GRAPPLING WITH ISSUES OF LEARNING SCIENCE FROM EVERYDAY EXPERIENCE: AN ILLUSTRATIVE CASE STUDY

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Abstract

There are different perceptions among researchers with regard to the infusion of everyday experience in the teaching of science: 1) it hinders the learning of science concepts; or, 2) it increases the participation and motivation of students in science learning. This article attempts to contemplate those different perspectives of everyday knowledge in science classrooms by using everyday contexts to teach grade 3 science in Singapore. In this study, two groups of grade 3 students were presented with a scenario that required them to apply the concept of properties of materials to design a shoe. Subsequently, the transcripts of classroom discussions and interactions were analyzed using the framework of sociocultural learning and an interpretative analytic lens. Our analysis suggests that providing an authentic everyday context is insufficient to move young learners of science from their everyday knowledge to scientific knowledge. Further, group interactions among young learners of science to solve an everyday issue need to be scaffolded to ensure meaningful, focused, and sustained learning. Implications for research in science learning among younger students are discussed.

Introduction

Everyone, regardless of schooling opportunities, has everyday experiences that they can share with others. These everyday encounters are experiences that are real and familiar to each individual. The accessibility and familiarity of these experiences make informal everyday experience an ideal starting point for discussions and learning in the classroom. Classrooms provide the space and platform for the diverse everyday experiences of students to be presented, discussed, negotiated, and appreciated. Despite the availability and potential usefulness of everyday experience in enriching classroom discussions and learning, critics of science learning see everyday experience as informal and a potential hindrance to students' learning as it increases the probability that students will develop misconceptions and naïve conceptions [1]. When compared with scientific knowledge, everyday experience and knowledge are viewed as less precise, more informal and, hence, less acceptable. In the face of this concern, there are also researchers and practitioners who position everyday experience as a valuable resource that will facilitate students' learning of scientific knowledge. Warren, Ogonowski, and Pothier argued for "scientific knowledge as growing out of experience, as a refinement, not a replacement, of experience" [1]. As such, science teachers create opportunities for students to recast familiar everyday experiences, through a process of creative synthesis, as scientific representation. Learning science can thus be described as a new interpretation of everyday experience. This study takes the stance that everyday experience enriches the science learning of young learners by increasing their participation in classroom discussion since everyday experiences are the most readily available resource.

Everyday Experience and Science Learning

Projects focusing on science education reform repeatedly highlight the need for students to learn both the content of science as well as the process of science. Indeed, one common recommendation is a call to move away from dull, uninteresting, memorized scientific facts presented in textbooks toward applications of science that are relevant to students' lives in the curriculum [2, 3]. The widespread isolation of school science knowledge from students' everyday experience often contributed to students' low motivation and interest in learning science [4]. In an era where scientific literacy is often emphasized as an asset and a desirable outcome of science education, the urgency for science education to make science more relevant to the lives of students is heightened. Scientific literacy can be defined as "an understanding of science and its applications to social experience," and teaching scientific literacy involves a process of socializing and enculturing young learners of science for active membership in a science- or technology-based democracy [3-5]. However, the urgent question that remains largely unanswered is how the socialization and enculturation of young learners can be carried out in schools that are often characterized by unique and independent cultures different from the real world. The school culture is often defined by a crowded curriculum, standardized testing, textbooks, and syllabi that are dogmatic about scientific facts that students are expected to learn.

Efforts have been made in many classrooms by science teachers and science education researchers to examine how students can be socialized and accultured to become scientifically literate consumers of science and technology. For example, the promotion of science inquiry in science classrooms, the use of problem-based learning in solving authentic school science problems, and other innovations are strategies and programs planned to bring students' experience into science learning. The infusion of everyday context for the development of twenty-first century skills among students has been discussed at great length. Bybee aptly asks the question whether the focus of science curriculum in the twenty-first century ought to be on science subject matter itself or whether the emphasis should be on life situations whereby science plays a key role [5]. He argued that basic science concepts should be taught, but the knowledge must be applied in contexts that the learners encounter in life. The ability to apply scientific understanding to real-life situations should be an important outcome of science education. In this research, we take the position of applying science concepts to everyday life and use this as a starting point in a science learning activity. We structure the activity in such a way that scientific understanding is developed as the students share their everyday experiences and knowledge with each other in order to complete the task.

Research into these strategies and programs support the notion that productive learning of science is and can be built upon a foundation of students' shared everyday experience and their interaction with materials inside and outside the science classroom [6, 7]. However, King, Bellocchi, and Ritchie highlighted that methodological obstacles have prevented researchers from comparing context-based and content-based curricula [8]. Hence, we have knowledge of what students gain from an experience of learning with everyday context, but we have little knowledge of their process of learning. Additionally, the bulk of earlier research in the use of context and applications of science—or science-technology-society approach—to develop scientific understanding was carried out with learners of science between the ages of eleven to sixteen years of age [9]. Further, in their review, Bennett, Lubben, and Hogarth suggested that more research ought to be carried out on particular activities that are not traditionally associated with science teaching, and how they can be used to support development of scientific understanding by appealing to students' everyday experience [9]. Therefore, this study was designed to examine the kinds of knowledge and the resultant tensions during interaction in developing scientific knowledge of young learners of science (aged nine) by using their everyday experiences as starting points.

Everyday Knowledge and Scientific Knowledge

This study stems from a sociocultural perspective of learning [10, 11]. Adopting a social view of learning means that higher order functions like logic and argumentation of scientific knowledge are a result of social interaction. Physical tools and language are used to facilitate the learning process by mediating the relationship between the learners and the world. Based on this perspective, we examine students' learning of elementary science content and processes by examining three key components: 1) individual ideas; 2) knowledge (everyday and scientific) that is revealed by the situation; and, 3) how students use language/tools to articulate or represent their knowledge. Individual ideas refer to students' prior knowledge about the contents of science, their personal beliefs about science, and their experience with the phenomena. Learning in this context views students using and applying their prior knowledge, beliefs, and experiences to make sense of the circumstances. Finally, we also note how students communicate and present their ideas.

In this research, we acknowledge the presence of different kinds of knowledge. According to Thomas Jefferson, knowledge can be scholarly or practical—or it can be stable or situational [12]. Furthermore, knowledge can be classified according to where and how it is applied. For example, we can have knowledge that is practiced by a particular group of people (such as scientists), knowledge that is presented in books, and knowledge as content that resides in the minds of individuals. Knowledge, we argue, is not bound to a situation, but rather located within a particular situation [12]. As such, an individual's idea, the context in which this idea is accessed, used, and discussed does not have a static nature, but rather it changes in nature and complexity when applied to different situations. The way that knowledge is talked about in the classroom can also be different. Students can be engaged in contextualized discourse which is characterized by talk that focuses only on the situations and objects in the immediate context. Students can also be occupied in decontextualised talk which is discourse involving past or future events that are not part of the present environment [13]. Engagement in different kinds of discourse suggests the application and formation of different kinds of knowledge.

Scientific knowledge in school is often perceived as "abstract and self-contained" entities, and one of the possible reasons for this is that science is often presented as standalone statements of truth that are context free, having little relevance and application to real-life situations [3, 14]. Students who are exposed to compartmentalized, ready-made, and textbook-based knowledge of science might develop misconceptions about the nature of science and possibly lose interest in it. There is little opportunity for application of these abstract concepts in authentic situations, and the absence of appropriate application of scientific concepts often results in the learning of unusable scientific knowledge. The learning and acquisition of unusable scientific knowledge will ultimately impact the motivation of students and how they learn science. We postulate that increasing students' abilities to make relevant connections between school science and their everyday experience would develop more motivation in studying science and, in the process, develop more accurate conceptions of the nature of science. As such, we devised this research to examine the kinds of knowledge grade 3 students use when they interact with each other as they learn science through solving a problem based within an everyday context. We hypothesize that using familiar everyday contexts and knowledge as starting points for students to gain school science knowledge would present a more concrete means for young learners of science to build their scientific knowledge. To facilitate our understanding, we examine the forms of interaction in the light of the kinds of knowledge, talk, and skills that the students practice in solving the problems and learning the science.

In many classrooms, science teachers and students are faced with the challenges of curriculum demands, standardized testing, and inadequate resources, as well as a lack of curriculum time. Such limitations often result in frustration among teachers who resort to planning lessons for students to "do the lesson" rather than "do science" [15]. Students' everyday experience is often ignored in the urgency to cram as much content within the limited curriculum time. Based on a sociocultural perspective, we hypothesize that students' everyday experience and knowledge can serve as valuable resources in science learning, and can be used as a primer to develop authentic and in-depth scientific understanding in schools. Research has argued for the use of everyday context in the learning of science as it helps improve students' enjoyment of learning [16, 17]. We concur with the notion that the role of everyday context in the learning of science will make science more manageable and approachable for young learners of science since "concepts in the scientific domain are explicitly defined, based on rules and universally coherent logic. Concepts in the everyday domain are implicit, based on experimental schema, and organized through locally coherent association" [16].

Purpose

The primary purpose of this study was to examine the classroom interactions and the learning outcomes of two groups of grade 3 students' learning about properties of materials. This is done through a detailed analysis of events that take place when a video of a scenario related to their everyday experience was presented to the students. This research is guided by the following research question: "What forms of interaction occur among grade 3 students when they work in groups to solve a science problem that is based on everyday experience?"

Integrating Everyday Context Using the Scenario-Based Inquiry Approach

In this section, we present the principles and rationale of "scenario-based inquiry"—a strategy that utilizes video playback technology to present an everyday issue that would require the students to use at least one scientific principle to either explain an issue or solve a problem that is embedded in the story presented in the video. Scenario-based inquiry is used as a means of incorporating everyday context in elementary science classrooms. The context presented in the video contains a situation that is familiar to the students, and each situation presented contains both information that is useful for the students to solve the problem and also information that is not required by the students. This condition creates the opportunity for the students to discuss and make decisions about which piece of information (evidence) is necessary and useful to help them solve the problem. The different information is incorporated into the scenario to allow for multiple perspectives to be formulated during group discussions. Chinn and Malhotra argued that opportunities for multiple perspectives are necessary to make science inquiry tasks authentic [18]. We termed the information that is not required by the students "noise." This "noise" can come in two forms: 1) that which is intrinsic within the scenario that is presented; and, 2) the diverse prior knowledge (often naïve conceptions) that the students bring into the discussion. This is fundamentally the basis for the need for students to talk and discuss the issue as a group so that all of their ideas are presented in a public forum, and thus scrutinized by their peers before it becomes legitimate knowledge. In authentic situations, scientists also bring with them a multitude of ideas and knowledge, some orthodox while others less so. It is also a negotiating process to legitimize knowledge.

Video playback technology is chosen as the medium of presentation of the scenarios as it allows motion, sounds, and colors to be integrated, unlike traditional stories that are predominantly textual. Video playback technology also allows the incorporation of "noise" within the scenario in the form of graphics, colors, sounds, and actions; these could possibly serve as distractions to the actual evidence on which the students should be focused. All of these components increase the authenticity of the learning experience. Distinct from problem-based learning, the scenario presented to the students focuses on the targeted application of scientific concepts in the context of the scenario presented, rather than on solving a problem that may have multiple solutions which may be unscientific and too complex for young learners of science.

The scenarios in the videos are crafted with the intention of harnessing students' everyday experience in developing scientific understandings. Components of these scenario-based videos are aimed at engaging the students with scientifically oriented questions in a serious, informed, and sustained manner (see Table 1). In addition, these videos provide situations in which the students take the scenarios as a personal or collective challenge which require creative responses to understand.

Table 1
Characteristics of Scenario-Based Videos

Categories	Characteristics
Story line	• Based on everyday experience or exposure to popular culture of students • Must have at least one scientific principle/concept embedded • Must have an issue or a scientific question for the students to discuss or solve scientifically • Embedded in the scenarios are "noise" which serves as distractions to the learning process or embedded information, and helps students solve problems or questions by allowing for multiple perspectives to be presented
Duration	Five to eight minutes
Language	English
Software	Windows Movie Maker® or iMovie®

Method—Participants

The school where the study was conducted is situated in a prestigious neighborhood with students generally coming from privileged family backgrounds. The participants in this study are two classes, each with forty students in grade 3 (both girls and boys) and their teachers. The two teachers are "Ling" and "Feng," both of whom have an average of five years of teaching experience.

Method—Context

The elementary science curriculum is designed around five themes: Diversity, Cycles, Systems, Interactions, and Energy [19]. The scenario-based video was incorporated as part of the unit of work on materials that is under the theme of Diversity. In this unit, the students are to learn about the diversity of non-living things, with the goal of achieving the following learning outcomes:

- to list the various types of materials and relate their properties to their uses (for example plastics, wood, ruler, metals);
- to compare materials based on their physical properties of hardness, strength, flexibility, and ability to float/sink in water; and,
- to show objectivity by using data and information to validate observations and explanations about the properties and uses of materials.

Method—Video Content

The scenario video is eight minutes long and is intended for grade 3 students. The scientific content of this video illustrates the properties of different materials, which include hardness, strength, flexibility, and the ability of materials to float or sink in water. The video is based on the popular children's fairy tale of Cinderella and her glass slipper. The key character in the story is a prince who broke the glass slipper he intended to present to the princess. As a result, he commissioned the shoemakers in his kingdom to design a new pair of shoes for his princess. The following materials were given to the shoemakers: 1) rubber bands; 2) plastic bags; 3) Styrofoam™; 4) metal rulers; 5) a piece of wood; 6) name cards; 7) ceramics; 8) cloth; 9) sponge; and 10) leather. The students were also given a worksheet with two parts: the first part required them to record their observations about the materials; and in the second part, they made decisions about the materials best suited to make the shoe. The two parts of the worksheet allowed students to engage in a decision-making process based on their observations, as well as on their everyday experience and prior knowledge.

Based on the context and content of the video, the task required students to evaluate the properties of the materials required to make a good pair of shoes for the princess. The scientific content they needed for this task consisted of the properties of the materials provided, as well as the design and construction of shoes. The everyday experience that they brought into the discussion included the following: 1) their exposure to different kinds of shoes; 2) observations about the durability of different parts of the shoes; and, 3) the different materials that they are exposed to in their everyday life. The task also required the students to communicate, negotiate, convince, and collaborate with their group members. Consequently, this task demanded that students put together knowledge gained from the video, their everyday experience, their prior scientific knowledge, and their science process skills.

Method—Data Collection and Analysis

This study used an interpretive qualitative case study method to illustrate the students' response to the use of scenario-based videos in learning science. The illustration is based on the two data sources of video recordings of classroom observation and students' worksheets. Video recordings of the lessons were transcribed, the transcriptions of the lesson were read, and then events during the lessons were coded see Appendix A). Data analysis was carried out by examining the classroom interaction between the following groups: 1) between students; 2) between students and materials; 3) between students and the teacher; and, 4) between students and scientific knowledge. Here, we examine the four forms of interaction in light of the kinds of knowledge and skills that the students practiced in solving the problems and learning the science. The students' worksheets were examined to index the scientific knowledge that they acquired through the lessons.

Results and Discussion

Analysis of the interactions and events in the classroom revealed the prominence of two forms of interactions and knowledge within the grade 3 science classroom: teacher-directed learning, and students' learning and interaction to solve the problem. In *teacher-directed learning*, we discuss how teacher-directed instruction fulfilled instructional goals so that the knowledge presented in textbooks can be transmitted, then we discuss how students engaged in group work accomplished the goal of task completion, and that the knowledge practiced is the knowledge of doing school science and making explicit the knowledge that resides in the minds of different individuals.

Further, it became evident that younger learners of science exhibited two difficulties: 1) they needed more scaffolding so that they could present their points of view within a group context to convince their peers; and, 2) they had an unclear idea of the boundary between scientific and everyday language when using everyday contexts as the starting point to learn scientific knowledge. The everyday contexts presented bring forth different types of knowledge usage among the students, and consequently shape the interactions in the classroom. Furthermore, our analysis of these interactions among the students suggest the following results: 1) they are concerned with task completion goals more than knowledge building given the limited curriculum time; 2) they need to be taught explicitly how to construct scientific knowledge from everyday knowledge when solving problems; and 3) they need to learn how to work collaboratively in a group setting to solve problems. These three points will be explained in the section "Students' Learning and Interaction to Solve Problems."

Teacher-Directed Learning

At the beginning of class time, Ling asked her class of thirty-seven students to push back their desks and sit on the cleared floor, facing the projector screen (see Figure 1). After orienting them about the day's agenda, she showed a video that presented a Cinderella-like story. In the story, the prince faced the problem of replacing the maiden's broken glass shoe and posed the question, "What materials should I use?" Excerpt 1 begins where the teacher paused the video to discuss what the students understood from what they had seen up to that point. Sequential line numbers have been assigned to the dialogue in the Excerpts, and are used to illustrate our observations.

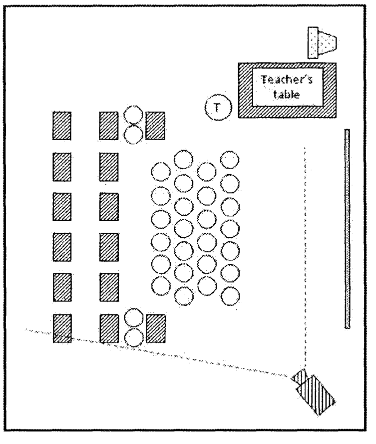

Figure 1. Arrangement of students with respect to the teacher and the projector screen; the video recorder was placed at the corner of the classroom.

After watching the video, Ling addressed the whole class, asking "What actually happened? What's the story all about?" These questions provided a springboard for discussing the science concept of properties of materials that was embedded in the story shown in the video. In conversations with the researchers prior to this class observation, Ling expressed that her aim was to take an inquiry teaching approach for the lesson and to use the story scenario as a platform for instruction. While constantly referring to the events in the Cinderella-like story, she systematically led the discussion with her questioning to elicit students' knowledge of the properties of materials (i.e., glass). She referred to the glass slipper and asked why it broke (15); and after showing another segment of the video, she directly presented the prince's question on the properties of glass (50) and connected the student's responses to a past discussion on this topic (58). While deploying these concept questions, she also helped the students recall particular story elements (3, 7, 9) and, before showing the next video segment, asked them to predict what would happen next (24).

The foregoing moments of instructional discourse in the teacher's instruction were interspersed with, or embedded within, regulative discourse [20]. She asked her students to wait to be called upon (15, 17), required non-verbal cues for attention (24), instructed the students to guess what would happen next (24), asked them to quiet down (45, 64) and watch the "movie" (47, 62), and directed them to recall a previous discussion to connect with the current topic (57). It is therefore quite evident that the interaction was to a large extent shaped by the combination of the teacher's purposes and the chosen instructional material. In some sense, the interaction was predetermined and the teacher exercised control over the task to be accomplished for that day. The institutional roles of being a *teacher* and a *student* were expressed in the strict turn-taking format of the interaction.

In Excerpt 1, pauses often appeared as thinking time in the classroom interaction. Every time the teacher addressed a question to the whole class, she paused for varying lengths of time (1, 15, 30, 48), although in most instances she took only a fraction of a second. According to Owocki and Goodman, the length of the pause has been said to be critical in engaging more students to participate in discussion [21]. However, in this excerpt the students were already quite engaged by the story in the video. Many were eager to answer the teacher's questions. At one point, Ling had to tell an eager student to wait (15) and she complained that too many of them were responding to her question at the same time (17). Moreover, pauses were used not only to give students time to think, but also to command the students' attention, to make sure they were listening and keeping up (9, 45, 63). Sometimes, they were used to put emphasis on a conjunction ("but") (9) or on an adverb ("anyway") (15), or to solicit tacit agreement with forthcoming words (22, line 2).

Excerpt 1
The Lovely Maiden's Glass Shoe Is Fragile

Turn	Speaker	
1	Ling (T):	OK, now, what actually happens? (.) If the sou::nd is not really that clear, but from what you have observed just now, what actually happens? What's the story all about? (0.2) Yes, Arlie?
2	Arlie:	The shoe is (brittle)
3	T:	The shoe is made from?
4	Ss:	Glass

5	T:	Gla:::ss. OK [(0.6) so↑]
6	John:	[Cinderella]
7	T:	Ok who is the lady in the picture, [(.) in the] video?
8	John:	[Cinderella]
9	T:	Ok maybe Cinderella, but (.) alright what name did the prince call the lovely maiden?
10	Ss:	((talking among themselves))
11	T:	S:::::o yes Bong?
12	Bong:	This (is East) Park ((pointing to the projector screen))
13	T:	Ok never mind↓ Yes. Oh, ok! Did you get to see them recording?
14	Bong:	No ((shaking his head))
15	T:	Ok. Wait ah ((addressing a student who has been calling out teacher's name while raising his hand)) Anyway (0.2) why do you think the slipper (0.4) broke?
16	Ss:	((speaking all at the same time))
17	T:	Too many of you are answering me. Ok, Grace.
18	Grace:	Glass is fragile.
19	T:	Glass is fragile. Very good!
20		((One student answers inaudibly))
21	T:	Sorry? ((looking at the student; student gives no response))
22	T:	Alright so because glass is fragile (.) and unfortunately alright the lovely maiden's shoe is made from glass, ok? (.) And the prince's itchy fingers (0.4) <alright held the> slippers and he was not careful↑ he let it go and it broke.
23	Ss:	((students talking loudly among themselves))
24	T:	So ((raising her hand)) what do you think happened next? Guess what happens (0.4) Dion?
25	Dion:	I think (.) he go[es to] buy another pair.
26	T:	He will buy another pair of shoes for the lovely maiden. Ok↑
27		((some students talking and some raising their hands))
28	T:	Wahidah?
29	Wahidah:	He will make
30	T:	He will make, [alright↑ (0.4)] He will make another pair of slippers. (.) Yusuf?
31	Bong:	[I know I know] ((raising his hand, vying to be called))
32	Yusuf:	He will just fix it.
33	T:	He will just fix it with what?
34	P:	Glue=
35	P:	=super [glue!]
36	T:	[Ok super glue↑]
37		((students talking animatedly among themselves))

38	Bong:	Teacher, I know! I know! The prince go take the other shoe and drop and buy another pair.
39	T:	Ok↓ now
40	Ss:	((everyone laughs))
41	T:	Let's (.) Let's see
42	P:	Shhhhh!
43	T:	Right, who gets it right, ok? Right now you know that.
44	P:	Shhhhh!
45	T:	↑Three Flex::ibility↓ (.) ((class name)) You want to listen very carefully right?
46	P:	Yes.
47	T:	Ok so let's go watch the movie. ((Teacher resumes the video and students all quietly face the projector screen. After a 28 s video segment, the teacher continues with the discussion.))
48	T:	Ok (1.0) so (.) eventually what happened? (.) The prince decided to↑=
49	P:	=Create!
50	T:	Create another pair of shoes, a:::nd (2.0) the prince is asking you, what's the properties of glass↓ What did you say just [now?]
51	Gie:	[Fragile.]
52	T:	Fragile↑
53	Gie:	Breaka[ble]
54	Brian:	[°hard°] ((uttered while hand raised))
55	T:	Ok fragile and breakable↑
56	Brian:	Hard (1.0) °hard° ((student put down his hand))
57	T:	°Hard°. Alth::ough, remember what I said yesterday, alth::ough (0.4) somebody says glass is hard, alright it is when you ok when it fell it will definitely↑=
58	P:	Break
59	T:	=be broken. Yes ((moves to the computer behind her desk to control video)) Are you ready?
60	P:	°Yes°
61	T:	Shall I continue the story?
62	Ss:	Yes, yes.
63	T:	So what am I supposed to expect you people (1.0) ok. (5.0) ok? Now. ((video plays again))

While students individually brought into the classroom various everyday knowledge, the teacher arbitrated which knowledge was relevant to the task at hand. When Ling posed the question, "What's the story all about?" at the onset of the whole class discussion, Arlie answered, "The shoe is brittle" (2). It was difficult to ascertain if Ling heard the last word of Arlie's utterance because it was made in quite a soft tone, or if she thought it was not the appropriate description for the shoe. However, we could still ask if the adjective *brittle* is an acceptable replacement for the word *glass* that Ling validated as the correct response (5) to her complete-the-sentence question, "The shoe is made from—?" (3) In other words, can a glass material be described as being *brittle*? Evidently, Ling did not take up this issue in the turns following Arlie's utterance.

John readily associated the story in the video to the well-known Disney classic *Cinderella.* The integration of this familiar children's narrative into the design of the video story was intended to activate the students' experiences outside school and reuse it as a learning platform in the classroom. John responded to this built-in video feature and must have felt confident about the narrative connection. He persisted in vying to participate in the discussion, uttering "Cinderella" more than once (6, 8) and stopping only when Ling acknowledged his expression. Ling's question, "Who is the lady in the picture?" might have been prompted by John's initial, eager nomination of the topic (6). Interestingly, Ling's response, "Ok, maybe Cinderella" (7), while acknowledging the possibility of John's identification of the heroine, also seemed to push that knowledge into the sidelines of the discussion. Instead, Ling asked the students to restrict identification of the "maiden" in terms of the video story context, asking them "Alright, what name did the prince call the lovely maiden?" No response to this question was expressed distinctly by any of the students.

Bong is an interesting case in that Ling perceived his responses as trivial and irrelevant, and thus deserving sanction. Noticing his restlessness (11), Ling called on Bong to share what it was he was eager to say. Bong said, "This is East Park" while pointing to the screen, implying that he knew the location where the video was shot. Ling dismissed outright the comment by saying, "Ok, never mind" (13) and in the same breath challenged Bong's confident claim that he *knows* the video setting: "Did you get to see them recording?" Bong confidently resurfaced later in the classroom exchanges (31-40) with another knowledge claim, this time in answer to Ling's prompt for them to anticipate in the forthcoming video segment playback what the prince might do now that the glass slipper is broken (22-24). Several turns after his first vigorous bid to recite (31), Bong decided to volunteer his idea, saying "The prince go take the other shoe and drop and buy another pair." It elicited laughter from the whole class, except Ling. She just managed a smile and then called attention from the whole class, which had burst into much animated talk.

In the preceding descriptions, we have seen how Ling acted as a gatekeeper of everyday knowledge that is taken up in the public space of the classroom. Her responses (or non-responses) to some of the students' ideas ascribed degrees of relevance to the instructional agenda at hand. Some of these ideas were appraised as irrelevant and could thus be ignored, while others were only slightly irrelevant and deserved some mention during the discussion. In contrast, student expressions that Ling deemed relevant to her instructional goal were warmly complimented. For the correct response Grace made to the question "Why do you think the slipper broke?" she received the first enthusiastic affirmation from Ling: "Glass is fragile. Very good!" (19) Ling repeated the property of glass as being *fragile* twice for the rest of this Excerpt (22, 52), perhaps as a way of reinforcing the school science content knowledge the students needed to learn. Similarly, the concept that glass is *breakable* was mentioned twice (55, 59), and must therefore be relevant and important for students to remember. In fact, when Brian nominated *hard* as a property of glass (54, 56) as if to correct an inaccurate answer, Ling was quick to refer to the previous day's discussion (57) as a source of prior knowledge. Presumably, in that discussion Ling qualified the idea that while glass is hard, it is not unbreakable. As *fragile* and *breakable* are descriptors of glass found in their textbook, Ling thus manoeuvred through the discussion intent on focusing student understanding on the properties of materials as formal scientific knowledge.

This teacher-led, whole-class discussion can be categorized as a formal type of institutional conversation [22]. It is labeled "formal" as it is more restricted than those found in casual conversations, and typically involves a large number of potential participants and an audience. The features of turns in formal exchanges are closely linked to the social roles of the participants in the institutional setting. The traditional teacher/student relationship is governed by a certain protocol for engagement: students should stay on-topic (11-15), wait to be called to recite (15), speak one at a time (16, 17), pay attention (24, 64), and listen carefully (45). Students are constrained to follow these rules and there are consequences if these are undermined: they will be ignored (15) or issued a stern warning (45). In contrast, teachers are expected to lead the discussion by asking, in this instance, all of the questions, and then evaluating student responses (19, 58). Unlike informal conversations between friends (i.e., between equals), this teaching episode exhibited asymmetry in the distribution of knowledge. The teacher constantly took an evaluative frame in her questioning, making sure that the students got their facts straight and had an accurate understanding of what was presented by the knowledge source (video). In this way, the teacher positioned herself as the arbiter of knowledge in the classroom. The question-and-answer format persisted throughout the exchange, soliciting mostly single-word or short-phrase answers from the students.

The two teachers, Ling and Feng, used the video in different ways in their respective classrooms. Unlike Ling in Excerpt 1, Feng played the entire video before commenting on it. Despite the difference in the way the information in the video was presented, the students in both classes were intrigued when the video was played, as evidenced by the students' unwavering gaze on the projector screen. Although Feng carried out structured questioning only once, Feng's checking and questioning of the students was similar in structure and function as that presented in Excerpt 1. In this teacher-directed segment, the students were reminded of the formal scientific knowledge that they had acquired earlier so that they could make use of this prior knowledge to make sense of the scenario presented in the video.

After the teacher-directed question-and-answer session, the students in both classes were subsequently divided into groups of four or five to work on the problem. The general mood of the class during the group work can be described as excited.

Students' Learning and Interaction to Solve Problems

In this section, we illustrate the following observations: 1) students' concern with the goal of task completion overwhelms their goal to build knowledge in science; 2) students demonstrate an inability to move from everyday experience and knowledge to scientific knowledge as intended as the learning outcomes of the lesson; and, 3) students lack the skill to collaboratively make decisions as a group within a classroom context. In Excerpt 2, Jill and her group members were deciding which material is most suited to make the shoe after they have examined all the materials given. Jill expressed the idea that plastic is not a suitable material for making shoes as it would break when a heavy load is added (1). She is likely to have applied her everyday experience and knowledge with using plastic bags to make this claim. After a pause of thirty seconds, she declared with excitement that Crocs™ shoes are made of rubber and hence, rubber is the best material to make their shoes. Her reference to Crocs™ shoes was evidence of her usage of decontextualised language, suggesting that she was able to think about ideas and apply knowledge that was outside her immediate environment [13]. The causal relationship that she made (1, 3) by relating the heaviness of an object to the possibility of breakage of the plastic bag suggests that she was bridging a real-life example to the idea of breakability. Crocs™ shoes are popular among many young children and teenagers in Singapore. Her suggestion was not immediately accepted by her group members, as Bill countered that rubber shoes are not comfortable (2). Bill was also using his everyday experience, knowledge, and personal preference to justify his claim. Jill was adamant that rubber is the choice material by telling Bill that rubber is unbreakable (as compared to plastic), and hence should be used to make the shoe (3). Jill's criterion for selecting a material to make shoes is one of strength, something that would not break under weight. Without waiting for collective agreement, Jill proceeded to make changes in the group's worksheet and handed the worksheet to the teacher. Bill and the other group members did not protest or provide counterarguments.

Excerpt 2

Crocs™ Shoes

Turn	Speaker	
1	Jill:	Plastic, if you put too heavy, it will break. (30s) Crocs shoes is rubber. Crocs. No, rubber is best.
2	Bill:	It is not comfortable.
3	Jill:	No, rubber is unbreakable. Rubber is fine.

[Jill proceeded to ask the recorder in the group to change the group decision on the worksheet and submitted it to the teacher.]

Excerpt 2 demonstrated how the students' everyday knowledge, experience, and personal preferences influenced their decision making and discussion during the group work. The difference in opinion between Jill and Bill suggests that everyday experience and knowledge varies according to the individual, and is likely to be found within their personal realm of experience. Using the variety of everyday experience to make a collective decision to solve a problem and understand the properties of material would require the students to have more in-depth discussions, and understand the intrinsic properties of the materials rather than rely on their personal preferences. The short negotiation between Jill and Bill before a final decision was made could possibly suggest that the students are not familiar with using the skills of negotiation within a group setting and/or they are more concerned with completing the task at hand rather than building collective knowledge of materials suitable to make shoes.

Excerpt 3 illustrates yet another example of how the students were keen on completing the task, but were not mature enough and sufficiently competent to negotiate their ideas within the group, so that they were able to complete the task accurately and within the time frame provided. The students in this group were examining the properties of metal to determine if it was an appropriate material to make the shoe. Paul examined the metal ruler and declared that it was unbendable. Daniel, the scribe in the group, examined the metal ruler to confirm what he needed to record in the group worksheet. Paul, who was standing behind Daniel, added that one of the properties of metal is that it is not able to absorb water (2). He got impatient and repeated the fact that metal cannot absorb water. He directed his frustration to his three other team members whom he perceived to be clowning around and not contributing to the completion of the task. He subsequently moved away from the group. After Paul moved away, Fred added that the metal ruler is a solid (3), and Noel approached the teacher to ask if the metal ruler is fragile (4).

Excerpt 3
Unbendable

Turn	Speaker	
[Holding a metal ruler]		
1	Paul:	It's unbendable.
[Daniel, who is recording, starts to pick up the object and tries to bend it before recording the observation in the group worksheet]		
2	Paul:	It cannot absorb water. (.5) I ALREADY said it cannot absorb water. [speaking to the other three members of the group who are playing with the ruler] Everything anyhow do, anyhow do, then how to get correct huh?
[Paul moves away from the group]		
3	Fred:	Solid, made of solid.
4	Noel:	[asking the teacher] Is this fragile?

In Excerpt 3, the students demonstrated uncertainty as to how they could communicate and interact with each other within their groups in order to collectively negotiate an agreed upon answer on the properties of metal. With different experiences and expectations about what group work and collective decisions are, it does not help the rest of the group members who are not ready or who are uncertain about the properties to learn about them. This particular situation was exacerbated by having a frustrated group member (Paul) who was keen to complete the task, obviously ahead, and thought he was right. The different levels of knowledge (both about group work as well as scientific knowledge) among the group members can be seen (4) when Noel actually had to turn to the teacher to ask whether metal is fragile; this indicated a lack of understanding of the word "fragile" or the properties of metal.

To further illustrate the complexity of using everyday scenarios as a starting point for grade 3 students to learn the properties of materials, Excerpt 4 shows another group of students trying to determine the property of wood so that they can determine if it is suitable for making shoes. Seth examined the block of wood given and commented that wood comes from trees and that the block of wood is hard (1). Sabrina, another member of the group, added that it is also light. Keith sought clarification (3) about the relationship between wood and trees, but this was not built on by his team members. Seth added that the wood is strong. Mike noticed that every time they recorded that something was hard, they also commented that it was strong (5), and he is not convinced by the relationship. Indeed, during the group discussion, it was evident that many students associated hardness with strength.

Excerpt 4

Strong and Hard

Turn	Speaker	
[Holding a block of wood]		
1	Seth:	Wood is made up of trees. It is hard.
2	Sabrina:	And light.
3	Keith:	This material is wood? (.2) what made up of trees?
4	Seth:	It is strong.
5	Mike:	Every time you write it is strong, it is hard. Crazy ah, you? [Colloquial way of speech meaning: "Are you crazy?"]

In this Excerpt, we observe how Seth, Sabrina, and Keith built on each others' ideas relating to the properties of wood (1-4). This was done through clarification (3) and stating their ideas. Mike played the role of a critic (5) by commenting that he thought it was wrong that the property of strength is almost always related to hardness. In fact, he thought that his team members were crazy to think that way. In Excerpt 4, the rest of the group eventually ignored Mike's input which is indicative that Mike was unsuccessful in convincing his group members of his point. We argue here that this is indicative of the students' uncertainty with their knowledge of the properties "strong" and "hard," and how they should be collaborating and communicating this with the members in their groups.

All the students submitted their completed worksheets to Ling, and their work was assessed based on accurate usage of scientific terms like strength and flexibility, and on the way their arguments were presented. From the completed worksheets, Ling noticed that some students used "comfortable" and "ticklish" as properties of a material. These descriptions are common everyday expressions of materials and their personal preferences, and are not part of the stable scientific language used formally to describe the intrinsic properties of materials. This indicated that some students were unclear on how to describe the properties of materials scientifically, and hence provided descriptions that they were familiar with from their everyday experience. As Ling commented, this form of description is not aligned with the instruction objectives spelt out in the syllabus.

The difficulties of these grade 3 students to describe the intrinsic properties of the materials and then use them for making shoes suggest that for the grade 3 students to recast their everyday experience, knowledge, and preferences to a more stable and acceptable scientific knowledge and language, they needed more explicit instruction and guidance, besides being presented with a scenario within an everyday context to solve a problem. Further, the complexity of the task given suggested that younger learners of science also need more scaffolding in order to be able to distill the multiple perspectives and then present them to their peers in a convincing manner. From Excerpts 1-4, it is noted that, while these students did support their claims with evidence (for example, Excerpt 2, lines 1 and 3), that largely comes from their everyday experience. This is a good start for more in-depth discussion which will likely happen only with more time and teacher guidance. Ling decided that an extension of the lesson by using the students' answers as building blocks to shift the students' understanding of properties of materials from an everyday perspective to a scientific perspective is necessary.

Conclusion

In this article, we set out to answer the research question, "What forms of interaction occur among grade 3 students when they work in groups to solve a science problem that is based on everyday experience?" Two key forms of interaction were observed: 1) teachers used questioning to focus students' attention and achieve instructional goals; and, 2) task completion goals took priority when the students worked in groups. There is little evidence of knowledge building goals being achieved in the classrooms observed since it requires a longer period of time to achieve. Our findings in this study concurred with Bereiter's hypothesis that knowledge building goals are likely to be the most important but least often observed in classrooms as they tended to be difficult to achieve as well as to measure [12]. He argued that task completion goals and instructional goals are likely to be most evident and observable since they are short term and more easily achieved.

Analysis of group discussions among the students showed that more needs to be done to prepare the grade 3 students to engage in open-ended problem solving in science, use dialogue to recast their everyday experience and knowledge to more rule-based scientific knowledge, and use tools like argumentation for collaborative decision making. As shown in Excerpts 2, 3 and 4, the students were unable to sustain meaningful and focussed discussions so that they could collectively agree upon the answer to their task. Their discussions were abrupt (possibly due to the constraints of curriculum time) and were often based on their personal preferences as well as emotions. While research has shown that incorporating everyday contexts in the learning of science allows for better understanding and also increased motivation in learning, the interactions observed in the grade 3 classrooms suggest that more structure and guidance are needed for students to engage in meaningful discussions of science that use everyday context as starting points [6, 7]. The movement between everyday experience/knowledge to scientific understanding is not unidirectional, but rather dialectical, and this needs to be made explicit to the students, especially younger learners [23]. However, despite the hurdles and tensions illustrated, the grade 3 students showed that they were able to engage in both contextualised and decontextualised talk to link the present and concrete (what is presented to them) to past, future, and abstract ideas. This is an important aspect in the learning of scientific knowledge as well as science literacy. Further, students' problem solving in everyday contexts helped them reflect on and bring their own experiences to the conversation, so it made their discussions richer and more contextualized. While it was evident that they lacked communication skills, the opportunity to explore with others in more collaborative ways is a good opportunity for them to learn communication skills.

As the call for curricula to shift toward context-based instruction to provide meaningful learning in science and to produce scientifically literate citizens is addressed, the findings from this research serve as a reminder that attention needs to be paid to pedagogical structures, and that readiness of the students needs to be examined before the intended goals of context-based science curricula can be fulfilled [3, 5]. There are many issues that young learners of science need to grapple with before the learning of science can be a fruitful and meaningful experience for them. As shown in Excerpts 2, 3 and 4, the students in this study spent the bulk of their time trying to figure out how they could work with their group members to complete the task. They had to convince group members to listen to their ideas and also struggled to make themselves understood. We suggest that, for young learners of science, the development of certain skills (e.g., working in a group, ways to put forth argumentation, etc.) has to be incorporated into the context-based science curriculum and be taught explicitly before the students can work in groups effectively.

Starting with everyday experience as a context for learning science offers realistic and authentic perspectives that allow students to bring in their direct experience, making classroom discussions richer. It can, however, be seen from our research that everyday experience can be either a hindrance to learning science or it can serve as a catalyst to speed up acceptance and understanding of abstract scientific concepts. As students with different experience come to school, sharing and merging their largely local experience to become scientific knowledge that is universal involves a process of negotiation, collaboration, argumentation, and understanding [16]. These processes are all part of the scientific inquiry process to which learners of science need to be acculturated, and the integration of everyday experience not only provides a platform, but serves as a primer to facilitate discussions, conversations, and argumentation among students.

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Appendix A
Key to Excerpt Dialogue Codes

[	Point of overlap onset
]	Point of overlap termination
=	(a) Turn continues below, at the next identical symbol (b) If inserted at the end of one speaker's turn and at the beginning of the next speaker's adjacent turn, indicates that there is no gap at all between the two turns (c) Indicates that there is no interval between adjacent utterances
(3.2)	Interval between utterances (in seconds)
(.)	Very short untimed pause
word	Speaker emphasis
e:r the:::	Lengthening of the preceding sound
?	Rising intonation, not necessarily a question
!	Animated or emphatic tone
,	Low-rising intonation, suggesting continuation
.	Falling (final) intonation
° °	Utterances between degree signs are noticeably quieter than surrounding talk
↑ ↓	Marked shifts into higher or lower pitch in the utterance following the arrow
< >	Talk surrounded by angle brackets is produced slowly and deliberately (typical of teachers modeling forms)
(guess)	Indicates the transcriber's doubt about a word
.hh	Speaker in breath
(( ))	A description enclosed in a double bracket indicates non-verbal activity. Alternatively, double brackets may enclose the transcriber's comments on contextual or other features.
T:	Teacher
P:	Unidentified student
Ss:	Several or all students simultaneously