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Exploring Pre-Service Teachers' Democratizing Knowledge in A Knowledge Building Community: Indicators and Results

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Competing interests The authors declare that there is no potential conflict of interest in the work.

Abstract

Democratizing knowledge is about empowering all participants to be legitimate contributors to a group's shared goals and helping them take pride in advancing community knowledge. It is a crucial principle of Knowledge Building theory, the importance of which to developing more equitable learning environments is well recognized. However, what the indicators of democratizing knowledge are and how they manifest in pre-service teachers' Knowledge Building discourse are rarely studied topics; it is not clear how the indicators of democratizing knowledge correlate with students' adoption of Knowledge Building principles. This exploratory study addressed these issues by identifying the cognitive and social aspects of democratizing knowledge of 35 pre-service teachers' Knowledge Building discourse and analyzing the correlations between participants' adoption of Knowledge Building principles and different subcategories of democratizing knowledge. We identified greater frequencies of advancing ideas in their groups and being open to different ideas by participants, but lower frequencies of achieving a shared understanding or goals and rising above individual ideas to achieve synthesis by participants. Moderate to strong correlations between the indicators of democratizing knowledge and Knowledge Building principles were found. In addition, participants' notes that fell into the rise-above subcategory of democratizing knowledge were significantly fewer than notes of other subcategories. This study provides theoretical and practical implications concerning supporting and fostering

learners' democratizing knowledge in Knowledge Building communities. Limitations and directions for future research are discussed.

Keywords: democratizing knowledge, inclusive participation, pre-service teachers, Knowledge Building, Knowledge Building principles

Introduction

Innovation-driven societies require people to apply their knowledge and skills to various, complex situations. This expectation necessitates learners to develop strong problem-solving skills. Direct instruction, in which students are instructed to read and recall given content, evaluates students based on the extent to which they memorize the provided content. Thus it fails to meet the needs of educating an innovation-driven society. On the other hand, constructivism approaches advocate for supporting students to actively construct their knowledge and build understanding (Woolfolk et al., 2009) and thus uphold the needs of an innovation-driven society.

Knowledge Building is a deep constructivism pedagogical approach that responds to innovation-driven and knowledge-based societies (Scardamalia & Bereiter, 2014). In Knowledge Building, students are viewed as legitimate knowledge contributors; their diverse ideas are regarded equally rather than separated or distinguished as more or less beneficial than others (Hong et al., 2019; Scardamalia, 2002). Then, it is no surprise that ideas are placed at the center of Knowledge Building theory. All tasks and activities are organized to improve students' ideas and advance the frontiers of their community knowledge (Philip, 2009).

According to Knowledge Building theory, advancing ideas relies on principles such as epistemic agency, idea diversity, collective responsibility, and democratizing knowledge (Scardamalia, 2002). To make learning relevant and meaningful for students and sustain their

collaborative inquiry, students are expected to cultivate epistemic agency by deciding on directions for inquiry, what ideas to pursue, and how to work on them (Scardamalia, 2002). Improving an idea requires students to deeply understand the idea itself and the supporting or tangential ideas, propose various explanations, find alternative explanations, and integrate diverse ideas (Scardamalia, 2002). This complex process not only involves the cognitive aspect but also depends on the social and technological affordances of a Knowledge Building community (van Heijst et al., 2019).

Democratizing knowledge interconnects with the principles mentioned above and involves the cognitive, social, and technological aspects (Scardamalia, 2002). It refers to "all participants are empowered as legitimate contributors to the shared goals; all take pride in the knowledge advances of the community" (Scardamalia, 2002, p11). In other words, democratizing knowledge is about finding ways to empower participants to be legitimate contributors and to help them take pride in the group's work. As such, democratizing knowledge is more about students' participation in a Knowledge Building community, in contrast to the focus of democratizing education, which concerns the learning of marginal populations within a society (Blessinger & Anchan, 2015; Crea & Sparnon, 2017).

Democratizing knowledge well aligns with the call of finding a place for equitable education in computer-supported collaborative learning (CSCL) through community members' shared efforts to deep conceptual understanding, collaboration, and identity development (Eberle, 2018; Uttamchandani et al., 2020). Knowledge Building falls under the umbrella of CSCL.

Though the significance of democratizing knowledge is well recognized (e.g., Moss & Beatty, 2010; Scardamalia, 2002), there is limited empirical research on how democratizing knowledge is reflected in students' Knowledge Building discourse and participation. This study aimed to explore how cognitive and social aspects of democratizing knowledge are manifested in student discourse, specifically by analyzing discourse on a Knowledge

Building-based educational platform called Knowledge Forum (Scardamalia, 2004).

Furthermore, we investigated how pre-service teachers' practice of democratizing knowledge correlates with adopting the twelve Knowledge Building principles.

Literature Review

Knowledge Building and Knowledge Forum

Knowledge Building theory is based on the belief that ideas are improved through a collaborative, equitable discourse of everyone in the community (Scardamalia & Bereiter, 2014). In Knowledge Building, immaterial ideas (e.g., questions, hypotheses, theories, and explanations) are considered conceptual artifacts that people can produce, test, and improve (Bereiter & Scardamalia, 2003; Popper, 1972). In other words, ideas can be questioned, refined, and transformed to achieve greater understanding and more coherent theories (Bereiter & Scardamalia, 2003).

In Knowledge Building, the community knowledge advancement process relies on democratizing knowledge, consisting of cognitive and social aspects (Blayone et al., 2017; Howley et al., 2011; Scardamalia & Bereiter, 2003; van Heijst et al., 2019). Cress and Kimmerle (2008) stated that "social systems depend on cognitive systems because there would be no communication without cognitions" (p.109). However, we argue that it is very challenging, if not impossible, to advance community knowledge without the social aspect because it is a collaborative endeavor. Thus, democratizing knowledge's cognitive and social aspects are equally essential and inform each other in the community knowledge advancement process. Democratizing knowledge also rests on the belief that students' contributions are critical to understanding an idea fully. Students' diverse ideas can lead to theories evolving in new directions and create environments for new syntheses and coherent theories to be achieved (Scardamalia, 2002).

Student engagement with ideas can occur in face-to-face Knowledge Building circles or online Knowledge Forum (Scardamalia & Bereiter, 2006). However, because face-to-face Knowledge Building discourse is difficult to record or build upon, students often are encouraged to summarize and record their ideas using online group workspaces such as Knowledge Forum.

Knowledge Forum is an educational software developed according to the twelve Knowledge Building principles to support students' knowledge advancement and foster equitable participation (Scardamalia, 2004). Every member is given equal opportunities to share ideas in a public space and read, build on, and improve community ideas in Knowledge Forum (see Figure 1, Hong, 2014). Knowledge Forum provides customizable scaffolds to support students' thinking and idea development. For instance, socio-cognitive (e.g., this theory cannot explain) and socio-metacognitive (e.g., putting our knowledge together, we still wonder about) scaffolds can be developed to support different purposes. Furthermore, students can rise above individual ideas (see Figure 2) to identify ones that share the same central idea, theme, or issue and thus summarize the status of community knowledge, identify gaps, and decide the next steps for further improvement. As a result, Knowledge Forum makes the idea development process visible and enables students to modify ideas and create new ideas as a learning community (Scardamalia & Bereiter, 2003).

Insert Figure 1

Insert Figure 2

Democratizing Knowledge

In learning sciences, issues related to equity are drawing increasing attention and offering new ways to think about the relations between equity and collaboration, technology, and data (e.g., Esmonde, 2009; Philip et al. 2016; Reinholz & Shah 2018). Piaget (1995) viewed the

"symmetrical" relationship between interlocutors as important because asymmetrical relationships could lead to conformism and obedience to authority, which would make argumentation extremely difficult (Milgram, 1974). Kreijns et al. (2004) identified respect, strong relationships, group cohesiveness, trust, satisfaction, and a strong sense of community as characteristics of a good social space.

Democratizing knowledge, one of the critical principles of Knowledge Building, directly links to equity issues because it is about considering all participants as legitimate contributors to community knowledge advancement (Scardamalia, 2002). Democratizing knowledge supports the notion that contributions made by each student are valuable and can be improved (Moss & Beatty, 2010). The cognitive and social aspects of democratizing knowledge indicate being open and inclusive to all participants and their ideas (van Heijst et al., 2019). Community members understand that Knowledge Building requires multiple perspectives and voices, including ideas just beginning to be formulated, to extend current understanding (Moss & Beatty, 2010).

As described in the previous section, democratizing knowledge consists of cognitive and social aspects. The cognitive aspect evaluates group members' Knowledge Building discourse based on how they 1) contribute different ideas, 2) advance previous ideas, 3) achieve shared understanding or goals, and 4) rise above individual ideas to achieve synthesis. These subcategories of the cognitive aspect align with the principles of effective discourse described by Mercer and Sams (2006), who suggested that principles of effective discourse require that all group members contribute to the discussion and share relevant information; respect and consider one another's opinions and ideas; make the reasons for their beliefs clear; negotiate challenges and alternatives; reach an agreement before making decisions.

Knowledge Building principles such as idea diversity, improvable ideas, and rising above also are involved in the cognitive aspect of democratizing knowledge (Scardamalia, 2002). Contributing diverse ideas and theories is encouraged because idea diversity is essential for ideas to evolve into new and refined forms (Scardamalia, 2002). Plus, valuing student-contributed ideas may make them more motivated to engage in a learning community (Mullins et al., 2013). Advancing ideas is about improving the quality, coherence, and explanatory power of ideas by using authoritative sources to support, criticize, refine, and extend ideas and rise above the individual ideas to achieve new syntheses and advanced structures. Democratizing knowledge is also about students taking the epistemic agency to set their goals, engage in long-range planning, use different ideas to spark and sustain ideas, monitor idea coherence, and assess their work. Embedded and transformative assessment is reflected in monitoring progress, moving toward shared goals, and exceeding expectations.

The social aspect of democratizing knowledge evaluates group members' Knowledge Building discourse based on how they display 1) a sense of community membership, 2) an openness to different ideas, 3) a participation invitation to other group members to contribute their ideas or a direct response to a previous idea, and 4) an evenness in building-on to existing relationships. Based on these subcategories, good collaborators in Knowledge Building discourse should demonstrate intense, positive, socio-emotional interactions throughout learning (Kwon et al., 2014).

Regarding the first subcategory of the social aspect, indicators such as inclusive pronouns (e.g., we, our) indicate students' sense of ownership, which may shorten the psychological and social distance between community members (Baker, 2010; Rovai & Barnum, 2007). Also, "Is everybody considered when making a collective decision" is an indicator for analyzing group talk (Polo et al., 2016). Being inclusive also means being open to, or even actively inviting, different ideas. Engaging in high-quality group interaction

requires students to adopt a "politeness system," in which there is no shame in expressing ill-structured ideas or changing one's mind, nor aggressiveness in criticizing others' views, nor sadness at failing to convince everybody that one's thoughts are the best (Polo et al., 2016).

Participation invitation, the third subcategory of the social aspect, is about inviting other group members to participate in community discourse. Such an invitation may make other members feel they belong to the community and are respected; their ideas are valued. As a result, a sense of belonging can be enhanced. Evenness of building-on relationships, the fourth subcategory of the social aspect, is derived from Shannon's Theory of Communication (Shannon & Weaver, 1998) and measures the extent to which group members' participation is not greater than chance can predict in a purely unstructured and random state (Authors, 2017; Matei et al., 2010).

Previous research shows that Knowledge Building supports students at all levels to contribute to their community knowledge. For instance, Moss and Beatty (2010) studied what happened when three classes of Grade 4 students from different socioeconomic backgrounds were exposed to Knowledge Building ideas and used Knowledge Forum for discourse. Their findings suggest that not only were high-achieving students motivated to solve complex math problems, low-achieving students built on their peers' ideas and meaningfully incorporated these ideas into their solutions. Yang's study (2019) with two Grade 9 classes indicated that with a reflective assessment (relevant to the embedded and transformative assessment principle of Knowledge Building), even low-achieving students could engage in high-level epistemic work such as setting goals, analyzing their inquiry and ideas, and addressing identified gaps. Authors' study (2017) with Grade 1 to Grade 5/6 classes suggested that the evenness of building-on relationships seen in the five Knowledge Building communities was high.

Although the previous literature emphasized the importance of democratizing knowledge and suggested students' competence to contribute to community knowledge and attitudes of valuing diverse ideas, these studies lacked understanding of the indicators and manifestation of democratizing knowledge in Knowledge Building discourse. This study aimed to address this research gap.

The Current Study

There is a gap between recognizing the importance of increasing people's democratic innovative capacity and knowing how to do it (Scardamalia & Bereiter, 2010). This study aimed to address this research gap by exploring the indicators of the cognitive and social aspects of democratizing knowledge in Knowledge Building discourse and examining the correlations between these indicators and Knowledge Building principles. Specifically, the following research questions guide this study:

1. How is democratizing knowledge manifested in participants' Knowledge Building discourse?
2. What are the relationships between participants' adoptions of Knowledge Building principles and the democratizing knowledge levels of their groups?
3. Do different dimensions of democratizing knowledge sustain Knowledge Building discourse?

Methods

CSCL research benefits from quantitative research and micro case studies (Stahl et al., 2006). Detailed case studies adopting methodologies such as discourse analysis (ten Have, 1999) and video analysis (Koschmann et al., 2005) contribute to our understanding of students' collaborative meaning making (Stahl et al., 2006). This study adopted an exploratory study methodology and focused on a specific case given our limited understanding of the indicators and manifestation of democratizing knowledge in students' Knowledge Building discourse.

This methodology is appropriate for exploring a concept with little or no previous studies in a particular context (Chen et al., 2021; Yin, 1992). It also enables us to describe certain phenomena and context specificity in detail (Näykki et al., 2017).

The chosen context of this study is a class of pre-service teachers in China who were required to design lesson plans of their chosen topics in small groups. Furthermore, within this context, we conducted correlations analysis to understand the relationship between different indicators of democratizing knowledge and students' employment of Knowledge Building principles. Plus, we conducted Welch Two Sample t-tests to analyze whether different indicators sustain Knowledge Building discourse. We will now elaborate on the participants, course design, data collection, and data analysis of this study.

Participants

Convenient sampling was adopted. The participants were 35 pre-service teachers (24 females, $M_{\text{age}} = 20$) enrolled in the *Knowledge Building and Collaborative Creation* course in a teachers university in China in the fall semester, 2019. This optional course aimed to develop participants' ability to engage in Knowledge Building discourse, collaboratively design lesson plans of their choosing using the Knowledge Building approach and apply the approach in their teaching in the future. The course was taught by an instructor with four years of experience in employing the Knowledge Building approach to teaching and who had offered the course to undergraduates twice before. The pre-service teachers were in their second or third year of undergraduate study, and it was expected they would teach at elementary schools after graduation. They came from several different program specialties, including Mathematics Education, Biology Education, Second Language Education, and Communication Technology in Education. The pre-service teachers formed eight groups based on their interests and choices.

The facts given above make the pre-service teachers in this course an ideal sample for the study because it allowed us to track participants over several months, which is important to CSCL research (Authors, 2019; Reimann, 2009) which values the time dimension to study learning and collaborative process.

Course Design

The *Knowledge Building and Collaborative Creation* course lasted for 16 weeks (a week-long national holiday was excluded) and consisted of three phases. In Phase 1 (weeks 1 to 5), the instructor introduced the background, history, twelve principles of Knowledge Building, and Knowledge Forum. Several video lectures were recorded and published in Knowledge Forum to help the students understand the principles and make connections between the principles and Knowledge Forum affordance. Phase 2 (weeks 6 to 9) was about engaging participants in group activities with the support of Knowledge Forum. Each group chose a problem related to artificial intelligence (AI) and tried to design an AI product or find a solution through Knowledge Building discourse. The students were encouraged to adopt Knowledge Building principles in their collective discussion. In Phase 3 (weeks 10 to 16), each small group chose a teaching topic from a K-12 subject and designed a lesson plan that applies the Knowledge Building approach. They negotiated the learning topics in Knowledge Forum. Each group presented their lesson designs to the class in the final week.

A blended learning approach was adopted, and two platforms were employed to support the hybrid learning. The students watched online videos, read materials, and participated in online discussions in the Moodle-based learning platform and Knowledge Forum every week before class. The Moodle-based learning platform was mainly used for class management, such as sharing teaching resources, posting notifications, and submitting final assignments. Knowledge Forum was mainly used for students to collaboratively work on their group projects (i.e., AI-related products or solutions, lesson plans). The students were

encouraged to apply the Knowledge Building principles in their discourse in this process. The instructor customized the scaffolds (e.g., sharing information, negotiating ideas, integrating and improving ideas). In class, the instructor checked the students' understanding of online materials and led the discussions of questions raised by the students during reading of the materials. After class, the students remained involved in group work and online discussions through Knowledge Forum.

At the end of the course, guided by nine questions, each participant wrote a reflection on the changes in their understanding of Knowledge Building, the usage of Knowledge Building principles and Knowledge Forum. They also provided suggestions for future course refinement and responded whether they would apply the Knowledge Building approach in their future teaching.

Data Collection

We mainly collected data from two sources. One of the sources is the 307 Knowledge Forum notes contributed by eight groups of students. In each group, we analyzed the content of the notes to identify indicators of democratizing knowledge and parse out the cognitive and social aspects. The building-on relationships of the notes were recorded in Knowledge Forum. The other source is individuals' reflections. Student responses to the reflection question "*Did you intentionally apply the Knowledge Building principles in your group discourse? Please use Knowledge Forum notes as evidence for each principle that you will list here*" were included in the analysis of this study.

Data Analysis

Based on the above review of the cognitive and social aspects of democratizing knowledge and based on our data, two researchers with experience analyzing Knowledge Building discourse developed a coding scheme (see Table 1) using an iterative and deductive

qualitative approach established in the literature (Hsieh & Shannon, 2005; Armat et al., 2018).

To respond to the first research question concerning how democratizing knowledge was manifested in students' Knowledge Building discourse, the two researchers used the coding scheme to code all 307 notes, discuss the differences between their understandings, and finally achieve an agreement for each note. Approximate three months after the coding, the two researchers again coded all the notes using the same coding scheme to check if their coding was stable. The average agreement between the two rounds of coding results for all seven democratizing knowledge categories was 88.61%.

Different from other cognitive and social subcategories that were analyzed based on the various groups' Knowledge Forum discourse, each group's evenness of building-on relationships was measured using the evenness index as described in Table 1. Evenness is a group indicator that measures how equally each group member contributes to the group discourse (i.e., the number of notes contributed by each member). The evenness index ranges from 0 to 1, with 1 denoting perfect evenness while 0 representing total unevenness (Authors, 2017). This measurement evaluates how equally the members of each group build onto each other's notes. To visualize the building-on networks of the groups with the highest evenness and the lowest evenness, we conducted social network analysis using Gephi, open-source software that displays networks in real time (Bastian et al., 2009).

Insert Table 1

To respond to the second research question regarding the relationships between students' adoptions of Knowledge Building principles and the democratizing knowledge levels, we first identified the Knowledge Building principles employed by each participant based on the responses and evidence in their reflections. Then we conducted two different correlation analyses. In the first correlation analysis, the variables were individuals' adopted

Knowledge Building principles and the frequency of the indicators of democratizing knowledge in their personal Knowledge Forum notes. In the second correlation analysis, the variables were individuals' adopted Knowledge Building principles and the frequency of the indicators of democratizing knowledge in the Knowledge Forum notes contributed by other group members.

To answer the third research question on whether subcategories of democratizing knowledge sustain Knowledge Building discourse or not, we conducted Welch Two Sample t-tests to compare the build-on length of notes that fell into a democratizing knowledge category and the build-on length of other notes.

Results

Indicators and Manifestation of Democratizing Knowledge Manifested in Pre-Service Teachers' Knowledge Building Discourse

Table 2 shows the frequency of the cognitive and social subcategories of democratizing knowledge in each group. Overall, in the cognitive subcategories, the groups have greater frequencies of diverse ideas and improving ideas, while fewer shared goals and rise above. Concerning the social dimension, the groups had more notes that fell into the category of openness to different ideas, while relatively fewer notes fell into the categories of participation invitation or response and sense of ownership. Compared to the groups with higher building-on centrality, the groups with lower building-on centrality had a lower frequency of participation invitation or response.

Insert Table 2

Figure 3 shows the building-on networks of the two groups with the highest (1.00) and lowest (0.87) building-on evenness index. In the Brainstorming group (Figure 3a), Sophia built onto others more times (14) compared to Rob (five), Mia (five), and Eva (three). Sophia's notes also were built on more times by other group members (nine), while Eva's notes were built on fewer times by others (four). Therefore, Sophia played a relatively

dominant role in this group while Eva played a relatively peripheral role. In contrast, in the Computer Science group, Tom, Jane, Linda, and Dave built onto other group members nine, twelve, eight, and twelve times, respectively. Therefore, they had a near-perfect evenness concerning the frequency of building on group members' notes.

Insert Figure 3

Relationships between Indicators of Democratizing Knowledge and other Knowledge Building Principles

Table 3 shows the correlation analysis results between participants' adoption of the twelve Knowledge Building principles and their notes falling into each cognitive and social subcategory. As we were especially interested in the correlations between democratizing knowledge and other principles, we only focus on describing the correlations here.

Democratizing knowledge was positively correlated with community knowledge and collective responsibility, symmetric knowledge advancement, pervasive knowledge building, knowledge building discourse, and constructive uses of authoritative sources. Regarding the cognitive and social aspects, there is a moderate correlation between openness to different ideas and the contribution of diverse ideas. This result suggests that the participant who was more open to different ideas was likely to contribute different ideas to their community. There is a strong correlation between being open to different ideas and a sense of ownership and improving ideas, indicating the ones who were open to different ideas tended to consider the knowledge belonging to the community and improve community knowledge. There is a moderate correlation between participation invitation and shared goals, suggesting that when the students talked about their shared goals, they tended to invite other group members to participate.

Insert Table 3

To investigate how being a member of groups with various levels of democratizing knowledge would influence their adoption of Knowledge Building principles, we analyzed the correlations between one participant's adoption of Knowledge Building principles and other group members' frequency of each democratizing knowledge subcategory. As shown in Table 4, there is a moderate negative correlation between an individual's adoption of community knowledge and collective responsibility and other groups members' contributing of diverse ideas. There is a moderate negative correlation between an individual's adoption of the advancing ideas and rise-above principles and other groups members' shared goals.

Insert Table 4

Sustainability of Notes Coded as Different Subcategories of Democratizing Knowledge

The Welch Two Sample t-test on the length of build-on notes in different subcategories suggests that rise-above notes significantly have fewer build-on notes compared with none rise-above notes. For any other indicator of democratizing knowledge, its number of build-on notes did not significantly differ compared with those of notes not falling into this subcategory. The results indicate that besides rise-above, the other indicators of democratizing knowledge did not differ in sustaining Knowledge Building discourse.

Discussion

This study explored the indicators and the manifestation of democratizing knowledge in pre-service teachers' Knowledge Forum notes. Furthermore, to investigate the effects of democratizing knowledge, we examined the correlations between the adoption of Knowledge Building principles and a participant's as well as other group members' contributions in terms of the cognitive and social aspects of democratizing knowledge. Furthermore, we also examined the extent to which different subcategories of democratizing knowledge sustain the Knowledge Building discourse. Several findings are worth discussing.

First, this study developed a framework for analyzing democratizing knowledge in students' Knowledge Building discourse. The cognitive aspect includes the contribution of diverse ideas, advancing ideas, achieving shared understanding or goals, and rising above; the social aspect includes a sense of ownership, openness to different ideas, participation invitation or response, and evenness of building-on relationships. Previous studies on collaborative relationships or inclusive teaching have mentioned these concepts as well. For instance, Pratesi and colleagues (2019) supported students in breaking down the hierarchies in classrooms in which students' ideas are undervalued while teachers are seen as the sole authority. They suggested that the emerging expertise of students should be centered and that the students should be empowered to take ownership of their learning. Abbas and colleagues (2020) suggested the importance of people being open-minded and allowing other sides to come up with innovative ideas and providing critical comments to improve the ideas in collaborative research relationships. The research field of CSCL also gives all students equal opportunities to contribute to their community knowledge and particularly benefits those who are too shy to speak in public settings (Dooly, 2008).

The social aspects of democratizing knowledge interconnect with the cognitive aspects. In a context in which inclusive and equitable participation is emphasized, students may intentionally ask their peers for opinions or share ideas. Inclusion can be achieved when students in a learning community can deal with conflicts and accept diversity (César & Santos, 2006).

The overall frequencies of the various cognitive and social subcategories of democratizing knowledge are consistent with our previous study (Authors, 2021). The participants had greater frequencies of diverse ideas and improving ideas than shared goals and rise above. Shared goals and rise above are more advanced levels of cognitive contributions, requiring community members to come together, discuss their goals, reach an

agreement, synthesize different ideas contributed by group members, and identify gaps in understanding. These activities would require students to take ownership of their community knowledge and invite others to participate to make inclusive and collaborative decisions. The relatively lower frequency of participation invitation or response and sense of ownership also suggest that the participants legitimately contributed to Knowledge Building and were open to different ideas. However, they needed more support and effort in helping others to participate so that they could work on shared goals and rise above individual ideas to achieve new syntheses.

Second, this study confirmed the moderate to strong correlations between democratizing knowledge and community knowledge and collective responsibility, symmetric knowledge advancement, pervasive knowledge building, knowledge building discourse, and constructive uses of authoritative sources. Previous studies mainly suggested that the Knowledge Building principles are interconnected and that implementing one principle tends to unlock the others (e.g., Scardamalia, 2002; Zhang et al., 2007). However, some other studies (e.g., Authors, 2021; Law & Wong, 2003; Tarchi et al., 2013) suggested that several principles (e.g., authentic ideas and real problems, idea diversity) are easier for students and teachers to implement while some are more challenging (e.g., symmetric knowledge advancement, rise above). Researchers have made varied efforts to group the twelve Knowledge Building principles; however, few studies have produced reliable subsystems or clusters of the principles (Chan & Chan, 2011). This current study suggests that it may be possible to empirically examine how the Knowledge Building principles are represented in well-developed Knowledge Building discourse and study their correlations.

Notably, there is a moderate negative correlation between an individual's adoption of the improvable idea and rise-above principles and the frequency of shared goals manifested in other groups members' Knowledge Forum notes. A possible reason is that there were

relatively fewer notes falling into the subcategory of shared goals in each group; a participant did not have to synthesize the status of their group knowledge once other group members summarized their shared goals. In other groups, not all members would contribute in the same ways or adopt the same Knowledge Building principles; they operated collectively by taking different responsibilities. We noted that all groups tended to continuously deepen their discussions rather than contribute more diverse ideas during our coding. It is possible that the students discussed different ideas face-to-face and recorded their improvement trajectories in Knowledge Forum. This hypothesis may explain the negative correlation between an individual's adoption of community knowledge and collective responsibility and other group members' contributing of diverse ideas.

Third, concerning the number of build-on notes to different types of democratizing knowledge notes, rise-above notes have significantly fewer build-on notes compared with non-rise-above notes. The reason for this observation may be that rise-above notes represent students' syntheses of previous notes and identification of knowledge gaps or plans based on the synthesis. They may represent students' state-of-art community knowledge and lead to new inquiry directions. Therefore, students may be less likely to build on rise-above notes.

No significant difference was found concerning the sustainability of other indicators of democratizing knowledge. It may suggest the similar importance of different indicators of democratizing knowledge in sustaining Knowledge Building discourse.

Theoretical Contribution and Practical Implication

This study has important theoretical and practical implications. Theoretically, as one of the very few studies examining the indicators and manifestation of democratizing knowledge in students' Knowledge Building discourse, this study contributes to the literature on democratizing knowledge. This paper provided a framework for analyzing democratizing knowledge from the cognitive and social aspects in Knowledge Building groups or

communities. Practically, this framework can guide the research design that aims to promote democratizing knowledge. For instance, practitioners can use it to design appropriate strategies and scaffolds to create an inclusive and open Knowledge Building environment. Furthermore, a better understanding of the relationships between pre-service teachers' adoptions of Knowledge Building principles and the democratizing knowledge levels of their groups provides implications concerning how to regulate community interactions to promote students' adoption of certain Knowledge Building principles.

Limitations and Future Directions

This study contributes to the Knowledge Building and equitable education literature by exploring the indicators of democratizing knowledge, how the indicators are manifested in pre-service teachers' Knowledge Building discourse, and the correlations between the indicators and Knowledge Building principles. Despite these strengths, this research has several limitations.

First, as an exploratory study, this study has a relatively small sample size (i.e., 35) and was conducted in a specific Chinese cultural context. As such, the generalizability of the findings is limited. For instance, during our coding, we noticed that the pre-service teachers used words like "may" and "maybe" to indicate impoliteness and friendliness rather than openness in some contexts. This phenomenon should be related to the specific culture. On the other hand, this issue does not thwart the importance of this study for the following reasons. One, like other CSCL research, the data collection of this study lasted for 16 weeks, and our analyses focused on student-generated discourse. CSCL studies typically examine core concepts such as student interactions, collaborations, knowledge building, and technology use over weeks or months to understand their nuanced collaborative mechanisms and learning process (Authors, 2019; Reimann, 2009). Two, the sample size of this study is comparable with studies of similar nature. For instance, we previously examined the relationships

between 39 pre-service teachers' adoption of Knowledge Building principles and their small group performance. Hong and colleagues (2019) investigated 25 pre-service teachers' reflective capacity. Future research on democratizing knowledge will benefit from extending this study with larger sample sizes and including the cultural context into consideration.

Second, the Knowledge Forum discourse might not fully capture group members' efforts in democratizing knowledge. The group members mainly discussed their selection of a certain learning topic and relevant lesson design ideas in the Knowledge Forum. However, part of the process of developing the lesson plans took place in the face-to-face context. Further research might consider capturing students' online and offline Knowledge Building discourse more holistically to understand better how democratizing knowledge is manifested.

Third, the students reflected on their adoption of the Knowledge Building principles and provided relevant evidence. However, future research may consider analyzing students' adoption of Knowledge Building principles more objectively, for example, by conducting content analysis to identify the adopted Knowledge Building principles (Authors, 2021).

Finally, student discourse concerning their lesson design plans mainly occurred at the group level because the groups chose various design topics. However, Knowledge Building emphasizes community knowledge and symmetric knowledge advancement. Future research may consider how to promote inter-group discussions and knowledge syntheses, for example, by designing community goals for small groups to tackle from different perspectives.

Conclusion

This exploratory study researched the indicators of democratizing knowledge—a core principle of the Knowledge Building pedagogical approach—and its manifestation in pre-service teachers' discourse. Through discourse analysis, cognitive (e.g., contribution of diverse ideas, ideas, achieving shared understanding or goals, and rise above) and social aspects (e.g., a sense of ownership, openness to different ideas, participation invitation or

response, and evenness of building-on relationships) were identified. This study also indicated correlations between democratizing knowledge and other Knowledge Building principles such as community knowledge and collective responsibility, symmetric knowledge advancement, and pervasive Knowledge Building.

This study represents an attempt to extend our understanding of the elements and nuances of democratizing knowledge, providing empirical evidence of the interconnections of different Knowledge Building principles and shedding light on how to foster democratizing knowledge in Knowledge Building in practice. Future research can extend this study by enlarging the sample size and including more culturally diverse contexts.

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