Tracing a Teacher's Reflective Noticing and Scaffolding of Student Inquiry in Grade 5 Knowledge Building Communities

Hyejin Park, Jianwei Zhang, University at Albany, SUNY, 1400 Washington Ave, Albany, NY 12222
Email: hpark7@albany.edu, jzhang1@albany.edu

Abstract: This study provides a precise tracing of how a teacher engaged in student-centered reflective noticing and envisioning to facilitate yearlong scientific inquiry in two grade 5 knowledge building communities. On a weekly basis, the teacher updated a reflective journal in which she recorded her noticing of students' ideas, connection, and inquiry needs, interpreted pedagogical meanings, and envisioned strategic moves to foster students' sustained inquiry. Qualitative analysis of her journals identified seven themes of reflective noticing and scaffolding, her reflection flow, and outstanding scenarios. These core patterns of noticing further informed the teacher's pedagogical thinking and ongoing envisioning in order to provide responsive scaffolding. Her focus on reflective envisioning changed in line with students' needs.

Introduction

Research in the learning sciences has produced solid advances in understanding how students engage in joint problem solving and collaborative discourse to build deep knowledge supported by technology-based learning environments. Researchers have developed various collaborative, inquiry-based learning programs with effective learning outcomes in light of these advances. However, despite the research advances, the field still confronts the challenge of how to implement and sustain the new learning models in broad classrooms to transform educational practice. A critical issue underlying this challenge pertains to the new role of teachers in student-driven collaborative knowledge building. Although existing research highlights the original roles of the teacher as a co-learner in students' inquiry deepening progress (Tabak & Baumgartner, 2004; Zhang, Tao, Chen, Sun, Judson, & Naqvi, 2018), it remains unclear how the teacher may play out such roles to engage effectively and nurture his/her students' efforts for sustained, creative inquiry. This study provides a detailed tracing of how a teacher engaged in student-centered reflective noticing and envisioning to facilitate yearlong scientific inquiry in two grade 5 classrooms.

The inquiry-based practices analyzed in this study were designed based on the Knowledge Building (KB) pedagogy, which aims to transform classrooms into authentic knowledge building communities where students "produce ideas of value to others and share responsibility for the overall advancement of knowledge in the community" (Scardamalia & Bereiter, 2010, p. 80). Teachers in the KB contexts engage in reflective and adaptive practices (Zhang, Hong, Scardamalia, Toe, & Morley, 2011). They engaged in students' ongoing inquiry and iteratively re-design customized pedagogy for enhancing students' collective idea progress (Sergis & Sampson, 2017). Their deep reflection builds insights for their professional development (Zeichner & Liston, 1996) as well as students' learning (Brookfield, 2017). The genuine implication of teachers' reflection ties with the subsequent action (Shulman, 1987), dealing with complicated and uncertain situations (Schön, 1983) to ultimately advance their instruction in practice for improving students' knowledge. Throughout the critically introspective examination of own instruction and students' idea progress, teachers find ways to resolve the complicated problems in the classroom (Dewey, 1933) and fuel the learning milieu with unceasing inquiry and resilience to the changes in the classroom (Brookfield, 2017).

In order to facilitate students' collective knowledge building, teachers engage in open-ended planning and co-engage with their students in the inquiry process to catalyze productive knowledge building moves. As an important aspect of their teaching, teachers engage in reflective noticing and ongoing envisioning, to notice students' emergent inquiry and deeply muse on that moment to envision responsive moves to foster students' deeper inquiry (Judson, 2016; Hammer & van Zee, 2006; Robertson, Atkins, Levin, & Richards, 2016). In light of the previous literature, we identified three interconnected elements of teachers' reflective noticing and envisioning in students' collaborative inquiry-centered learning: *Attend*, *Interpret*, and *Make Moves* (A-I-M, Zhang, 2019). That is, teachers notice students' individual and collective inquiry, reflect on the noticed moments, and envision and plan the following lessons for facilitating students' inquiry progress.

The current study was conducted to provide a comprehensive account of the ongoing reflective noticing and envisioning of a grade 5 teacher to facilitate yearlong scientific inquiry. The research questions address: a) How did the teacher attend to and reflect on students' ongoing inquiry on a weekly basis to envision

opportunities to foster deeper knowledge building among students?; and b) What types of flow and scenarios did the teacher's reflective envisioning follow to address emergent classroom needs?

Research Context and Methodology

Classroom Context

This study investigates a teacher's concurrent reflection and envisioning two grade 5 science classrooms with 42 students in KB pedagogy in 2015-2016. At the beginning of the school year, students in the classrooms started with exploratory activities to bring initial inquiry about the human body system. While collaborating, they deepened knowledge about their interests and created new inquiries to improve a wider range of ideas. They developed their ideas during a metacognitive meeting (MM) that is an interactive conversation to build on theory with each other. They also generated inquiry and built on peers' ideas on a virtual discussion platform, Knowledge Forum (KF).

Two teachers participated in the whole project, and the present paper focuses on one (Mrs. G). Mrs. G monitored the progression of students' ideas, theories, and inquiries on KF and in MMs. In order to record her reflection and envisioning of students' knowledge building process, she kept reflective journals in her homeroom class and Mrs. W's class every week. She wrote her observations and reflections on the students' idea progress and scaffolded follow-up lessons to improve the students' collective knowledge building using a table that has three columns in order: *I notice……*, *I think……*, and *In the coming week*, *we may……*. This format was outlined based on the idea that reflective teachers noticing and envisioning in students' thinking (Jacobs et al., 2010; van Es, 2011), which is further identified A-I-M framework (Zhang, 2019) that consists of the three interconnected elements (Attend, Interpret, and Make Moves, in order) of teacher noticing and scaffolding. A total of 27 reflective journals were collected from the two classrooms.

Data Sources and Analysis

The primary dataset for the present study is the teacher's reflective journals. For the analysis, 172 sets of Attend, Interpret, and Make Moves (A-I-M) columns from the collected reflective journals were arranged chronologically in a row in Excel format. Conducting the grounded theory approach (Strauss & Corbin, 1998), the two authors of this research discussed the qualitative data analysis process a number of times and reached a satisfactory agreement of the patterns of teachers' reflection with overarching themes. The initial analysis examined the teacher's reflective notes in A-I-M in the columns. After the initial analysis, the authors felt the need to classify the analysis unit of A-I-M more specifically. For instance, in the Attend column, sometimes the teacher attended to students' learning and interpreted what she noticed simultaneously. Thus, each stage of Attend, Interpret, and Make Moves, respectively, was segmented into smaller A-I-M to investigate the teacher's reflection flow more sophisticatedly. The outstanding scenarios were also identified by re-reading and qualitatively tracking the teacher's reflective notes in Interpret and Make Moves columns, following the notes in Attend columns. After three more turns of carefully re-reading the data and matching that with the coding result for iteratively revising it, the final coding book was built (also see Park & Zhang, 2020, which investigated teachers' reflective journals of a different school year). We found interesting results of tracing the teacher's focus of noticing and envisioning, segmented A-I-M, and critical scenarios, which will be reported in this paper. The coding result will be presented in the following section below as a summary and detailed description.

Findings

Teacher's Reflection and Envisioning in Students' Knowledge Building

The analysis result of teacher's reflective journals revealed seven overarching themes across teacher's A-I-M—idea progress (students' individual and collective focal inquiry), collaboration, students' need/intent/emotion, supportive materials/tools, KB practices and norms, teacher's intent/emotion, and tracking students' ideas. Overall, the teacher took notice of students' idea progress, students' need/intent/emotion, and use/creation of supportive materials/tools the most throughout the reflective envisioning process. She increasingly focused on her own intent and emotion in Interpret and envisioned tracking students' idea progress in Make Move. The cases of *skip* that teacher did not write about her reflection or envisioning increased in Interpret and Make Move than in Attend. The detailed descriptions of coding categories are presented in the following sections.

Attend

The teacher noticed and reflected on not only students' important moments of collective knowledge building using necessary sources but also the teacher's own support for their learning progress. She recognized

individual and collective students' emergent and expanded inquiry and asked them follow-up questions. She found students' shallow ideas, misunderstanding, or static idea progress and spotted students who had a deep knowledge of certain topics. She carefully noticed students' needs and emotion and their use or creation of supportive materials and tools. Also, she found a lack of keeping class norms and felt stunned or struggled by students' idea progress and attitude (see Appendix A).

Interpret

The teacher continued monitoring students' learning progress and reflecting on the meaning and reason behind what she noticed and her own support for students' learning. In particular, she reflected on new inquiry, emergent connections between diverse concepts, and expansion of the community's discussion topics, which all was to be improved aligned with classroom activity to deepen collective knowledge. She wondered about the reason behind students' thinking flow and felt the need for facilitating students' idea progress and collaboration, especially by matching students who were researching adjacent concepts. Her reflection on facilitating students' learning also followed their real and urgent needs and growing motivation to work with peers. She felt that students needed to understand their responsibility to devote the best knowledge to the community, keep decent class norms, and use supportive tools with a clear purpose of advancing the community's knowledge. During her reflection, the teacher increasingly introspected about her own knowledge and instruction as well as stunning or struggling moments of students' progress and attitude (see Appendix B).

Make Moves

The teacher mostly envisioned her support and instruction to facilitate students' knowledge building, while she still recalled and reflected on students' expression of their growing enlightenment and motivation for learning with peers. She planned an advanced strategy to facilitate students' best and deepening inquiry but leverage their idea progress with each other. She also envisioned highlighting emergent and deep theory with meaningful use of supportive tools to build their collaborative knowledge. In order to meet students' positive learning intent and improve better class norms, she planned to provide students with adequate help and had a conversation with them in class or on KF accordingly. Moreover, she referenced her co-teacher's envisioning and planned to build on students' KF notes. While envisioning her better pedagogy, she felt the need to track students' emergent ideas that can be a big inquiry of the community and have effective ways of facilitating students' and her idea tracking process (see Appendix C).

Flow of Segmented Reflective Envisioning

What was further found from tracing the teacher's segmented A-I-M was that the three phases of the teacher's noticing, interpreting, and envisioning did not always happen in order; rather, she sometimes conducted two or three phases simultaneously, even in reverse order. Consequently, the teacher mostly focused on attending, interpreting, and making moves in each matched big phase. Nonetheless, interesting patterns were found that she deeply interpreted important moments of her attending to student's learning concurrently (A-I), interpreted student's knowledge building as envisioning how to facilitate student's collective progress (I-M), and did envisioning first and then interpreting student's important moment related to her envisioning (M-I). Examples extracted from the teacher's reflective journals are presented below in [1], [2], [3], sequentially. A-I mostly happened in the big Attend phase, while I-M and M-I occurred in big M frequently.

> [1] **(A-I)** *S1 seemed to be just playing around, so I sat close by..... Then, he had an AHA moment CELLS DIVIDE and THAT is what makes things GROW!!!*
> [2] **(I-M)** *I think there is too much belief that specific people OWN ideas..... why is this? I so want the shift to COLLECTIVE responsibility and desire to share, but that competitive world of learning is a hard shift.*
> [3] **(M-I)** *I will talk with them to find out what knowledge they need to share and help them find a better place to connect..... I am thinking they are talking about white blood cells fighting infection..... so this ought to be in a different view.*

Critical KB Scenarios of Reflective Envisioning

Six outstanding scenarios were found by qualitatively tracing the teacher's reflective envisioning and scaffolding of students' knowledge building after noticing process (see Table 1). The teacher captured crucial moments of students' deep and emergent inquiry, lack of progress, collaboration, class norms, motivation and intent, and use of supportive tools. She focused on new directions of inquiry and missing connection between students' inquiries. She envisioned students' moves in efforts to leverage as well as advance the sustained

progress of the community's inquiry by facilitating collaboration between students in need and knowledgeable students, with needing a timely track of idea progress. At the same time, the teacher's scaffolding was to maintain students' high motivation and responsibility to build KB class norms and use authoritative tools for collective idea progress.

Table 1: Critical KB scenarios of teachers' reflective envisioning according to students' progress

KB scenario	Attend	Interpret and Make Move
Scenario 1	Students are making progress with an area of inquiry, having deep ideas and emergent area/direction.	· The teacher thinks the need to facilitate emergent areas aligned with the community's progress and clarify students' new misunderstanding. · Typical reflective moves include highlighting/linking emergent directions with the community to co-design the next steps in class or KF and having a face-to-face talk with students to provide support.
Scenario 2	Students have been working on an area but are stuck with a lack of progress and deep understanding.	· The teacher thinks of students' best knowledge and high responsibility for clarifying and deepening ideas. · Typical reflective moves include having a face-to-face talk with students, promoting positive motivation and responsibility for making progress, and matching knowledgeable students with students in need.
Scenario 3	Students have collaborated with peers on an area of inquiry.	· The teacher thinks of building deeper and more connected knowledge by learning from knowledgeable students with high motivation. · Typical reflective moves include enhancing effective tracking of collective ideas and highlighting emergent ideas with the whole community to leverage the collective progress as meeting students' learning needs.
Scenario 4	Students have read and written KF notes without deep ideas, and the teacher discovered the need for improving class norms.	· The teacher thinks about the need for improving class norms and facilitating students' deep and collective ideas. · Typical reflective moves include highlighting important class norms with the community as meeting students' learning needs.
Scenario 5	Students have the motivation or need help to make progress.	· The teacher thinks about the need and reason for facilitating idea progress and collaboration, using useful tools and class norms. · Typical reflective moves include tracking and facilitating idea progress as meeting students' needs and using useful tools.
Scenario 6	Students have used supportive tools and created materials either individually or in groups.	· The teacher thinks about the need for using tools with a clear purpose for collective idea progress. · Typical reflective moves include facilitating purposeful use of tools for collective idea progress as meeting students' learning needs.

Conclusion and Discussion

The present study traced a teacher's concurrent reflective noticing and scaffolding of grade 5 students' knowledge building community. While the teacher cyclically reflected on students' progressive learning and designed the next moves, she followed seven patterns: idea progress, collaboration, student' need/intent/emotion, supportive materials/tools, KB practices and norms, teacher's intent/emotion, and tracking student' ideas. The teacher iteratively mediated on critical moments of students' idea progress with its reason, which informed the teacher's pedagogical thinking and ongoing envisioning to provide responsive scaffolding. The teacher's reflective envisioning was conducted in a dynamic and sophisticated way rather than in a linear sequence. Notably, her interpretation of students' knowledge building tended to be synchronized with noticing moments to picture the follow-up instruction in line with students' needs. During this process, she reflected on students' and her pedagogical intent at the same time and needed to track students' dynamic progress more effectively.

This study aimed to understand a primary school teacher's complicated thinking process in her responsive scaffolding of students' collective knowledge building. Reflective teachers are proactive in challenging the issues raised in the classroom from diverse perspectives with high responsibility and expertise in practice. Their reflective teaching is facilitated based on their deep meditation on hands-on experiences of teaching, from which they attain insights for their professional improvement (Zeichner & Liston, 1996) and for enhancing students' learning (Brookfield, 2017) by often further sharing their reflective noticing and thinking with students engaged in collaborative decision making (Zhang & Messina, 2010). Teachers' participatory pattern in student-driven collaborative idea progress (Scardamalia & Bereiter, 2010) is dynamic in that they consider diverse aspects of pedagogy and students' progress concurrently. Moreover, their responsive envisioning pattern is complicated since their thinking flows back and forth across classroom events of the past, the present, and the future. They do timely reflection while observing students' learning and designing students' more in-depth inquiry and join students' progress as co-learners to make a promising vision for facilitating students' real-life inquiry (Zhang, 2019). For this reason, additional support is needed for them to pass through the reflection and envisioning along with students' progress flow more sustainably. Since teachers consider various ideas and inquiries of individuals, small groups, and whole community simultaneously, their thinking can be easily disconnected or miss crucial moments of students' progress. Thus, teachers' monitoring of students' knowledge building needs to be sustained with timely assessment and evidence of students' natural learning, which further helps teachers provide students with responsive feedback to facilitate the community's idea process. Our next study will mine students' authentic discourse as a transformative assessment to provide teachers with spontaneous feedback for their reflective envisioning of students' collective knowledge building.

References

Bielaczyc, K., & Collins, A. (1999). Learning communities in classrooms: A reconceptualization of educational practice. In C. M. Reigeluth (Ed.), I*nstructional design theories and models: A new paradigm of instructional theory* (pp. 269-292). Mahwah NJ: Lawrence Erlbaum Associates.

Brookfield, S. (2017). *Becoming a critically reflective teacher* (2nd ed.). John Wiley & Sons: San Francisco, CA.

Dewey, J. (1933). *How we think.* Buffalo, NY: Prometheus Books.

Hammer, D., & van Zee, E. (2006). *Seeing the science in children's thinking: Case studies of student inquiry in physical science.* Portsmouth, NH: Heinemann.

Judson, D. (2016). Teacher noticing associated with responsive support of knowledge building. In Looi, C. K., Polman, J. L., Cress, U., and Reimann, P. (Eds.), *Proceedings of the 12th International Conference of the Learning Sciences* (pp. 986-989). Singapore: International Society of the Learning Sciences.

Luna, M. (2018). What does it mean to notice my students ' ideas in science today ?: An investigation of elementary teachers' tractice of noticing their students' thinking in science, *Cognition and Instruction*, *36*(4), 297–329.

Park, H., & Zhang, J. (2020, Apr 17 - 21) *Teachers' Reflective Noticing and Responsive Scaffolding to Support Student Knowledge Building in Grade 5 Science* [Roundtable Session]. AERA Annual Meeting San Francisco, CA http://tinyurl.com/wtbdg6b (Conference Canceled)

Robertson, A. D., Atkins, L. J., Levin, D. M., & Richards, J. (2016). What is responsive teaching? In A. D. Robertson, R. E. Scherr, & D. Hammer (Eds.), *Responsive teaching in science and mathematics* (pp. 1–34). New York: London: Routledge.

Scardamalia, M., & Bereiter, C. (2010). A brief history of knowledge building. *Canadian Journal of Learning and Technology*, *36*(1), 1–16.

Schön, D. (1983). *The reflective practitioner: How professionals think in action.* NY: Basic Books.

Sergis, S., & Sampson, D. G. (2017). Teaching and learning analytics to support teacher inquiry: A systematic literature review. In A. Peña-Ayala (Ed.), *Learning analytics: Fundaments, applications, and trends* (pp. 25–63). Berlin, Germany: Springer.

Slotta, J., Suthers, D., & Roschelle, J. (2014). CIRCL primer: Collective inquiry and knowledge building. In *CIRCL primer series*. Retrieved from http://circlcenter.org/collective-inquiry-knowledge-building/

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed). Thousand Oaks, CA: Sage.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-22.

Tabak, I., & Baumgartner, E. (2004). The Teacher as Partner: Exploring Participant Structures, Symmetry, and Identity Work in Scaffolding. *Cognition and Instruction, 22*(4), 393-429.

Zeichner, K. M., & Liston, D. P. (1996). *Reflective teaching: An introduction.* Mahwah, NJ: Lawrence Erlbaum

Associates.
Zhang, J. (2019). 2019 Summer Institute. Reflecting & envisioning: catalyze dynamic Knolwedge Building across discplines [PowerPoint slides].
Zhang, J., Hong, H.-Y., Scardamalia, M., Toe, C., & Morley, E. (2011). Sustaining knowledge building as principle-based innovation at an elementary school. *Journal of the Learning Sciences, 20*(2), 262–307.
Zhang, J., & Messina, R. (2010). Collaborative productivity as self-sustaining processes in a Grade 4 knowledge building community. In K. Gomez, J. Radinsky, & L. Lyons (Eds.), *Proceedings of the 9th International Conference of the Learning Sciences* (pp. 49-56). Chicago, IL: International Society of the Learning Sciences.
Zhang, J., Tao, D., Chen, M.-H., Sun, Y., Judson, D., & Naqvi, S. (2018). Co-organizing the collective journey of inquiry with Idea Thread Mapper. *Journal of the Learning Science, 27*(3), 390-430.

Acknowledgments

This research was sponsored by the National Science Foundation (IIS #1441479). We appreciate the teacher and students for their creative work that made this research possible.

Appendix A

Code categories in Attend of teacher's reflective journals (number of frequency and percentage in parenthesis)

Code category		Code sub-category
Noticing/Reflecting on **Idea progress** (58, 33.72%)	Student/Students (55, 31.98%)	**Noticing/Reflecting on student(s)'/community's emergent/expanded/(dis)connected/shallow idea/inquiry** · Bringing/Building new information/theory/inquiry · Building emergent connection between diverse concepts by certain student(s) · Building on peer's ideas with expanded ideas/concepts · Building unclear/shallow/disconnected ideas · Expanding the community's discussion topic by certain student(s)/community · Synthesizing ideas
	Teacher's support/instruction (3, 1.74%)	**Recalling/Noticing/Reflecting on facilitating student(s)' idea progress by asking follow-up/clarifying questions** · Asking student(s) follow-up questions · Clarifying student's misunderstanding · Noticing student(s)' static idea progress
Noticing/Reflecting on **Collaboration** (8, 4.65%)	Student/Students (7, 4.07%)	**Noticing students' collaboration to advance collective ideas** · Collaborating with peers for building on/expanding/connecting ideas in groups · Finding a knowledgeable student to learn about adjacent topics
	Teacher's support/instruction (1, 0.58%)	**Recalling/Reflecting on facilitating students' collective ideas** · Facilitating student(s)' participation to build collective knowledge
Noticing/Reflecting on **student(s)' need/intent/emotion** (37, 21.51%)	Student/Students (32, 18.60%)	**Noticing on student(s)' need/intent/emotion while making progress on research** · Feeling the need of additional resource/tools or help to use them · Feeling unsure about his/her idea · Getting intent/motivation to make progress on research · Getting motivation/excitement to share his/her new enlightenment with specific group/community · Struggling while collaborating with peers · Showing byproducts to teacher
	Teacher's support/instruction (5, 2.91%)	**Reflecting on facilitating student(s)' sustained research and sharing it** · Helping student(s)' sharing of deep ideas that are missing in the community · Wondering student(s)' inquiry progress · Encouraging student(s) to keep on research out of science class
Noticing/Reflecting on use/creation of **supportive materials/tools** (28, 16.28%)	Student/Students (25, 14.54%)	**Noticing student(s)' individual/collective use/creation/sharing of supportive materials/tools** · Creating/using supportive materials/tools individually or in groups · Sharing created materials about specific topics · Using new analogy · Using tools in a community-friendly way
	Teacher's support/instruction (3, 1.74%)	**Reflecting on student(s)' purposeful use/creation of supportive materials/tools for collective knowledge** · Monitoring student(s)' purposeful use of tools · Reflecting on creation of materials to advance collective knowledge
Noticing/Reflecting on **KB practices and**	Student/Students (10, 5.81%)	**Noticing/Reflecting on student(s)' deficiency of keeping class norms and discussion about class norm**

norms (13, 7.56%)		· Highlighting/Discussing class norm to improve collective knowledge · Not reading peers' KF notes · Opening KF notes without deeper reading · Writing KF notes regardless class norms
	Teacher's support/instruction (3, 1.75%)	**Noticing weakness in classroom practices** · Noticing weakness in classroom practices
Recalling/Reflecting on **teacher's intent/emotion** (8, 4.65%)	Teacher's support/instruction (8, 4.65%)	**Recalling/Reflecting on teacher's own intent/emotion about student(s)' idea progress/attitude** · Musing on stunning/struggling moments of student(s)' individual/collective idea progress/attitude · Intending to highlight student(s)' promising idea for further discussion · Matching analogy with her enlightening idea
Skip (20, 11.63%)		
Total (172, 100%)		

Appendix B

Code categories in Interpret of teacher's reflective journals

Category		Details
Noticing/Monitoring/ Reflecting on **idea progress** (45, 26.16%)	Student/Students (9, 5.23%)	**Noticing/Reflecting on student(s)'/community's growing knowledge with emergent connection between concepts and new inquiry** · Building emergent connection between diverse concepts/Expanding discussion topic by certain student(s)/community · Matching student(s)' new inquiry aligned with classroom activity to deepen knowledge
	Teacher's support/instruction (36, 20.93%)	**Monitoring/Reflecting on student(s)' idea progress, reason behind the progress, and the need for facilitating it** · Clarifying/Noticing student's misunderstanding · Reflecting on the need for facilitating student(s)'s individual/collective idea progress · Reviewing student(s)' deep idea/theory · Wondering if student(s) made any progress · Wondering/Reflecting on the reason behind student(s)' line of thinking/idea progress
Reflecting on **collaboration** (4, 2.33%)	Student/Students (2, 1.165%)	**Reflecting on student(s)' collaboration to advance collective ideas** · Collaborating with peers for building on/expanding/connecting ideas in groups
	Teacher's support/instruction (2, 1.165%)	**Reflecting on the need for student(s)' participation and collaboration to advance collective/adjacent ideas** · Reflecting on the need for facilitating student(s)' participation in collective idea progress · Reflecting on the need for matching students who research adjacent concept
Monitoring/Reflecting on **student(s)' need/intent/emotion** (26, 15.12%)	Student/Students (13, 7.56%)	**Reflecting on student(s)' motivation and need to exchange expertise with peers** · Feeling the need of other's help · Getting motivation to envision the next step/share his/her enlightenment with the community
	Teacher's support/instruction (13, 7.56%)	**Reflecting on student(s)' high authority to deepen their collective knowledge while monitoring student(s)' difficulty** · Encouraging student(s) to have high responsibility and independence to deepen individual/collective ideas · Noticing student(s)' reluctance/difficulty · Reflecting on student(s)' need for devoting their best knowledge to advance individual/collective with deeper theory/inquiry
Monitoring/Reflecting on **supportive materials/tools** (23, 13.37%)	Student/Students (14, 8.14%)	**Monitoring/Reflecting on student(s)' creation of supportive materials/tools and purposeful use of them for collective knowledge building** · Creating/using supportive materials/tools individually/groups · Misunderstanding the purpose of using tools · Using new analogy
	Teacher's support/instruction (9, 5.23%)	**Reflecting on facilitating student(s)' decent creation and use of supportive materials/tools with the help of teacher** · Facilitating student(s)' purposeful/sustained use/creation of tools/materials · Feeling the need for teaching student(s) correct use of tools
Monitoring/Reflecting on **KB practices and norms** (12, 6.98%)	Student/Students (5, 2.91%)	**Monitoring student(s)' recognition of class norms in building collective knowledge** · Reflecting on student(s)' noticing of having class norms and its' effect to class
	Teacher's support/instruction (7, 4.07%)	**Reflecting on the significance of sustaining decent class norms for collective idea progress** · Feeling the need for keeping class norms

		· Feeling the need for revising class norms
Reflection on **teacher's intent/emotion** (19, 11.05%)	Teacher's support/instruction (19, 11.05%)	**Reflecting on teacher's stunning/struggling emotion about student(s)' idea progress/attitude and her necessary instruction for collective idea progress** · Feeling the need for teacher's deep knowledge to facilitate student(s)' advanced inquiry · Matching stunning/struggling moments of student(s)' individual/collective theory building with using authoritative materials · Musing on stunning/struggling moments of student(s)' individual/collective idea progress/attitude
Skip (43, 25%)		
Total (172, 100%)		

Appendix C

Code categories in Make Move of teacher's reflective journals

Category		Details
Reflecting on/Envisioning **idea progress** (38, 22.09%)	Teacher's support/instruction (38, 22.09%)	**Reflecting on/Facilitating student(s)' best and growing ideas to the community through advanced strategy and collaboration with co-teacher** (38, 22.09%) · Building on student(s)' KF note to share teacher's idea and deepen student(s)' idea/inquiry · Envisioning an alternative strategy to deepen student(s)' idea/theory/inquiry or clarify student(s)' misunderstanding · Facilitating student(s)' devotion to their best knowledge to advance individual/collective with deeper theory/inquiry · Having a talk with student(s) to deepen student(s)' idea/inquiry · Highlighting student(s)' emergent/deep idea/theory with the community · Referencing co-teacher's idea to facilitate student(s)' collective knowledge building
Envisioning **collaboration** (6, 3.49%)	Teacher's support/instruction (6, 3.49%)	**Facilitating student(s)' partnership to leverage and advance collective knowledge** (6, 3.49%) · Envisioning student(s)' collaboration to deepen/connect emergent idea · Matching student(s) with knowledgeable student(s) researching on adjacent topics
Recalling/Reflecting on/Envisioning **student(s)' need/intent/emotion** (31, 18.02%)	Student/Students (4, 2.32%)	**Recalling/Reflecting on student(s)' expression of their growing enlightenment/excitement/motivation** (4, 2.32%) · Sharing student(s)' enlightenment with the community for peer(s)' understanding of its' value · Speaking out student(s)' increasing excitement/motivation to enjoy researching
	Teacher's support/instruction (27, 15.70%)	**Sustaining/Facilitating student(s)' positive intent/need to advance collective knowledge while providing student(s) in need with adequate help** (27, 15.70%) · Envisioning an alternative way of satisfying student(s)' intent/need · Envisioning an alternative way of overcoming student(s)' reluctance/difficulty · Having a talk with student(s) to check/sustain his/her intent/need · Highlighting student(s)' intent/need
Recalling/Reflecting on/Envisioning **supportive materials/tools** (29, 16.86%)	Teacher's support/instruction (29, 16.86%)	**Facilitating the best adoption of supportive materials/tools to advance collective knowledge** (29, 16.86%) · Linking student(s)'/community's emergent idea/concept to KF/ITM · Recalling/Reflecting on/Facilitating student(s)' purposeful/effective/correct use of tools/materials
Reflecting on/Envisioning **KB practices and class norms** (12, 6.98%)	Teacher's support/instruction (12, 6.98%)	**Improving class norms and facilitating student(s)' cultivation of the norms to advance collective knowledge** (12, 6.98%) · Highlighting/Facilitating class norms for student(s) to cultivate the norms · Improving/Revising class norms
Envisioning **tracking student(s)' ideas** (13, 7.56%)	Teacher's support/instruction (13, 7.56%)	**Envisioning/Sharing better ways of timely monitoring of the community's idea progress** (13, 7.56%) · Enhancing/Highlighting student(s)' and teacher's tracking of ideas more effectively · Tracking student(s)' emergent/growing ideas
Skip (43, 25%)		
Total (172, 100%)		