ABSTRACT

An interpretative style was employed in reporting teacher and students’ action in a context of teaching and learning in an urban high school in Canada, with a teacher of 30 years of experience, in a grade 11 Physics class. Student and teacher interviews, student discussions in the database, videotapes of special events and artefacts of the poster presentation were the main data sources. Two narratives were constructed for the perspectives of an average student and a high school physics teacher within the project that took place. These narratives were used to provide a detailed description of what happened in the class; it describes the beliefs of students and the teacher about the role of a learner, the role of a teacher and their learning/teaching goals. These findings are discussed in terms of (1) the difficulties of initiating and sustaining new knowledge building strategies when students are satisfied with the existing practices and other sociocultural factors that tend to preserve the existing pattern. (2) the importance of the researcher’s role in helping the teacher to make sense of what is happening in his/her own class which facilitate sustainability and continuation of the innovation.

This paper uses narrative inquiry (Clandinin & Connelly, 2000) to understand what we regard as a failed attempt at implementing Bereiter and Scardamalia’s knowledge building perspective (Bereiter, 2002; Bereiter & Scardamalia, 1993). The goal is not to understand “what went wrong,” but to understand the knowledge building perspective itself better, especially how it may conflict with a teacher and students’ competing educational goals. The paper is one of five in a symposium on individual, social, and cultural aspects of knowledge building. We use narrative inquiry because we want to focus on the point of view of the “lived experience” of the teacher and students rather than our own point of view of extending and disseminating knowledge building practices. Drawing from a series of interviews, we constructed two narratives that are presented in parallel columns. One narrative represents the teacher, in the voice of “Mr. Scott;” the other narrative represents the main themes raised by small groups of students, in the voice of “Ricky.” This way we can learn how the students and the teacher interpreted what happened during the nuclear physics unit. We believe that the paper will be helpful in thinking about knowledge building in the broader context of classroom life that goes beyond understanding the disciplines (Bereiter, 2000; Gardner, 1999). It may be helpful in seeing knowledge building juxtaposed with other educational influences on classrooms and may provide insight into the learning needs of students, teachers, and researchers in working with (and on) the knowledge building perspective.

The context for the study is a teacher’s attempt to use Knowledge Forum™ software to support an ongoing inquiry into nuclear physics by a grade 11 physics class. This curriculum area is not meant to lay a foundation for more advanced work in grade 12 and can be connected to problems of general interest such as the disposal of nuclear waste.
and the use of radiation in medical care. Thus, we thought that it might lead to what Scardamalia (2002) refers to as “real, authentic problems,” one of the principles that she uses to characterize best practices in knowledge building. The teacher had earlier learned to use Knowledge Forum in a four-day workshop and had spent a semester with another teacher to explore knowledge building in a joint grade 8 English-Science program. The teacher, although intrigued by the “learning community” aspect of knowledge building (see Bielaczyc & Collins, 1999), had a long history of working to allow students to learn in different ways and at different rates. Our paper therefore raises questions about the fit of knowledge building to the larger agenda of schooling.

The organization of the paper is as follows. We first provide some background about narrative inquiry as well as the setting in which the study was conducted. The narratives are then presented, followed by our analysis of them and a general discussion of the implications of the study for knowledge building.

**NARRATIVE INQUIRY**

We employed narrative inquiry as the method of research. Clandinin and Connelly (2000) define it as a form of narrative experience. We see the world through our own experiences. In doing this research and writing this paper our culture, our experiences in the education field and our worldviews have influenced the research questions, the framework, the method of analysis and the interpretations. Our presentation of students’, teachers’ and researchers’ experience become narrative. Further, this narrative thinking becomes our major form of experience. Then as Clandinin and Connelly argue, narrative becomes “both the phenomenon and the method” of this study.
Clandinin and Connelly (2000) argue, “If we understand world narratively, as we do, then it make sense to study the world narratively” (p. 17). While their claim justifies our selected method, Schultz (1964, 1970) further confirms it by arguing that it is important to focus on ways that individuals experience their world. Otherwise he argues that members of the world, in their “natural attitude,” take their world for granted and believe it is “out there” in the present and it will be there in future. The focus of narrative will allow individuals to get away from the taken for granted view since experience is both interactional and continuation (Dewey, 1938). This makes both the world and the experiences dynamic, which Clandinin and Connelly describe as temporality. They posit that each event has a past, a present and an implied future, which we need to account for when we observe experiences.

Using narrative inquiry, findings are reported as narratives in the voice of students and the teacher focusing on “the immediate and local meanings of actions, as define from the actor’s point of view” (Erickson, 1986, p. 119). With these narratives, as Maynard (1989) notes, the central focus is on “How participants see things as well as how they do things.” In constructing our narrative the main data source became interviews. Further to this, we examined the students’ database in the Knowledge Forum, collected data from selected class sessions like poster presentations, which were video recorded and some artefacts students prepared for the nuclear physics project.

**Interviews with students.** We interviewed students in Mr. Scott's class at the end of the nuclear physics unit in the groups of two to three that worked together during the unit. These interviews were semi-structured. Each interview lasted 35-45 minutes. We explained to students that the purpose of the interview was to learn what happened in the classroom
and to learn why it happened in that particular way. Further, we expressed our expectation
to hear from everyone in the group. Initially students were asked to describe their project in
general terms with references to their selection of the topic, the group, and how they
worked. Then we asked questions based on the knowledge building perspective, focusing
on four principles that van Aalst and Chan (2001) had introduced (working at the cutting
tedge, collaborative effort, progressive problem solving, identifying high and low points,
and creating new knowledge, see the next section). We probed deeply with these questions
to learn what had happened in the classroom, why it had happened, and what they would
prefer instead to happen and the reasons for that. The interviews were audio recorded,
transcribed verbatim, and then coded using codes based on the above knowledge building
principles as well as sociocultural theory. These interview data provided a rich description
of their physics classroom life in terms of what was expected and what had happened.

Knowledge Forum database. We examined the students database in the Knowledge
Forum which they used to discussed their ideas, share information, and tried to put their
thoughts together.

We used these data sources and a software program for qualitative data analysis
(ATLAS-TI™) to identify main themes for the narratives. Clandinin and Connelly (2000)
describe this process as “composing field texts” where some selectivity takes place by
“foregrounding” some aspects and making others less visible. “Sometimes, our field texts
are so compelling that we want to stop and let them speak for themselves. … But as
researchers we cannot stop there, for our inquiry task is to discover and construct meaning
in those texts.” (p. 130). There fore a narrative was constructed (research text) to represent
the main themes in the student responses in the voice of one student. (Since most students’
responses to our interview questions were along the same line we constructed this narrative as an amalgamation of many students’ opinions). Therefore, Ricky (a pseudonym) represents the general class view.

Ricky’s story provides a detailed description of what happened in the class from the students' point of view. It describes the student beliefs about the role of a learner, the role of a teacher, culture of the classroom and student learning goals. In constructing Ricky’s story our aim was to capture the character of naturally occurring student thinking and behaviour. Hammersley (1997) explains that to maintain the natural aspect of the study "social events and processes must be explained in terms of their relationship to the contexts in which they occur" (p.8).

Interview with Mr. Scott We interviewed Mr. Scott before we showed him Ricky’s narrative. As with the students, first we asked him to describe his goals, expectations, and outcomes of this unit in general terms. Then we probed deeply with the questions based on knowledge building principles to gain an ideas about his perspective of what has happened, why it happened, what he would have liked to been happened instead, and the reasons for that. Then we gave Mr. Scott the narrative of Ricky and several conversations were conducted subsequent to showing Mr. Scott the narrative. All these discussions were recorded and transcribed verbatim then went through the same process as of the students’ interviews.

Since the narratives could be shaped by researchers interests and interpretations respondents were provided with the copies of transcripts and narratives providing them the opportunities to suggest changes. These “member checks” (Gall, Borg & Gall, 1996) improve the trustworthiness and genuineness of our narratives. Further, we presented
Ricky’s narrative to participants of the Fifth Knowledge Forum Summer Institute, held at the University of Toronto in 2001. Participants in this institute were engaged in a similar genre of research, focusing on knowledge building in their classrooms. Their insights and feedback provided a forum for a dialogue for Mr. Scott as teacher and for us as researchers within a community of learners. These dialogues provided valuable insights and perspectives to make sense of our narrative experiences.

As researchers, we are concerned not only with the here and now but also with the teacher’s life as it is experienced on a continuum situated within his school, and educational landscapes contextualized within a longer-term which Clandinin and Connelly (2000) present as temporality. This focus views change not as an event but as a process (Fullan & Steigelbauer, 1991), through the succession of experiences, which Dewey (1938) saw as one important criteria of learning through experience. From an educational point of view, it is important to be able to narrate the person in terms of the process without taking for granted that people, at any point in time, are in a process of personal change. Mr. Scott’s narrative presents this continuum of experience.

When we constructed these narratives the question of how much should we be in the text—our signature as researchers—arises (Geertz, 1988). Clandinin and Conelly (2000) discuss the importance of balancing participants and researchers signature so as ‘not to obscure the field and its participants’ and also to avoid subjectivity issues. We decided to balance these signatures by presenting Mr. Scott’s narrative along side with Ricky’s narrative under the same themes prior to our discussion. As these narratives have been given to the participants to check for its authenticity the verification of the ‘participant’s signature’ has been fulfilled. Further, by presenting these narratives side by side we
provide an opportunity for readers to construct their own opinions before we present our views.

SETTING THE STAGE

Narrative inquiry makes experience centrally important. As Clandinin and Connelly (2000) point out, the “background” to a narrative consists of both theory and experience. In this section we first provide some cursory information about knowledge building (a theoretical perspective), and then describe the experiential basis of Mr. Scott’s identity as a teacher. For our purposes, Mr. Scott’s current identity as a teacher has been shaped by his role in the development of an innovative school, Golden Ears High School (a pseudonym) and his early experience with Knowledge Forum.

Knowledge building

Inquiry has been around for most of the twentieth century as a way to organize educational experiences. In Democracy and Education, Dewey (1916) already proposed that educators should “utilize the familiar occupations and appliances to direct observation and experiment, until pupils have arrived at a knowledge of some fundamental principles by understanding them in their familiar practical workings” (p. 336). In the 1970s learning by doing or “discovery” became popular due to the influence on classroom practice of Piaget’s constructivism and a concern for more emphasis on “doin science.” Studies into scientific practice—current and historical—have led to an understanding of scientific practice that is less rational and linear than previously assumed (e.g. Kuhn, 1962/70; Lakatos, 1970; Latour, 1987; Popper, 1972). Our current understanding is that science is a
socially constructed activity in which progress is mediated by discourse in communities. Studies of practice in non-scientific settings such as workplaces have also emphasized communities of practice (Lave & Wenger, 1991). A recent trend in education has therefore become to emphasize the idea of a learning community that improves its knowledge by means of a community discourse.

Bielaczyc and Collins (1999) reviewed three educational approaches in this trend: Communities of Learners (Brown & Campione, 1996), mathematical discourse (Lampert, Rittenhouse, & Crumbough, 1996), and knowledge building (Bereiter & Scardamalia, 1996). Of these, only the knowledge building perspective uses a computer-supported database to support and record the discourse, first with CSILE (Computer Supported Intentional Learning Environments (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989) software and now with its successor, Knowledge Forum. We use Bielaczyc and Collins’ characterization here to situate knowledge building against the other approaches (see van Aalst & Chan, under review, for further details). Bielaczyc and Collins’ four characteristics of learning communities are as follows.

Members with diverse expertise, who are valued for their contributions and who are given support to develop. This diversity is necessary so that a problem can be examined from a range of perspectives. The emphasis on giving “support to develop” diversity means that diversity increases (Brown & Campione, 1994). This is different from most educational approaches that aim to minimize diversity.

A shared objective of continually advancing the collective knowledge and skills. In the knowledge building perspective the emphasis on knowledge advancement is important; Bereiter (1992, 2002) sets this off against what he calls referent-centered education, where
the goal is the production of material artifacts such as posters, presentations, and essays. In the knowledge building perspective the product is the knowledge itself. A second emphasis is that “knowledge advancement” refers to communal knowledge, not just personal knowledge. Van Aalst and Chan refer to this as “working at the cutting edge.” A third emphasis is “progressive problem solving”—reinvesting cognitive resources to study a problem at progressively deeper levels.

**Emphasis on learning how to learn.** Knowledge building makes heavy demands on metacognition and self-regulation of the learning process. In particular the responsibility for identifying gaps of understanding is shifted from the teacher to students. Thus a claim of the knowledge building perspective is that students can learn to monitor their understanding and identify what is deep about a problem. The teacher acts as a resource and scaffolds this process, but is not the primary agent.

**Mechanisms for sharing what is learned.** Every learning community establishes procedures and uses tools to do this. In the case of knowledge building, Knowledge Forum™, a computer-based discussion environment, provides a reliable trace of the knowledge building discourse that makes it possible to highlight how ideas are developed over time and, therefore, what has been learned. (Some authors attempt this without computers, for example with a “knowledge wall” that embodies a network of ideas, see Hume, 2001.)

In knowledge building classrooms, the class usually starts with a general exploration of the topic to be studied. The goal is to enable the class and the teacher to articulate questions and ideas they have about the topic, and to delineate the general scope of what the class wants to attempt to accomplish. Students may contribute their ideas to the
Knowledge Forum database and/or talk to each other about them. With some scaffolding, the class may then settle on a general plan for what it hopes to accomplish in the unit (van Aalst, submitted); individual students or groups of students may also “major” in specific problems (Brown & Campione, 1994). From this point, students work progressively to understand their problems of understanding. Often the problems themselves undergo refinement. Students have a responsibility to make their ideas available to the knowledge building community; at the same time, the discourse helps to make knowledge more meaningful.

A competing student-centered perspective

In British Columbia 15% of students who graduate from high school will go directly to university and another 10% will transfer to universities from colleges. Therefore, high schools that focus primarily on the academic requirements of university entrance are focusing on a minority of the student population. The school district that Mr. Scott works in is committed to providing relevant education to all of its students, in a variety of ways. For example, it has a strong reputation locally for its work to provide differentiated support to students with special needs (i.e., “special education”). Early in the 1990’s it created an alternative school, Golden Ears High School (Balcaen, 199x); Mr. Scott was one of the teachers who developed the school’s program and taught there for eight years before moving to his present school.

The Golden Ears schooling model recognizes that individual students learn at different rates so that in most classrooms, in which students work through curriculum in lock-step fashion, the learning rate is wrong for many students. After grade 8 each course
consists of a series of instructional modules and projects. In some subject areas, including science, there are no traditional classrooms but larger spaces in which students work, supervised by a team of teachers. The students sign out materials, and sign up for experiments and workshops; they make appointments with teachers for consultation. When a student has completed all the modules in a course, the student can write the final exam (particularly in grade 12, where there are provincial exams). There is small group teaching and much peer interaction, but little of the whole class teaching found in traditional classrooms. The students typically spend their time in school to work on the modules, but occasionally they may choose to socialize and catch up later. As a result, some students may complete a course in eight weeks, while others require more than a semester. By evaluation measures that the Fraser Institute uses to rank schools in British Columbia, Golden Ears performs well. For example, the percentage of students who graduate (96.7), the number of provincial exams attempted per student (2.1), and the average examination marks (74.2) and school rating (6.7) are relative to the school district and provincial averages (Cowley & Easton).

We think it is laudable to develop the skills that students need regardless of their career paths (academic or more vocational). But how does the Golden Ears model fit with knowledge building? Referring to the four characteristics of learning communities discussed earlier, we see that there is no learning community in the sense used by Bielaczyc and Collins (1999) because there is no “shared commitment to continually advance ideas”. In fact, in a given subject area there may not be a community at all in that the students working on that subject may not know each other. There also is not the emphasis on “learning to learn” in the sense used in knowledge building. In the Golden
Ears model the emphasis is perhaps better characterized as “learning to work,” that is, developing strategies that enable students to meet external goals (set by the teacher or curriculum designer); in knowledge building learning to learn has more to do with the identification of conceptual knowledge gaps and ways to close them, which requires considerable metacognition. The Golden Ears model does not appear to put “ideas at the center” (Scardamalia, 2002); it puts activities and task completion at the center.

Nevertheless, we believe the Golden Ears model, in certain renditions, has good potential for supporting knowledge building if we think about the learning community somewhat differently. First, the model does away with the lock-step mode of operation of traditional schools. Learning resources—including computers—are available to students when needed by their personal learning. Different students are studying different modules at the same time. Second, the model is designed to support students in becoming more independent as learners. Its primary strength is in developing work habits but the idea can be modified to include more metacognitive features of learning to learn. Third, with groups of students working together, with many things going on at the same time, there is a greater dependence on peer teaching than in traditional classrooms. In Table 1 we use Scardamalia’s (2002) twelve knowledge building principles and comment on how the Golden Ears model can be aligned with them.
Table 1. Evaluation of the Golden Ears model with Knowledge Building Principles

<table>
<thead>
<tr>
<th>Principle</th>
<th>Fit of Golden Ears model with principle</th>
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<tbody>
<tr>
<td>Real ideas, authentic problems</td>
<td>Pre-designed modules can be used, but they are completed as needed to understand conceptual problems that students are trying to understand. Projects offer good possibilities if the projects are to create new knowledge (Bereiter, 2002) (****)</td>
</tr>
<tr>
<td>Improvable ideas</td>
<td>“Ideas at the center” is essential to developing a disposition that the work is not done at the end of a module, but that additional modules may be required or that the students may need to develop a new module when they get to the knowledge frontier. (****)</td>
</tr>
<tr>
<td>Idea diversity</td>
<td>Limited potential for this within small groups who are studying a problem at the same time. (**)</td>
</tr>
<tr>
<td>Rise above</td>
<td>Students are unlikely to rise above their own understanding without a strong manifestation of idea diversity. (**)</td>
</tr>
<tr>
<td>Epistemic agency</td>
<td>This requires “instructional design” that helps students develop strategies for monitoring their knowledge and learning. (****)</td>
</tr>
<tr>
<td>Community knowledge, collective responsibility</td>
<td>Limited potential without a strong sense of community, but applicable within small groups. (**)</td>
</tr>
<tr>
<td>Democratizing knowledge</td>
<td>Possible because the power structures of traditional classrooms can be circumvented. (****)</td>
</tr>
<tr>
<td>Symmetric knowledge advancement</td>
<td>Applicable if multiple groups have access to one another’s learning, as in knowledge building classrooms. (***)</td>
</tr>
<tr>
<td>Pervasive knowledge building</td>
<td>The disposition toward knowledge creation should pervade all learning situations that a student encounters. (****)</td>
</tr>
<tr>
<td>Constructive use of authoritative sources</td>
<td>Students need to question sources. There is limited potential for this with static modules, but can be developed over time. (**)</td>
</tr>
<tr>
<td>Knowledge building discourse</td>
<td>Limited potential due to the smaller number of students who work on a problem at the same time. (**)</td>
</tr>
<tr>
<td>Embedded and transformative assessment</td>
<td>Possible, but limited opportunities to benefit from peer feedback. (****)</td>
</tr>
</tbody>
</table>
Mr. Scott’s teaching at the time of the study

Grade 8 English/Science program

At the time of the study, Mr. Scott taught junior science (grade 8) and physics (grades 11 and 12) at a more traditional school. For the grade 8 class, and working with an English teacher, he used a “school within a school” approach to develop a joint English/Science program with some of the features of the program at Golden Ears. Within a traditional school it was not possible to implement the Golden Ears fully, and all students in the class were in the same timeline in terms of the completion of starting units of study, assignments and writing tests. The “module” approach was not used, but assignments were highly structured, using criterion-referenced assessment. The criteria and standards were sometimes developed by the students, so that they had to decide if an assignment was ready to be handed in for marking. (Students initially tended to want to know from the teachers if an assignment was good enough to be handed in.) The two teachers had contact with about 60 students over a period of approximately 2.5 hours per day, which was useful for doing experiments and for field trips. One aspect of this “school within a school” approach was that the teachers were attempting to develop a strong sense of community as part of the work in the two subjects; they worked toward all four of Bielaczyc and Collins’ (1999) characteristics of a learning community, and the use of Knowledge Forum was designed to support the community discourse. The teachers were new to Knowledge Forum and knowledge building except for a four-day workshop, and explored these in several instructional units. They started with a short unit on the Elizabethan Era in which students
were to investigate aspects of life in this era—it’s literature, transportation, science, and so on. A second unit later in the semester dealt with the biology of the human body.

The teachers conducted a survey to assess the success of the program relative to its goals (see also Chan & van Aalst, 2003, this symposium), and observed some positive effects. For example, students knew a large percentage of students in the class; and the learning environment was positive in terms of students being helpful to each other and being able to learn from each other. Students also said that they were reasonably challenged by the program and were able to learn what they thought they needed to learn. The teachers also noted that approximately 80% of the students were able to meet the various instructional objectives in the time planned, with the remaining students needing additional opportunities to meet them. Over several months, the students appeared to adjust to the necessity to self-regulate their learning and their academic achievement met the teachers’ expectations.

The work with Knowledge Forum was, in the teachers’ estimation, the weakest aspect of the program. We think there are several reasons for that. First, the inquiry was not authentic. The drive to study the Elizabethan Era and the human body came from the teacher and the curriculum, not from the students, and there were no problems of understanding. The computer discourse had low participation rates—except for a few boys interested in computers—and remained fact-based and superficial; it did not lead to significant new understanding of content beyond what the students were likely to have learned from classroom activities. Second, the computer discourse was not essential to the life of the classroom. It did not inform what the class should do next. In addition, there was competition for students’ time from other assignments that required computers. Third, the
relaxed atmosphere that allowed students to work at their own pace meant that a significant number of students needed to complete large amounts of work in short periods of time. Although that mode of operation allowed students to cope with other program requirements, it was detrimental to a reflective and progressive discourse that knowledge building requires.

The nuclear physics unit

In the second semester of 2000-2001, Mr. Scott taught a grade 11 physics course, and he expressed interest in using Knowledge Forum there. His approach was similar to the joint English/Science program. His main interest was to provide a safe environment in which students could learn some physics—in which they could find out if they had a taste for physics. If they did, he said, they could come back for Grade 12 physics and take a course that was designed to prepare students for university physics. Here, too, he did little direct teaching, as represented in the following vignette from field notes, written by one of us during the class’s work on motion and force, for which a set of motion detectors with computers were used:

When the motion detectors arrived, the students were shown how to connect one to a computer and the basics of using the software; the students were also given instructions for a lab that would use these materials. Some students tried to figure out how to use the apparatus and began to work on the lab. Many other students at first socialized and “played” with the apparatus, exploring what they could find out from it, but not focusing on the lab. After a few days of this most of these students had exhausted their curiosity and desire for socialization, and began to work on the lab. Most students learned some physics from the lab, but the designers’ learning goals for the lab did not appear to be met by more than a few students. Mr. Scott said he expected the class to learn from the lab that the acceleration at the highest point of the motion of a ball thrown vertically upward would not be zero. Although all students had seen this in the graphs made with the software, they did not
reach this conclusion. The teacher did not want to draw attention to the main conclusions of the lab by direct teaching, expecting students to make the discovery themselves. When I suggested to him that the experiences the students had were probably not sufficient for achieving the desired conceptual change, Mr. Scott said that was reasonable; but at the same time he was persuaded by the literature that argues that direct teaching is ineffective for conceptual change. He did not appear to think that his explaining or drawing attention to these issues would make much difference for the majority of the students.

The nuclear physics unit was conceived as an extended unit that students could work on once to twice a week over a period of two months; it was initially interleaved with the unit on motion and force for which the motion detectors were used. The start of the nuclear energy unit essentially coincided with the beginning of the one-semester course. Its design was influenced by our interpretation of experience in the English/Science program. For example, we felt that it was necessary to provide a series of “milestones” and provided Mr. Scott a paper in which project-based science teaching was evaluated (D’Amico, 1999). Mr. Scott consented to introducing some milestones. In the first week of the unit, one of us visited the classroom several times to explore what the students already knew in the area of nuclear physics; to provide a brief introduction to the idea of knowledge building, and what we hoped the students would experience in the unit (inquiry); and to introduce students to Knowledge Forum. From the initial conversation with the class, it was apparent that the class knew very little about nuclear physics. They did not appear to be aware of medical applications of nuclear radiation; of fission and fusion; or of nuclear power plants and environmental issues associated with them. Nevertheless, the students did appear to be interested in learning more about such topics. At the start of the unit, we also discussed our ideas about the importance with background knowledge with Mr. Scott (van Aalst, 1999;
van Aalst, submitted). We felt that some foundational knowledge would be necessary that would provide students with language (concepts) that would underpin inquiry in the different areas that individual groups might investigate. Mr. Scott asked the class to search for information on the Internet, which he collated into a booklet that was to be a resource. However, the class did not study this booklet together (this was left up to the students). Therefore, the class did not acquire the hoped-for language, and the students were not able to cast their interests in conceptual terms. As time went on, the students did acquire factual knowledge. The unit was ended with a poster fair. We visited the classroom approximately once a week throughout the unit, but as visitors in a student-centered classroom we could not have the directive role that we felt was necessary to guide the unit—a role that would have been in conflict with the teacher’s beliefs about teaching and learning.

**Problem Statement**

Visiting Mr. Scott’s classes, one might be tempted to say that students are “blowing off” classes, and that the teacher’s goals are inconsistent with knowledge building goals (Bereiter & Scardamalia, 1993). It is difficult to see the knowledge building process in the day-to-day class work. But dismissing the teachers’ goals is more difficult. For many students, these classes are a haven. Bringing a wide range of problems from their personal lives into the classroom, some students frequently run into trouble with other teachers and are sent to the office. In Mr. Scott’s class problems that occur are dealt with in the classroom, by means of a democratic process that involves the learning community. Most of the students in these classes know each other, which is unusual in high school. The academically oriented students are able to prepare themselves for university. And
“immaturity” is recognised as part of the messiness of teaching teenagers. The teachers know that students will eventually grow up, out of immaturity into maturity, and they wait patiently for students to do that in their own way, at their own pace. The result is education that is not relevant to just the small minority of students who are bound for university, but education that is relevant to most students’ lives in the “here and now”.

Knowledge building is about making the process of expertise more prevalent in schools (Bereiter & Scardamalia, 1993). As Bereiter (2002) argues, knowledge building is important for positioning students competitively for the requirements of work in the 21st century. The problem we are attempting to understand in this paper is how knowledge building is situated in the social context of classrooms. Knowledge building, with its focus on “deep understanding” of the disciplines is very intellectual. These intellectual goals address only a small part of what goes on in classrooms for most students. Is knowledge building another example of “the rich get richer,” or can it make an impact on the lives and learning of a wide variety of students?

Drawing from series of interviews we had with students and the teacher the following narratives represent their voice. Students’ and teacher’s perspective on a similar issue is presented below in parallel columns letting the reader to make his/her own interpretation.

THE NARRATIVES

<table>
<thead>
<tr>
<th>Beginning of the Unit</th>
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<tbody>
<tr>
<td>Ricky’s</td>
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<tr>
<td>Mr. Scott first listed some topics that we can learn about in nuclear physics. Following this, he had a</td>
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</table>
discussion with us, we suggested some topics and in the end we decided on five topics: Nuclear medicine, Nuclear weapons, History of nuclear physics, Nuclear energy and Nuclear processes. We signed up for the topic that we wanted to study. Some people selected the topic on personal interests but others did it just because their friends were there. Clara, since she doesn’t like science, selected history of nuclear physics because it is more like social studies and less like science. Dick was in the energy group because there were too many students in the nuclear weapons group. I selected nuclear medicine inasmuch as our entire family is in the medical field.

thought when compared to other units usually you don’t spend much time on nuclear physics unit and it is not important as other units. If you don’t make it then it is not a big deal because you don’t touch it in grade 12 but it’s a topic that is becoming more prevalent with the idea of power, nuclear energy and in medicine. Further nuclear physics was not one of my strengths. I thought we could learn it together. We as a class discussed some possible topics that we can explore. We axed some and kept some.

Working in Groups

If you have a good organizer, like Adrian in our group, then things become easier. In our group each one of us had a special task to do. It is not stressful working in a group if you structure it well within your group. In other groups every one is finding bits and pieces of facts from here and there and then putting it together. They had no organization and goal of their group work. It is easy to work in a group when each member takes responsibility and is accountable for their individual part. Success of group work depends on the personality of your group members. There were people who really worked hard and there were some that just slacked off. If you are with people who don’t want to try then there’s no point of doing group work because they won’t contribute anything. Especially with our class I don’t think our class dynamics are conducive towards this type of group work. I think we need some more time to build that type of classroom culture.

Sometimes it’s fun to work in a group. You get to know about others, their interests, habits, passions, etc. I think we learned a lot from just talking about what we are working on like how hydrogen bombs are made, how they worked, etc. But we didn’t have much time for group discussion. Each one of us was working on our individual part within our group then at the end we put all those things into a poster.

I allowed students to select their own groups thinking that they would work better if they could choose what they like to do. I realized that these groups were not balance for numbers, sex, etc. But I decided to let it go, as it was students’ choice.

I think Medicine group did produce the best work and they built a fairly strong community around their project. This group had probably four of the top ten students in grade 11 s of the whole school. I can see that class ‘dynamics’ did affect their learning and I think it brought down from their high level to be ‘ok’. If I were to describe the Process group “lazy and taking the path of least resistant” was the trademark of this group. Energy group tended to sit together and work all the year, except for Jim- he was the outsider to this group generally- the guys doing the nuclear weapons didn’t necessarily like these guys. With the Medicine group it was an all female students group. There were two ESL students who never talked in class except for me and that was also when we had the opportunity to talk to face to face.

What happened is that their whole attitude was brought down by a couple of people within the group. They were the ones always first to talk and that brought the whole level of conversation down rather than keeping it up.

After reading Ricky’s story as I reflect on the group dynamics I can see that negative attitudes of some students had an effect on group work and the final outcome. The making up of groups the way we did probably added to the lack of progress made by the groups. So how would I select next time? I do not know but I think I would let the students select their own groups.
How students found information

As I said we split our major topic into subtopics. Then we divided up on who wants to do what.

Internet was the major source of information. There was so much information. We collected the information that we thought would be useful and covers the topic. Information on the net is very current, but sometimes they can be unreliable when compared with books. In the history group they found different dates for the same event. Then they had to refer to a few more web sites and they decided to select the most frequent one.

I took all the students to the lab where each student had access to a computer and asked them to find as much information they can get on nuclear physics from the internet. I asked them to show me what they got so that I can decide what we should print and what not. In the end we ended up with a fair size of booklet on nuclear physics. I thought that student have that as a resource manual. They can use that to begin their inquiry into nuclear physics.

The Process

As we didn’t have much time to discuss we found out as much information as we could on our individual subtopics. Some of the information we found was not really relevant, so we had to throw it away. I think it’s a waste of time. Since we had lots of information and we had a hard time selecting what was important to put on our posters. So what we did was summarize most of the information. In that way we were able to include all of them in our presentation. We tried to sort the information we had into categories. We tried to form new categories from the categories that we already had.

In some groups they just copied and pasted information directly from the Internet, either to the Knowledge Forum database or onto their posters. Especially with Nuclear history and its’ time line there is nothing much you can do with that information. They are just a bunch of facts. So they just copied and pasted them from the net. Some times we needed to do minor editing on them and add in some pictures or diagrams to make them attractive.

With some groups like the processes, they didn’t find that much of information. I think we need to think about our topics again. Some times our subtopics were too narrow like Tim’s. He was working on Cold fusion. So you find out what it is and that’s as far as you can go. As each one of us was working on our individual part we didn’t bother about finding information for others. But if we came across any we gave it to them.

I think that having a poster presentation is a good way of sharing what we learned. There were people who were learning it for the first time from the posters. We put the best information we had on the posters. We walked around and wrote down some facts that are interesting or that we might want to think about later. Posters are much more
attractive things to look at. You can pick out interesting things easily than reading from a paper. We were just working on one topic. With the posters you are sharing it with others. So we can get an overall idea about the nuclear physics. Now I have specific knowledge about my topic and general knowledge about other topics. Some facts I had learned from other groups were helpful in clarifying things now I am learning in Biology and Chemistry.

Sure whether this was the best way to go as I was experimenting this method.

When I attended the fifth Summer Institute of Knowledge Forum had the opportunity to talk to other teachers who are using KF and learned many things about using KF effectively in classroom. For an example now I know if I asked kids to prepare a portfolio with criteria set as such where they have to read each others notes I don’t have to force them or worried about them not reading others’ notes. Further, having too many diverse groups in the database causes the people to lose interest in the other groups and I need to guide them more.

Knowledge Forum

Knowledge Forum could be useful with a good classroom culture. So I think first you need to build that culture in your classroom before you start to work with KF. I think it is better to introduce Knowledge Forum later when the class has settled down, not at the very beginning with a new teacher and a new class. Then we needed sometime to get familiarized with the software. Further we needed to organize our class time on how we are going to work on KF and how much time we are going to spend on that. I think it will be good to work with KF on some topics like evolution but may be not with all the topics.

Some people put notes in KF directly from the Internet. There was one note with 38 pages! We posted questions in KF. But didn’t get much response. Some people didn’t know what to say because they had no idea about our topic, but with the others they didn’t post their information onto KF. They saved it for their posters. So I think we don’t need two ways of sharing what we are learning. We should either use KF or do a poster at the end.

I think if we had one big problem KF would be a better strategy to use. We can use it to post our ideas and arguments. I think to debate about theories, KF would be one of the most pertinent software to use. Whenever we were working on the KF we were in the class. The people you need to talk were sitting next to each other. So we preferred to talk directly than talking through KF. It is better if you are doing this with another school, or you are meeting once a week or something but not with the people you are meeting everyday.

Teaching and Learning Physics

I introduced the Knowledge Forum software to this class at the same time as the nuclear physics unit. So the students had to simultaneously learn the software and nuclear physics. But priority was on how to use KF. We learned about how to make a note and read each others notes and to access it from home if they had computer etc. Students had computers in their classroom if they want to work with the knowledge forum but if they want to find out something from the internet they needed to go the lab, which was in another building. They had the flexibility either to work in the class or go to the lab. They had their deadline and I believed that these students were mature enough to take the responsibility to be honest with themselves.

After Ricky’s story and listened to colleagues I think more KF learning must be done to show students how to make their views/notes more interesting. I need to do a better job working on the KB principles to help guide students to higher levels of understanding. But I am sad to hear kids saying that we’ve wasted our time. I think with every mistake that we made we learned something.
I think Mr. Scott’s teaching style is different. He gives us more freedom; lets us select our topics and groups; lets us work on our own pace. I am glad that at least with one of my courses that I don’t have to worry about doing three or four hours of homework. But many people aren’t very good with self-pacing and self learning. They just keep putting things off and procrastinate. I don’t like deadlines but I am a hard worker. So for me when there is no extra push to go I feel like I didn’t do my best. I think we took it too easy with our nuclear physics unit.

Mr. Scott expected us to do work without being told. But most of us didn’t know how to do that. We were used to a different type of teaching. Before we start each unit he may talk about it in a general way for about half a block of time and that’s all we get from him. We expect to get much more from our teacher. I need to have confidence in my teacher. When I know he knows about what he is teaching it gives me lot more confidence in my learning.

There were many tasks for the students to complete and there was hardly any time. There were several problems with people not understanding concepts because they were too broad. We were expected to have some knowledge about our unit but we didn’t. It would have helped us, just to get started, if we revised what we have learned about nuclear physics in previous years. When you get into a project like ours knowing at least the basic details are better than nothing. It helps us to understand what we are doing and specially provide us with some guidelines. In other classes we use our textbooks to learn our lessons and to do the assignments. I can understand better that way. We get the exact information from textbooks. We won’t get off track as we did with this project. Sometimes we can’t find the main points of what we are searching for from the Internet directly. We need to search for that. We are not experts. We don’t know what exactly to pick, what people need to know and how to go about with the information we have.

I know this is a kind of unique way of learning. But we didn’t learn from our books. We didn’t take notes. I don’t feel like I’ve learned a lot after the project. I learned a few facts. It was fun doing this project because it was relaxing. We knew that Mr. Scott was not going to test us on this. We really enjoyed the freedom. But when you think about exams it’s not fun. It is kind of weird because the whole course and the school system are very sequential with deadlines, rules

I do not do up front teaching. I don’t tell them the answers at the beginning. I will post some questions; provide some handout on what we are going to learn. In those handouts they have all the information they need like questions, labs that they have to complete. If there are problems as they do the labs or the questions they have to come and ask me individually. That is when I will do most of the teaching. If there is a question that keeps coming up over and over and that they just can’t get it from the textbooks, or from friends, then I might teach the whole class. Spend five minutes may be going over the concept and then let them get back to work. I let them discover things. They can read the textbook as well as I can. So I think by giving them the freedom to do that, eventually they will learn to learn. They don’t make to Grade 11 without learning how to learn somehow.

I tried to treat them as ordinary people. If they are late I listen to why they are late. If they have a legitimate excuse then it isn’t a problem for me. It doesn’t bother me if they were a minute or two late because in a way they were getting up tight with frustration level rising and I wasn’t worried because they weren’t going fast enough. They didn’t think they are learning any thing. I saw their heads. In the long run I think they will learn more.

I saw some kids got really up tight during the project, especially some good students, because they weren’t going fast enough. They didn’t think they were learning anything. I saw their frustration level rising and I wasn’t worried because in a way they were getting up tight with themselves because they don’t have enough confidence to do it by themselves. Ricky said at one point “we had to throw some material it was not good or it was not that relevant.” How come they knew to throw it out? They had to make a decision. Most students don’t realize that is a knowledgeable decision. Isn’t categorizing what information they have is displaying epistemic agency?

When they presented their posters, there were some good questions, some good answers or
and regulations. In the middle of that we are having this freedom for a short period of time knowing it wouldn’t fulfill the usual requirements of the system. High schools are more like knowledge intakes. We need to learn lots of facts because that’s on what you are tested. comments. That told me that they actually learned something. They did quite well for the KF; produced good notes; did a lot of research, I think they learnt quite a lot.

I did some up front teaching at one point to take their pressure off a little bit. That is what they wanted me to do all the time. They want me to teach. I did some teaching at one point because I didn’t wanted to hear “I don’t want to do Physics” from them so early in the project.

They were used to having an assignment given to them each day; taking notes; doing homework; hand it in next day; and I don’t do it that way. So it was really different as far as I was concerned. The way I am trying to do things was running against what they’ve always been taught to do. So there was a problem.

After Ricky’s story and the discussion I had with the researchers I think I would clearly state my expectations with more tightly time lines. I would probably do some teaching on the basic principles, at least to get them all on the same page. May be then we can look at the problems until they get used to this type of learning. When they are more familiar with the strategy may be we could start with a problem.

I still think children learned best
1. when they have a friendly environment
2. when they can develop themselves without a teacher pushing them and
3. when they were allow to make mistakes.

DISCUSSION

In this section, we add our own voices as researchers to the voices of Mr. Scott and Ricky.

Problem Based Learning (PBL)

Mr. Scott selected an inquiry approach for the nuclear physics unit because it the grade 12 physics curriculum did not build on it, and because it seemed a good topic for an inquiry approach. The students decided to inquire into topics such as history of nuclear medicine, nuclear weapons, and nuclear energy. According to Gallagher et al (1995) there are three features that set limits to PBL: initiating learning with a problem, exclusive use of ill-
structured problems, and an instructor who is a “metacognitive coach.” In PBL, students begin to learn after they encounter an ill-structured problem. Dewey defined this kind of inquiry as “the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the element of the original situation into a unified whole” (1938, p. 108). The topics the class selected were not authentic problems, and therefore the class ended up collecting scattered information, which did not converge towards a unified whole. In other words, this learning experience or inquiry lacked the ways and means of reabsorbing what occurred into existing experience. It became a single event rather than a continuum of learning. Further, as a metacognitive coach, a teacher needs to make certain that students become aware of their knowledge gaps to ask questions during problem definition, searching for information, analysing and synthesizing, and to sift through possible interpretations or solutions.

“Teachers help students to take on the role of problem solver first by modeling and coaching, and then by requiring that students take on the responsibility of using the skills on their own” (Gallagher, 1995, p. 138). Mr. Scott said that “nuclear physics was not one of my strengths. I thought we could learn it together.” Nevertheless, he seemed detached from the inquiry process and did not provide the modeling that Gallagher mentions.

**Working in Groups**

The students had many insights about working in groups such as: clearly stated goals, which include structural and organizational parameters, group commitment, and a classroom culture conducive to group work. Mr. Scott, while verifying the students’ claim that some groups slowed down or withdrew effort, claimed that some groups, like the medicine group, “built a fairly strong community around their project”. No two individuals
will perceive an experience in the same way. Yet in many circumstances, as Koschmann (2002) says, “we must go on trusting that our understandings are sufficiently in alignment for joint activity to proceed. When these assumptions become problematic, some negotiation in meaning is called for” (p. 20). For Mr. Scott this necessity for negotiation came through Ricky’s story. He reflected, “I can see that negative attitudes of some students had an effect on group work and the final outcomes. The making up of groups the way we did probably added to the lack of progress made by the groups.” When we presented Ricky’s story at the Fifth Knowledge Building Summer Institute, participants of that workshop discussed their experiences and suggested many ideas. In one of our subsequent discussions, Mr. Scott said that he realized Knowledge Forum provides a good platform for these negotiations and this element was weak and less pursued in his pedagogy.

The Process

The students saw inquiry as finding information and sorting it into categories or deciding on which information to post on KF and which to put on posters. On the other hand Mr. Scott said, “My hope was that they would go and read each other’s notes but there wasn’t any of that cross-fertilization happening. I mentioned in class one or two times. . . I was worried about them not doing it.” In addition, the way students went about their research did not require collaboration. Students individually located and studied information, and then brought that back to the group. But other group members did not study the information, and there was no basis for an online discussion aimed at understanding the information. It would, in our view, have been better if all students in a group had read (some) common texts and then had jointly attempted to understand them. In retrospect, it would also have been better to start from one or more ill-defined problems—
rather than topics—that the whole class worked on together (Bereiter, 1992). As more information became available to the students, the problem definitions could have been refined.

Effective learning and teaching takes place when both teacher and students are willing to explore new teaching/learning approaches and stretch their epistemological assumptions. The students’ understanding of the process of knowledge building differed from that of the teacher. Therefore students’ ability to connect in the process of knowledge building depended on the extent to which the teacher connected with their thinking effectively and meaningfully.

Knowledge Forum and building a classroom culture

The students said that one needs a good classroom culture to work with Knowledge Forum. Ricky said, “First you need to build that culture in your classroom before you start to work with KF. I think it is better to introduce Knowledge Forum later when the class has settled down, not at the very beginning with a new teacher and a new class”. Mr. Scott, in consultation with us, introduced the Knowledge Forum software to this class at the same time as the nuclear physics unit. So the students had to simultaneously learn the software and nuclear physics, but the priority was on how to use KF. In retrospect, this tension between knowledge building and learning through KF created a conflict in this class.

When students did not share Mr. Scott’s vision of learning and teaching Mr. Scott imposed his personal vision on them. We now realize how crucial and difficult the process of converting Mr. Scott’s personal vision to a shared vision for both students and the teacher was. Senge (1990) described “the practice of shared vision involves the skills of unearthing shared ‘picture of the future’ that fosters genuine commitment and enrolment
rather than compliance” (p. 9). Scardamalia (2002) describes this as “Community knowledge, collective responsibility”. The challenge of developing a shared vision was further complicated by diversity in students’ view of knowledge. We saw the major challenge for Mr. Scott was to gain a clear understanding of his students’ needs and their current view of the learning process. As Kegan (1994) says, knowing what students understand is not sufficient but also the way they understand it important. This process of getting to know each other is a vital in the notion of learning in a community.

We realized when the students and the teacher had different ideas about what the classroom culture should be like, there needed to be a process of negotiation with clearly expressed expected goals. Ricky argued, “Whenever we were working on the KF we were in the class. The people you need to talk were sitting next to each other. So we preferred to talk directly than talking through KF.”

We now understand better that the journey of becoming a learning community is a long and gradual process, in which a teacher needs to introduce and nurture many skills. Among these are: exposing personal thoughts and ideas; learning to value and respect others’ ideas; learning to provide critical yet constructive feedback; learning to evaluate what is relevant and what is not; and learning to adapt or change one’s ideas and learning to arrive at a conclusion. As these skills are new and need practice, a classroom environment is necessary where it is safe to be open and be critical of others.

Teaching and learning physics

The students appreciated the freedom to select what they wanted to learn, and the flexibility and pace of learning within the nuclear physics project. At the same time, these students were new to self-pacing and self-learning.
Structures and processes. Ricky reflected, “When there is no extra push to go I feel like I didn’t do my best”. The medicine group recommended some kind of “punishment” for not achieving targets. Mr. Scott said he felt sad about that these grade 11 students could not assume responsibility for their own learning. Further, he thought that by having a different kind of evaluation through poster presentations, students would experience the freedom to explore their own learning goals. Ricky’s said, “It is kind of weird because the whole course and the school system are very sequential with dead lines, rules and regulations. In the middle of that we are having this freedom for a short period of time knowing it wouldn’t fulfill the usual requirements of the system.” These comments articulate the illusive nature of this flexibility and freedom to learn.

Through Mr. Scott’s efforts we learned three important characteristics of teaching. First, Mr. Scott believed that students should take responsibility of their own learning. Thorough the narratives we learned this self-authorship extends beyond critical thinking or making informed judgements. We saw it not just as a skill but also a way of making sense of the world and oneself, where a teacher needs to create opportunities for students to become aware of their knowledge gaps.

Second, literature on student learning, specifically on constructivist learning (Piaget, 1983; von Glasersfeld, 1983, 1987), advocates making connections with students’ prior experiences in order to engage in meaningful learning. Ricky’s comment “We didn’t take notes. I don’t feel like I’ve learned a lot after the project” highlights students’ epistemic assumptions about the nature and beliefs about knowledge. The students’ absolute view of knowledge made it difficult for Mr. Scott to move them towards taking ownership of their own learning. Student ideas such as “I need to have confidence in my teacher” demonstrate
their home cultures, which could create roadblocks toward epistemic agency. A teacher who is a metacognitive coach models and promotes self-directed learning, and understands the evolution of meaning-making structures of his students in this process of search for knowledge, as well as the approaches and preferences students demonstrate within these structures.

Third, when students’ perception and teacher perception of learning differ, the teacher needs to focus on not only students’ prior experiences but also on their epistemological development. Ricky said, “We are not experts. We don’t know what exactly to pick, what people need to know and how to go about with the information we have”. The students lacked the background knowledge and basic concepts to build on their new experiences. Mr. Scott later commented, “I would probably do some teaching on the basic principles, at least to get them all on the same page. Maybe then we can look at the problems until they get used to this type of learning. When they are more familiar with the strategy may be we could start with a problem.”
CONCLUSIONS AND IMPLICATIONS FOR EDUCATIONAL CHANGE

Through Ricky’s narrative Mr. Scott came to know students “lived experiences” that was different from what he expected and assumed. Mr. Scott said:

I thought after reading Ricky’s story that is a useful exercise to go through which allows kids to really vent their feelings. I feel you gave them ample opportunity to do that. I felt that they were really speaking from their hearts so to speak. Both positive and negative comments were honest comments. I think I learned from the positive comments as well as from the negative comments. As there are things that are strong for me and weak for me. I know that I am not all weak and I am not all strong in those things. So there is always room for improvement. (Third Interview, October, 2001.)

In constructing these narratives as researchers, we were exposed to diverse perspectives of a common phenomenon. When we presented Ricky’s narrative at the Fifth Summer Institute, participants commented on our narrative approach. They said the narrative provided a compelling story, which offered them a place to reflect on their own experience and to engage in a dialogue. As Witherell (1995) comments:

Narrative allows us to enter empathically into another’s life and being- to join a living conversation. In this sense, it serves as a means of inclusion, inviting the reader, listener, writer, or other teller as a companion along on another’s journey. In the process we may find ourselves wiser, more receptive, more understanding, nurtured, and sometimes even healed (pp. 40-41).
Knowledge Building Revisited

Mr. Scott’s approach to teaching was clearly shaped by his commitment to the personal development of his students and by his experiences at Golden Ears. We admired his approach and the underlying goals, but from the beginning we found it difficult to reconcile Mr. Scott’s objectives with the knowledge building perspective. Mr. Scott was interested in making the knowledge building approach work, but was unwilling to do more direct teaching than he had been used to, and was at a loss (as we were) about what to do when the students did not respond to the planned timeline or activities. To conclude, we map the lessons learned onto Scardamalia’s (2002) knowledge building principles, relating them to the three areas we discussed above—individual development, development of a classroom culture that supports knowledge building, and maintaining a constructive dialogue.

Individual development

Each individual make sense of an experience in a unique way. Our language, culture, and personal experiences shape approved ways of seeing and understanding. Therefore each individual’s perception, form, and approach to problems vary. When selecting a problem to study, if the problem has real interest for the learner, one may have an authentic problem. In search for solutions, interaction with other people help to adapt, clarify or develop existing ideas on this problem. With the rise above principle, Scardamalia argues that this exposure to others’ ideas helps in working toward more inclusive principles and higher-level formulations of problems. An individual learns to synthesis new meanings out of “diversity, complexity and messiness.” This helps an individual to rise to an advanced level of understanding.
Advanced knowledge helps an individual to search for other sources of information with authority and critical stance, which Scardamalia posits as the principle of constructive use of authority. The resulting breadth of view provides an individual a wider scope to see the world beyond their textbooks and classrooms. An individual sees connections between what was learned and the “real world.” It provides a system perspective to see the world, which could be described as pervasive knowledge building. The process of coming to know provides a developmental path for individuals through problem based learning.

1. Finding a problem
2. Problem clarification
3. Gathering and evaluating information to solve the from
4. Concluding solution leading towards next problem

The questions still remain about how one could go about this process. While Scardamalia’s knowledge building principles embrace a communicative approach to learning, Habermas (1984) and Mezirow (1991) argue that in a given situation most learning involves fundamentals of both instrumental and communicative domains, not just the communicative domain only. This argument indicates a need for further research in implementing knowledge-building approach to learning.

**Development of classroom culture**

Having a safe psychological environment to present an individual’s ideas and beliefs is important when we expect students to become a member of a learning community. Within a classroom, students need to feel safe to expose their ignorance or “half baked ideas”. They also need to develop skills such as listening to others, who may express
different ideas (Idea diversity) and provide “critical constructive feedback.” Individuals in this learning culture accept that their ideas are improvable ideas. When students’ ideas differ, they need to learn how to negotiate those ideas so as not to win one’s own argument but to reach to an educative conclusion. Rather than waiting for the teacher to tell the answer to the problem or others to solve it, individuals deal with problems of goals, motivation, evaluation, and long-range planning; all these are part of epistemic agency. The process involves:

1. presenting diverse ideas
2. examining alternative perspectives (Listen to others)
3. identifying and understanding supporting evidence and arguments (be prepared to accept others ideas which could be more justifiable)
4. balancing evidence and arguments to assess reasoning and
5. arriving at a tentative judgment (Democratizing knowledge)

Goleman (1998) argues if members are engage in a learning process through discourse they need “emotional intelligence” which comprise of competencies such as the awareness and management of one’s emotions, self motivation, clear thinking, understanding of others empathy, having social skills such as getting required responses from others by handling relationships and creating opportunities etc. Then in parallel to the knowledge building principles, it is important to focus on developing such a culture within a classroom. Indeed, one of the key differences between Mr. Scott’s class and other classes that we have worked with and consider more successful as knowledge building communities, is the length of time that is devoted to building the social and cognitive infrastructure necessary for knowledge building. It takes time to develop a class to the level
where it can really discuss problems in ways that are respectful to diverse views, that take all the available evidence into account, and that involves questioning that can open up a problem rather than close it. The social infrastructure is important if there is to be a sense of community, but the community exists primarily for the purpose of knowledge construction, so it has to be a knowledge building community. The teacher needs to provide experiences designed to help the class grow as a knowledge building community. Some teachers work on these things as long as three to four months before they introduce Knowledge Forum, and continue to work on them afterward. In a semester-based school there is limited opportunity for achieving these things and still get to knowledge building with Knowledge Forum in a single course. One of the lessons learned from the experiences in Mr. Scott’s class is that developing a knowledge building culture takes time, and unless the required time is allocated, strong examples cannot be expected. From that perspective, the problem with knowledge building in Mr. Scott’s class was not that knowledge building was not evident in the class’s experience, but that there was nothing to build on that experience to get to more sophisticated and powerful knowledge building. Educational change that requires a significant cultural shift is difficult to achieve in a single classroom and requires a more systemic approach. We think that one of the reasons that the focus on personal development at Golden Ears was more effective than at Mr. Scott’s current school was that the instructional design was applied across subject areas and grades. **Maintaining a constructive dialogue in the process of knowledge building**

When the key learning aspect becomes communicating with other members of the learning culture the process of engaging in a constructive dialogue becomes crucial. Mezirow defines “knowledge as function of association and communication” (1991, p.57).
It depends on the cultural norms, sanctions, methods of transmission, and understanding. Our belief about something and expressed ideas on the same thing can be different in a given situation (Idea diversity). Senge (1990) see this as the ‘left hand column’ of thinking and says it is critical to become aware of the left hand column when an individual engages in a dialogue. According to Senge, to engage in a learning conversation we need to expose our assumptions for examination by other members in the group in an environment where one could be open without fear of judgment (Embedded assessment). Mezirow sees our culture as an “argument culture” where you are conditioned “to approach anything we need to accomplish together as a fight between opposing sides. We set out to win the argument rather than to understand different ways of thinking and the different frames of reference, and to search for a common ground, to resolve differences and to get things done” (2000, p. 12). Therefore it is important to listen to other’s points of view and engage in constructive discourse. Senge sees this discourse as consisting of two dimensions: dialogue and discussion: dialogue is the occasion where participants can present their ideas freely, bring their assumptions to the surface, and see how coherent their ideas are with others, and accept the incoherence of their thoughts. In discussion, participants present their views on others’ ideas, defend their thinking, and make decisions on the process of reviewing and revising according to the data and issue at hand. By learning to balance these two dimensions one could learn to move from “self serving debate to empathic listening and informed constructive discourse” (Mezirow, 2000, p. 12). Scardamalia’s version of this is knowledge building discourse. Senge posits that it is important to have a facilitator “who could guide the context” of dialogue at least during the early stages. Maintaining a balance
between the dialogue and discussion is an important role of this facilitator. This indicates the role of a teacher needs to become versatile and dynamic.

Therefore, in the process of searching for knowledge to solve the problem a teacher can:

1. Provide a safe forum for dialogue
2. Encourage students to be open with their ideas
3. Facilitate dialogue
4. Regulate and monitor constructive feedback
5. Inspire alternative thinking
6. Support and guide to arrive at a consensus

Introducing unsettling challenges through mutually constructed meaning offers an opportunity for students to rethink and reconstruct their thinking. Then learning becomes a process of developing one’s own mind to understand the complexity presented through curriculum and teaching becomes a commitment to help students to develop their minds. It is very different from teachers requesting students to follow a pre-mapped journey. It is a journey of teachers transforming their practice to accompany students on their journey.

This study became a reference point for us as researchers as we continued to work with other teachers in other classes. Lessons learned provided us many insights to go about with our next research agendas. We realized that we needed to take into consideration the teacher’s ability to adapt and transform their practice to accommodate this changed role of a teacher. The study also pointed toward various avenues that further research is needed such as: Is this approach to learning is suitable for all students? How important it is to develop a classroom culture simultaneously and what should be the nature of it? And what
kind of professional development is needed for teachers engage in a knowledge building approach to teaching and learning?

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