Knowledge Building as a Way of Life: Enculturating Students into World 3

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Abstract: Communities can be powerful drivers of learning and transformation. Knowledge Building communities aim to foster students' epistemic agency toward high levels of ownership over individual and collective learning – students come to enjoy relying on one another to advance their community knowledge. This case study examines pedagogical and technological designs for enculturating students into World 3, the world of ideas, theories, designs, and conceptual artifacts. From the first day of school, the teacher adopted a holistic approach toward principle-based designs, simultaneously engaging in multiple principles across multiple curricular areas. Furthermore, the process was catalyzed when she directly involved students in co-designing their Knowledge Building culture, including the norms of interaction, discourse structures, knowledge goals, and trajectory of knowledge advancement. Student and teacher reflections reinforce the notion that Knowledge Building is more than just an instructional framework: It is a philosophy – a way of living and being in contemporary knowledge societies.

Introduction

Communities can be powerful drivers of learning. In schools, learning communities have been designed to support: (1) development of diverse expertise among students, (2) advancement of shared goals, including knowledge and skills, (3) continual reflection on learning how to learn, and (4) mechanisms for sharing what is learned (Collins & Kapur, 2014). A growing body of research in the learning sciences demonstrates that learning communities deepen students' disciplinary understanding while promoting key competencies for working creatively with knowledge (Chan, 2013; Bielaczyc, Kapur, and Collins, 2013). Learning communities, thus, represent a promising approach to enculturate students into knowledge societies.

In a Knowledge Building community, the teacher finds ways to enable students to take on high levels of ownership over their learning from day one of school. One way to achieve this is through immersion into authentic knowledge work. In an effort to transform traditional participation structures, the Knowledge Building teacher encourages students to assume *collective responsibility* (Scardamalia, 2002) by intentionally de-centering herself from class discussions. Students come to rely on one another to sustain community knowledge advancement (e.g., Zhang et al., 2009; Ma et al., 2016; Ma & Akyea, 2020). Additionally, the teacher can shift traditional relations between students' ideas and experts' ideas, such as the curriculum, to bring students' ideas to the forefront of classroom interactions (e.g., Teo, 2014; Caswell & Bielaczyc, 2002; Toth & Ma, 2018). By making students' ideas the objects of inquiry for the community, students are enculturated into activities in World 3 (Bereiter, 2002) – the world of ideas, theories, conjectures, and design problems – and they learn to see themselves as *epistemic agents* responsible for improving conceptual artifacts, otherwise known as *real ideas and authentic problems* (Scardamalia & Bereiter, 2014). Students come to understand that community knowledge "lives 'in the world' and is available to be worked on and used by other people" (Scardamalia & Bereiter, 2003). A few of the Knowledge Building principles (Scardamalia, 2002) are discussed here, and concrete examples of all 12 will be detailed in this case study.

The design challenge for teachers is creating a holistic system of principle-based practices that facilitate self-organization around community knowledge advancement (Chen & Hong, 2016). Teachers new to Knowledge Building face the added challenge of unlearning practices that keep them at the center of discourse and assignments. Students must also unlearn the game of schooling, including the desire to look smart by contributing fake theories (Bielaczyc, 2018) and relying on the teacher to validate their ideas (Milinovich & Ma, 2018). While past studies (e.g., Zhang et al., 2009; Tarchi et al., 2013) indicate that it can take anywhere from a few months to a few years to foster a Knowledge Building culture in the classroom, recent work in the context of the Knowledge Building Innovation Network (Ma et al., 2019) in Ontario suggests that engaging educators in iterative design cycles of principle-based practices can support and even catalyze the development of teachers' efficacy in Knowledge Building.

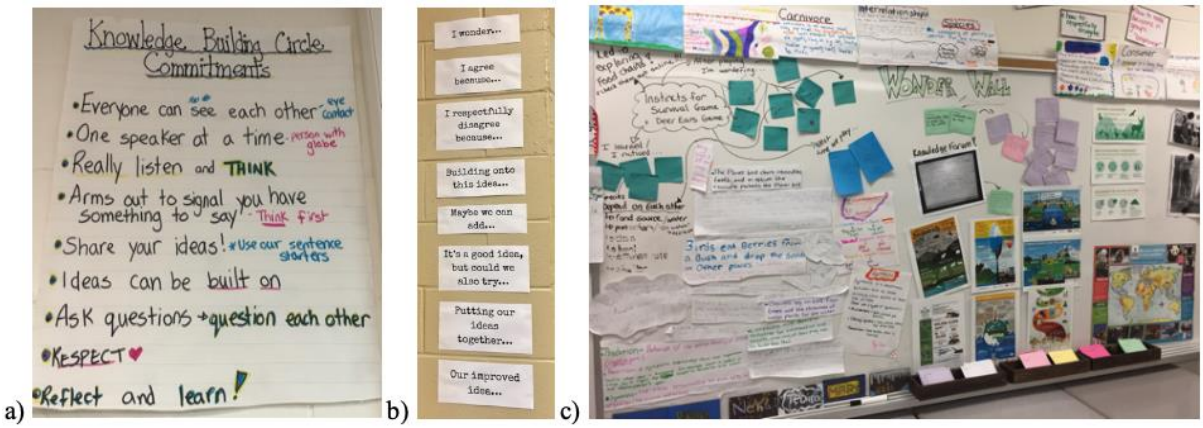
In this paper, we elaborate on exploratory and iterative processes involved in designing a holistic system of principle-based practices in an elementary classroom. More specifically, we follow the journey of Emily Horner, a Knowledge Building teacher in Milton, Ontario dedicated to fostering a learning community that departs from traditional classroom practices so that students may see themselves as Knowledge Builders. Emily involved

her students directly in co-design and re-design of classroom practices that facilitated community knowledge advancement. In each subsection, we provide an overview of Emily's design ideas before describing how she simultaneously implemented multiple principles into classroom practices that spanned across multiple curricular areas: science in the fall, social studies in the winter, and math in the spring. We conclude each subsection with excerpts of student discourse and teacher reflections on how Knowledge Building and Knowledge Forum have transformed their classroom experiences.

Co-Designing Norms and Practices for a Knowledge Building Community

Epistemic agency, Community knowledge, Democratizing knowledge, Knowledge Building discourse.

When Emily first started the school year, she was experimenting with different tools and strategies from the Knowledge Building Gallery (Resendes & Dobbie, 2017) to help students go deeper with their collaborative inquiries. Examples included planning with a big idea, looking for cross-curricular connections, and using "wonderwalls" to make student thinking visible.



a) b) c)

Figure 1. Knowledge Building a) circle commitments, b) scaffolds, and c) wall.

One of the first practices she tried was Knowledge Building circles, which at the time, she viewed as a place for students to share their learning. She also worked with her students to co-create commitments for Knowledge Building circles (Figure 1a) to help students understand that this was meant to be a safe space to share ideas and reflect on their learning together. Their commitments focused on how all ideas mattered, ideas can be improved upon, and how students (not the teacher) would choose who would speak next. This practice addressed the principles of *epistemic agency*, *democratizing knowledge*, *improvable ideas*, and *collective responsibility*.

Shortly after, Emily reflected on the quality of discourse happening in her classroom: "Were our conversations really leading us to deeper understandings?", "Were students truly listening to each other in a way that they actually thought about what each other was saying and how their own ideas fit or didn't fit with each other?", and most importantly, "Did they see the value in learning from each other or just from the teacher?". Guided by these questions, Emily redesigned the Knowledge Building circles to include the use of Knowledge Building scaffolds (Figure 1b) and noticed that students began to use them right away. As they moved along, they added in more scaffolds, such as "I used to think", "Now I think", to support metadiscourse, and she also encouraged students to co-create their own scaffolds. This shift in practice addressed the principles of *Knowledge Building discourse* and *embedded, transformative assessment* while maintaining the centrality of the previous principles.

From there, Emily also began to rethink the idea of "wonderwalls" by adding the Knowledge Building scaffolds in print as well. Based on an example in the Knowledge Building Gallery, she created little squares of paper with Knowledge Building scaffolds colour-coded to represent the different types of contributions. Students started writing their thoughts and posting them in a public space where they would refer to and work on over sustained periods of time. This shift in practice helped deepen the principles of *democratizing knowledge* and *community knowledge*. Figure 1c shows the Knowledge Building wall, which includes students' theories (green), questions (purple), artifacts (e.g., notes, observations, drawings, writings), *authoritative sources* (e.g., diagrams, maps, infographics), and a screenshot of their view in Knowledge Forum, which was introduced to the class in early fall.

Student Reflections

Students treated Knowledge Forum as an extension of their Knowledge Building wall and were excited to continue their work in a dynamic online space where their ideas could be organized flexibly and grow infinitely along with everyone else's ideas in a giant web. To Emily's surprise, students were so engaged with each other's ideas that they would log onto Knowledge Forum during evenings to continue discussions with their peers. Because their discussions were no longer confined to school hours, their Knowledge Building became *pervasive* and their community knowledge started taking on a life of its own. Using *embedded assessment* tools, such as the activity dashboard, Emily could see which students were taking initative to start conversations and which students were providing supportive roles by building on. Below are a few students' reflections on their experiences using Knowledge Forum.

> **Student A,B,C:** Knowledge Forum is a good resource for getting more ideas on a topic and seeing what other people have to say about your ideas and research… [It's] good for organizing a group of people's thoughts.
> **Student D**: Basically you paste your ideas on it… so the whole class has access to this and you can put in whatever idea you like.
> **Student E**: You add on to each other's knowledge and it keeps on going.
> **Student D**: For example… [if] you were wondering something you would have the sentence starter called "I wonder", and you could add on to that.
> **Student F**: Also another good thing about Knowledge Forum is that you can work/read people's ideas while being away/at home.

Teacher Reflections

Below are Emily's reflections about Knowledge Building circles and Knowledge Building scaffolds:

> I don't think I really recognized the power [the Knowledge Building circles] held… [until] I saw them as a collaborative space to work on and improve ideas… The Knowledge Building scaffolds [were] a real game changer for me. [They served as] starting points for some of my quieter students to enter into conversations and challenged some of the other students to go deeper. These scaffolds gave my students the power of language and they took over the direction of learning, as students' thinking moved to the forefront. It broke down some of the pressure I felt and my students felt because we learned we did not have to have the answer right away but that we were a community and we would help each other to work towards creating this knowledge – we were all co-learners, teacher included. This naturally led way to my own and my students' understanding of *community knowledge and collective responsibility*. We learned how to depend on each other to move our thinking. I started to rethink my role in a Knowledge Building circle and learn to wait and to let my students speak.

Below are Emily's reflections about Knowledge Forum:

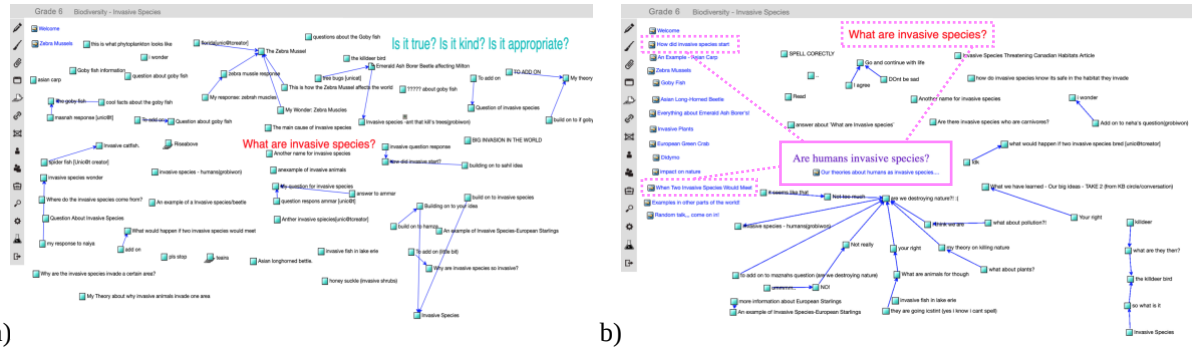
> In a way, Knowledge Building walls and Knowledge Forum have become a tracker of our learning journey in a public space – one that we can interact with throughout the year. We can see our ideas and knowledge progress over time, further deprivatizing our learning. Knowledge Forum has provided a public space for my students to document the evolution of their ideas and learning journey, while visually being able to see and form deeper connections between ideas. Knowledge Forum also naturally taught my students digital citizenship, and it opened up many more opportunities in connecting with students at other schools, which really helps with *idea diversity* for the students. I loved how all my students felt they had a voice, even the quieter ones… [It gave everyone] multiple opportunities and platforms to speak, whether it's in a Knowledge Building circle, on a Knowledge Building wall, on Knowledge Forum, or even in reflection logs.

Knowledge Building/Knowledge Forum Designs in Science

Real ideas and authentic problems, Idea diversity, Improvable ideas, Rise above.

The first curricular area Emily tried with Knowledge Forum was science. After reviewing norms for digital citizenship (i.e., "Is it true?", "Is it kind?", "Is it appropriate?"), students were given full control to create and design their views in Knowledge Forum, thus furthering the principle of *epistemic agency*. Figure 2a shows the Knowledge Forum view where students shared initial theories about invasive species. The blue links on the left of Figure 2b show the different types of invasive species that students chose to research individually or in groups,

such as zebra mussels, goby fish, Asian long-horned beetles, and other examples in other parts of the world (*idea diversity*). Students were also personally invested in learning about the Emerald Ash Borer, a beetle that "originated from Asia in China", which humans "accidentally introduced to North America in imported wood packaging" and consequently "killed over 250 ash trees in Milton" (*real ideas, authentic problems*). As students conducted their research, they continued to advance overarching issues that they had identified would be relevant to their community knowledge, such as "How did invasive species start?", "How do invasive species know it's safe in the habitat they invade?", "What would happen if two invasive species bred?", and "Impact on nature". Eventually, their discussions led to the *rise-above* question "Are humans invasive species?".



a) b)

Figure 2. Knowledge Forum view on biodiversity a) at the beginning and b) at the end of their research.

Student Discourse

Below is an excerpt of the online discussion in Figure 2b). It can be seen that students were engaging in key scientific processes, such as theorizing, asking questions, and providing evidence to support their explanations. Of note, students were so deep in design mode with ideas that they did not settle on a quick yes-or-no answer to their rise-above question. Instead, they showed a willingness to explore alternative perspectives and discuss tensions that arose between humans and their environment, such as the need for using plants for shelter, tools, medicine, and research. One student even developed an analogy to highlight these complexities – a hallmark of design thinking (Bereiter & Scardamalia, 2003; Martin, 2009).

> **Student G**: An invasive species is a plant, fungus, or animal species that is not native to a specific location (an introduced species), and which has a tendency to spread to a degree believed to cause damage to the environment, human economy or human health.
> **Student H**: [I wonder:] are humans considered invasive? We came from nowhere and destroyed the environment and killed thousands of species such as the thylacine (a hyena tiger mix) and the elephant bird.
> **Student I**: We really are destroying the wildlife. We cut down trees. We kill so many animals. We pluck out plants. Are WE the ones destroying nature?! :(
> **Student J**: [My theory:] is not really. We cut down trees to make things for us to survive. And some plants help sick people. It isn't exactly the best thing to do, but doing this saves lots of people. We will continue to plant more plants though.
> **Student K**: Yes and no. Some people pick flowers for nothing but also, some people will do it for research. Some people cut down trees for no reason, but some people cut down trees to make peoples lives easier to make toothpicks, paper, chairs, doors, and so many more things that we use every day. So really, it's not a yes or no question, it's a both kind of question, like pizza or donuts – the answer is both! :D

Teacher Reflections

Below are Emily's reflections about her evolving role in the Knowledge Building community as students began taking on increasing amounts of collective responsibility for idea improvement. As an alternative to giving students big questions to answer, Emily was finding promising questions that students had asked which had potential for sustaining discussions:

> I became more intentional about highlighting certain ideas expressed by students that would prompt more thinking, such as "Are we, are humans invasive species?". When we highlighted this one idea, this led to so many more theories and questions being asked… I also focused on redirecting students' ideas and questions to the group to help students form connections between what they were learning and to see how they could support each other in moving forward. This

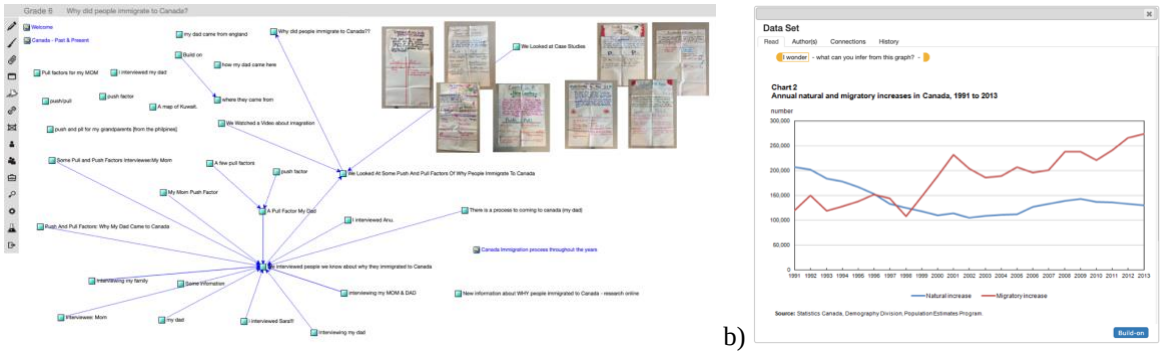
really helped my students feel comfortable in sharing ideas because they knew their ideas mattered. Not just to themselves or to me, their teacher, but to their peers. They started to depend more on each other across subjects, really believing "We're not good until we're all good".

Knowledge Building/Knowledge Forum Designs in Social Studies

Real ideas and authentic problems, Constructive use of authoritative sources, Pervasive Knowledge Building.

As students became more proficient in using Knowledge Forum, Emily also began to rethink the way she introduced provocations and how she could design authentic tasks that really made students think. In particular, she was interested in understanding the *real ideas, authentic problems* her students wanted to solve or questions they wanted to unpack that lived within the curriculum. For her next design, she tried using Knowledge Forum in social studies, reframing the concepts of "invasion" and "migration" from ecological to societal contexts. Figure 3a shows the online discussion about "Why do people immigrate to Canada?" as part of the larger investigation into "Communities in Canada: Past and Present", which also covered the history of colonization and legacy of residential schools in Canada, institutionalized sexism/racism, and cultural genocide (e.g., black slavery, WWII).

The Knowledge Forum view in Figure 3a contains notes with students' theories, as well as artifacts from the classroom that documented students' ideas about push and pull factors related to immigration. In line with previous designs which aimed to provide multiple entry points for students, students working in this view drew from multiple sources of information (*idea diversity*), including videos, case studies, and interviews with members of their community, such as parents, grandparents, siblings, and even one of their classmates. Collecting their own interview data made their investigation real and authentic. Moreover, having the opportunity to discuss the lived experiences with immigrants helped students develop a greater sense of empathy toward others, as well as a sense of appreciation for the rights and privileges they have as Canadian citizens. Students learned that Canada: is "wealthy and safe", has a "really good health care system,… amazing services, lots of food, and no pollution", offers "a better future in terms of education and job opportunities", and overall, represents "a better place [for families] to live". Additionally, Emily supplemented the discussion with an *authoritative source*, a graph from Statistics Canada, to help students get a birds-eye view on immigration trends in Canada.



a) b)

Figure 3. Knowledge Forum a) view on why people immigrate and b) note with data on immigration trends.

Student Discourse

Below is an excerpt of the online discussion about the graph on immigration trends as shown in Figure 3b. It can be seen that students were engaging in key mathematical processes, such as reading the legend, defining key concepts, identifying patterns (e.g., minimum, maximum, range, scale), analyzing the rate of change across the groups, as well as generating theories and predictions to explain their observations. Additionally, students who were co-authoring brought in different conceptions of "migration" from social studies and natural sciences perspectives, which further enriched their discussion. Their Knowledge Building was becoming increasingly *pervasive* as ideas cut across different curricular areas.

Student L,I,M: Migratory=red, Natural=blue. We say that the red rate was at its lowest in 1998 and blue was lowest in 2002. It was highest at 2013 in the whole graph.

Student N,J,OK: One way the population increases is Migratory which means people move to that area which is in this case Canada. The Annual Natural increase is for when babies are born. This graph compares the two topics and shows the increase and decrease. The range of this data is 160,000.

Student P,Q,K: The natural increase means the birth rate in countries. Migration means the migration of animals. Migration(Migratory) increases one year and decreases the next. The natural increase has decreased from 1991. The scale goes up by 50, 000.
Student E: We notice that the migratory went up and the natural went down. We think that the migratory increase will go higher in the years because if you look at the line graph, it went higher. Also, we think that the natural increase will go lower each year.

Teacher Reflections

Below are Emily's reflections about her evolving perspective on connections in the curriculum:

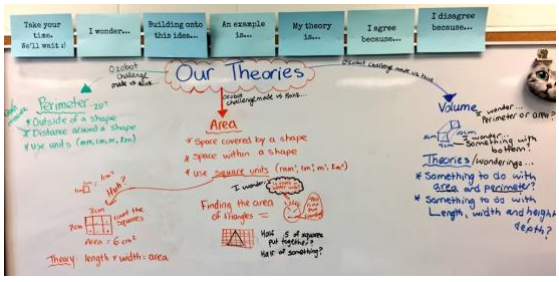
> Students have been uncovering the curriculum through their questions and wonderings and we can see the progression of their thinking over time. I have learned that I need to be intentional in planning provocations and highlighting students' promising ideas, but at the same time remain flexible in changing my plans as I respond to my students' curiosities. The connections students have made across subjects and beyond curriculum blow me away, and I can see them empowered as they build their knowledge together. Curriculum areas permeate into other curriculum areas, with students applying what they have learned in different situations, as well as highlighting new connections. I think this truly shows movement of ideas and that learning has taken place. Ultimately, learning is an iterative process. It's not just when the unit is done, this learning is done. It continues. Students think about how they are going to connect and move the knowledge forward for the next inquiry that they look into. I think this shows real growth in their views about knowledge and learning.

Knowledge Building/Knowledge Forum Designs in Math

Idea Improvement, Knowledge Building discourse, Symmetric knowledge advancement, Rise above.

Once Emily became more comfortable with Knowledge Building and Knowledge Forum, she started to reflect on how her teaching practices could be applied to mathematics: "How could she bring students' ideas to the center of math, as she had done in other curricular areas?". To tackle this problem of practice, she focused on provocations that had potential for students to create new knowledge about the concepts in the curriculum. Although she was initially nervous that encouraging students to generate theories and conjectures would uncover many misconceptions, she later realized that it was the misconceptions themselves that provided basis for investigations that led to *idea improvement* and deeper understandings of important mathematical concepts.

Figure 4a shows notes from a Knowledge Building circle about area, perimeter, and volume. It can be seen that the Knowledge Building scaffolds (in blue) were added to the top of the white board, which helped students engage in *Knowledge Building discourse* in math. Students co-designed additional scaffolds to use specifically in math, such as "Another strategy is", "Have you thought about", and "Maybe we could try".

a) 

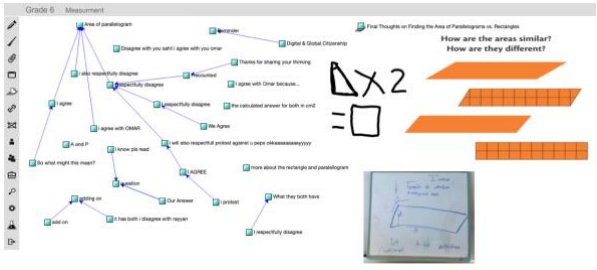
b) 

Figure 4. a) Knowledge Building wall and b) Knowledge Forum view on area and perimeter.

Student Discourse

Below is an excerpt of the online discussion about properties of rectangles and parallelograms, such as area and perimeter, as shown in Figure 4b. Similar to previous designs, Emily added a picture of student ideas from the whiteboard into Knowledge Forum to sustain discussions. It can be seen that students were engaging in key mathematical processes, such as classifying/decomposing shapes, counting metric units, calculating formulae, and reasoning spatially. A student even created a drawing to show how a square would decompose into two triangles.

> **Student R**: They are both quadrilaterals… [with] two sets of parallel sides. The rectangle has all angles equal, while the parallelogram has opposite angles equal.

> **Student S**: [My theory]: When looking at the picture, I noticed the 2 parallelograms and the rectangle both have the same area: 20cm^2.
> **Student J,T**: The length of the rectangle was 2cm and the width was 10cm long. The parallelogram also had the length of 2cm and the width of 10cm, so we did the formula for finding the perimeter (L + L + W + W), and both of the final perimeters were 24cm. For the area, since both of their lengths were 2cm and the width was 10cm, we just did the formula for area (L x W). We multiplied 10 x 2 and ended up with 20cm^2.
> **Student F,V**: We noticed that… The parallelogram has 4 half squares, add them together and it's 2 full squares! [My theory]: Our theory is that a parallelogram and a square could be classified in the same category.

Teacher Reflections

Emily noticed that students were as engaged in math as they were in science and social studies when they did Knowledge Building. Moroever, she saw that as students became more comfortable discussing strategies and math concepts (*democratizing knowledge*), they shifted their engagement toward gaining deeper understandings of math processes instead of rushing to get to the final solution. This inspired her to connect with another grade 6 class in order to provide new perspectives to students for *improvable ideas*. The two classes engaged in math and robotics problems and connected via online conversations in Knowledge Forum, followed by a virtual Knowledge Building circle on Google Hangouts which led to *rise-above* theories about the relations between speed, distance, and time. Students made connections across various strands in the math curriculum. Below are Emily's reflections:

> Overall, I have become a conscientious teacher, and I have learned with my students how to co-create ideas, work with them, improve on them… I have learned the power of co-teaching and co-planning. We teach math differently now. [Students are] focused on the bigger skills like communicating, expressing their ideas, being able to disagree with each other but then in order to move it forward, "Well I could solve it this way, have you thought about this?". It's about being able to listen to other perspectives and to be open about trying new things. One student reflected that, "Without using KF I wouldn't have known that – had I not had a place to read what other students discovered.". It was amazing to see the connections students were making to previous math knowledge, even more than we expected students to connect to and reflect on. Students also took time to help their peers who were not in their own group as they were excited to share their knowledge, and they truly exemplified what it means to be part of a community. My students are more curious, they think more about each other, and they feel more empowered.

Discussion

Knowledge Building aims to enculturate students into World 3 by the most direct means possible. This case study proposes that the process of enculturation can occur through an immersive co-design approach. From the first day of school, Emily empowered her students to design their Knowledge Building culture, which included the norms of interaction, discourse structures (i.e., scaffolds), and knowledge goals. Through co-design, they became Knowledge Builders advancing the frontiers of their community knowledge. When working in design mode, students came to learn that Knowledge Building was not just something they did in science, social studies, or math, but that their questions would continue traveling into different curricular areas, allowing them to criss-cross knowledge domains (Scardamalia & Bereiter, 2016). Additionally, Knowledge Building was not something they did in Knowledge Building circles or on Knowledge Forum – their physical and digital spaces became seamlessly integrated to facilitate the flow of ideas within and between classrooms. Their Knowledge Building was pervasive.

Past work suggests that teachers new to Knowledge Building commonly start with the principles of *real ideas, authentic problems; idea diversity*; and *Knowledge Building discourse*, then as they go deeper with their practices, they start addressing *community knowledge, collective responsibility; democratizing knowledge*; and *improvable ideas* (Ma et al., 2019). This case study reinforces the notion that the Knowledge Building principles are interrelated and work together as a system. While this is only one classroom example, it should be noted that Emily chose different principles than other new teachers in the Knowledge Building Innovation Network, which may explain how she led to deeper practices faster. One reason could be due to her design approach, which aimed for simultaneous and holistic integration of multiple principles. Another reason could be due to her choice of principles – ones that are drastically different from traditional schooling cultures (i.e., *epistemic agency, community knowledge, democratizing knowledge, Knowledge Building discourse, improvable ideas*). In a similar way, another Knowledge Building teacher in Ontario started with principles of *community knowledge, democratizing knowledge,* and *Knowledge Building discourse* which not only deepened student learning but also shifted their attitudes toward learning (Milinovich & Ma, 2018). We are not promoting a sequential or scripted

approach to Knowledge Building, but we also do not rule out the possibility that some principles may be more effective than others at getting started with fostering a Knowledge Building culture. For example, starting with *constructive use of authoritative sources* may be challenging to bring student ideas to the center, however, this principle may prove to be useful when students are already dealing with *real ideas* and working *collectively* on *improving* them. The key takeaway here is that the teacher must engage students in co-design and re-design of emergent structures for ever-deepening inquiry processes (Zhang et al., 2018).

Communities can also be powerful drivers of change. Learning communities emphasize "learning to be" instead of "learning about" (Sawyer, 2006). Our case study illustrates that students can become Knowledge Builders by participating in iterative design with their teacher. This work has practical implications for an emergent line of research on the development of teacher identities (Vokatis & Zhang, 2016) and student identities (Hod & Ben-Zvi, 2018) in Knowledge Building communities. As Bereiter (2002) notes, "The knowledge building classroom… [re]presents a miniature of the knowledge society into which students are to become enculturated". We further that the mini knowledge society co-created by Emily and her students are not merely a reproduction of existing realities outside the classroom, but rather, a re-imagining of what life in a knowledge society can look like when all ideas are valued and all members are empowered to contribute equitably to the advancement of collective goals. For this to happen, Knowledge Building must be a way of life for the teacher as well as her students (Scardamalia & Bereiter, in press; Tan et al., 2016).

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