc

Reflection and assessment for learning in science enrichment courses for the gifted

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ARTICLE INFO

Article history:
Received 7 November 2015
Accepted 28 May 2016
Available online xxx

ABSTRACT

This study was conducted in enrichment programs for the gifted. It aimed to address the relative absence of suitable assessments in such programs. Although enrichment programs for students with special talents expose them to various areas of knowledge and to science ideas that are usually not taught at their regular school (e.g., Pitts, Vebville, Blair, & Zadnik, 2014), they lack consistent and thoughtful assessments. Despite calls for including suitable modes of assessment in programs for the gifted in order to respond to their unique capabilities (Van Tassel-Baska & Stambaugh, 2006; Gagné, 2011) and to enhance the students' self-regulation and metacognitive abilities (Taber, 2007), most of the programs include only summative assessment.

In the study, we intended to show that the "Assessment for Learning" (AfL) framework (Birenbaum et al., 2006; Shepard, 2000) that was employed in project-based science courses for the gifted enhanced the students' reflective thinking and metacognitive processes. Furthermore, we hope that incorporating AfL in these programs would contribute to the design of suitable curriculum projects for gifted students. Although our study is focused on students with special talents, we believe that instruction that enhances the development of metacognitive skills is important to all students regardless of their intelligence or academic level. The multidimensional assessment framework that was employed in this study encompassed various modes, such as self, peer, teacher and expert assessment, and was employed throughout project-based science courses for gifted students in a pull-out program. In aim to understand the way assessment for learning affects reflection of gifted students we addressed the following research question:

In what ways student reflective skills and metacognitive thinking processes were expressed in the context of self- and peer-assessment?

1. Theoretical Background

The theoretical framework of this study ties assessment for learning with the development of cognitive processes that are comprised of higher thinking strategies in general and such of gifted students in particular.

Our study is framed by the sociocultural perspective, which focuses on science learning as a human social activity conducted within institutional and cultural frameworks (Lemke, 2001). Social interactions among learners and between learners and teachers are central in the context of programs for the gifted in Israel.

2. Assessment for Learning

The shift from assessment of learning to assessment for learning is rooted in the mid-1980s, while the awareness of educators in the Western world towards changing the traditional assessment methods employed at schools has substantially increased (Black, 1995). While Assessment of Learning (AoL) is commonly single dimensional, summative, and detached from the curriculum, Assessment for Learning (AfL) is multi-dimensional, formative, flexible and integrated into the curriculum (Birenbaum et al., 2006; Corrigan, Buntting, Gunstone, & Jones, 2013; Cowie, 2012).

AfL is characterized by the use of authentic tasks that are performed in real or simulated situations. It allows assessing higher order thinking skills, it is continuous, reflective, and enables

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http://dx.doi.org/10.1016/j.stueduc.2016.05.001
0191-491X/

attention to differences among students (Treagust, Jacobowitz, Gallagher, & Parker, 2001). Consequently, AfL allows teachers and learners to gain information about the students' learning progression.

Although this study was conducted prior to the publication of the Framework for K-12 Science Education (NRC, 2012) and the Next Generation Science Standards (NGSS Lead States, 2013) in the USA, and the following Developing Assessments for the Next Generation Science Standards (2014), it is in line with these influential documents' focus on more meaningful assessments that intend to promote deep learning of scientific ideas which are integrated with science and engineering practices and cross-cutting concepts. We believe that the integration of AfL with project-based science addressed the NRC formwork's emphases. As stated in the Developing Assessments for the Next Generation Science Standards (2014).

> formative assessments may also be used for reflection among small groups of students or by the whole class together. Classroom assessments can play an integral role in students' learning experiences, while also providing evidence of progress in that learning (p.85).

The idea that learning is promoted through social interaction and conversations, and that formative assessments help to elicit a range of students thinking, and provide opportunities to advance students learning (Corrigan et al., 2013; Cowie, 2012; Furtak & Ruiz-Primo, 2008) was at the background of this study. More specifically, this study was informed by the importance associated with dialogic learning (Ash, 2004). In the sociocultural view, what matters to learning and doing science is primarily the socially learned cultural traditions of what kinds of discourses and representations are useful and how to use them (Lemke, 2001).

One way to integrate the individual and social aspects of assessment is by using both self- and peer-assessment which are key features of Integrated Assessment Systems that represent AfL (Birenbaum et al., 2006). Self assessment means more than students just grading their own work. It means involving them in determining what good work in a given situation is (Topping, 2003). It allows learners to address the level, value or quality of their own products or performances. The students assess their performances according to criteria suggested through discussions with the teacher and these criteria are usually related to the content and the skills taught and practiced in class.

Peer assessment is grounded in the philosophy of active learning and in the sociocultural theory (e.g., Vygotsky, 1962; Gipps, 1999), as it involves the construction of knowledge through discourse. It refers to the opinions of colleagues regarding the work of an individual according to criteria formulated ahead of time by the participants in negotiation with a teacher (Fachikov and Golfinch, 2000; Topping, 2003). Peer feedback can promote action and reflection, which help the students in turning their experiences into accessible, discussing the rationale behind their own decisions and hearing about the designs and rationales of others. This helps them identifying what else they need to learn and how to come up with better solutions (Topping, 2010). Self and peer assessments are frequently accompanied by teacher's assessment, which is often considered as more credible (Maclellan, 2001). The teacher is expected to engage students in discussion and feedback conversation as well as provide the opportunity to negotiate criteria for assessment.

3. Metacognition

Metacognition emphasizes the active role of the learner during knowledge construction, and the learner's ability to monitor and control learning processes (Gunstone, 1994; Tsai, 2001). Brown et al. (1983) stated that in order to become effective learners, students need to know something about themselves, their learning activities, the demands of various learning tasks, and the inherent structure of materials. In other words, students must *learn how to learn* (p.106). Metacognition is perceived as the knowledge and awareness of the individual's own cognitive processes and the ability to monitor, regulate and evaluate one's thinking (Brown, 1987; Flavell, 1979; Schraw & Dennision, 1994; Schraw, Olafson, Weibel, & Sewing, 2012). Schraw (1998) suggested that metacognition consists of both knowledge about cognition, and regulation of cognition. Some scholars refer to these two components as metacognitive knowledge and metacognitive skills (Schraw et al., 2012). In this study, we adopted Schraw (1998) terminology.

Knowledge about cognition relates to many diverse experiences: declarative knowledge (what), procedural knowledge (how) and conditional knowledge (why and when). Declarative knowledge includes knowledge about oneself as a learner and the factors that affect performance; procedural knowledge is knowledge about strategies that can be employed to improve performance whereas conditional knowledge refers to knowing when and why to use declarative and procedural knowledge (Schraw, 1998; Schraw & Dennision, 1994; Yore & Treagust, 2006).

Regulation of cognition consists of *planning* activities prior to tackling a problem (predicting outcomes, scheduling strategies, various forms of vicarious trial and error, etc.), *monitoring* cognitive activities during learning (testing, revising, rescheduling one's strategies for learning), and *checking* their outcomes (evaluating the outcome of any strategic actions against criteria of efficiency and effectiveness) (Brown, Bransford, Ferrara, & Campione, 1983; Schraw, 1998; Schraw et al., 2012).

Metacognition is often viewed as a process which is both individual and social in nature (e.g., Adler, Zion, & Mevarech, 2015; Hogan, 1999; Iiskala, Vauras, Lehtinen, & Salinen, 2011; Schraw, Crippen, & Hartley, 2006; Volet, Vauras, & Salonen, 2009). Anderdon et al., (2009) revealed that in addition to the traditional individual-centered view of metacognition, other metacognitive processes and knowledge about cognition exist that serve the *collective* and *individual* actions of group members on both learning task and social relationship levels. They claimed that students are highly aware of their social status and the group's social condition, that they monitor these conditions carefully, and employ strategies that support the task as well as their social relationships. Moreover, group members can co-construct knowledge and even experience social regulation of other's cognitive and metacognitive processes (Volet et al., 2009). This co-construction of knowledge means that they can be engaged in mutual discovery and reciprocal feedback (Adler et al., 2015). Iiskala et al. (2011) examined metacognition in collaborative problem-solving processes. They found that the participants experienced socially shared metacognition (i.e., shared experiences, jointly monitored and regulated a cognitive process towards a common goal). Adler et al., (2015) developed a model to develop students' environmental literacy, in which they explicitly embedded a metacognitive guidance in open based-inquiry learning. The model included students' interactions between a pair of students working on an inquiry project and interactions among students working on different projects. They found that these social interactions triggered the students to self-examination and identification of personal environmental behaviors. In addition, they had more opportunities to provided feedback to each other, exchange ideas, insights and strategies and it fostered their motivation to learn

4. Reflection as a metacognitive activity

Metacognition is more likely to be evident in situations that stimulate a great deal of careful, highly conscious reflection.