Enhancing Teacher Education Students' Collaborative Problem-Solving and Shared Regulation of Learning

Piia Näykki, University of Oulu, Finland, piia.naykki@oulu.fi
Johanna Pöysä-Tarhonen, University of Jyväskylä, Finland, johanna.poysa-tarhonen@jyu.fi
Sanna Järvelä, University of Oulu, Finland, sanna.jarvela@oulu.fi
Päivi Häkkinen, University of Jyväskylä, Finland, paivi.m.hakkinen@jyu.fi

Abstract: This study aims to explore how collaborative problem solving (CPS) and socially shared regulation of learning (SSRL) can be enhanced in practice in a technology-rich collaborative learning context within the domain of mathematics. The participants of this study are first-year teacher education students in two Finnish universities. This paper will elaborate how collaborative problem solving (CPS) and socially shared regulation of learning (SSRL) can be supported by scripting and prompting. It is argued here that we need theory-based pedagogical designs for developing effective collaborative learning practices that aim to provide students with possibilities to experience the new collaborative, technology-rich learning culture as teachers-to-be.

Keywords: collaborative problem-solving, socially shared regulation of learning, teacher education

Introduction

21st century skills, such as skills for collaboration and collaborative problem solving, and an ability to take an active role in one's own learning and in the learning of others as well as to make use of technologies in these areas are highlighted as success factors in modern society (e.g. Griffin, McGaw, & Care, 2012). Teacher education students have a significant role in acquiring first-hand experiences of novel learning practices to graduate not only with task mastery but also with adequate skills required in the 21st century. However, skills for collaborative learning do not occur naturally, and the experiences gained by the students are not always positive (Häkkinen et al., 2010; Näykki et al., 2014). For example, when learners are left alone without any guidance, they rarely engage in productive and knowledge-generative interactions (Kirschner et al., 2006) and varied cognitive, motivational, and socio-emotional challenges may emerge (Näykki et al., 2014; Van den Bossche et al., 2006). To face these challenges, we need theory-based pedagogical designs for effective collaborative learning practices that aim to provide student teachers with opportunities to experience the new collaborative, inquiry-based and technology-rich learning culture.

Albeit collaborative problem solving (CPS) skills (Griffin et al., 2012; Griffin & Gare, 2015) and skills for regulation of learning (self-regulated learning, SRL and socially shared regulation of learning, SSRL) (Hadwin, Järvelä, & Miller, 2011) are theoretically characterized as an important part of collaborative learning, little is known about how those skills can be promoted with pedagogical instruments (i.e. scripting, prompting and utilizing technological tools). To rise to these challenges, this study aims to operationalize and combine the notions of CPS and SSRL theories into practice and to implement a theory-based pedagogical and technological design to support CPS and SSRL skills development as a part of inquiry-based teacher education practices in the mathematics domain.

CPS and SSRL skills in collaborative learning

Problem solving, in its individual meaning, points to the activity involving problem identification and analysis, problem representation, planning, executing, and monitoring (Hesse et al., 2015). Collaborative problem solving (CPS) (Griffin et al., 2012; Griffin & Gare, 2015) is a specific form of collaboration, where two or more learners need to externalize the aforementioned problem solving stages (Hesse et al., 2015). That is, to communicate, exchange and share the identification of parts of the problem, their interpretation of the connections between the parts, relationships between action and effect (rules) and the generalization they propose in search for the solution (Hesse et al., 2015). In the PISA 2015 study (OEDC, 2013), CPS competency is defined as the capacity of an individual to effectively engage in this joint and shared problem solving activity. In order to reach the common goal, CPS requires participants to share their understanding and successfully combine their knowledge, skills and efforts (OECD, 2013). However, CPS does not rely on a uniform skill, but draws on a set of sub-skills defined in the ATC21S™ project (Assessment and Teaching of 21st Century Skills; Griffin et al., 2012; Griffin & Gare, 2015). CPS skills consists of five strands of individual and group level capacities under the broad skill classes of social and cognitive skills (Hesse et al., 2015). Following Hesse and colleagues (2015), social skills (i.e. participation, perspective taking, social regulation) are about managing participants (including oneself), referring to the "collaborative" part of collaborative problem solving. Cognitive skills (i.e. task regulation, knowledge building), then, are about managing the task, referring to the "problem solving" part of collaborative problem solving. These skills do not proceed linearly but may overlap and run parallel between the different stages of the CPS process

High-level collaborative learning requires metacognitive, motivational and emotional efforts, which are operationalized here through the theories of self-regulated learning (SRL) and socially shared regulation of learning (SSRL) (Hadwin et al., 2011). Regulation (SRL at individual level and SSRL on group level) in group context means that students are engaged in metacognitive monitoring and controlling of motivation, cognition, and behavior – in addition to and as a requisite for task-level activities. Effective regulation processes in collaborative learning require, for example, groups to set goals and standards together, and to jointly monitor and evaluate their progress against these standards (Zimmerman, 1989). Self-regulated learning theory and the concept of SSRL extend ideas of successful (collaborative) learning beyond cognitive processes and outcomes, acknowledging the interactive roles of motivation, emotion, metacognition, and strategic behavior in successful learning (Järvelä & Hadwin, 2013). Järvelä and others (2014) summarize the need for supporting the challenging factors of collaboration in terms of the cognitive level (i.e. task understanding, content understanding, use of learning strategies), motivational level (i.e. goals, interests, beliefs, expectations), and emotional level (i.e. trust, sense of community).

CPS and SSRL processes both target the cognitive and metacognitive levels: i.e. problem identification, problem representation, planning, execution and monitoring (Hesse et al., 2015; Winne & Hadwin, 1998). Furthermore, both theoretical constructs include the social level, as (meta)cognitive functioning is targeted within group interaction. Like SSRL, CPS, at its core, considers students' academic engagement in joint and shared problem solving activity as an intentional and goal-oriented activity. But even though CPS competency includes regulation activities and the understanding of the role of students' engagement in successful problem solving (Hesse et al., 2015), CPS seems, to a large extent, to stay in the cognitive domains of regulation. Also, except for the knowledge building strand of CPS competency, CPS mostly highlights the individual levels of collaborative problem solving (Griffin et al., 2012). However, SSRL expands on these cognitive and group-level aspects of regulation and provides broader understanding of motivation and emotion as essential parts of successful collaborative learning processes. The advantages of combining these approaches within the same framework make it possible to extend from collaborative problem solving to socially shared regulation of learning in collaborative problem solving. Furthermore, we expect that more profound and more permanent CPS and SSRL skills can be enhanced by designing theory-based pedagogical models that enable, in practice, together with the cognitive and metacognitive aspects of collaborative learning, also motivational group processes to become more visible to the teacher students.

CPS and SSRL skills in collaborative learning

Following Järvelä and others (2014), three design principles are further developed and implemented to support CPS and SSRL: (1) scripting, (2) prompting, and (3) utilizing technological tools in collaborative learning tasks. The general aim of the design principles is to increase, first, students' awareness of their own, other group members' as well as groups' learning processes. Second, the aim is to support students' externalization of situational cognitive, motivational and emotional interpretations and third, to activate problem solving and regulation skills.

Collaborative learning scripts are defined as activity models that aim at enhancing knowledge generative activities during collaborative learning (Tchounikine, 2008). In brief, the scripts may vary from rather coarse-grained macro-scripts (i.e. pedagogical models, such as jigsaw) to more fine-grained micro-scripts (i.e. a model of argumentation) (e.g. Dillenbourg & Hong, 2008). This paper relies on the first approach. In this regard, we have designed a macro-script, a pedagogical PREP21 model that combines elements of both CPS/SSRL processes. The structure of the designed model implements the cyclical idea of SRL learning theories (e.g. Zimmerman, 1989). Starting with orienting and planning whereby groups set goals for their learning (forethought phase), followed by strategic learning activities that are constantly monitored and controlled (performance phase), and completed by reflection and evaluation (reflection phase). The pedagogical model thus includes the elements of purposeful, intentional, and goal-oriented collaborative activity, also recognized as essentials of successful collaborative problem solving processes (Hesse et al., 2015).

To activate and to enhance CPS and SSRL skills, specific prompts utilizing iPads will be designed and used as a part of the pedagogical model of PREP21. Prompting is defined here as an instructional method for guiding and supporting students to activate their problem solving and regulation activities while engaged in task performance (Bannert & Reimann, 2012). Such prompts will focus students' attention on their group members' thoughts and understanding and stimulate cognitive and metacognitive processing. Question prompts will thus instruct groups to stop and reflect on their thoughts or consider the efficiency of their strategies. It is presumed that individual and group level awareness is one of the main factors supporting group members to set goals, monitor and control group functioning as well as evaluate groups' performance and outcomes.

Methods

Design and participants

The study described here is an ongoing sub-study of a four-year research project that aims to promote future teachers' CPS and SSRL skills, and competencies and attitudes towards the use of ICT in teaching and learning. The project includes long-term data collection (during 2014-2016) that combines a quantitative self-report approach and a qualitative process-oriented approach. The sub-study here is part of the latter approach. The participants of the sub-study are first-year teacher education students (n=90) from two Finnish universities, following a mathematics course in early spring 2015. The course design implements the ideas of inquiry-based education to engage students in authentic, ill-structured and complex problem solving. During the task, the students will be working as groups of three to four members. To support the students' working processes, a theory-based pedagogical model that includes prompts and technological tools will be utilized. Technological tools will be implemented for two purposes; firstly, to activate the groups' CPS and SSRL processes and secondly, to support the groups' knowledge co-construction (i.e. through domain specific tools, such as GeoGebra).

Procedure and expected outcomes

The focus of this sub-study is on evaluating groups' learning processes in regard to CPS and SSRL skills (i.e. video observation data) and in terms of their own interpretations of their groups' learning process. In-depth content and interaction analysis will be used for video data in exploring groups' CPS and SSRL processes in detail. It is assumed to be able to recognize different types of groups in regard to the CPS and SSRL skills and processes (differences in terms of quantity and quality of CPS and SSRL). It is also expected to find out how CPS/SSRL processes are activated and sustained; i.e. what kind of interaction triggers the actualization of the specific processes at group level. The groups' task products will be evaluated according to task-related, academic requirements and they will be used as an outcome measure of their group learning. By combining process analysis with the outcomes it is possible to find out whether groups with high and low levels of CPS/SSRL skills and processes also differ in terms of their academic outcomes. Data examples of the implementation will be presented.

Conclusions

The particular challenge in this study is to combine CSP and SSRL processes within the same theoretical framework, which aims to extend from collaborative problem solving to socially shared regulation of learning in collaborative problem solving. There are many crossings between CPS and SSRL skills. For example, the capacity to be a purposeful and engaged learner (as part of a collective) is common to both CPS and SSRL. In this regard, we might here also speak in terms of engaging in collaborative problem solving, which aptly relates to both the cognitive and motivational areas of regulation as well as to strands related to collaborative problem solving. However, it is apparent that conceptual studies and empirical experimentations are needed to operationalize and re-define the theoretical construction utilized in the ongoing sub-study described here.

References

Bannert, M., Reimann, P. (2012). Supporting self-regulated hypermedia learning through prompts. *Instructional Science*, *40*(1), 193-211.

Dillenbourg, P. & Hong, F. (2008). The mechanics of CSCL macro scripts. *International Journal of Computer-Supported Collaborative Learning, 3(1), 5-23*.

Griffin, P., McGaw, B., & Care, E. (2012) (Eds.). Assessment and teaching of 21st century skills. New York: Springer.

Griffin, P., & Care, E. (2015) (Eds.). Assessment and teaching of 21st century skills. Methods and approach. New York: Springer.

Hadwin, A., Järvelä, S., & Miller, M. (2011). Self-regulated, co-regulated and socially shared regulation of learning. In B. Zimmerman & D. Schunk D (Eds.), Handbook of Self-Regulation of Learning and Performance (pp. 65-84). New York, NY: Routledge.

Hesse, H. Care, E., Buder, J., Sassenberg, J., & Griffin, P. (2015). Framework for teachable collaborative problem solving skills. In P. Griffin & E. Care (Eds.), Assessment and teaching of 21st century skills. Methods and approach (pp. 37-56). New York: Springer.

Häkkinen, P., Arvaja, M., Hämäläinen, R., & Pöysä, J. (2010). Scripting computer-supported collaborative learning: A review of SCORE studies. In B. Ertl (Ed.), E-collaborative knowledge construction: Learning from computer-supported and virtual environments (pp. 180–194). New York, NY: IGI Global.

Järvelä, S. & Hadwin, A. (2013). New Frontiers: Regulating Learning in CSCL. *Educational Psychologist*, *48*(1), 25–39.

Järvelä, S., Kirschner, P., Panadero, E., Malmberg, J., Phielix, C., Jaspers, J., Koivuniemi, M. & Järvenoja, H. (2014) Enhancing Socially Shared Regulation in Collaborative Learning Groups: Designing for CSCL Regulation Tools. *Educational Technology Research and Development, 63*(1), 125-142.

Kirschner, P.A., Sweller, J., & Clark, R.E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75–86.

Näykki, P., Järvelä, S., Kirschner, P., & Järvenoja, H. (2014). Socio-emotional conflict in collaborative learning – A process-oriented case study in a higher education context. *International Journal of Educational Research*, 68, 1-14.

OECD (2013). Draft PISA 2015 collaborative problem solving framework. Retrieved 1st of October 2014 from http://www.oecd.org/pisa/pisaproducts/Draft%20PISA%202015%20Collaborative%20Problem%20Solving%20Framework%20.pdf

Tchounikine, P. (2008). Operationalizing macro-scripts in CSCL technological settings. *International Journal of Computer-Supported Collaborative Learning*, *3*, 193-233.

Van den Bossche, P., Gijselaers, W. H., Segers, M., & Kirschner, P. A. (2006). Social and Cognitive Factors Driving Teamwork in Collaborative Learning Environments - Team Learning Beliefs and Behaviors. *Small Group Research*, *37*(5), 490-521.

Winne, P.H. & Hadwin, A.F. (1998). Studying as self-regulated learning. In D.J. Hacker, J. Dunlosky, & A.C. Graesser (Eds.), Metacognition in Educational Theory and Practice (pp. 277-304). Mahwah NJ: Lawrence Erlbaum Associates.

Zimmerman,B.J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, *81*(3) 329-339.

Acknowledgments

We thank participating teachers and students. This research is supported by the Academy of Finland (Grant no. 273970).

 © ISLS