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# **KNOWLEDGE BUILDING IN ACTION**

## **INTERMEDIATE (7–8)**

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### **Knowledge Building Through Inquiry in the Intermediate Mathematics Classroom**

**Written by Paula Molloy**

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**Bringing IDEAS to life!**

# 3.5 KNOWLEDGE BUILDING THROUGH INQUIRY IN THE INTERMEDIATE MATHEMATICS CLASSROOM

Written by Paula Molloy, Grade 7/8 teacher, TDSB

## INTRODUCTION

My name is Paula Molloy and I am an Intermediate Mathematics teacher at John A. Leslie Public School in Scarborough. I have a background in Early Childhood Education, and have spent many years observing children and how they acquire knowledge. Culturally, we seem to understand that children learn from their environment and the stimuli that we provide for them. We freely and naturally provide young learners with tools with which to build, create and problem-solve. We prepare an educational environment that supports open-ended approaches to learning, encourages a variety of problem-solving strategies, and assesses and honours the process of learning.

I have adopted these same practices in my intermediate mathematics classroom. Not only has this process involved investigations such as building structures with embedded algebraic expressions, or creating picture books that tell a story about the birth of a mathematical concept and the mathematicians behind the concept, but we extend our sense of wonder into inquiry projects that make connections beyond the classroom and into the global community.

The following case study is a snapshot of the experience that my students participated in while they considered themselves Agents of Change. Mathematically, and thinking as mathematicians, through the strand of Data Management and the framework of Knowledge Building and Knowledge Forum, the Intermediate students explored relevant issues such as; Crime Rates in Toronto, Muslim Discrimination, Genetically Modified Organisms, Teens and Screens, Gender Inequality, Poverty in Toronto, and The Consequences of drinking bottled water on the Environment.

## STARTING WITH THE KB PRINCIPLES:

**Real Ideas, Authentic Problems**

**Epistemic Agency**

**Community Knowledge, Collective Responsibility**

## KB PROVOCATION

### Move 1: Real Ideas, Authentic Problems

As students mature they continue to make sense of their world. The Intermediate student is a curious learner who is able to receive and synthesize information, and form and share their own perspectives. As a class, we discussed current events and global issues that impacted their lives. The provocation started with a discussion around the election process in the United States and Donald Trump's perspectives on Muslims and immigration. Conversations were filled with emotion and personal narratives, as connections were made and opinions shared.

Students were asked to select an issue that not only provoked emotion, but one that they were genuinely interested in learning more about, with the belief that they could better educate themselves to make more informed decisions or even create change for the future. They needed to think about how information was presented to them mathematically. Learning goals and success criteria were collectively constructed and the curriculum expectations were clearly identified.

Real ideas and authentic problems allowed students to acquire relevant knowledge, making sincere and meaningful connections. This not only informs the learning but may inspire and motivate, and give students the skills to challenge and change the world around them.

### Move 2: Epistemic Agency

Students collectively or independently determined the issue that was of importance to them; similarly, they had autonomy in determining their work teams. In establishing a culture of Knowledge Building, it is imperative that teachers lay the foundation of what collaborative communication looks like and sounds like. For example, it was reinforced that we are all learners and that all efforts in moving forward are to be built and expanded on as a collective. Students were reminded that all team members had an equal role to play in establishing the inquiry question and participating in the Knowledge Building process. Further to this, team communications and responsibilities were to be documented in a Communications Book in every class. When conferencing with groups, I would refer to the Communications Book and reference individual contributions and their documented process of how the team was building and developing suggested ideas, as well as having a greater understanding of their next steps.

## STRATEGIES TO SUSTAIN IDEA IMPROVEMENT

### Move 3: Community Knowledge, Collective Responsibility

As students worked throughout the inquiry process, they needed to work through the challenge of what it looked like to research data independently and to share and learn from it collectively. For example, students were often referencing data that were presented on charts and graphs. Although graphs may have been collected by different team members, the analysis of information and the conclusions made were collectively accomplished. Team members may have developed their own survey questions but collectively they discussed the purpose and quality of those questions before establishing a final survey. Collectively, they made inferences on the results of primary and secondary data. Collectively, they made predictions, based on their data, about the future of their issue. Collectively, they discussed how their generation could play a role in shaping

the future of their issue. Students were heard discussing the need for governments to change standards and policies on issues such as increasing penalties for criminals, greater consumer education on genetically modified organisms, the consequences of drinking water from plastic water bottles on the environment, and other topics.

Students participated in a practice that required the contributions of all team members with the expectation that all ideas would be validated and collectively refined.

#### **Move 4: Improvable Ideas**

Within the culture of the learning environment and the learning itself, the process of learning is where the growth, development and building takes place. All ideas are valid and must receive recognition. If the team decides that an idea is productive to their overall goal, then the idea must be nurtured in order for it to develop and expand. Upon observation during the inquiry process, I could hear a team with a focus on gender inequality attempting to work through a problem with a comparison that they were making. One of the team members was quietly offering a suggestion that could move the thinking forward, allowing the group to narrow their comparison of data. The team, however, remained focused on their current train of thought and were unresponsive to the student's improvement plan. As an observer and a facilitator, I asked the team to explain their challenge and then I asked them to once again listen to the improvement plan of their peer. It was a learning opportunity that served to not only push their idea forward but also to reinforce that all team members must be heard when sharing ideas and improving upon them.

In terms of the mathematics, for example, groups often experienced difficulty with primary data collection. They were faced with the challenge of attempting to collect accurate and representative data within their own school. The growth was observable as teams worked through and improved their ideas, ensuring that they were asking bias-free questions that allowed the person being surveyed to answer honestly, and sometimes even anonymously, to ensure the most accurate results. Similar discourse took place when faced with the challenge of selecting appropriate graphs to represent particular data. Students improved upon their ideas through discussions that included the purpose of communication for each graph type.

The use of the Communication Book was also a valuable tool as it documented the process, development and improvement of their initial ideas, and allowed students to reflect on the rich journey that lead them to success.

#### **Move 5: Embedded, Concurrent and Transformative Assessment**

During our mathematics inquiry, the assessment was embedded within the process. The process is the learning. I had regular and ongoing communications with individuals and with teams. I anecdotally recorded observations that also included the support and direction that I gave to each team. Students continued to document their process within their Communications Book paired with occasional progress reports.

Providing feedback throughout the process was critical. It was my role to ensure that students were maintaining a clear focus, asking and researching rich questions, working equitably as a team and referring to the learning goals and success criteria that were collectively established. Throughout this process I was able to push the students' thinking forward. Students were asked to go beyond researching information on their issue and ensure that they were bringing their own informed perspectives to the project. For example, the team that was comparing gender inequality in Canada to Pakistan, speculated that it was likely that information regarding issues of inequality and abuse perhaps is not reported and that the actual data may indeed be more concerning than is mathematically documented.

The growth and achievements made throughout the process need to be assessed. The process is where the thinking, problem solving, and refinement take place. The product is a result of the process, therefore, the assessment, embedded within the process, and the finished product and presentation, are all necessary to assess.

### **Move 6: Conclusion**

The conclusion of our inquiry included a reflection piece. Students must reflect on their journey and their process of learning. A reflection should highlight their challenges and discuss how challenges were overcome, their surprises, their successes, the knowledge that they built as well as the new curiosities that arose from their inquiry.

With this particular inquiry, a part of the concluding process was actually the birth of a new and thought provoking journey as students identified the possible future. Based on the actual data within their inquiry projects, students were to make informed predictions about what their issue would look like 10 or 20 years from now, with the realization that they are indeed the Agents of Change. We abstractly placed these supported predictions into a time capsule and acknowledged that the behaviours of their generation would shape, not only their own future, but the future of the next generation. As an educator, reflection is equally as important as we continuously strive to refine our own ideas, take risks, maintain an open-mind and provide best practice methods that will further the quality of learning for our students.