

# Students' Intuitive Understanding of Promisingness and Promisingness Judgments to Facilitate Knowledge Advancement

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**Abstract:** The ability to identify promising ideas is an important but obscure and undeveloped aspect of knowledge building. The goal of this research was to examine the extent to which young students can make promisingness judgments and, as a result, engage in more effective knowledge building. Toward this end we embedded a design experiment in a Grade 3 classroom. In this experiment students were engaged in discussion and reflection of the concept of promisingness and used a Promising Ideas tool to identify promising ideas in their written online discourse. They used the tool for two refinements of idea selections to focus ongoing community dialogue. Results suggest that students as young as 8 years of age can make promisingness judgments that facilitate knowledge advancement in their work. These results inform future work in classroom interventions and tool development to promote promisingness judgments in collaborative knowledge building.

Like scientists in research laboratories (Dunbar, 1995), students engaged in knowledge building participate in constructive and progressive *knowledge-building discourse*, in which they contribute to group dialogue in distinctive ways, including proposing theories, synthesizing ideas, and making analogies (Chuy, Zhang, Resendes, Scardamalia, & Bereiter, 2011). A knowledge building principle that frames such discourse is “collective cognitive responsibility” (Scardamalia, 2002), according to which students share responsibility for advancing the knowledge of their community. To advance community knowledge, knowledge building calls for risk taking in pursuing novel solutions to problems, with an ongoing commitment to continual idea improvement. Knowledge Forum (Scardamalia, 2004) is an online, community space specially designed to support Knowledge Building pedagogy. This pedagogy and technology has been adopted in international contexts and across the school curriculum (Scardamalia & Egnatoff, eds., 2010).

The ability to identify *promising ideas*—ideas that with development might grow to something of consequence—is essential for creative work with ideas, but remains unexplored (Bereiter & Scardamalia, 1993). According to Bereiter (2002), knowledge of *promisingness* is crucial in every kind of creative work at all levels, and accordingly should be recognized as an important component in the knowledge-building process. Knowledge of promisingness is acquired over time as people engage in creative practices, by taking risks and learning from the successes and failures that are integral to the creative process. This type of knowledge increases with creative expertise, helping people improve their ability to take successful risks. Thus, to prepare young generations to be future creative achievers in various fields, we should encourage them to make promisingness judgments during their knowledge building work. This study serves as a first step in a program of research that seeks to explore the extent to which young students can make promisingness judgments and how educators can support them. The study addresses two central research questions: Can young students assess promisingness, or the knowledge building potential of their own ideas? Do their selections of promising ideas, and further community discourse on these selections, facilitate knowledge advancement in the community?

## Promisingness and Knowledge Building Discourse

Substantial work is normally needed to develop ideas to address knowledge creation goals. Single ideas seldom constitute problem solutions; neither do simple combinations of ideas. When the goal is knowledge creation, the problem space tends to be complex and the extent to which an idea will prove valuable cannot be known at the beginning. As Johnson (2010) points out, “an idea is not a single thing, but more like a swarm (p. 43);” to better grow, an idea should live in a “liquid network” where it can more easily connect with its “adjacent possible” (Kauffman, 2002, p.47). However, an abundance of possible connections to an idea does not guarantee the fulfillment of a knowledge creation goal. A significant challenge in all creative work, in both the fine and broad grain, is to identify promising directions and to avoid wasting time or becoming entrapped by unpromising ones (Bereiter & Scardamalia, 1993).

In the knowledge-creating context, promising ideas provide indication of future success or good results in a specific problem domain. Evaluation of risk and promisingness is a natural component of the knowledge creation process. For example, in his study of scientific reasoning in real-world laboratories, Dunbar (1995) found that scientists tend to categorize their projects into different levels of risk: a high risk project has a low probability of working out but may lead to breakthroughs, whereas a low risk project has a high probability of

success but does not promise important discoveries. Assessments of promisingness help scientists determine how and when to invest their resources and time. Promisingness guides action of the moment as well as overall approach. To become a creative achiever in any field, one has to take risks at many levels and learn from the results (Bereiter & Scardamalia, 1993). The current study focuses on knowledge-building discourse by young students, exploring the extent to which promisingness judgments might facilitate their knowledge advancement.

## Method

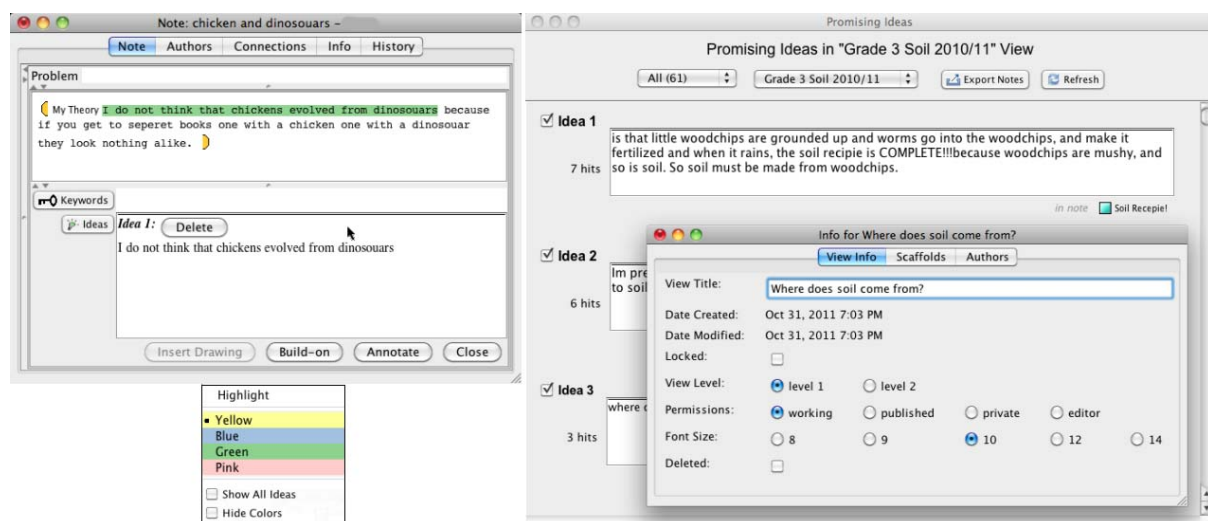
### Participants

Participants were students from a grade 3 class at the Dr. Eric Jackman Institute of Child Study in downtown Toronto. There were 11 boys and 9 girls taught by a novice Knowledge Building teacher in 2011. They were studying earth sciences, with focus on soil and worms, for eight weeks. In this elementary school, Knowledge Building pedagogy and technology are used from grade 1 on, so students each year had roughly equivalent experience in the pedagogy and technology.

### Promising Ideas Tool

A Promising Ideas tool was added to Knowledge Forum to facilitate this research. It includes two components: (a) a highlight feature to allow students to tag an idea within a note using a customizable categorization scheme (see Figure 1, left side) and (b) a component aggregates all selected ideas within a same view, merges overlapping ideas, and visualizes them in a list (see Figure 1, right side). An early version of this tool was implemented and tested in a small-scale pilot study (Chen, Chuy, Resendes, & Scardamalia, 2010). The goal of that study was not to enhance students' ability to make judgments on idea promisingness, but to identify whether they are able to make these judgments at all. Results indicated that without any explanation of the concept of promisingness, grade 5/6 students tended to identify important-sounding facts and questions as promising. Thus, we had reason to doubt that students were making promisingness judgments based on the potential for deepening their understanding or identifying new directions in their research and development (Chen, Chuy, Resendes, Scardamalia, & Bereiter, 2011).

Based on results from the first pilot study, we reengineered this tool to emphasize the concept of promisingness as the essence of this tool. The new version maintained functionalities from the previous version, including highlighting, tagging, and filtering. To make the endeavor of identifying promising ideas more meaningful, we implemented a third component that allows students to export a subset of identified promising ideas from the aggregate list to a new workspace for further inquiry. By reviewing the promising idea list together, a class could collectively determine which ideas or questions they wish to pursue for next steps. These ideas can be selected by clicking on checkboxes corresponding to each chosen idea on the list (see Figure 1, right side). Then, notes which contain those promising ideas can be exported to a new Knowledge Forum view by clicking on the "Export Notes" button. After that, students can work to develop those exported promising ideas to a deeper level. This function could engage students in identifying promising ideas with a commitment to define new directions for their work.



**Figure 1.** The Promising Ideas tool currently has three components: (a) tag an idea—on the left, a student can identify an idea with a customizable scheme; (b) list tagged ideas—in the background window on the right side, all identified promising ideas from a view are listed; and (c) export selected ideas to a new view—users can then select a subset of ideas from this list and export them to a new view (the foreground window on the right).

## Procedure

Beside the grade 3 class which participated in this study, another grade 3 class from the previous year in the same school was included to provide baseline data. Both grade 3 classes studied “Soil in the Environment” for around 8 weeks, a unit in the Ontario Science and Technology Curriculum. In studying this unit, both classes were following a knowledge-building approach guided by twelve knowledge building principles (Scardamalia, 2002; Zhang, Hong, Scardamalia, Teo, & Morley, 2011). Knowledge building practice in this school usually contains four components: Knowledge Building talk (“KB Talk”), online discourse in Knowledge Forum, study on authoritative sources, and experiments or observations. There is no routine that defines how these four components should proceed. Rather, these components are organized in a classroom in a flexible and organic manner that facilitates student’s collective knowledge building. Both classes started with a KB talk, with students sitting in a circle sharing their initial authentic questions and ideas about soil. After the first KB talk, “what is soil made of?” and “how to make soil?” emerged as the focus of students’ study of soil in both classes. To keep students’ ideas alive and to extend student discussion to a broader scale, students then moved to Knowledge Forum to record their ideas and start online dialogue. They contributed to their discourse in various ways, including proposing their own theories, building on each other’s theories, providing observation results to defend their claims, designing and conducting experiments to test hypotheses, and reading and introducing authoritative sources such as books or online materials. Although two classes were led by two different teachers, dynamics in both classrooms followed a similar knowledge building process.

In the experimental class we implemented a promisingness intervention into regular knowledge-building discourse. This intervention mainly comprised two components. The first component was a 30 minute pedagogical intervention targeting students’ understanding of promisingness. As the first step, we asked grade 3 students to brainstorm with their partners the meaning of “a promising idea” and “a promising question”, and recorded their group thoughts on paper. Student notes were collected for later analysis. Ten minutes later, students brought their thoughts back to a class discussion, advancing different but plausible definitions of the concept and supporting them with meaningful examples. In this discussion, the teacher specifically invited students to ponder the difference between promising ideas and verified facts, to help them distinguish promisingness from “truthfulness.” By the end of the 30-minute discussion, the class arrived at a shared understanding that promising ideas are ideas that “they wish to spend time on,” “may change in further inquiry,” and would “deepen their shared understanding.”

The second component of this intervention engaged students in progressive use of the Promising Ideas tool. The whole process involved two iterations of note writing and promisingness intervention. During the first two weeks, students worked on a view named “Grade 3 Soil 2010/11” in Knowledge Forum. After that, students were directed to conduct promisingness judgments on this view, picking ideas that they thought were promising using the Promising Ideas tool. Then the whole class had a discussion on identified ideas, and decided to export several promising ideas to a new view called “Where does soil come from?” The second iteration of note writing and promisingness evaluation then followed. During the next three weeks students kept working on the exported view. After that, students did a second round of promisingness evaluation on that view, and exported their promising ideas to another new view named “Worms and Soil,” on which students worked for another two weeks. In the whole process, promisingness evaluation was integrated into regular knowledge-building discourse as a component to determine future steps of student inquiry. Student notes and selections of ideas were collected for data analysis.

## Data Analysis

Students’ notes of their intuitive understanding of promisingness were collected from the brainstorm session in the experimental class. Overall, 8 groups of students produced 35 distinctive notes. We coded data based on a “grounded theory” approach (Glaser & Strauss, 1967), with a goal to identify popular conceptions, especially misleading ones, of promisingness among this group of students.

In work on this soil unit, students from the experimental group created 125 notes in three views (respectively 38, 47, and 40 notes). During two sessions of promisingness judgments, students identified 57 and 94 “promising ideas” from the first two views. Each single highlighting action was counted as an idea. Since several students could independently select a same idea, there were a number of repetitions of ideas. In the baseline group, students produced 130 notes in five views. They were not making promisingness judgments in any form, so no idea was identified. Two independent raters used the following criteria to code the notes and ideas. They agreed on 82.5% of the coding. Discrepancies were discussed to reach a final agreement.

*Contribution types of identified promising ideas.* Because promisingness judgments in knowledge building focus on potential for growth, we expect ideas identified by students as promising to be of a “theoretical nature” rather than pure facts (Chen et al., 2011). In order to understand the nature of identified ideas and assess whether the pedagogical intervention was effective in transforming students’ understanding of

promisingness, we applied an extended list of ways of contributing scheme previously developed by Chuy and colleagues (2011). This scheme includes six major categories, including: *formulating thought-provoking questions* (e.g., explanatory, factual, and design questions), *theorizing* (e.g., proposing, supporting, and improving a theory), *obtaining evidence* (e.g., seeking evidence, reporting experiment results, introducing facts from sources or experience), *working with evidence* (e.g., using evidence to support or discard a theory), *synthesizing and comparing* (e.g., synthesizing discussion, creating rise-aboves, and making analogies), and *supporting discussion* (e.g., facilitate discussion, give an opinion).

*Measurements of individual and community knowledge advancement.* Knowledge advancement by students in both the experimental and baseline groups was assessed through content analysis of student notes in Knowledge Forum. First of all, *scientificness* of student ideas was assessed using a four-point scale developed by Zhang and colleagues (2007): 1–pre-scientific (containing a misconception while applying a naive conceptual framework), 2–hybrid (containing misconceptions that have incorporated scientific information), 3–basically scientific (containing ideas based on a scientific framework, but not precise), or 4–scientific (containing explanations that are consistent with scientific knowledge). To evaluate whether the experimental class has made any progress in terms of scientificness of their ideas, we analyzed all student notes that fell into the theorizing category in the ways of contributing analysis, and compared across three views produced by three phases of student work. The same analysis was performed for the baseline group, and results were compared between two groups.

Second, *latent semantic similarities* between student notes and authoritative sources were calculated through Latent Semantic Analysis (LSA) to approximately represent students' level of collective understanding of the subject matter. LSA is a theory and model for extracting and inferring contextualized, latent meaning of words from statistical analysis of a corpus of text (Landauer, Foltz, & Laham, 1998). It has been widely applied to compare semantic meaning of different documents, and its adequacy in reflecting human knowledge has been established in extensive educational settings (Foltz, Kintsch, & Landauer, 1998; Forster & Dunbar, 2009; Landauer & Dumais, 1997; Rehder et al., 1998; Teplov & Fujita, 2009). In LSA, each document is treated as a "bag of words"; comparison between documents is based on latent connections between their words in a pre-defined semantic space trained through complex mathematical computations. To train a semantic space about soil, we first selected four pieces of authoritative sources that represent varied levels of complexity, including Soil in the Environment unit in the Ontario curriculum standards (2007), Wikipedia article about Soil (2011), an entry level article about soil from US Environmental Protection Agency (2011), and a more sophisticated education article from US Department of Agriculture (2011). Then we exported student discourse in three views to three individual documents, and compared them with the list of authoritative sources for similarity. Similarity scores between student discourse and authoritative sources represented the advancement of community knowledge at different knowledge building phases.

## Results and Discussion

### Student Understanding of Promisingness

#### Students' Intuitive Understanding of Promisingness

As shown in previous studies, when asked to select "promising" ideas, young students often select "important facts" of the sort they address in their school work (Chen et al., 2011). In this investigation we considered students' intuitive understanding of promisingness. Analysis indicated that some students thought a promising idea was "a true idea," "an idea that promises you something" or "actually happened;" for a promising question, some students thought this could be explained as "a question you promise to answer," "a question that has multiple answers," "a question that has not many answers," or "a question that is difficult and should be solved." Overall, students revealed different understandings of promisingness in different contexts.

However, three themes emerged from students' notes about the meaning of promisingness. First of all, consistent with the results from previous studies (Chen et al., 2011), the feature of "being true" or "truthfulness" was a popular notion present in notes of all groups. For example, some students thought a promising idea was:

Group 1: "A *true* idea" or "an idea that is *not incorrect*."

Group 2: "*True*."

Group 3: "You know that an idea is *true*", or "you promise that it is *right*."

Group 5: "An idea that you are pretty sure is *right*."

These thoughts could explain why students in our previous study were identifying facts such as "The universe is 13,000,000,000 years old!" and "the grand canyon could have 912,456 layers of rock" (Chen et al., 2011).

The second cluster of thoughts focused on the notion of "likelihood." For example, a number of groups mentioned that a promising idea was:

Group 4: "An idea that is very good and *probably* be right."

Group 5: “An idea that *might* work.”

Group 7: “This is *probably* a right idea.”

Group 8: “Idea that is *most likely* to be right,” or “*90% sure* it’s right.”

This notion of “likelihood” went further than emphasizing “truthfulness,” in that there is a recognition that we cannot tell whether a promising idea is true for sure, but a promising idea has high odds of being true. According to dictionaries such as Merriam-Webster, promising means “showing signs of future success or excellence,” “likely to turn out well,” or “likely to succeed or yield good results.” Bereiter (2002, p.337) explained promisingness by the metaphor of “hill climbing,” highlighting that a promisingness evaluation is like to find the way up the hill although you cannot see a path to the summit. In this sense, the notion of “likelihood” students captured is an essential component of promisingness. However, it is important to note that students were thinking of likelihood in terms of an idea’s current status of being true. Apparently, they were not thinking of ideas with a trajectory for growth.

The third notion that emerged from students’ notes was about “future actions.” When thinking about what is “a promising question,” a few groups wrote:

Group 1: “A question you can spend time on.”

Group 2: “A question you need to know.”

Group 5: “A question that can help you do something.”

The notion that a promising idea or question is something that you can spend time on or can help you better know or do something fit the notion that a promising idea could be flawed but worth laboring to improve it (Bereiter & Scardamalia, 1993; Bereiter, 2002). This notion provided a good basis to work from to prepare students with a favorable understanding for promisingness judgments. To summarize, without intervention the concept of promisingness proved to have different meanings under different conditions for grade 3 students.

### Was promisingness talk effective?

Previous research shows young students tend to select important facts of the sort they address in their school work as being promising (Chen et al., 2011). In the current study we introduced a pedagogical intervention module to engage grade 3 students in thinking and discussing about the meaning of promisingness as a group. Given this was our first attempt to engage them actively in the concept of promisingness, it is important to evaluate whether this intervention was effective in preparing students to consider promisingness as extending beyond factual content to ideas that might advance work in the field. To answer this question, we applied the ways of contributing scheme described above. Results showed that grade 3 students identified a large portion of *theorizing* (68.9%) and much less *obtaining evidence* contributions (6.7%) as being promising. Students also identified other contribution types, including *questioning* (9.8%), *working with evidence* (4.9%), *synthesizing and comparing* (1.8%), and *supporting discussion* (8.0%). Overall, the proportion of fact/evidence has decreased significantly, comparing to selections by grade 5/6 students reported in previous research (Chen et al., 2011). This finding indicated that the concept of promisingness could be easily extended, so that rather than a focus on “true ideas” students have more of a sense of ideas with a promising growth trajectory.

To further understand whether evidence picked by grade 3 students was introduced with a goal to move discourse forward, we analyzed the dialogue context of the contributions related to *obtaining evidence*. Results indicated most these contributions fell into the *introducing new information* sub-category, mostly containing new facts or new pieces of evidence; this situation was similar to that in two grade 5/6 classes (Chen et al., 2011). However, further analysis on the grade 3 discourse revealed that *obtaining evidence* contributions identified by students as promising usually co-occurred with the contribution type of *using evidence or reference to support a theory* (which falls within the *working with evidence* contribution category). Apparently, students from this grade 3 class were identifying those *obtaining evidence* contributions which were made to drive discourse forward. In contrast, as reported in previous study, fact/evidence contributions were identified by grade 5/6 students, who did not spend time brainstorming or discussing the concept of promisingness, were more likely to be standalone. The shift in understanding can be seen in the following contrast. In an idea identified by one grade 3 student, the new information “when it’s night it’s cooler ... in the day the sun is shining and it’s warmer” was introduced to support her theory that “worms sense light by temperature.” However, grade 5/6 students were more likely to identify standalone facts, such as “the solar system formed 4570 million years ago.” Notably, grade 3 students who went through the promisingness discussion were more likely to identify facts or evidence that contributed to their knowledge-building discourse, while grade 5/6 students tended to identify pure facts that had some distinctive “attractiveness” (Chen et al., 2011).

### **Promisingness Judgments to Facilitate Knowledge Advancement**

Promisingness judgments are to boost community knowledge by identification of promising directions that are refocusing in ongoing discourse. Evaluating the promisingness of their own ideas engages students in deep reflection on the state of their knowledge work and helps them recognize ideas that they deem worth extended work. In this way, students can denote their limited time and energy to more promising ideas. As a result, their

individual and collective understanding may get more opportunities to grow. In this study, our hypothesis was that students in the experimental class, who performed promisingness judgments, would achieve greater knowledge advancement than students in the baseline class. To test this hypothesis, in this section we examine idea improvement and knowledge advancement in two classes by two means: rating students' theorizing contributions for scientificness, and comparing semantic space of student discourse with expert content.

### Scientificness of notes and conceptual change

First of all, we rated students' theorizing contributions in two classes on the continuum from pre-scientific to scientific understanding. In the experimental class, we identified and analyzed 91 theorizing notes, 26 notes from "Grade 3 Soil 2010/11" (view 1), 42 notes from "Where does soil come from" (view 2), and the rest 23 from "Worms and Soil" (view 3). In the baseline class, we identified a total number of 68 theorizing notes. Because the baseline group did not integrate promisingness judgments into their discourse, there was no natural distinction of different phases; so we sequenced student notes according to the time of creation and manually divided them into three phases with equivalent number of notes. Mean scores and standard deviations for three discourse phases in both classes are presented in Table 1. A 2 (Group)  $\times$  3 (Discourse Phase) factorial ANOVA was performed to assess whether scientificness scores of student ideas could be predicted from student group (experimental vs. baseline), phases of discourse (phase 1, 2 and 3), and the interaction between these two factors. This analysis of variance revealed a significant main effect for discourse phases,  $F(2, 30) = 13.51, p < .001, \eta^2 = .15$ , indicating the mean scientificness scores were different among three phases. The main effect for group difference was not significant,  $F(1, 30) = .47, p = .49, \eta^2 = .00$ . The interaction between discourse phases and group difference was significant,  $F(2, 30) = 3.81, p < .05, \eta^2 = .05$ .

Table 1: Mean and Standard Deviations for Three Discourse Phases in Experimental and Baseline Groups.

	Phase 1	Phase 2	Phase 3
Experimental Group			
<i>M</i>	1.29	1.45	2.24
<i>SD</i>	.38	.55	.89
<i>n</i>	26	42	23
Baseline Group			
<i>M</i>	1.50	1.50	1.77
<i>SD</i>	.58	.62	.67
<i>n</i>	23	23	22

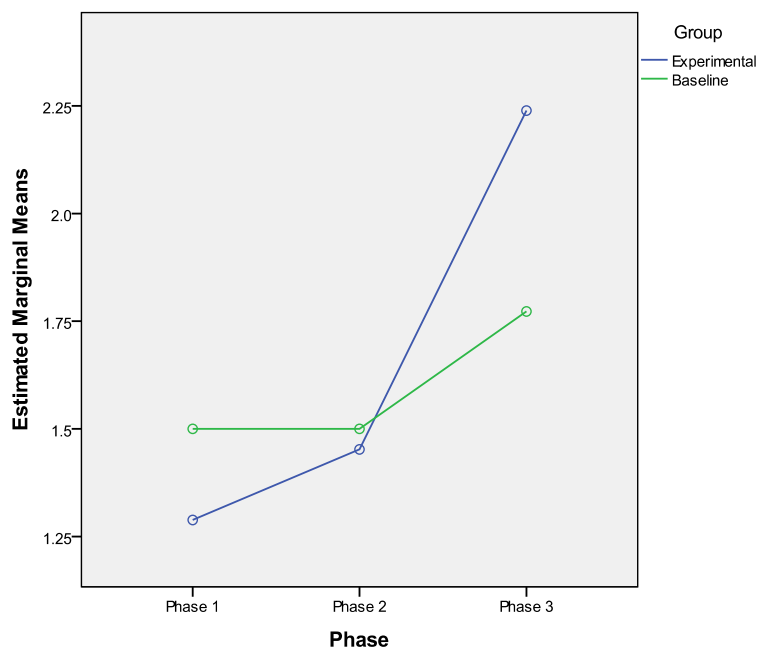


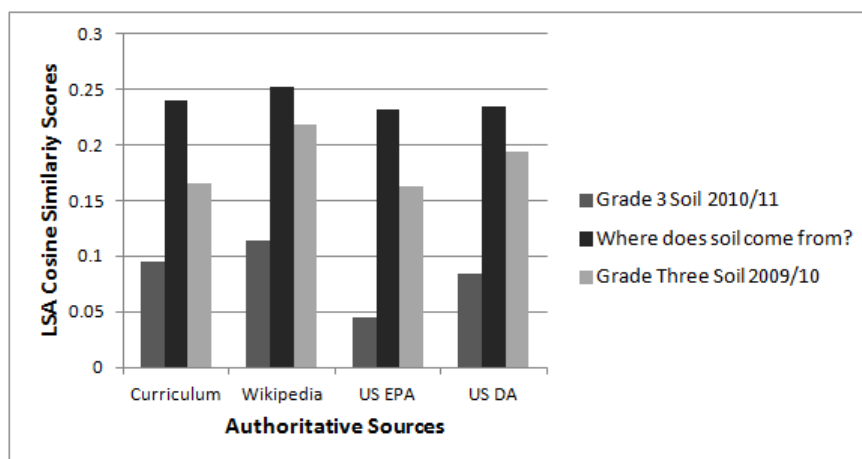
Figure 2. Mean scores of scientificness of theories across three discourse phases.

The graph of mean scores (in Figure 2) indicated that scientificness scores in the experimental class have been substantially improved across three phases, while scientificness scores in the baseline group were

only slightly improved. Planned contrasts were done with L-Matrix subcommand to assess whether these differences (between phase 1, 2, and 3) were significant within the experimental and baseline groups. For the experimental group, the improvement from phase 1 to 3 was significant,  $F(1, 153) = 28.70, p < .001, \eta^2 = .16$ ; so was the improvement from phase 2 and 3,  $F(1, 153) = 23.94, p < .05, \eta^2 = .14$ . In contrast, none of the differences in the baseline group was significant. Notably, the experimental group started with less scientific ideas than the baseline group, and finished with more scientific understanding about soil and worms. In conclusion, students in the experimental class, who performed promisingness judgments, achieved greater knowledge advancement than students in the baseline class.

### Growth of subject domain knowledge

To further explore the changes of community knowledge in the experimental group, we applied Latent Semantic Analysis (LSA) as another distinctive analysis technique. LSA is able to accurately identify semantic similarity between two documents within a semantic space. In this analysis, student notes in three different views were exported to three individual documents, and then respectively compared with authoritative sources about soil. LSA semantic similarity scores between student written dialogues and authoritative sources were used to infer students' levels of understanding in different phases. Because view 3 ("Worms and Soil") in the experimental group focused on worms rather than soil, we only included view 1 ("Grade 3 Soil 2010/11") and view 2 ("Where does soil come from?") into this analysis. We also included a view ("Grade Three Soil 2009/10") produced by the baseline group for comparison. Figure 3 presents LSA cosine similarity scores of three views when they are respectively compared to four pieces of authoritative sources, i.e. Ontario curriculum standards, Wikipedia article, US Environmental Protection Agency (US EPA) article, and US Department of Agriculture (US DA) article.



**Figure 3.** LSA cosine similarity scores between views and different authoritative sources. The first two views, i.e. "Grade 3 Soil 2010/11" and "Where does soil come from?", were produced by the experimental class, and the third view, "Grade Three Soil 2009/10", was from the baseline group.

From this analysis a notable pattern emerged that the similarity scores of view 2 ( $M = .24$ ) were substantially higher than view 1 ( $M = .08$ ) in comparing with those different pieces of authoritative sources. The similarity scores of view 2 were even higher than the baseline group ( $M = .18$ ) taught by a more experienced Knowledge Building teacher. These results from LSA indicated that students in the experimental group had improved their understanding on soil across the first two dialogue phases, to an equivalent or higher level of the baseline group.

### **Discussion and Conclusion**

The goal of this study was to examine the extent to which young students can make promisingness judgments on their own ideas, and accordingly achieve more advancement in their knowledge-building discourse. Toward this end, a promisingness intervention was employed in a grade 3 class, which engaged students in discussing the concept of promisingness and then using the Promising Ideas tool to identify promising ideas during knowledge-building discourse in a progressive manner. Analysis of results indicated that with discussion and analysis of the concept of promisingness, students as young as 8 to 9 years old could make promisingness judgments which, compared to those of grade 5/6 students (Chen et al., 2011), advanced beyond the idea that factual content defines promisingness. Scientificness and knowledge coverage of student notes were further analyzed across three discourse phases divided by two sessions of promisingness judgments. Results showed a significant growth of scientificness as well as domain knowledge across three phases in the experimental group,

while the baseline group, who did not engage in making promisingness judgments on their work, did not reveal such growth.

Promisingness evaluation is an important, but obscure component in knowledge-building discourse (Bereiter & Scardamalia, 1993). Substantial further research is needed to examine the role promisingness evaluations play in different contexts. New studies will tackle fundamental research issues such as how people make promisingness judgments, a developmental trajectory for making promisingness judgments, and means to help students gain deeper understanding through making more promisingness judgments.

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## Acknowledgments

This research was funded by a Research Grant from the Social Sciences and Humanities Research Council of Canada titled "Ways of contributing to dialogue in elementary school science and history." We would like to express our gratitude to the students, teachers and principals of the Dr. Eric Jackman Institute of Child Study, University of Toronto for the insights and the opportunities enabled by their involvement.