

Effective Communication for Strategic Sustainable Development Education: The Hook and Ladder Technique

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Abstract:

In order to reach sustainability, a greater capacity to facilitate the implementation of the principles on which sustainability is founded is required. Effective methods of communicating sustainability will be necessary. Although there is a notable range of successful methods, opportunities to expand that range always remain and are worthy of exploration. This study pursues capacity building by testing a communication method variation that uses questions, audience participation, and metaphors intended to make the subject matter more easily understood and more permanently retained. An initial trial of the method was attempted with several groups of senior secondary students who were introduced to the ideas of sustainability during group and individual sessions. The students were surveyed before, during and after the sessions to measure their understanding and acceptance of sustainability concepts and principles. Of the students surveyed, all showed greater knowledge after instructional sessions using this technique. Results suggest that using a consciously dynamic and adaptive approach to choice of metaphors and questions can make the subject of sustainability easier to understand and remember.

Key Words: Communication, Educational Intervention, Metaphor, Remediation, Strategic Sustainable Development, Context

1 Executive Summary

1.1 Background

In the simplest model of the transmission of knowledge, one encounters two problems: encoding and decoding. Encoding involves a sender putting thoughts and knowledge into a transmittable form of expression, usually spoken or written words. Decoding entails a receiver taking in this symbolic information and then interpreting it. Though this process seems quite straightforward, not infrequently those who attempt to transmit knowledge feel their efforts meet with less than ideal outcomes and, more importantly, those intended to receive the knowledge fail to receive the maximum benefit from it. Thus there is a need to constantly refine the tools communicators use in the pursuit of more effective transmission and more accurate interpretation of knowledge. Many tried and true methods have been developed, of course, but there unfortunately always remain instances of failure, as well as opportunities to improve the effectiveness of communication. With this in view, we performed evaluative surveys to assess the potential for the “hook and ladder” method specifically as a tool for introducing younger students to the concepts and principles of sustainable development. This method was developed based on The Natural Step organization's "5 level framework" and adaptation of the Deming cycle concept into an educational context in which a circular looping back approach, from planning through doing, acting and, finally, checking before starting again with planning, was applied. Here, the emphasis was directed toward acting on feedback and flexibly adapting the teaching approach continuously even while the teaching process was in motion.

1.2 Methodology

This study could most easily be split into three portions of work. Those components are shown in the figure below, which is a graphical model of this report’s three phases of work. In the first stage, we formulated research questions. To address these questions, a literature review was conducted. This information was coupled with findings in the teacher skills survey and later enacted through a series of preliminary pilot lessons through group and individual sessions with Ehrensvärdska Gymnasiet of Karlskrona students from that school's International Baccalaureate (IB) program. From

these experiences we assembled our hypotheses, which were tested in a series of lessons through group sessions with students from the same school's Technology Information Media Environment (TIME) program. Finally, the findings from the TIME sessions were assessed for the final report.

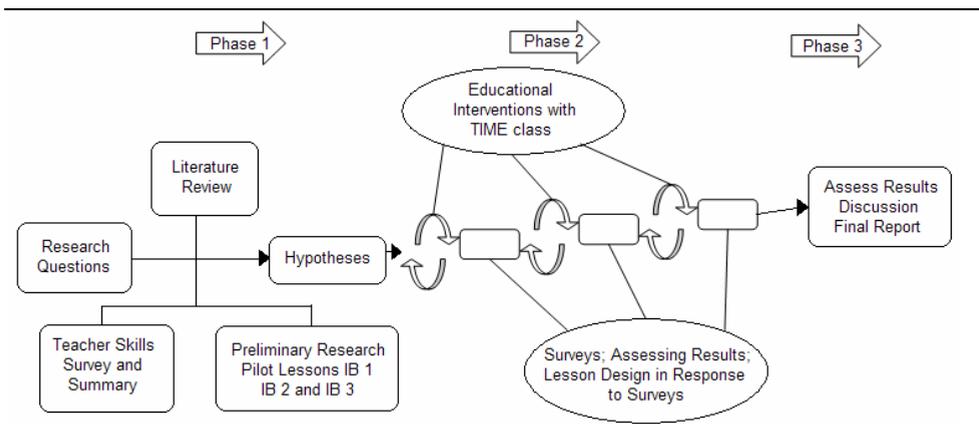


Diagram of project structure.

1.2.1 Phase One:

Research Questions: We isolated a problem concerning sustainability and proffered possible solutions to deal with the problem and its related questions.

Literature Review: We consulted journals, texts, and other relevant information in the fields of literacy, education, and communication.

Teacher Survey and Summary: We surveyed 14 teachers from the USA, Sweden and Pakistan to create a general framework for teacher skills and behaviors used during the design and execution of a lesson.

Preliminary Piloting of Lessons: A series of trial lessons was given to three groups of students during which the method used, which we call the hook and ladder method, was refined and content and lesson plans were revised.

Hypotheses: Informed by the earlier portions of Phase One, we proposed three hypotheses concerning methods of communicating the ideas of Strategic Sustainable Development.

1.2.2 Phase Two:

Lessons with TIME class: The main part of the project's study involved the TIME class, which is instructed in the library at Blekinge Institute of Technology. The hook and ladder technique was used during these sessions and comprehension and gains in knowledge were gauged through a series of surveys.

1.2.3 Phase Three:

Analysis: The survey results from the TIME sessions were analyzed to verify the accuracy of the study's hypotheses. Results were checked to measure what change in knowledge took place between the beginning and end of the lessons. As well, linguistic patterns were observed from the results that suggested some effectiveness to the techniques used.

1.3 Results

Survey responses from the TIME sessions were compiled and studied. Data were comprised of student answers. There was also a compilation of questions used during the second TIME session. This information was supplemented by an interview with the individual student group. Interpretation of the data set informed the study's final results.

1.4 Discussion

The result of the survey indicated that choice of metaphors have a strong effect on how students digest information. The use of examples, metaphors, analogies and dynamic remediation has the capacity to shape the understanding students have of an alien topic. Thus, the hook and ladder communication method can be interpreted as beneficial to someone trying

to understand SSD, and consequently to someone attempting to teach these concepts.

Results also indicated that the use of frequent questioning had myriad benefits. From the interview information, we derived that the use of questions had the effect of keeping students involved in the process of transferring knowledge and making meaning of the topic of SSD. The use of questions was also seen as valuable through anecdotal evidence taken from the TIME sessions. Teachers involved with this study commented on the importance of using questions during a presentation or lesson. As well, interview information pointed to the fact that the use of questions had a cognitive benefit as students were not able to sit passively during a lesson, but rather had to think actively.

Building on the work of this study, some suggestions for continuing this work include:

- a. surveys utilizing quantitative methods of measuring and interpreting results
- b. study of a larger number of cases that encompasses a broader cross section of the student population including both younger and older cohorts
- c. case studies based on longer session times than two 1 ½ hour sessions
- d. having an extended session during which there is the opportunity for students to be tested for knowledge and application of the SSD content taught
- e. allowing teachers more time to hone their skills in applying the hook and ladder method, and allowing the development of greater student involvement with the topic.

1.5 Conclusion

This study, while not exhaustive at any level, produced some interesting findings which may be of use for people hoping to present information for the purpose of building capacity for SSD. First, repetition in the form of remediations and metaphors is a useful part of facilitating learning the principles of sustainability. Second, it is useful to listen to the audience and develop dialog with it to engage it as an active part of the process rather

than a passive receptor of it. Third, go to the audience in the sense of finding the emotional and intellectual space in which its members are comfortable and will accept communication. Fourth, develop the skills of presenters to apply a method that demands a high level of preparation, sensitivity and the ability to adapt metaphors on the fly. Thus, hopefully, the hook and ladder method can be developed into an additional effective tool to be used in the creation of a fully sustainable society, a tool to help make this subject both meaningful and less daunting to all involved.

1.6 Further Research Questions

Does retention of SSD content translate into action?

Does comprehension of SSD content remain without constant revisiting?

Can apathy and anomie be overcome through educational intervention?

How much more effective is this method compared to traditional lecture styles, if at all?

How can SSD content infiltrate a school's curriculum?

1.7 Definition of Key Terms

Action research: a process of improving practice by taking practical action and inquiring into it in a continuous practice and research cycle.

Context: The frame of reference in which a lesson or intervention takes place. Context, in this study, entailed establishing the connotations of the important terms in a lesson. We attempted to take sustainability out of its traditional context and put it in a context according to the metaphors and remediations used in the lessons.

Delta: Usually the difference, delta in this case refers to the change in knowledge between the beginning of a lesson and the end of a lesson. Also, this delta can refer to the significant changes over the course of several lessons. It is the difference in knowledge as a result of the study's educational interventions/lessons.

Divergence: During an intervention/lesson, moments when a teacher decides to alter the course of instruction to comply with students' interests. A divergence can be as small as asking more questions to reinforce a point to using a new remediation to teach a concept, but it could also go as far as choosing a new topic entirely if students are uninterested with the present sustainability topic.

Educational Intervention/Lesson: In this study, the planned interactions with students for the purpose of teaching the ideas of SSD.

Lens: Tied the previous ideas of metaphor and remediation, in this study, a lens is thought organizing device used to reduce the scope of comprehension from the whole of sustainability content to only a smaller area. In this study, the lens can be a metaphor, a remediation, an analogy, a symbol, a simile, etc. It is the device by which a teacher attempts to teach sustainability, and through which the students have a window for investigating the topic. From this entry point, students can then hope to explore the topic further.

Loops: Teaching cycles in which the effectiveness of presentation and metaphor are constantly evaluated and then remediated before returning to an earlier point. Looping entails meeting the students at a level where they are comfortable before moving them forward. This procedure is repeated numerous times within a lesson, as well as between lessons, to ensure student acceptance of the material as teachers adapt to and utilize the students' prior knowledge.

Meaning-making: For the purpose of this study, the process by which people assign significance to an idea. Looking at present reality, many of the terms tied to SSD and sustainability are not so esoteric and may have been used by people commonly, but a deeper understanding of the significance and meaning of these words is not there. This study attempts to investigate effective ways of making the terms of sustainability significant and meaningful.

Metaphor: A direct comparison between two, superficially unlike things for the purpose of deeper understanding and appreciation of one or both things. In this case, the meaning of the word, metaphor, is stretched, as such comparisons used in this study, in the form of analogy, simile, etc., are still

considered metaphors. Metaphor is the common term used in this study to denote a comparison of unlike things, for the purpose of explaining a difficult topic.

Remediation: The casting of an idea into a different form, or simply, if communication fails or cannot be completed using one medium, it is the reoffering of it using another. In this study, a remediation is used when the same content is taught through a variety of media and forms. The remediation will be most effective when chosen from a media set with which the particular audience is familiar.

Strategic Sustainable Development (SSD): Combining the Brundtland definition – meeting the needs of the present without compromising the future (World Commission 1987, 43) – with The Natural Step sustainability principles (Robert, et al 2004), SSD is development that, from a systems approach, utilizes tools such as "backcasting from sustainability principles" to identify the steps necessary to reach that state. (Robert et al. 2002; Tom Slick Professorship of World Peace n.d.)

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1 Introduction

While the concepts and information of Strategic Sustainable Development (SSD) are meeting with open minds, the speed with which this is occurring is still alarmingly slow. Looking at the present reality, vast majorities still adhere to an assumption which effectively holds the world and its natural systems to be in no imminent danger, a belief that has been illustrated through the "cylinder paradigm." This metaphor describes the commonly held world view as being one in which outcomes are a constrained give and take between social and environmental cost and benefit, and that costs are basically always in balance, even if not always ideal (Robert et al. 2004, 6-11). Legislation and general habits seem congruent with this. Given the obvious problem with the cylinder paradigm, where does one find strategic points of intervention? It seems that public school education can be an effective point of intervention, but the question to research remains: How does one teach this subject, Strategic Sustainable Development, in a way that is effective and meaningful?

There is considerable support for spreading these ideas e.g. the UNESCO Decade of Education for Sustainable Development, 2005-2014, and cooperating national programs around the world, or various university or nonprofit institutes of sustainable education such as ones at Daugavpils University in Latvia, the Centre for Alternative Technology in Wales or the Cloud Institute for Sustainability Education in New York City. But how does one ensure that the message is offered effectively? How does one transmit the information of SSD in a way that will be understood? Traditional methods of presentation usually see one person delivering information using the method of "telling." The presentation of concepts is executed in a series of statements where the audience is most often passive, simply receiving information in a unilateral fashion. If a person is expected to learn a concept in a way that will also bring about retention and greater capacity, that person can benefit by being involved in the conversation. The lecture style of presentation, with one person dictating and many listening passively, can sometimes be a less effective method, and for some educators at least, may not be the tool that best suits their need.

The endorsement and actual use of metaphors to explain the concepts of SSD seems to be pervasive. Reference, to images such as the rules of the game, playing baseball, and looking at the tree's trunk rather than its leaves (Robert et al. 2004, 19), provides a potentially understandable metaphorical

framework around this complex subject – understandable, at least, after the metaphors themselves have been explained to show how they are comparable to actual conditions. This study develops the concept of using metaphors for the teaching and presentation of SSD through techniques of remediating the subject matter of SSD into terms and metaphors that audiences will more readily find compelling and understandable. Great emphasis is placed on a method of presentation that involves constant questioning of the audience to ensure their comprehension and involvement in the meaning making process of learning. It is through involvement in this process that audiences will come to “own” the newly delivered information and feel invested in it. This method attempts to bring about greater comprehension and a more effective, rather than efficient, transferal of information.

Through a short series of lessons, this study attempted to isolate some key aspects of an iterative loop model of educating. The lessons attempted to maximize communication by engaging the prior knowledge of students, and using commonly understood concepts and images as metaphors for explaining SSD. Questions were the centerpiece of this method where students were asked questions to ensure their involvement in a lesson. Then, the students were asked to piece together their prior knowledge with SSD concepts. These higher order questions helped the students to make connections between their prior knowledge and the SSD concepts. Surveys were used before and after the lessons to gauge what the students may have gained as a result of the lessons.

1.1 Research Question

There are many individuals who are potentially excited by and capable of leading change towards sustainability. The stumbling block of communication remains, though. If those willing individuals are, or feel, incapable of communicating their ideas to constituents, stakeholders, potential investors, etc., the rate of adoption of the ideas of SSD could be slowed unnecessarily.

Two very apt metaphors are regularly used in sustainability education; that of the cylinder illusion and that of the funnel reality. The first is suggestive of the commonly held model of reality, "where isolated social and ecological impacts come and go in an ad hoc series of events, without

creating large-scale or cumulative impacts," (Robert et al. 2004, 21). The second, the reality of the funnel, is very illustrative of two powerful trend lines and what will be conceptually necessary to achieve sustainability. Figure 1.1 shows this funnel metaphor and illustrates how the trend lines of upward demand for resources and downward capacities to support that demand are converging with the obvious end result unless these trend lines can be made to level off parallel to each other and leaving some space for a margin of human action.

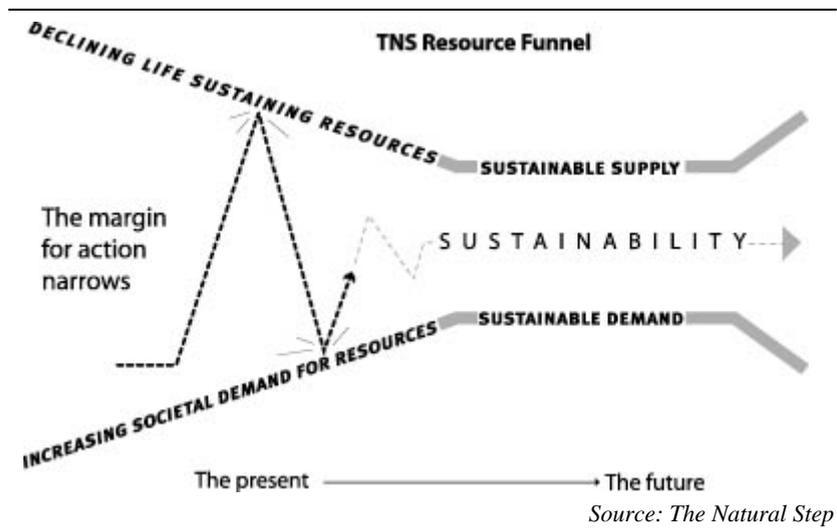


Figure 1.1. The SSD funnel metaphor

While acknowledging past achievements using the basic metaphors of SSD – particularly the above described cylinder and funnel paradigms that illustrate the current converging trend lines of increasing human consumption and waste concentration versus the decreasing integrity of natural resources (Robert et al. 2004, 6-11) – we nevertheless hoped to further expand the capacity to move people away from the cylinder illusion to an understanding of the reality of the funnel by putting forward the question:

How does one make the sometimes difficult subject of Strategic Sustainable Development more accessible and meaningful for students?

2 Methodology

This section outlines the methods of this study, from the earliest phases where the research questions were formulated to the final discussion and report. The first portions of the study occurred mostly in the form of research, literature review, but eventually graduated to pilot lessons with three groups to refine techniques and finalize hypotheses. Finally, the techniques were tested during the Technology Information Media Environment (TIME) program of the Ehrensvärdska Gymnasiet of Karlskrona and the results were analyzed and summarized in the final report. Figure 2.1 shows the study's structure graphically, with three phases starting with basic literature review and development of study methods, to the implementation of the study itself and finally an assessment of what the study revealed.

The first phase of this study can be broken into five sections:

1. Research Question
2. Literature Review
3. Teacher Survey and Summary
4. Piloting of Lessons with trial groups and on the individual level.
5. Hypotheses

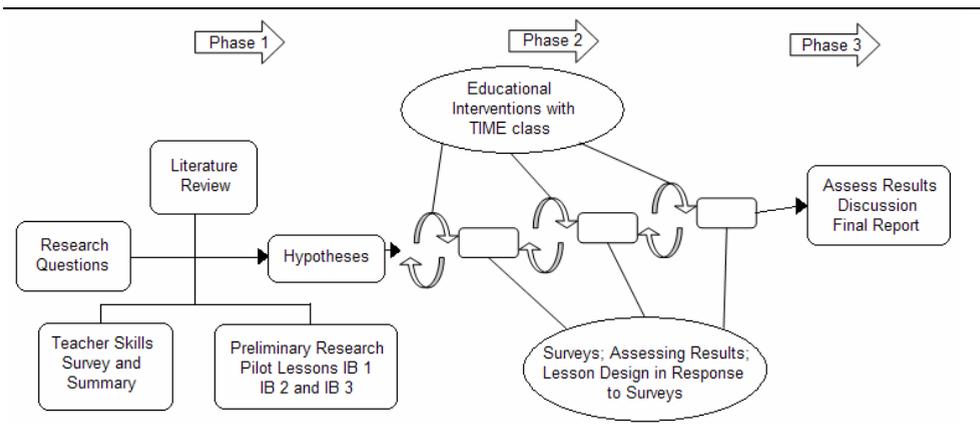


Figure 2.1. Diagram of project structure.

2.1 Literature Review

When dealing with a complex topic, people tend to shape their understanding using terms with which they are familiar. They make sense out of a complex situation by using past experience as a reference point. This was illustrated by a study of young lesbian students who “constructed their identities” or made meaning by using “formulaic” perhaps even stereotypical “meaning-making structures.” Their experiential “context strongly influenced the content of their identity” (Abes and Jones 2004). Thus, there is a strong connection between “the importance of creating contexts that foster the meaning-making capacity” (Abes and Jones 2004, 627) and the way presenters plan to deliver SSD information.

This assertion is further supported by literature explicitly designed for pedagogical purposes. For example, in work on literacy education, research has described a “meaning-making cycle,” where a teacher “establishes a context for reading a selected text” and uses a “question or prompt that will guide the students’ reading” (Annenberg n.d.). Both of these cases dealt with people trying to make meaning from previously unseen landscapes, something akin to the information and concepts of SSD. Similarly, an agent of change asks people to make new meaning by leaving their “comfort zones,” the information set with which they are most comfortable. Indeed, for SSD, the agent asks that people make the substantial shift from the cylinder paradigm to the funnel paradigm. This transition can be assisted if the agent acts to minimize the discomfort of the other person. A physical example was given in these terms: “If...the boss wants to reach out to the subordinate – to have a conversation on the other’s terms – he or she might well consider traveling to the other’s office” (McCaskey 1999, 129). By moving to where the subordinate feels most comfortable, the boss minimizes the subordinate's discomfort and helps to create a non-hierarchical atmosphere. Along the same lines, an agent who wants to teach SSD concepts can move to where the student is more comfortable. This move need not be a physical one. Through remediation of SSD concepts, the agent can create a psychological environment where the student feels less discomfort and greater capacity to accept new meanings.

Similarly, in a study of post-war Bosnia, the importance of trust for communication was described as, “every social interaction [...] is based on an implicit assumption of trust in others” (Botan and Taylor 2005, 687). Thus, if one is to communicate the ideas of SSD to students, one must gain

their trust, and in order to gain their trust and lead them to greater understandings it is an agent's responsibility to move to them and out of his own comfort zone of contexts, ways of communicating, and familiar metaphors. A successful agent will skillfully and effectively move to the audience, seeking a language they will understand.

Remediation is one way to accomplish movement toward an audience that is not comfortable with, or responding to, an initial set of metaphors. Besides creating a new context to make the unfamiliar less threatening, remediation will likely make a richer context in which to understand other metaphors such as the funnel paradigm and similar SSD concepts. In literature on the functioning of organizations, the use of metaphor has become commonplace for explaining difficult ideas as it, “is through this subtle, yet powerful linguistic device – metaphor – that we understand our experiences, and through this understanding, that we reason” (Hart 2003). Still, some will point out that metaphors can at times have the effect of limiting a person’s comprehension of the world, as they do act as a lens: “they orient us in specific directions – and due to their subtle influences, we proceed in those directions, giving little attention to other possible paths” (Hart 2003). Indeed, there is a danger that a metaphor may act as a blinder to other avenues for making meaning, but like the case with the lesbian students making meaning of their new identities, such metaphors and contextual clues help by providing meaning-making structures to make the untamed world more comprehensible. It is in finding new ways to explain the subject of SSD that capacity building will be facilitated. “The challenge is to become skilled in the art of using metaphor to find fresh ways of seeing, understanding, and shaping the situations that we want to organize and manage,” (Hart 2003). Thus, this method will center on the use of metaphors and metaphor remediation to explain SSD, to reference common contexts and experiences, and questioning to teach the ideas of SSD.

Finally, in order to communicate, the literature suggests that one must first be an effective listener. If one has little awareness of the audience and is too rapt in his own thoughts, he can have little hope of connecting with students. The two parties become like Brownian particles, unaware of each other, connecting and colliding only randomly. Addressing the topic of listening, it has been reported that average rates of human speech occur at around 125 words a minute, while human mental capacities allow people to process information at a much higher rate. The result of this discrepancy is the wandering attention of the listener (Nichols and Stevens 1999, 6). To

counteract this tendency, one must keep the listener involved in the conversation, and thus rather than building SSD education on statements of information or possibly formulaic repetition of metaphors that have been successful in other venues, one should facilitate meaning making through effective remediation, and, of equal importance, questioning to keep students actively thinking about the subject and to help them feel as if they are discovering the information rather than having it forced upon them.

Many of these observations concerning communication were treated by Lee in "Effective Communication: Collaborative Practices for Educators" (Lee 1999, 7). She advocated effective collegial communication and created a structure for doing so by contrasting the way people usually communicate (ineffectively when addressing colleagues) with the way teachers communicate effectively with their students. In her work, she outlined six components of communicating in the classroom:

1. Developing expectations
2. Preparing ahead
3. Understanding perspectives
4. Asking questions
5. Listening
6. Speaking Clearly

From this list, we developed a basic understanding for what a teacher does to facilitate communication, and later this list was incorporated into the Framework of Teacher Skills and Behaviors which was created following a survey of several teachers. The survey, results and the framework description can be found later in section 2.2.

Besides these resources on communication, the hook and ladder method was informed by techniques prevalent in the business community, especially in situations involving planning in complex situations. Also, seeking approaches for solving complex problems, we decided to visualize our research problem within an organizational tool favoured by a leading sustainability oriented NGO, The Natural Step (TNS). This tool is a five-level framework, described in Robert¹ (Robert et al. 2006, 28-29). The five steps of this planning framework are: the system level; the success level; the strategic level; the action level; and the tool level. A description of our

¹ Robert was prime founder of TNS, 1989.

use of these levels follows. By placing the salient components of the situation within this framework we expected to derive a number of viable strategies that would result in a more integrated and holistic systems perspective.

Level 1: The Systems Level:

At this level of operation, we listed the following aspects as being integral to the system:

1. Teachers who facilitate the interaction between students and SSD content
2. Students towards whom these interventions are aimed with the immediate intent of effecting long-term retention of SSD concepts
3. The classroom environment, the setting in which the class occurs as well as the atmosphere that the teacher creates

Level 2: The Success Level:

Here a favourable outcome was imagined. We defined this as increased effectiveness of communication which leads to the increased access to and understanding of the taught subject matter. This should result in a general increase in student awareness of the material and, in the case of sustainability issues, should yield results in consonance with the four basic sustainability principles, also known as TNS system conditions (Robert 2004, xxiii-xxiv), and shown in figure 2.2. These principles call for preventing human generated concentrations of substances and degradation of means so that capacity to meet needs is not undermined. Accordingly, we imagined a success that would lead toward a more sustainable social fabric due to the improved breadth and depth of understanding of these principles that students have acquired during their education. The planned lessons addressed the sustainability principles, but it was our primary intention to deliver this information in a way that maintained continuity between teacher and students. Rather than employing lecture, we used a different tactic, explained below in the strategy level. Ultimately, the successful dissemination of sustainability concepts and the retention of this information were the criteria for success.

In a sustainable society, nature is not subject to systematically increasing...

- I. concentrations of substances extracted from the Earth's crust
- II. concentrations of substances produced by society
- III. degradation of physical means

And in that society

- IV. people are not subject to conditions that systematically undermine their capacity to meet their needs

Source: Robert 2004

Figure 2.2. Sustainability principles, The Natural Step and Robert

Level 3: The Strategy Level:

At this level, we considered possible options to reach the success imagined in the previous step. By consulting literature and delivering pilot lessons to the International Baccalaureate (IB) students from the Ehrensvärdska Gymnasiet of Karlskrona, we were able to begin laying the groundwork for a curriculum and the method we intended to employ. As well, we surveyed several teachers whose answers were summarized to create a framework of teacher behaviours which was also used in this study.

Level 4: The Actions Level:

After consulting with a variety of resources and piloting a number of lessons with the aforementioned groups, we narrowed down our method and curriculum to that which seemed most feasible and effective to attempt, and that “low hanging fruit” became the preferred option when we were faced with the actual task of delivering SSD content. During the second part of the study (the TIME sessions), we used short written surveys of the students to test for retention and comprehension of the sustainability material covered. These surveys were then each used to inform subsequent lessons.

Level 5: The Tools Level:

In the study, the surveys became the main tool used to gauge the learning taking place. Initially, the surveys showed what information the students understood as well as existing deficiencies. They also helped inform us of the predilections and abilities of the students and also provided feedback that would dictate the nature and direction of later lessons. Also, the

surveys helped the students focus their understanding, and thus they served as reinforcement for the content of the day's lesson.

The hook and ladder method was shaped by the template for solving complex problems contained in this five-level framework. Within its context, we assembled our strategies and actions which were eventually tested during the TIME class sessions. The hook and ladder method was also shaped by the plan-do-check-act (PDCA) method also known as the Deming cycle. This is an iterative learning and process management technique long used for business quality control (e.g. HCl n.d.), but conceptually, is equally applicable to, and used in, educational contexts (e.g. Lee and Yeap 2003). Figure 2.3 shows this cycle in a simple schematic which includes an inner circle suggesting further iterations. It should also be noted that complete PDCA cycles may also be followed as part of achieving each of PDCA stage. By using this four stage cycle we created a learning situation that resembled the iterative loop structure utilized by many action research projects.

Ultimately, this study's method followed in part the iterative nature of the Deming cycle, and its procedural steps are given further elaboration in section 2.6 on methods of communication. This is in keeping with the approach that improving educational content and its delivery is a process (Smith, Baker & Higgins, 1993; Zaczewski, 1994) for which the Deming cycle is a useful concept for accomplishing this (Lee and Yeap 2003). In employing it, our focus was to scrutinize and enhance the quality of the teaching and learning practices taking place in the classroom environment. As we later explain, the Deming cycle is embedded in our concept of incremental and iterative improvements.

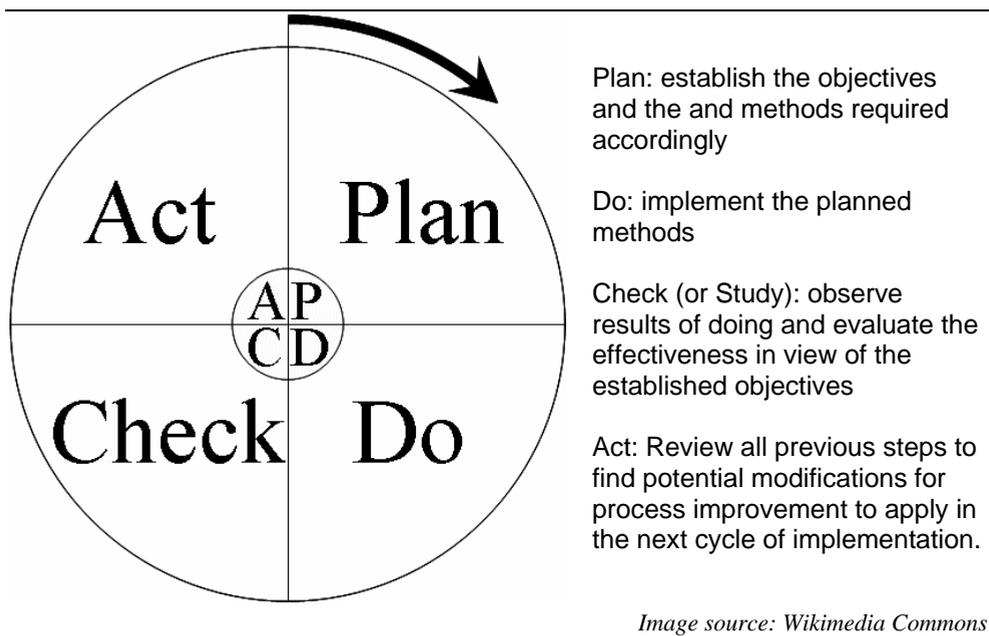


Figure 2.3. The PDCA or Deming cycle

2.2 Teacher Skills and Behaviors: Framework and Summary

In traditional educational settings, the most common teaching style is for teachers to follow the simple sequence of plan, teach, and test. In contrast to this traditional style, we employed a never-ending improvement model incorporating elements of the five level framework and the Deming cycle. The activity sequence, then (after Lee and Yeap 2003) is approximately: Plan → Teach (Do) → Determine the desired outcomes which students have missed (Check) → Revise the hook and ladder model (Act) → Test the revised model (Plan) and so on. With iteration, we aimed to produce improvement and hoped to see the knowledge changes that students achieved. Especially, starting from the check step, we integrated a feedback mechanism into the teaching and learning process which is a feature of the hook and ladder method.

The information from the literature review was supplemented with information from the teacher skills survey, which was created with the help of Jan-Olof Andersson, representative for Sustainable Vinberg, a part of Falkenberg, Sweden and an officer in ecological. We administered the

survey to 14 teachers who teach a range of disciplines at the secondary and university levels in the United States, Sweden, and Pakistan. The teachers surveyed teach technology, English, sciences, math, and foreign language in cultural diverse settings; their range of experience is thus fairly broad. The information from the surveys helped to develop our hypotheses, but was primarily summarized and used to create the framework of teacher skills and behaviors, see sub-section 2.3.1. For the purpose of making our action research (Smith 2005) replicable, and to add an element of consistency, this list of skills provides a framework of behaviors to employ when preparing for and delivering a lesson. The summary of teacher surveys and the framework of teacher skills and behaviors are shown in sub-sections 2.2.1 and 2.2.2, below. In appendix 1 the complete survey is provided.

2.2.1 Summary of Teacher Surveys

The responses to this study's survey were compiled and summarized. What follows is the summary of each survey question's answers.

On Scripting Questions: The range of behaviors runs from not at all to always. Depending on the situation, the type of lesson being delivered, having questions in mind is essential. Whether they are scripted or simply contemplated and held in mind is a decision that can be left to the instructor's comfort, experience, and his facility with language. In discussions, it is not necessary to script questions, but preparation, knowledge of the subject matter, thinking about the questions that may be needed, is necessary.

On Varieties of Questions: Questions often fall between high level and lower level questions, or deep thought questions without exact, right answers and recall/comprehension questions which are often used to build to high level questions. Questions often can be used to create a link between real life and the content at hand. This makes the topic easier to understand and more meaningful. Questions often ensure the attention of the students and retention of knowledge as the information, the direction and energy of the discussion come from their answers.

On Diverging from the Lesson Plan: An overall agenda, a bigger picture of the direction to be taken, seems to be most advisable here. Teachers must

be willing to leave the scripted plan in consideration of the interests and intellectual abilities of the class. If the students understand a certain way, it is the teacher that must follow that direction. Therefore, scripting becomes less important and an understanding of the class and its atmosphere and comprehension becomes more important. Prepare but be prepared to leave your plan to find another way to convey your points.

On Judging the Validity of a Divergence: Divergences will occur, and those to entertain are the ones that fall within curriculum responsibilities, the interests of the students, and current events. As long as the divergence from the original lesson plan falls within the greater scope of the class's objective, the divergence, because it carries the interest, energy and comprehension of the class, is worthwhile. Each lesson has an objective but each course has a curriculum, and if a lesson moves away from the original plan but still progresses in terms of the curriculum, a divergence becomes justified. As well, a divergence can very well be simply another way of reaching the original plan though the method of explanation and instruction changes.

On Whether These Divergences Occur Often: Divergences happen, for some often and others not, but the divergences that occur must not be seen as dangers or flaws in lesson design. Such divergences from the original scripting are opportunities to harness the interests of a class. Having a topic is important but then following the incarnation, the medium of comprehension that appeals to the class, is more important, and asking questions is the only way to find this medium, and being open to these methods of comprehension is necessary for harnessing the energy and comprehension of a class. A divergence from the original lesson plan is totally different from a divergence from curriculum or the interests of education.

On Whether a Teacher Needs To Be Able To Explain the Subject Matter in a Variety of Ways: A teacher must be prepared and capable of explaining the subject matter in a variety of ways. Students have such a wide variety of abilities and base of reference, and thus, having a wide range of ways for explaining a topic (be it metaphors, analogies, etc.) is essential. To ensure this ability, though, a strong command of the subject matter is a central responsibility of the teacher.

On Unconventional Ways of Explaining a Topic: Whether it is a metaphor, an unusual example or a remediation of a topic, these unconventional methods of explaining a topic are explorations into the meaning of a topic which aid comprehension. A teacher must use the means available to make a subject more concrete and easier to understand. These episodes may be time-intensive, but the returns in comprehension are significant. Also, these metaphors make a difficult subject easier to understand by linking the topic to a real life form which the students understand better.

On Teachers' General Rules for Preparing and Executing a Class: An atmosphere of respect is essential to making effective communication work. Students must feel comfortable enough to answer questions and engage the subject matter without being intimidated by it. This is the responsibility of the teacher. Adding to this comfort level is the fact that the teacher must be an expert on the subject matter of the day's lesson. If one tries to "wing it" or tries to instruct without properly preparing, the results can be embarrassing for the teacher, but the compounded effects on the level of respect the students have for the teacher, the classroom atmosphere, and the subject matter could be deeper than one can perceive. Preparation before the lesson to know the content is essential, but one should not mistake this with designing a plan from which one cannot diverge should the moment occur or the students not understand. Be prepared to use what the students give. As well, an effective classroom communicator must maintain an atmosphere of mutual respect, between students and between teacher and students.

On How To Make a Subject More Meaningful: Making the topic more concrete and easier to digest are the desired effect. Thus breaking the topic down into smaller chunks or parts, or using metaphors and models that make the topic more real is essential. Introducing a lens by which students will understand a topic greatly aids comprehension and meaning making. Finding the lens is also important and can only be done through a familiarity with knowledge of the class's predilections and common points of reference. To gain this, one again must question.

On Lessons Teachers Have Learned: It is advisable to over-prepare, to have more material than can be carried in the time period of the class, but one must also be ready to finish a lesson when the class is over. Ending a class, though, does not simply mean stopping instruction. One must survey the class at the end of a session to sum up what has been covered. Just as the

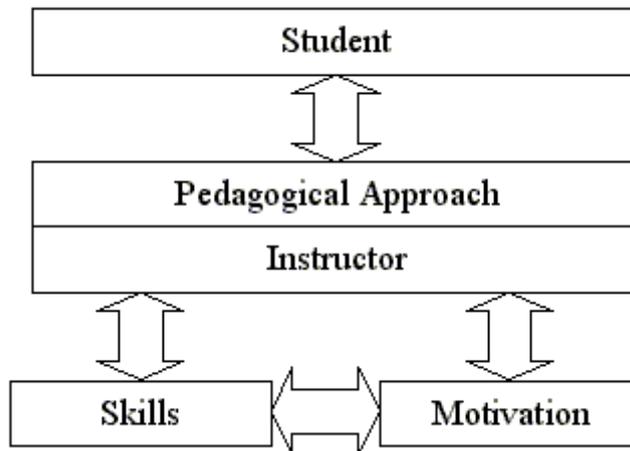
metaphors and remediations are neater, smaller ways for understanding, the lesson itself must also be packaged at the end of the class; closure must be reached, and the class must end where it started in some way. Although over-preparation is a must, over-scripting is a danger. Adhering blindly to what seemed theoretically sound in the planning stages is vanity. An effective classroom teacher must be willing to follow the method of comprehension that the students understand. Have an overall goal, topic, or concept to teach, but be ready to get to that understanding by whatever discussion the students provide. This will often take the form of real life situations and these, like the metaphors, are much easier to understand and make the information less alien.

2.2.2 Framework of Teacher Skills and Behaviors

1. Be prepared and versed in the subject matter
2. Plan and over-prepare the content for the day to be ready for extra time and in anticipation of the class not going exactly as planned
3. Question the students to gauge where and when to diverge from the lesson's exact scripting, to check comprehension and to bring about thought and participation
4. Be prepared to diverge from the scripting of the plan
5. Such a divergence does not mean another topic completely; it could mean another way of reaching the original goal, and is justified as long as the divergence falls within the bounds of curriculum and overall topic
6. Use models, remediations, and metaphors, references to real life, popular culture, anything to make a subject more meaningful, more concrete, and less alien and/or intimidating for students
7. Maintain a safe atmosphere of respect and trust between students and between students and teachers so that all feel that they are a part of the process taking place
8. You only really know a subject if you can teach it and present it in a variety of ways to accommodate the different learning styles within a classroom

Our method, then, requires responsible and totally committed teachers who teach by actively guiding the students according to student responses. The teacher must communicate the subject to the students by simultaneously focusing the learning process and interacting with the students in such a

way as to strongly motivate them. That, in turn, requires students willing to be responsive. We know that not all students are eager to learn or to take responsibilities in the learning process. However, the teacher can be a guide for these students by motivating those who are less likely to work extra hard and take responsibility. A highly motivated teacher, in view of Maslow's pyramid model, can help a student to develop a stronger motivation to learn (Lee and Yeap 2003).



Source: Norman Crumpacker

Figure 2.4. Pedagogical approach related to learning

Pedagogical skills are the primary element of the teaching process, and appear mainly as the effective management of classroom practices, the variety of methods used to teach and assess what students have learned, the planning of instruction, and the motivation of students. Teachers' practices have crucial effects on the learning capacity of students by providing students with alternative ways to learn. A teacher should therefore be aware of the importance of classroom practice and update pedagogical and even psychological skills. Well-structured classroom time should always be a teacher priority since apt use of pedagogical and psychological skills are necessary to enrich the education environment for learning. For example, a teacher having strong psychological skills can understand students well and can create a good rapport with students. Pedagogical skills are also drivers of motivation and appropriate approaches to students. Figure 2.4 shows a relationship between the teacher's pedagogical approach, the student, and

the teacher's skills and motivations. Note that the approach is dependent on student feedback, but it is the motivations and skills of the teacher that are emphasized. Multi-mode and/or individualized pedagogical approaches which make the teacher's motivations and skills clear are the most transparent to students and aid in learning (Husmann and Miller 2001).

2.3 Preliminary Educational Research, Pilot Lessons

Before the final lesson trials with the TIME class, a number of pilot lessons were presented to three other student groups to fine tune the methods of communication outlined in this study. Two of these three groups were from the International Baccalaureate program of the Ehrensvärdska Gymnasiet of Karlskrona, a secondary school program that presents classes in English designed for students having international interests or connections. These groups are designated IB I and IB II. The students ranged in age from 15 to 17 and exhibited good English speaking skills. The third group, designated IB III, consisted of a single 18 year old female student from the Av Chapmans Gymnasiet of Karlskrona. Her English skills were strong and she brought with her a pre-existing interest in sustainability. Working with these students, we tested our methods and isolated the components, skills, and techniques of communication that would be emphasized in the final sessions with the TIME class.

Combining the information from the literature review (section 2.2) and the framework of teacher skills and behaviors (sub-section 2.3.1), and experiences gained during the pilot sessions, we formulated our hypotheses concerning methods for effective communication of SSD content.

2.4 Hypotheses

To communicate the ideas of SSD in a way that is effective, in a way that brings about retention, one must deliver this information in such a way that students feel as if they have seen this information before. This is to say that the student will most readily accept this information if it seems associated with pre-existing knowledge, i.e., it matches closely with the content of the student's intellectual comfort zone. It needs to be made less alien so that the student can more readily make sense and meaning out of it. Thus, the information needs to be explained in terms that students feel comfortable

with and understand. One must meet them on the intellectual territory where they are most at ease (McCaskey 1999). From this initial contact, then, one can hope to pull students out of the commonly held cylinder paradigm (Robert 2004) to see and understand the concepts of sustainability through the method of remediative looping back. We have called this the hook and ladder method, and with it have hoped to meet the students in such a manner that one can combine their knowledge with the ideas of sustainability and thus swing them forward towards the desired paradigm shift.

Hypothesis 1: Effective SSD education requires a teacher to enter the comfort zone of the student that is being taught.

The route to a student's comfort zone can be discovered through the use of careful questioning, which can reveal approaches that yield better student response. The questions serve the purposes of requiring activity and thought from the students and of providing a gauge of whether the teacher has been understood or not. This leads to another aspect of the communication loop method. At times it may well become effective to explain a topic in another form, i.e., through remediation or another metaphor. Should this be the case, and a new method of explaining a topic is needed, it is often only through questioning that a new and effective variant of the communication loop can be found. With every such iteration it becomes necessary to measure comprehension through another series of questions. It is thus that the teacher can see what the students have learned, but can also be informed of the direction needed for his subsequent lessons.

Hypothesis 2: Effective and consistent questioning aids student participation, aids a teacher's decision making, and aids student comprehension.

After reaching the target audience's territory and level of comprehension, it is then necessary to find effective ways to make the subject matter of sustainability more easily grasped, and to that purpose, questions coupled with effective metaphors, a lens for comprehension, make the subject matter less daunting, less complex (Robert 2004, 19; Hart 2003). In order to become effective at creating capacity and teaching this subject, using such metaphors will be integral.

Hypothesis 3: Effective use of metaphors (remediations) will aid comprehension of SSD topics.

2.5 Method of Communication

After the first pilot classes were presented to the IB groups, we solidified our method of communication to a model we called the hook and ladder method. This can most easily be explained in a number of diagrams which build on each other. The diagrams and the hook and ladder model itself reflect the action research approach (McKay and Marshall 2001; Zuber-Skerritt and Perry 2002) which we used throughout the study.

Knowing the importance of tool selection on the quality of output in the teaching and learning process, the five level framework and the Deming cycle were employed throughout this study for their unique capabilities to provide a structured approach. We considered it fundamental that producing desired, effective communication in any teaching and learning process requires primarily having a structured understanding of the problem or study in question. In our study, we considered the structured understanding of the problem as an application of the five level framework and the identification of the activities that needed to be planned, controlled, monitored and overseen throughout the complete cycle of the process as an application of the Deming cycle.

The organization and employment of appropriate ways to make effective learning happen was therefore guided by the five level framework through its structured planning techniques. With that framework in mind, we applied its unique planning capabilities to our study. We used it to guide us not just as a backbone for telling us what to do in order to reach desired results, but also, when developing the lesson plans, it was the main tool for directing and shaping those plans.

Deming cycle refers to the structured approach in the context of plan, do, check and analyze in the ongoing process. When we are doing things right, or reaching the required level of quality of teaching and learning, the process was checked by the feedback process inherent in the Deming cycle. This decreases ineffective action and increases student involvement in the decision making process of lessons by collecting feedback to improve

content, mode and method of delivery, and teaching and assessment methods.

2.5.1 The Hook and Ladder method

The name we chose, hook and ladder, for our trial method of teaching sustainability is derived from the name of a game maneuver sometimes used in American football. This maneuver involves the team carrying the ball to first pass the ball to one player and, as the other team's defenses concentrate on that player, quickly pass the ball a second time to a second player. If all goes well, the team carrying the ball can get it past the defenses of the other team and achieve significant gains, or even a goal. The parallel here lies in the idea of shifting metaphors, (the ball), broadly and quickly, and involving the students in a team effort of exchanges so as to get around the students' conventional resistance. The next paragraphs describe how we implemented this method.

First, the teacher moved toward the students through a number of means. The teacher tried initially to understand the students from a distance, contemplating their level and style of understanding, so that instruction would be as appropriate as possible. This required careful observation and knowledge of the students' tastes, fads, TV shows, pop cultural figures and so on. In this way, the teacher moved away from his or her personal comfort zone (McCaskey 1999) and toward the students' and the students' ways of making meaning. The teacher attempted to assume the language and metaphors of the students (Annenberg n.d.; Hart 2003). In effect, the teacher tried to make the complex subject of sustainability simpler for the students to understand. This was accomplished by changing the terms originally used to describe the content and replacing them with new ones (a metaphor or a remediation) that the students would be able to more easily grasp and understand. Choosing an appropriate metaphor is imperative, as it gives the students a window and an entrance into the conversation. Without such a metaphor, the students would have to understand the concepts in their original form, and this is often too complex and/or too intimidating to keep their attention and gain their commitment to the material. Thus, after careful consideration, the teacher gained a more vivid understanding of the students by the time the first lessons began.

Upon entering the classroom, the teacher asked the students to write a definition of sustainability on a piece of paper which was collected at the end of the lesson. This provided a baseline measurement of the students' knowledge from which later measurements of learning could be made. A short discussion concerning their definitions at this time may be helpful, but not totally necessary as it also may interfere with the flow of the first lessons. The object for the purpose of the study was to have a pre-test with which to help evaluate impact.

Once in contact in the classroom, the teacher asked questions about common issues and common topics to enhance his or her knowledge and frame of reference, again to ensure the appropriateness of the chosen metaphors and language. For example, one should hardly use metaphors about football or soccer with students who find such sports completely uninteresting or even repugnant. At this time, the teacher was also able to gauge more effectively the impact of the hook and ladder intervention on the students by asking what the students know about sustainability and other common topics. These initial steps set the context and milieu of the conversation, making the students more comfortable, and giving the teacher a frame of reference and an appropriate level of language.

Having found an approach the teacher thought would be effective with the particular group of students with which he worked, the teacher used the most fitting metaphors and remediations of the subject he could to connect with the students' willingness to comprehend, thus using the method to create a lens for understanding. In other words, the teacher attempted to make the sustainability lesson content more generally understandable to the student audience in a way that allowed them to make new meanings (Abes and Jones 2004). The teacher sought to use the lens of metaphor to reduce the scope of investigation, so that the content was both less complex and smaller in size. By exploring this lens and its analogous qualities, the students had a window for investigating sustainability. After this looping back, i.e., after seeking the most effective metaphors, the teacher was able to then loop forward by combining the students' prior conceptions to new sustainability concepts through the link of metaphors which were custom designed to aid the students' comprehension. This looping technique was the first step of the research method. After the first loop was completed, subsequent lesson sections sought to raise the students to higher levels of understanding by building on the previous section's, again referring to appropriate, topical knowledge, and using topically specific metaphors. At

the end of each remediated section, each metaphorical explication, the teacher questioned the students for comprehension, and guided the synthesis of prior knowledge with the concepts of sustainability.

At the end of the entire lesson, the teacher questioned the students again in the form of an exit survey. The survey consisted of three questions which gauged prior knowledge, comprehension of the lesson content, and interest and predictions for later lessons. Figure 2.5 shows the cyclical nature of the process schematically. The teacher meets the students at a common point to communicate sustainability concepts. To do this, the teacher first finds a suitable common point and takes the initiative to move to meet the student. The teacher uses metaphor and remediations to explain the concepts of sustainability in a language that the students readily understand and in terms that enable the students to participate in a conversation. The teacher skillfully combines the students' prior knowledge with sustainability concepts prior to moving onward to the next section of material

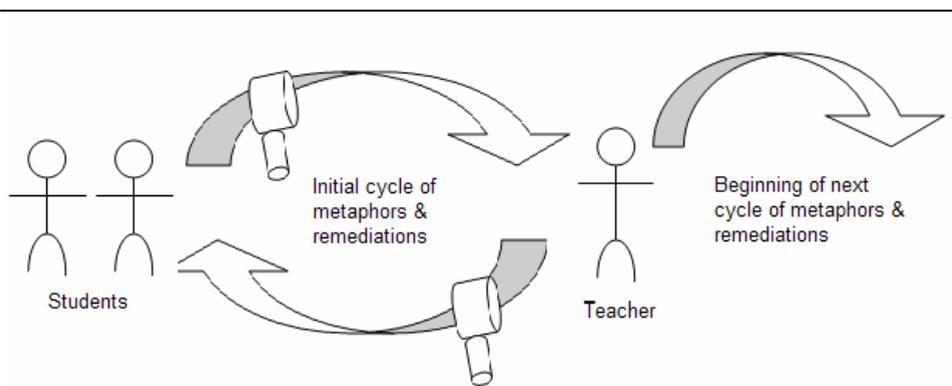


Figure 2.5. Hook and ladder, initial remediation cycle

2.5.2 The Next Loops

These techniques were carried out through as many iterations as possible within the constraints of the time and other resources available. Each time the cycle repeated the technique of moving back to meet the students at their level and combining their prior knowledge with new sustainability content. Thus the teacher attempted to move the students from A to A' and finally to A''. Through this process, lesson plans were archived and we

kept a journal of what worked and did not work. This was later combined with survey information from the students to develop later lessons and revisions of lessons just delivered.

Figure 2.6 shows this repetition of the hook and ladder cycle. With each subsequent lesson, the teacher builds on the students' knowledge from the previous lesson as well as common knowledge while remediating concepts and metaphors to best advance the students' acceptance of the material. In this way, students' knowledge from previous lessons is used as the basis for further interventions and more learning is achieved.

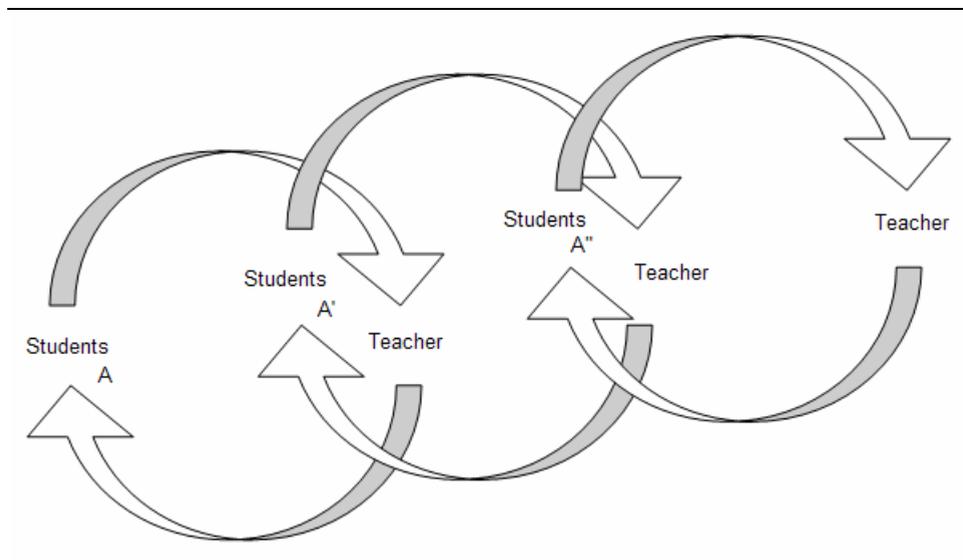


Figure 2.6. Hook and ladder, on-going iterative cycle

2.5.3 The Loop Dissected

The hook and ladder method of iterative looping can be more easily understood when broken down into four quadrants:

1. Before coming into contact with the students, the teacher tries to understand the students' level of comprehension, frame of reference, possible metaphors and lenses for understanding (Abes and Jones 2004). Also, the teacher is entirely responsible for having a strong command of the concepts of sustainability, strong enough

to be able to explain it in numerous ways, using a variety of examples and remediations. The teacher designs the lesson to explain the topic, scripting out a possible method of explication to be used in the lesson, though the teacher remains aware of the fact that this method may have to be altered.

2. The teacher enters the classroom environment with the students. Here the teacher surveys prior knowledge through a question survey to be collected or an initial activity or question. Initial questions are posed to gauge where the students are in terms of understanding sustainability and the students' prior knowledge from life or previous lessons. Metaphors are explored and remediation is introduced, giving the students a frame of reference, a lens, for understanding the concepts of sustainability being discussed.
3. After exploring the metaphor sufficiently, the student has a foothold for understanding the concepts of sustainability. Also, by this point, the teacher has established himself as having come out of his or her regular comfort zone to meet the students and builds a bond of trust (McCaskey 1999; Botan and Taylor 2005). At this point, the teacher can utilize remediation and metaphor to facilitate communicating the principles of sustainability. Thus, the student is given the opportunity to make meaning out of concepts which may have previously seemed more complex through the lens of metaphor. Through questions, which will guide exploration of the metaphor, ensure comprehension and bring about mental activity (Nichols and Stevens 1999) the students take ownership of the knowledge being formed (Annenberg, n.d.) and the teacher pulls the students from their original position, and encourages them forward.
4. Prior knowledge and sustainability concepts, combined in the previous quadrant, are now explored further for implications and significance. Here, higher levels of thinking are required as students make use of their newly acquired perspectives, and apply them to the real world. "What real life applications do you see for this information?" could be a question asked at this time. The student takes what they have learned at the metaphorical level and the teacher attempts to move them further toward practical applications and/or possible deeper understandings of significance and ramification, thus bringing the knowledge back to the practical

realm of common knowledge and context, thus making the learning more real (Abes and Jones 2004; Annenberg n.d.). At the end of the last cycle and lesson, the teacher gives an exit survey to gauge the learning accomplished during the session. Usually no more than three questions, the surveys check the understandings brought to the lesson from previous lessons (prior knowledge), comprehension of the lesson (effectiveness of the lesson), and possible applications of the day's content (further implications).

Figure 2.7 shows the hook and ladder method simplified as a parallel of the Deming cycle loop. Schematically, as above, the cycle is split into four quadrants: 1. the teacher moves towards the students' level of comprehension and adapts the sustainability topics of the planned lesson to forms that the students will most readily understand; 2. the teacher engages the students with questions to gauge whether they understand his or her explanations of sustainability concepts; 3. the teacher uses questions to pull the students toward the new ideas, and; 4. the teacher helps the students synthesize the new information by relating it to the practical implications for real world problems.

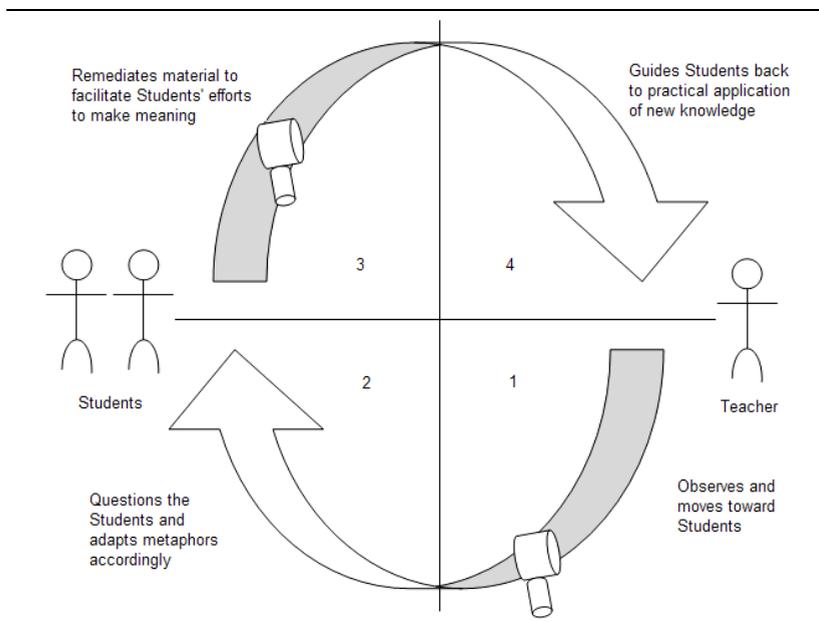


Figure 2.7. Hook and ladder, loop detail of Teacher actions

2.5.4 Loops within Loops

No lesson goes entirely as scripted. Metaphors may fail to find traction and students may not make a connection to a method of instruction. It is at this point that a teacher must be willing and able to make adjustments to accommodate the abilities and learning styles of the students. To this point, again questions were integral to ensuring that instruction was effective. Going forward only after being satisfactorily answered or changing tack when satisfactory answers were not forthcoming helped ensure that the session was not time wasted and that communication had been effective (Nichols and Stevens 1999). In cases of unsatisfactory answers, further remediation of the topic becomes necessary. The teacher, during these expected but indeterminate occasions, deviates from the script and uses alternate methods of explaining, some of which eventually return to the general idea of the scripted lesson. In other cases, though, divergences may move in directions that do not allow a return to the teacher's original script. In such cases the teacher should nevertheless be vigilant in maintaining relevance to the overall topic. These moments of divergence are treated with greater detail and expansion in a later section (see 2.3 Framework of Teacher Skills and Behaviors), but it is important to keep in mind that integral to effective communication in this setting is using what the students give. During the TIME sessions, if students did not understand something one way, we were ready to use the knowledge and interests students showed to move forward, even if the ultimate goal was not exactly what was originally planned.

Figure 2.8 shows the loops within loops approach that follows and supplants the eventual divergence from lesson scripts. The small loops in the figure may be viewed as representing these events and as reflecting the pattern of Deming cycle use within the larger Deming cycle of the whole process. It is through questioning that PDCA process can be realized. It is at these process moments that remediation is needed, the topic can be explained in a different form, and the cycle of the teacher moving to meet the students takes place again. It is at the teacher's discretion to decide when this needs to occur, but it is only through questioning that this decision can be made.

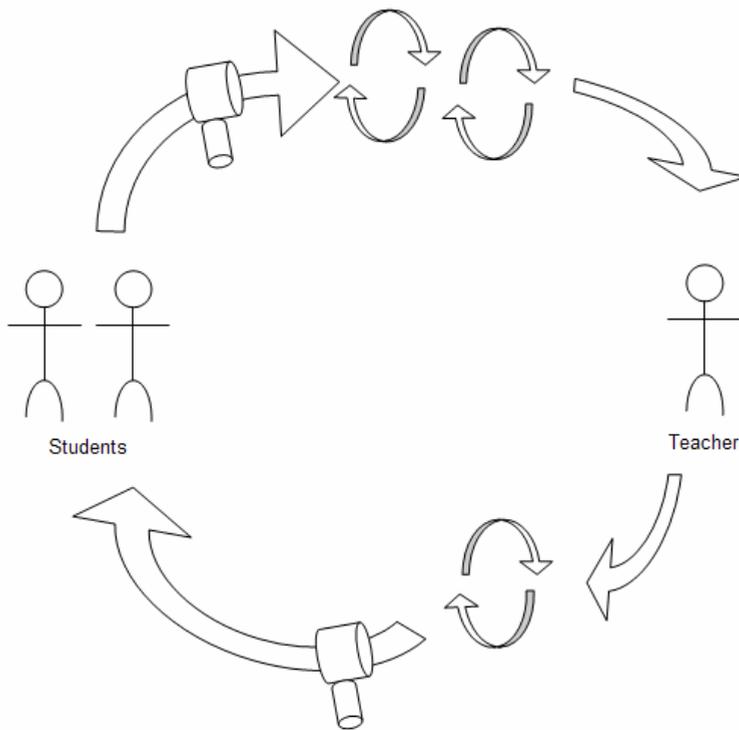


Figure 2.8. Hook and ladder, loops within loops lesson divergence

2.5.5 The Method over the Course of a Curriculum

Analogous to the idea that within a lesson there will be moments of divergence and decision-making, which are informed by questions and answers with the students, figure 2.9 shows this idea of divergence illustrated over the course of a curriculum. Between starting point A and ending point B, there are several key intermediary points that must be reached as well. With these points established, a teacher is free to move the class and instruct it using the skills and behaviors from described in 2.3 Framework of Teacher Skills and Behaviors which allows for divergences from an exact, straight line path between beginning and end, and the intermediate points between. Again, it will be through questioning the class during lessons and after lessons that the teacher will be informed of the class's understanding, predilections and interests, which will in turn aid in future lesson design.

Returning to figure 2.9, the point A represents the initial stages while B represents the overall objective. Analogous to the previous figure, which at the lesson level shows where there are loops and alternate paths towards an objective, here too there are loops and alternate paths to reaching the objective, B. The stars represent main points that must be reached in the curriculum, but reaching these points and ultimately point B do not necessarily take place in a straight path

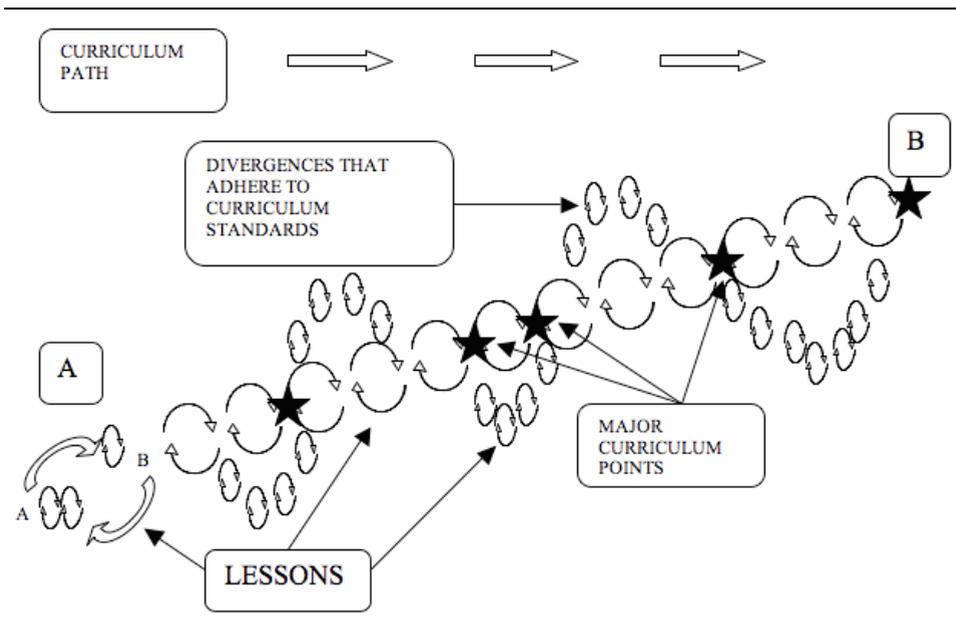


Figure 2.9. Hook and ladder, curriculum divergences

This hook and ladder method of instruction was employed during the TIME sessions and the students were surveyed for:

1. prior knowledge at the beginning of the lessons
2. comprehension of the day's lesson content
3. command of the day's lesson content through higher order questions which ask the student to apply the content independently, extend on the material.

The full lesson plans and survey information, including a journal of teacher reactions are included in the following section.

2.6 Educational Interventions

A series of educational interventions were administered to a group of students from the TIME program, based on the hook and ladder method outlined in the previous section. The students were final year students ranging in age from 18 to 19. Their English skills were good and the group's ability level could best be described as heterogeneous. The class was approximately 15 students, both boys and girls. Two 1½ hour sessions were carried out with a group that had no previous contact with sustainability or SSD concepts. During the lessons, and at each session's end, surveys were given to measure the level of learning taking place and to gauge whether the techniques of communication were effective. This survey information was then used to modify subsequent lessons and manner of delivery. The survey responses, and a journal outlining teacher impressions of the lesson, are presented in the section for the results.

2.6.1 TIME Class: Session One Lesson Plans

Lesson One: This introductory lesson was designed to give the students a general understanding of the concepts that are tied to sustainability. It introduces the earth and its economy as a unified system moving too quickly to long survive at the present pace. Thus, the lesson also started to give students an idea of why the world, under current patterns of resource management, is unsustainable and how to start dealing with this situation. Specific topics covered were sustainability (Slick n.d., Robert, et al. 2002 and Robert, et al. 2004) and upstream and downstream solutions (Broman, Holmberg and Robert 2000).

Regarding sustainability, focus was put on a key metaphor of running a race as a sprint versus as a long distance race, representing the ideas of non-sustainability versus sustainability. Sustainability was explained in terms of a race where everyone must keep running forever. The current situation was portrayed in terms of the world running the race like a sprint, and thus does not have the resources or capability to maintain its present pace. The procedure was a brief self-introduction and explanation of the reason we were there. During this process we attempted to create rapport with the students by asking them questions unrelated to the topic, having them ask questions of us and learning their first names. The class was surveyed at this time for prior knowledge of sustainability by asking each student to

give a written definition: What is sustainability? This was the first of a series of survey questions given the students.

This section, then, represented the earlier portions of the loop. Here the teacher moved toward the students (McCaskey 1999). In the planning stage of the lesson, the movement towards the students had already begun. The teacher contemplated the references and prior knowledge of the students and wrote an ability specific intervention (Abes and Jones 2004). Once in the classroom, incidental conversations were used as the first steps toward developing a connection with the students. This was necessary before moving forward with instruction (McCaskey 1999). Beyond introducing the race metaphor, the students were asked to connect it to their own lives and imagine solutions that were sustainable.

Regarding upstream/downstream solutions (Broman, Holmberg and Robert 2000), the students were introduced to an idea of how to solve problems at this level of complexity. Using the metaphor of a worker repairing a dam, this lesson tried to show the students that solving problems in ways that serve only as quick fixes are not effective and sometimes harmful. This lesson provided a bigger, systemic view to problem solving, showing that upstream solutions are more effective when attempting to solve big problems. Thus the students were asked to consider the maintenance of a leaking dam, representing any natural system, with repairs now typically made as leaks occur. The metaphor is initially used to show the downstream solution. As the students considered repairs to the dam from the downstream side, they were shown how easy it is to be unaware of the bigger, systemic problems occurring on the other, upstream side. Therefore, the advantage of working from an upstream perspective became clearer. Figure 2.10 shows a graphic used to introduce the metaphor. This graphic increases the students' sense of pressure behind a dam and so accentuates the futility of the downstream solution. It also prepares the students for figure 2.11 which shows the dam in elevation from the downstream side and suggests how small leaks may fail to indicate much larger problems disguised by the downstream perspective. This is further illustrated by figure 2.12 where the full severity of the problem is easily visible. The object was to focus the students' attention on how upstream solutions have greater effect, and more directly address the problem, than do ones made downstream.

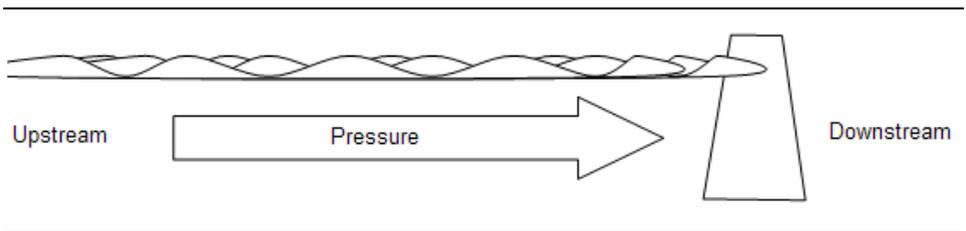


Figure 2.10. Dam metaphor, upstream-downstream section

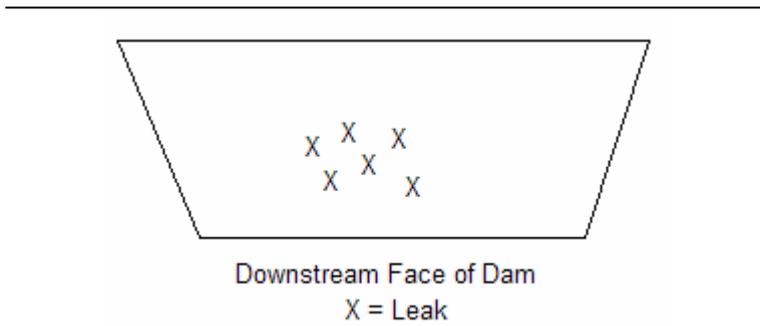


Figure 2.11. Dam metaphor, downstream face elevation

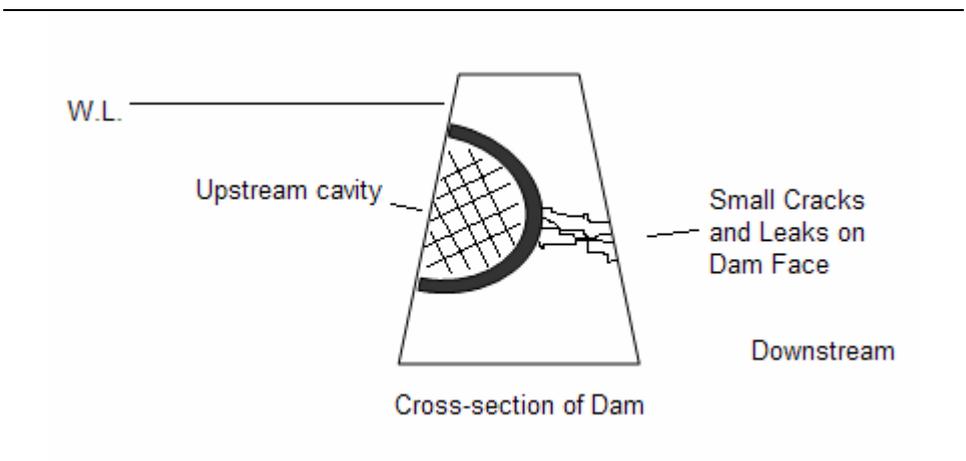


Figure 2.12. Dam metaphor, upstream cavity

Finally, students were asked to identify a sustainability problem, discuss how it has been historically dealt with and show how traditional solutions have been downstream “fixes” rather than upstream solutions. Note was

made of how the problem is often bigger than it appears to be and how big the solution may have to be to solve the problem.

At the end of each lesson the students were asked to give a written response to a question intended to reflect the new knowledge they gained. The answers served the further important function of informing us if the students used the metaphors used in the class. Such use can be considered an indicator that the students found the metaphors compelling. The question asked here was: Are we sustainable right now? Why or why not?

Lesson Two: Here, an introduction to backcasting (Holmberg and Robert 2000) was presented, picking up where upstream/downstream left off and moving ahead with techniques of problem solving. The metaphor discussed described the complex problem of becoming a world class athlete. Through developing an outline of a celebrity's life and listing the succession of his activities, we discussed whether following such a list will necessarily bring success. Then, by distilling the general ideas of this life history, we created a framework of general guidelines which would hopefully be more effective than a list of specific activities. This distinction between a succession of activities and a guiding framework thus becomes the foundation for understanding backcasting as a means of reaching success.

Thus the metaphorical emphasis was on achieving a goal that would likely be seen as desirable, in this case becoming a world class football player, e.g., Zlatan Ibrahimovic. The students were asked to imagine themselves as Zlatan or any other world class athlete, entertainer, celebrity, etc. The students then created scenarios about his life as a celebrity and answered questions after placing themselves in Zlatan's position: how did you get there, to that point of success, and; what do you do every day to maintain the success? The responses were listed on the board under a column labeled Zlatan's life. Then the items listed were discussed to determine whether following each of these steps would guarantee becoming Zlatan or, if not, why not? Then, in a second parallel list, the students and teacher derived a small set of general rules for becoming Zlatan and the question was then asked, which list would be more helpful for someone wanting to be Zlatan? Figure 2.13 shows what such a pair of parallel lists might be and how the specific action list can be analyzed for general rules.

<i>Zlatan's life and daily habits</i>	<i>General rules for reaching success</i>
Raised in Malmö Played on club team Practiced hard	Work hard with what you have been given
Played for Juventus Played for Swedish team	Play with the best players possible
Eats sandwiches Sleeps	Maintain health through nutrition and rest

Figure 2.13. Backcasting, specific actions vs. general rules

At this point, the concept of backcasting was introduced by drawing something like figure 2.14 on the board. In it, Zlatan's career is shown as a fluctuating, but rising line between point A, at the start, and point B, at the objective. For comparison, Boris Beckham's life path is given another shape, but also shown as going from A to B. The definition of backcasting was then given as: imagining your objective, your point of success, and then list the behaviors you would want to follow to reach that point of success.

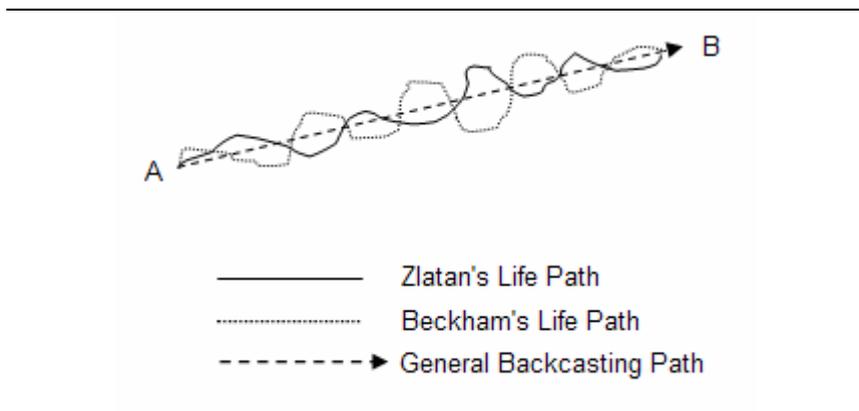


Figure 2.14. Backcasting, life paths, general vs. actual celebrity

By contrasting the diagram shown in figure 2.14 of Zlatan's life, with its many different turns to get to success, to that of another football player's life, we tried to show that everyone's path to success is not the same. The students were asked to understand that exactly copying what a celebrity does will not necessarily bring the same success, and that backcasting gives no exact answer for how to reach it.

Instead, they were asked what backcasting does show, and challenged to relate it to whether our society is sustainable at this moment. Regardless of their answer, the question remained of whether we know how to create a sustainable world and whether backcasting can help us reach sustainability. To give them a basis for answering these questions, the basic concepts of sustainability, as shown in figure 2.2, were explained. The survey question asked at the end of this lesson was: Does backcasting provide exact answers for a problem?

2.6.2 TIME Class: Session Two Lesson Plans

Lesson Three: This was a review of the race and dam metaphors and of the backcasting concepts discussed in the introductory session, intended to refresh students' memories and introduce the concepts to new students, while also developing the students' application of the metaphors to more real-world situations.

After again presenting the race metaphor and discussing its meaning, the students were encouraged to consider what strategies they would choose when running a race that is not a sprint, but is instead on-going – as the real world of a sustainable society must be. They were guided to view running the race with the assumption that, as the runner, they know the length of the race, they know they must keep on running and running. In that framework, the strategies the students suggested were listed and then compared to our current world and consumption patterns. The question was then asked if there was a good match between the strategies for a long race and the world's current consumption strategies. Finally, the students' list of strategies for running the race was used to develop a definition of sustainability and, based on that, the students were challenged to offer advice for how to make the world more sustainable.

The dam metaphor was similarly presented again and the students were again asked whether an upstream or downstream repair would be more likely to succeed. Here, the metaphor was applied to the problem of oil. The downstream solution of drilling more wells; building more pipelines; building more roads; tearing down more ecosystem was compared to the upstream solution of finding different fuels and making more efficient cars. Through this comparison, the upstream solution was shown to solve several problems simultaneously, while downstream fixes can be ultimately more harmful than good.

Finally, backcasting was discussed, first in terms of the previous concept of Zlatan Ibrahimovic's success as a football player and then by considering the approach of either trying to imitate him exactly or developing a list of general rules for football player success. The students were asked to evaluate which approach was more useful and to compare the situation to sustainability, with specific attention paid to how we get from our present state to sustainability, to whether we can have exact answers, and if we can tell which directions are not leading us to sustainability. With this, the upstream solutions approach was then compared to backcasting and the students were asked if the two methods are similar, what they both aim to do, and how we can use these methods for reaching sustainability. Finally, they were again asked to answer the survey question: what is sustainability?

Lesson Four: The students were introduced to the mineral cycle and how it affects us and we affect it (Azar, Holmberg and Lindgren 1996). The lesson was centered on Sustainability Principle One and was designed to give the students a better understanding of the environment as it appears naturally and what happens to it due to human interference. The lesson is a remediation of the mineral cycle, showing the cycle of innocuous substances and harmful substances entering the environment from the earth's crust and how that cycle is altered by mining for industry while the rate of remineralization cannot compensate for the mining practices (Azar, Holmberg and Lindgren 1996).

To help the students identify with the problem they were asked if they owned common items of modern life, i.e., a cell phone, MP3 player, computer, TV, or light bulbs, and if they had ever disposed of any of these items. This was the lead-in to discussion of consumption, obsolescence and the end location of waste material with the implications of how that all affects our environment.

Figure 2.15 was then presented. It is intended to illustrate the mineral cycle without human interference. The letter A represents the most toxic materials in the earth's crust, but also the rarest. The letter B represents minerals that are both less harmful and more plentiful in the natural setting. C represents those that are most common and least harmful in the environment. It was explained that every year, eruptions and weathering bring these elements to the surface and starts them moving through the environment. Fortunately, in normal, natural conditions, A appears the least often and C (fairly harmless) appears most commonly. Also, A returns to the earth's crust the slowest, while C returns the quickest. In such circumstances, concentrations of minerals are rare and usually fairly harmless to us.

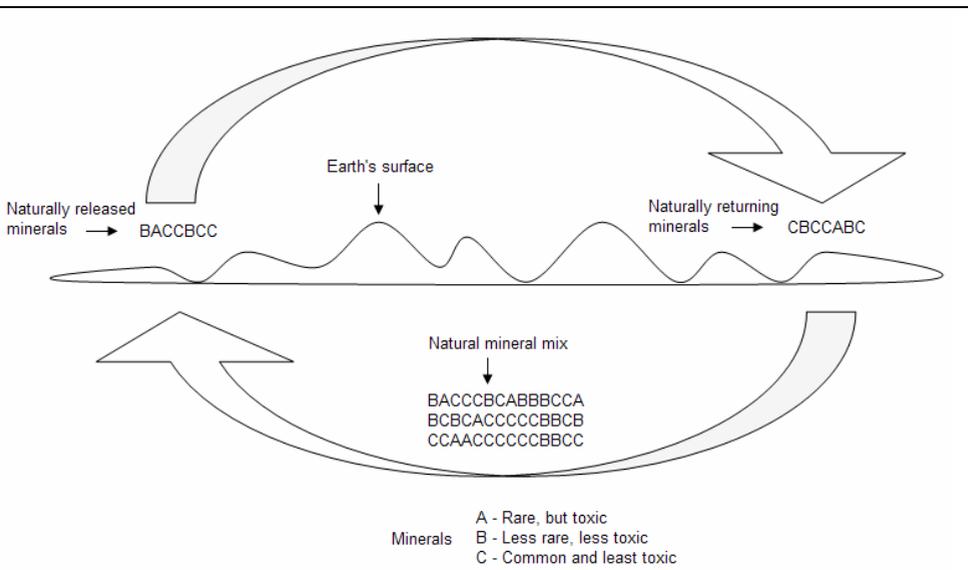


Figure 2.15. The mineral cycle without human interference

After discussing figure 2.15, with emphasis on the stability of mineral levels moving through the environment and why this stability is both safe and sustainable, we introduced figure 2.16 which shows the mineral cycle with human interference. In this diagram, mining of element A has allowed factories and consumers to use increased amounts of toxic element A, thus moving larger amounts of it through the environment in ways that can yield both greater general dispersal and greater local concentrations. This results

in an increasingly toxic environment. Also, unsustainable mining practices could lead to the depletion of rare materials like A.

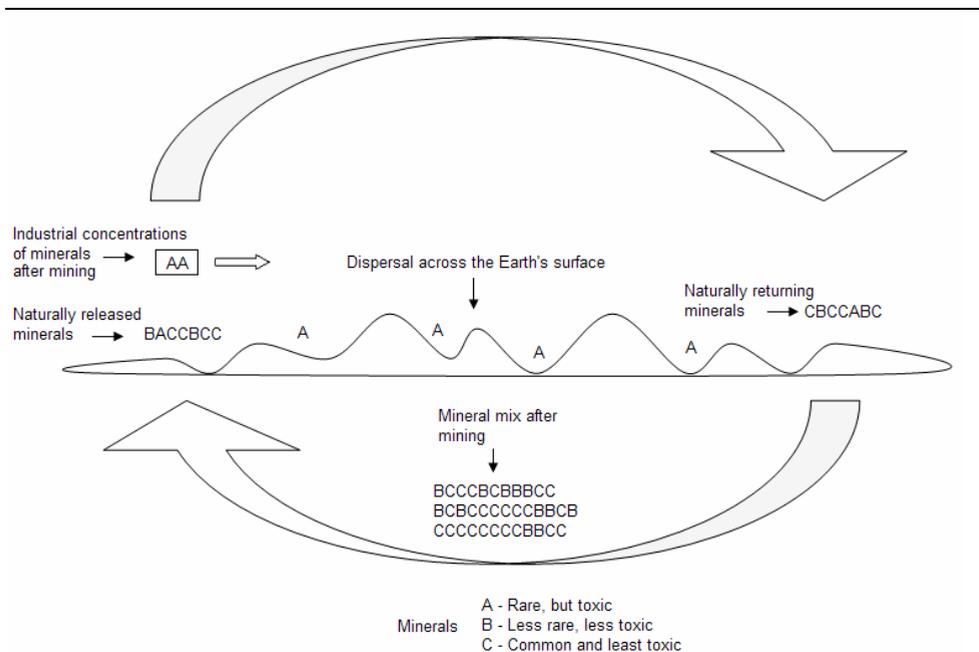


Figure 2.16. The mineral cycle with anthropogenic interference

These figures were discussed to emphasize the result of anthropogenic interference on the mineral cycle and what the consequences are to the environment. The students were then challenged to identify the sources of the problem and the actors responsible for it as well as appropriate solutions that could keep element A out of the dump. Again, the lesson closed with a survey question: give a sustainability problem and provide solutions to the problem. Summaries of the survey question responses are in the Results section.

3 Results

The following results were compiled from the student interactions during the study, starting with the survey questions from the TIME sessions for which the students were asked to write answers.

3.1 Survey questions and results from TIME sessions

The following are the questions and summarized answers from the first TIME session, presented in the order in which they appeared during the lessons.

Question 1: What is sustainability?

This question served to establish a baseline of student knowledge about sustainability to allow qualitative evaluation of change in students' knowledge. Answers ranged from no response to no idea indicating that the students had little or no previous knowledge about the subject of sustainability.

Question 2: Are we sustainable at this time? Why or why not?

All students answered this question by saying that we definitely are not sustainable now. The reasons given were largely that our rate of consumption is too high and inefficient, especially of energy resources. One response, however, suggested that the problem could be left to coming generations. However, the answers to this question suggested a gain in knowledge and acceptance of the present lack of sustainability.

Question 3: Does backcasting give exact answers for a problem?

Here, there were mixed responses where the answers ranged from no response to demonstrating a good grasp of the concept; out of 10 responses, 5 were blank. Of the 5 responses received, all correctly answered that only guidelines are created when using the technique of backcasting. In this case, we suggest there was a situation of wandering attention, rather than a lack of comprehension, as the class had been running already for 1½ hours.

The following are the questions and summarized answers from the second TIME session, presented in the order in which they appeared during the lessons.

Responses to Question 1: What advice could you give to make the world more sustainable?

Seven correct answers out of nine students were obtained. One answer was blank and another, which suggested a high level of hopelessness, read: "Destroy all humans, probably. I don't want a sustainable world, I want to keep spending resources like there's no tomorrow." Overall, however, the students showed a retention of sustainability knowledge from the previous lesson, which had taken place two weeks prior. In sum, the answers to this question were characterized as simple strategies to consume less, but with few suggestions about how to accomplish that. Where suggestions were made, they were suggestions to choose alternative energy.

Responses to Question 2: What is sustainability?

Responses showed a range of comprehensions and also included non-responses, but were a much more positive result than when the question was first asked to establish a baseline prior to any instruction. Still, three of nine students left the answer blank. Also, there was again one particular student that displayed anomie or simply apathy with this answer: "Sustainability is environmental crap." The majority positive responses, though, showed a developing understanding of sustainability, for example: "To be able to run the world through all time;" "Use our resources so we have some left;" and "The pace that we are using our resources in should be sustainable."

This question was very open ended and perhaps the most difficult asked. Because it was so formless, the students had to piece a great deal of information together to develop their answers. Also, as was apparent from earlier classes, the students had a tendency to tire if pushed to work beyond their comfort levels. This question, which required a bit of thought, may have pushed students harder than they wanted, but there were still some positive results.

Responses to Question 3 (allowed to work in groups): Name a sustainability problem and provide some solutions for that problem.

Water management, toxic wastes and oil resources were offered as examples of sustainability problems. Suggested solutions varied from leaving it to future generations or doing research, to simple demands to stop unsustainable practices now. This question tied together information from all of the lessons and thus was considered a good final measurement of the students' learning, though as mentioned previously, student participation wavered during latter portions of the lessons. Most answers were short, but did show both information taken directly from the lessons and information from outside the scope of the lesson, requiring an independent application of the knowledge gained. Out of six responses received, all showed some understanding by citing a sustainability issue, and by offering valid beginnings to solutions to the respective problems.

3.1.1 Discussion of Session One Results

While qualitative in nature, the above questions provided indirect feedback that helped to shed light on our hypotheses and the effectiveness of questions in aiding teacher decision making. Regarding this, factors particular to the TIME sessions may have been significant to the results we observed. We were informed by the regular teacher of the TIME class that our particular group of students tended to be hesitant about participation during discussion. This hesitation was very likely accentuated by the circumstances surrounding the session. The class took place the first thing in the morning, at 8:00 AM, and the students were expected to learn a new subject for which they would not be responsible from a completely new person. Although the class did “warm up” eventually, we feel there might have been a lack of student effort in responding to the survey questions since the work was not graded and there was little time to establish a strong relationship with the students. This group of students was thought by us to have a high level of ability since almost all were in their last year of secondary school, but consequently they were also thought to be in some ways apathetic and blasé when it came to complex social issues like sustainability. This combination of factors reinforced the contention of our hypotheses by indicating that, due to shortness of time, lack of teacher skills or both, entry into the students' comfort zone was not fully achieved

and the development of a full range of questions and remediations also could not be achieved. Thus the lessons did not yield a clear student commitment to sustainability that was our hoped for goal. A further issue of concern was the difficulty of tailoring the material to a heterogeneous class in such way as to not lose some to boredom or others to confusion. The attempt to make sure no one was left behind made it difficult to treat all the material as thoroughly as we wished to do.

The survey results showed that the students may not have been so enthusiastic about much of anything and especially SSD education. This is interesting in light of the fact that the students were responsive to questioning. During the lesson, students provided a good level of quality responses. At no point did an entirely new metaphor need to be used. Perhaps new phrasing of questions was needed, but there were no major divergences. There was always at least one student who seemed capable of answering any question asked. The first survey responses showed a lack of knowledge, but also a lack of connection to the subject. Many of the answers showed a desire not to write very much. Later question responses showed greater responsiveness from the students, which may be attributable to the fact that they had some time to warm up and understand the topic and that the teacher had succeeded somewhat in making a connection with them. They seemed to know some of the qualities that make a country unsustainable, though it is unclear whether they knew what makes a country sustainable. The last question showed again either a lack of understanding or a lack of connection. Responses were comparatively low compared to question two. Focus is needed on the beginning and the end of the class to ensure that comprehension and participation occur during these times.

3.1.2 Discussion of Session Two Results

As originally feared, the second class had a few students that were absent during the first session. Also, the session was again the first instructional period of the day after a week long break and the students were very subdued. This added to the necessity for review at the start of the session which provided new students a chance to hear the basic concepts, but also forced the students who were at the first session to activate what still remained in their heads. In this way, the hook and ladder looping process took place at several levels. We looped back to meet the students present at

the first class, but those students then looped back with their answers to meet their classmates. Although the pace of the first portion of the class was at times slow, due to many low level questions, it served to lay a good foundation for the latter portions of the class. Throughout the lesson, again, the students were capable of answering almost every question and thus no major looping needed to occur. At most, questions needed to be rephrased. The use of questions provided an effective method for combating the apparent air of apathy within the group, and seemed to provide evidence that questioning does help student involvement and comprehension, as well as teacher decision making.

The second portion of the class was centered on the mineral cycle and seemed successful at conveying some of the concepts of sustainability through both metaphors and a physical model. The use of cell phones and MP3 players to represent the most toxic material, pens to represent the medium toxic material and paper balls to represent the least toxic material seemed to engage the students with the material. Thus a remediation was successful in impressing on the students what items of their everyday life come from toxic metals and how deeply their lives are tied in to sustainability issues. The students also started to get an idea of the depth of what solutions in sustainability entail..

3.2 TIME Lesson Questions

During the second TIME session, we recorded the questions used during the lessons to confirm that the method was followed and to verify whether the lesson questions used yielded answers that appeared later in the survey responses. Table 3.1 is an approximate list of the questions used during lesson 3, the first lesson of session2, arranged in the order they were raised and according to which questions were high level questions, requiring more thought, and which questions were low level questions, which are predominantly aimed at bringing about recall and checking for comprehension. The table provides a form of narrative or running development of the lesson. The rationale for which questions were low level and which were high level is that, within the context of the progression of each lesson, the low level questions were each a lead-in that familiarized the students with concepts that would help prepare them to cope with the greater complexity of the high level questions. The attempt was to prepare the students for each high level question in such a way as to maximize the effectiveness of the metaphor.

<i>Table 3.1. TIME session 2, lesson 3, high and low level questions</i>	
Low Level Questions	High Level Questions
Are we sustainable?	
	Why are we not sustainable?
What have we done during this race?	
	Why is the world not sustainable?
	How is the world running too quickly?
If we want to make the world more sustainable, what do we need to do?	
In what way should we use our resources?	
What do you do to solve an upstream and downstream situation?	
What happens when this problem occurs?	
If we need oil, what do we do?	
What happens when we drill?	
What's left if we drill for oil?	
What is needed, what is the impact when drilling for oil in an area?	
Are there many problems?	
	Rather than drilling what can we do?
	Are we sustainable or unsustainable?
What are the general rules for being a good football player?	
	What advice could you give this world to be more sustainable?

Listed in table 3.2 are the approximate questions used during lesson 4, the second lesson of session 2, in order of use, and again separated by whether the questions are high level or low level. As in lesson 3, above, the contextual circumstances of the lesson determined the quality of whether the question was of low or high level. An emphasis was clearly placed on the importance of what the students themselves can do.

Table 3.2. TIME session 2, lesson 4, high and low level questions

Low-Level Questions	High-Level Questions
What are the most dangerous materials beneath the earth?	
How much most dangerous material is there?	
How much medium dangerous material is down there?	
How much least dangerous material is there?	
	Why is good thing for us?
Is it safe for us or dangerous?	
How much very toxic stuff goes back into earth?	
How much medium toxic stuff goes back into earth?	
How much least toxic stuff goes back into earth?	
	In the natural cycle, how dangerous is our environment?
Which one represents the least harmful?	
Which one represents medium harmful?	
Which one represents most harmful?	
What do you think we make VCRs or cell phones from, most, medium or least toxic material?	
	What do you think is the impact on the environment? Is it good for us?
How much most toxic stuff is in our environment right now, in a natural state?	
What do you think will happen if we put human interference in this cycle?	
	If you were in charge of industry what would you do?
How many cell phones do you have?	
What do you do with your cell phone?	

How quickly are materials returned to the earth from the dump?	
Can you return toxic materials any more quickly to the earth?	
Which is more harmful, the before or after situation?	
	How is our environment affected?
What are we doing with our rarest and our most harmful material?	
What is the consequence of method?	
What are we doing to our environment?	
Where did we bring this stuff?	
	How can we deal this situation?
What is our problem?	
What is the result of this?	
What can we observe in our garbage?	
How many materials are here?	
What are the side effects?	
	How can we solve this problem?
Can you make laws or any other things?	
How can government help to solve this?	
Consumers, what do they do?	
What is our situation right now?	
Can we stop production of cell phone? Is it a quick fix?	
	Especially, what can you do to solve this problem?

3.3 Interview with IB III Student

Looking at the results from the surveys, we saw a disjunction between the study's hypotheses and the survey questions. The surveys, having been designed to gauge content comprehension, did not directly provide evidence for the fit of the hypotheses. To gain more direct insight on how effective the use of metaphors and questioning was, we interviewed a single student, IB III, and asked her to comment on whether the method outlined

in this study was effective. This student was present during the piloting section of the study so she was able to observe as a subject the development and application of the method and her reactions to our initial attempts provided valuable feedback with which to check our approaches and act to refine them before introducing them to the TIME class.

Summarizing her comments, she told us that she perceived that there are strong links between the lecture material and daily life, that class uses of metaphor were effective and that almost every use of metaphor reminded her of some previous knowledge, and that lessons helped to create awareness of sustainability. She also noted that questioning increased class involvement and encouraged her and other students to think about the material more deeply.

4 Discussion

After the TIME sessions, we looked at the survey results to check what knowledge if any was gained as a result of the lessons. For the purpose of brevity the complete set of answers have not been listed, but only summarized in chapter 3. Originally, we intended to answer the question: How does one teach the often complex subject of sustainability in a way that is meaningful? To that end we developed and used the hook and ladder method to introduce the subject to a class of 15 secondary school students and saw a positive qualitative change in knowledge. Thus, we argue that the methods outlined previously were successful, predominantly due to the following factors:

1. successfully building trust was an important first step in communication
2. the use of questions aided in student involvement and teacher decision-making
3. metaphors, analogies, etc. were helpful in facilitating education

These three results correspond to the expectations of our hypotheses. Building a relationship between teacher and student, primarily through the teacher's initiative in finding and moving toward the students' comfort zones improved student acceptance of the sustainability message. Effective questioning facilitated the teacher's understanding of the students' perspectives and pedagogic decisions as well as student understanding.

Finally, adaptive use of metaphor, remediation, that was sensitive to the immediate classroom environment aided comprehension of the subject. The following discussion analyzes the study's data along the lines of the previously mentioned factors.

4.1 Checking for Delta in Knowledge

To gauge the effectiveness of this study's methods of communication, we surveyed students intermittently throughout the lessons. First, the students were asked what they knew about sustainability to establish a baseline of knowledge. Then answers to subsequent questions were studied and compared to the responses to the initial questioning to see whether significant learning had taken place.

4.1.1 Delta in Knowledge

Comparing the baseline measurement to the answers seen in the second TIME session, a discernable difference in knowledge can be seen. Students originally showed no knowledge of sustainability, while answers to questions two and three of TIME session two showed a developing ability to define sustainability, cite a sustainability problem and begin to offer solutions to that problem. Still, this delta in knowledge can be attributable to several things, and not specifically this method of communication. It could be said that a traditional lecture style of communication would have been just as effective. Thus, to gauge whether our hypotheses were valid we also looked at our results in terms of action research methods.

4.1.2 Metaphor Language in Responses

Looking at the survey results, we saw that the language of the metaphors used during the lessons, in several cases, guided the answers that were received. In other words, the context and guiding principles of the metaphors could be seen in the answers. In the first TIME session, the metaphor of a race was used to explain the world's sustainability situation and the language connected to the metaphor appears in several answers to the survey questions. For instance, in response to the question, "are we sustainable at this time? why or why not?" the answers reflected the race

metaphor with references such as: "too much [...] to keep on going;" "too fast;" and "too fast to keep going." During the second TIME session, the language of this same metaphor appears again when the question "what advice could you give to make the world more sustainable?" appeared. Here the solutions were stated in terms opposite of too fast, including: "use renewable resources at a slower pace;" "slow down our consuming;" and "use our resources less."

These answers show common patterns in language use that echo the language used in the lesson. In other words, the metaphor of the race and the language used in understanding sustainability through that remediation/metaphor found its way into the way the students understand sustainability (80% for the question "Are we sustainable?" and 62% for the question "What advice could you give..."). Thus, at some level, the common context of the metaphor provided by the framework for understanding the content was effective, and moving to the students' understanding and level of reference, through the use of metaphor, was also effective as this resulted in that language providing some framework for comprehension in their responses. Also salient is the fact that the same language showed up in the later session two weeks after the first class, though after a short review. Thus, the delta in knowledge, when considered in conjunction with the language used in the answers, shows both gains in knowledge and also that the use of metaphors aided and shaped the understanding.

4.2 Question Lists

Combining anecdotal evidence and the list of questions, we felt that using questions aids greatly from the presenter's standpoint. They provide essential feedback for directing a lesson. During the lessons, teachers recorded that questions helped in deciding what path to take with a lesson. A lack of answers or correct answers helped point the teacher to finding different metaphors for a lesson, but as well, the use of questions also helped teachers when comprehension was lagging. Regardless of the tact a teacher chose to take, the use of questions was essential to making decisions. With the information gleaned from constantly questioning students, a teacher can decide whether to move ahead with a lesson, backtrack to review and buttress what has been established before moving ahead, or decide to find a new example or metaphor to use in instruction.

4.2.1 High Level and Low Level Questions

The awareness of using high and low level questions also proved helpful when communicating. Referring to tables 3.1 and 3.2 that show the use of questions in lesson periods, a pattern may be seen in the way questions are used. On several occasions, four to five low level questions were followed by a high level question. This pace proved to be effective, anecdotally, using a series of low level questions to build up to one question that ties the information together. As well, this question usually represented a major piece of information that was imperative to the lesson. This sheds new light on the idea of loops within loops. The information of the higher level questions appears to be a staple piece of information that is essential to the overall objective of the lesson, while the low level questions are conceived as necessary, and to match the metaphor or example in use at the time. The high level questions lead to staple points and are supported by a series of low level questions that are created as needed during the lesson, and lead up to the answers in the high level questions.

4.2.2 Discussion of Interview with IB III Student

Anecdotal data provided by the journals we kept of interactions in the classroom and the list of questions used during the lessons show that questions helped in the teacher's decision making processes during presentations. Asking questions helped to guide the teacher toward the most effective direction for reaching the objective of effective education. Yet despite the benefit to the teacher's ability to present the material, questions remained about the effectiveness of questions for students during such presentations. The interview with the IB III student showed that questions do effect involvement. The student reported that she was actively thinking during the lessons and that information was not being simply given to her, but rather, she had to work to understand. Although the hook and ladder method is time intensive and therefore may be apparently less efficient than a lecture style, it is perhaps more effective for bringing about comprehension since it engages the student in the process of learning.

4.3 Building Trust

Before the TIME sessions began, we went to some lengths to create a relaxed atmosphere in the classroom where the students felt comfortable enough to answer and ask questions without fear of embarrassment. This came in the form of the presenter introducing himself, talking about his background, making jokes, letting students ask him questions about where his is from, making name tags for the class discussion, and engaging in conversation that had nothing directly to do with sustainability. These trust building exercises, while subtle, had important impacts on the communication taking place. In the case of the TIME sessions, unobtrusive joking and humor that did not detract from the lesson were effective at creating a rapport with the audience. It also conveyed a confidence that amplified this sense of trust. Inviting the students to make up silly or ridiculous codenames at the beginning of the class created an atmosphere where the students felt like they had a voice in the day's proceedings. Finally, displaying a strong knowledge of the subject matter, especially by being able to explain it in a number of ways, as necessary, also added to generating a feeling of trust between students and presenter. Whatever the method, it is intuitively clear that a presenter who is able to create a trusting atmosphere and invite an audience effectively into a discussion will have a better chance of successfully bringing about communication.

4.4 Fatigue and anomie

We feel it is necessary to point out that there was a clear factor of student fatigue and a degree of possible anomie during portions of the class, especially during the surveys. It is important to note that the surveys used in this study were short, and required little effort to complete. Still, answers during the first session in particular were at times lackluster. On one question, there was as low as a 50% return rate on survey responses. This low rate of return was coupled with the one student whose responses included "sustainability is environmental crap" and "destroy all humans," which, even allowing for youthful rebelliousness, suggests a deeper disconnect with general society. In the second session, response rates rose but it is important to note that it was after a comment urging students to respond truthfully from what they knew. While survey responses showed that the students may have gained knowledge from the lessons, if their effort on survey responses is an accurate gauge, it is difficult to say whether

their new knowledge will translate into real actions. If this is the case, it is difficult to say whether there is any difference between delivering information about sustainability in a lecture format and in the hook and ladder method. It can be said that there is no clearly established difference at this time. But if this study resulted in a method of raising awareness and creating knowledge about sustainability issues, perhaps it also positioned the classes closer to a tipping point such that the students will be more ready to take action in the future. At present, though, with this intervention alone, such positive action seems unlikely in view of the brevity of the study and the impracticability of follow up sessions. It is, however, perhaps also important to note that the IB III student, after the pilot sessions of this study, decided to pursue sustainability in her undergraduate career, so although she already showed a pre-existing awareness in this subject matter, in an unorganized manner, perhaps this method was effective in reinforcing her interests in taking action.

4.5 Opportunities for study refinement

In terms of improving on this study, if one were to extend on the work already started with this study, there are some avenues to explore:

1. Working with a greater number. After piloting the initial interventions, this study had greatly exhausted the possible pool of test subjects. Keeping this in mind, this study would have been well served to have had more test subjects who were capable of being tested for longer periods, to see the longer term effects of this method, as well as providing insight by simple means of numerical representation and variety
2. Finding a wider range of people. This study focused exclusively on secondary age students, and thus, there were tendencies like apathy and other pattern behaviors that are typical of people that age that could act as a hindrance towards effecting change that would result in action. Extending the test ages to a wider range might see better results, as adults or younger children, missed by this study, may be more receptive to these ideas as a springboard towards action.
3. A better baseline measurement. The only measurement of pre-knowledge used in this study was a single question, which showed

no previous knowledge in sustainability. Beyond that indication, we could have no clear idea how much knowledge students had in related topics or in sustainability though the lack of a structured definition made the audience unaware of their prior knowledge. A more refined picture of how much or little knowledge an audience has would give a better idea of how far an audience may be from action, which would in turn inform a study like this one, where information capacity is attempted for the ultimate purpose of effecting action.

5 Conclusions/ Recommendations

Education is a complex process, and though comprehension was seen during this study, it is still not assured that what was accomplished will result in a positive impact on the students' attitudes or the future of sustainability. What this study can be seen as is an extension of a method of communication that has been used extensively by The Natural Step organization and is part of the framework of Strategic Sustainable Development. Taking up from where talk of the funnel, the trees and the leaves, playing chess, etc. finishes (Robert and others 2004), this study explored what effect these metaphors have on effecting capacity and learning. What was discovered, though, was that many other factors play important parts in the transmission of information, and still others play a hand in whether or not the transmission of knowledge results in sustained change in thought and finally action. If this method was effective at making people more likely to take action because they are more versed in the problems facing the earth and maybe some of the students begin to look at their own habits a little differently, then capacity was augmented and some success was met. Looking at the positive results of this study, what can be made as suggestions to facilitate SSD communication would be the following:

1. Repetition of the process. In this study, gains in knowledge were seen after only one session, but how this translates to the real world is far from easily seen. Students learn in different ways and styles, but the criteria that determine how much a given student learns in the class is governed in part by that student's native ability and prior preparation and also by the compatibility of his or her learning style and the teachers teaching style. Repeating the process, reinforcing content and understanding and filling in the sustainability picture with more lessons would give students both a clearer picture of the world (and its dire situation) and a better understanding of sustainability issues as a whole. As well, even if information is retained, to be helpful as a means of effecting change, action needs to result and this would only be helped by revisiting the content and process for more than the study allowed.
2. Listen to the audience. If social sustainability is about maintaining the social fabric, then dialogue will be central to a desired future. Current beliefs on instruction tend to reject traditional pedagogic

practice and emphasizes an active role for the student (Dufresne and Gerace 1996). Student teacher communication (what Dufresne and Gerace called classtalk) is a tool that can help create the interactive classroom environment needed to facilitate the hook and ladder method. Consequently, questioning and metaphor for explaining SSD concepts encouraged higher levels of classtalk and trust between student and teacher. In this study, the students were centrally involved throughout the lessons, and they reported being more engaged in the learning of the lessons as, through questioning, the audience constantly had an opportunity to provide input and affect the direction of a lesson.

3. Connect with the audience. This can take place in a number of ways: physically, through proximity; emotionally, through personal questions; intellectually, through the use of metaphors, remediations, and alternate methods of explaining SSD. A good and trustworthy relationship between student and teacher is the key for improvement and good relationships nurture the communication and understanding necessary for support of substantive school and curricular restructuring. This relationship is also a social relationship during study sessions and some times also after them as well. If social sustainability is about maintaining the social fabric, then open dialog will be central to desired outcomes. In this study, the audience was centrally involved and reported being more engaged in the learning of the lessons. Through questioning, the audience constantly had an opportunity to provide input and affect lesson direction. Through the process of moving to the audience, then, a connection, both linguistic and emotional was made, which facilitated communication and built trust.
4. Provide more time for presenters to become adept at the method of communication. This idea works in conjunction with suggestion 1. Presenters who are new to this method will likely be more comfortable in the traditional lecture styles, and thus tend to be uncomfortable with the idea of straying from a scripted structure when presenting information. There is a give and take at play where people fear the lack of structure or divergences mean incompetence or a lack of preparedness. This method requires preparation but it also attempts to bring about greater comprehension and a more effective rather than efficient transfer of information. To make this

shift from efficiency and scripting to effectiveness and acceptance of divergences and audience contribution, one must become inured to this method through practice. We found that our first sallies with this method were uncomfortable and that often we tended to slip back into traditional methods. Thus, practice and repetition are needed.

Furthermore, we found that two instructional criteria need more focus: probing student understanding; and guiding student interpretation and reasoning. We found that some of the patterns of our practices needed to be modified. For example, question preparation should support revealing the development of students' conceptual understandings. High level and guiding questions should focus on helping students build broader and deeper conceptual understandings. A further important element that should be taken into account is the diverse learning needs of students who may have significantly different cultural and experiential backgrounds. With the IB classes of mixed nationalities, we observed that some students could complete a task quickly and have nothing to do while other students were having difficulties. Therefore, we recommend that teachers focus their instruction on building conceptual understanding. Generally, much more focus is needed on strategies of questioning since it seemed to us a potentially fruitful way of moving the students effectively.

Where traditional learning styles are not used, our experience with the diversity in the IB classes illustrated how important it is to develop an atmosphere of team learning where the team is the students and teacher together. This team learning environment empowers both student and teacher because students gain knowledge and, in the light of students' response, the teacher can adapt to their needs and also can understand how much they are learning. Accordingly we found that the teacher must be proactive not only in course design and overall management of learning and instructional processes, but also in developing the interactive social climate of a team. This is most possible when the evaluation and instructional process employed in team learning creates conditions in which the vast majority of students willingly share in the responsibility to ensure that learning occurs. Diversity can increase the complexity of accomplishing this and, therefore, requires more teacher attention.

It is mandatory for teaching sustainability, or any subject, to have also a solid grounding in the fundamentals of the topic and the ways of representing those ideas before teachers can think productively about how to improve their strategies for questioning students. On that point, metaphors and questions were the primary instructional tools that we used to make abstract ideas clear. After getting familiar with the appropriate metaphors and questions, teachers should welcome the opportunity to examine other tools that might help particular students, especially in diversified classes. Moreover, examining a range of metaphors and questions from other sources would probably enable teachers identify critical attributes of representations that are helpful for clarifying abstract ideas.

Real success in the classroom, then, occurs when it is shared and enhanced by a simultaneous working together of students and teacher, since it is in the nature of our method that students are prompted to participate and to take a degree of responsibility for the outcomes. Thus, the students become the most valuable asset in the design of our method since the continuous designing, refining and redesigning of the hook and ladder approach totally depends on student participation; it is in the light of feedback collected from students that corrective action is taken.

The success of this model requires teachers to be open to suggestion and to be always ready to change their methods according to the response of the students. The fact is that the teacher should retain a high level of control over every major element in the hook and ladder method such as subject (spoken words, depth of topic, making modifications, jokes, illustrations) and style (mode of delivery, tone of voice, facial expressions, movement, actions, discussion or debate) which makes the teacher very responsible for the method's success. So with this awareness, the challenge is to immediately recognize any barriers to learning and then to implement a corresponding solution with an appropriate use of subject and style that is sensitive to the students' feedback.

The importance of feedback collection should be emphasized. Shortly, it is one of the most striking and crucial parts of continuous improvement of teaching and learning in our method. Furthermore, for any continuous improvement effort to be effective, quality and reliable feedback is essential. Especially in our hook and ladder method, continuously collected

and analyzed feedback information is the centerpoint of our improvement actions for the planning of lessons, teaching style, appropriate humor etc.

Our method needs feedback collection because good feedback from students gives the teacher a chance to see the kind of changes that should be done to become more effective. Otherwise, it cannot be known how well the students are learning or how students respond to specific hook and ladder method approaches. We believe that feedback in approaches like the hook and ladder enables us to know what sort of actions and improvements are needed and what points need to be reviewed, reiterated and recapitulated so as to make the learning experience in the classroom a more complete one. In that regard, we see it as a crucial part to make a clear diagnosis of the problems taking place in teaching and learning and to use good analysis of feedback results.

The hook and ladder method, then, can be described as a unique teaching and learning method due to its special techniques and the approach that it employs. We developed the original idea of the method through the incorporation of the five level framework and the Deming cycle. Employing these two tools to increase the quality attributes in the educational context creates value for our method. It focuses on building quality relationships by generating effective communication among lecturers and students, and effective use of learning materials. By the incorporation of these two, we realized the important focus areas of our study, especially through the holistic viewpoint of five level framework and the iterative, continuous improvement nature of the Deming cycle. While enhancing the capability of our method with these two tools, we also took into consideration the importance of pedagogical methodology.

Further research questions would include:

1. Is there any greater level of individual participation in taking action for change generated by the hook and ladder approach versus, e.g., the traditional lecture approach? If any greater level of active participation is generated, is that greater participation consistent with every teacher's use of the method or is the method's success or failure to stimulate action a function of the individual teacher or teacher skill?

2. How well would this hook and ladder approach fit with educational systems that are poorly funded or rigidly structured? Education in less industrially developed countries may sometimes be less capable of supporting methods like the hook and ladder because it requires teachers to embrace a freer, more formless style of instruction that might be seen as unaffordable luxuries.
3. How would such a method of instruction be received in more culturally restrictive areas? In an attempt to adhere to the fourth sustainability principle of TNS – people are not subject to conditions that systematically undermine their capacity to meet their needs (Robert et al. 2002) – this method calls for audience participation, questions and answers, dialogue. In some cultures, such qualities are frowned upon, and thus, the question stands as to whether this method would be effective or adaptable to students of such areas. Could constant questioning overcome such cultural mores?
4. How effective is the lecture style? In comparison to the method used in this study, there is still the traditional lecture method which has been prevalent for years. If this is the case, one should at least question just how effective this method is at transferring knowledge by gauging the delta in knowledge for educational interventions using a lecture style. Perhaps it is both more efficient and more effective.

There are five considerations that can make improvements in sustainability education practice: plan actions with deliberation, imagination, and with understanding of the educational environment; act more experimentally and more responsively, don't fall back on established habits; check and study what occurs, collect reliable, quality data, use feed-back from multiple sources systematically; analyse the process to improve its effectiveness while always questioning our preconceived ideas and maintaining a healthy skepticism; learn from experience and share what is learned with other teachers and students.

In sum, therefore, what was learned in this study is that for similar action research and hook and ladder based sustainability education, it is

important to regard it not as an entirely new strategy, but as a process in which all participants can learn from experience. In the end, it is actually about doing what comes naturally, but in as systematic a way as can be achieved.

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Appendices

Appendix A-Teacher Skills Survey, Responses, and Summaries of Responses

Name: _____

Criteria of Effective Teaching Survey

Matulac, Araz, Muhammed

1. Do you script questions into your teaching plans?
2. Do you use different kinds of questions during your lessons? What kinds of different questions do you use?
3. When teaching, under what circumstances do you leave your scripted plan?
4. In the case of such a divergence, what criteria do you use to decide whether the divergence is legitimate? Which are legitimate paths to explore and which are not? Is the choice guided by curriculum standards, the interest of the students, current events?
5. Do these divergences happen often?
6. Do you feel that it is necessary to be able to explain your subject matter in more ways than one? If so, then why?
7. Teachers have used unreasonable (though fake) rules to introduce the novel, One Flew Over the Cuckoo's Nest, or explained Captain Ahab as being similar to the coyote chasing the roadrunner. Please recall a notable episode where you needed to find a new way to explain a topic. What techniques did you use and find most effective?
8. What general rules do you use in your instruction, planning, and in-class demeanor? Please be thorough in salient cases (general rules that are important to you). Do you make sure that you spend extra time reviewing content? Do you focus on classroom atmosphere?

Do you try to keep students interested? Do you use stories or metaphors to aid comprehension?

9. What techniques do you use to make a topic that is difficult to grasp meaningful to your students? Do you use metaphors to help explain? Do you use hands on activities? If so, explain one particular effective technique.
10. What lessons have you learned in lesson planning?

Appendix B-Lesson Plans

Lesson One

Level: High School

Summary: Planning in a complex system can be difficult. Due to the lack of linearity, one cannot be sure that an action will necessarily lead to a certain outcome. Thus, it is impossible to predict the future. What we can do, though, is affect the future. We can shape the future with our actions. This lesson is designed to show how our actions may not necessarily lead to an outcome but make a certain set of outcomes more likely. Also, it shows how climate change is an effect over which we have control.

Essential Questions:

1. How does the Law of Conservation of Matter affect sustainability?
2. What is the importance of carbon stocks and flows?
3. **How do you plan in a complex system?**

Do Now:

Will the son or daughter of an alcoholic become an alcoholic?

Aim: What is the effect of excessive carbon in our atmosphere?

Procedure:

Opening discussion:

1. Students answer the Do Now
2. Have them discuss their answers and reasons in pairs (5 minutes)

3. Come together to discuss whether a child of an alcoholic will necessarily become an alcoholic. It is too complex a situation to predict what a child will be.

Introduce global warming:

1. Ask what students know about **global warming**. What causes are there? What is greenhouse effect? Etc.
2. What are the major greenhouse gases?

Activity:

1. Have students tear a sheet of paper into 20 pieces, writing the following words on the pieces: (group one) fight (on three pieces of paper)/ not 1x/ avoid 1x/ anger 2x's/ promise 2x's/ (group two) avenge 2x's/ force 2x's/ react 2x's/ frustrated 2x's/ punish 3x's.
2. Have the students write a poem using the words in group one.
3. Review poems' topics. Were they necessarily violent in nature? Why not?
4. Write a new story using the next group too.
5. Make predictions about what the stories will be about.
6. Will the stories necessarily be about violent things?
7. Were the chances greater that they would be about these topics? Why?
8. Can you predict what will happen in a situation as complex as this?
9. What happens to the chances that the stories will be about violence as you flood this system with terms to do with violent terms?

Link to sustainability:

1. How do our present habits contribute to greenhouse gases?
2. What will be the result of these greenhouse gases? You do not know.
3. How should we amend our behavior in this complex system?
4. Can we predict what will happen?
5. What can we do if we cannot predict the future?
6. What are some other outcomes to flooding our system with carbon?
7. Ask exit questions:
 - a. What will be the effect of excessive carbon in the atmosphere?
 - b. Can we predict the future?
 - c. Ask a question concerning this topic.

Lesson Two

Summary: Planning and understanding of problems through ABCD methodology is not a tough job. It is easy and interesting. Obviously it's impossible to predict the future 100% but through this method we create a mental model regarding future and also prioritize some actions for our goal. And we can shape the future with our actions. This lesson is designed to show how we can do this.

Key terms: ABCD, back casting, funnel

Objective: Make the students sure that what will be the use of ABCD in daily life, and also make students know backcasting with ABCD methodology and also they will know the effect of air pollution and how we solve it through this method

Essential Questions

- 1- What's a meaning of ABCD?
- 2- How do we use this for planning?

Procedure:

First off some talk about just common things: How are you? What are your activities? Then I will introduce the example of air pollution; from this they will understand ABCD methodology and funnel.

Opening discussion questions:

- 1- What you think about our environment?
- 2- Do you think our air is good or bad?
- 3- If it is bad what are the reasons?
- 4- When you look before five years was the air as good as compared to today?
- 5- Does air affect the daily life of animals and plants?

About the current situation of the earth regarding natural resources and demand through funnel, ask some questions like:

- 1- Do you think that our resources are increasing or decreasing?
- 2- Is our use of fossil fuels good or bad?
- 3- Are fossils fuels are the cause of pollution?

C level questions would include:

- 1- In your point of view what should our environment look like?
- 2- If we use bio fuels is it good for our environment?
- 3- What will be the criteria for achieving the goal of good environment?
- 4- How can we solve our problems in sustainable way?

Ask some question about actions for achieving this goal like

- 1- How can we reduce pollution?
- 2- Can we meet with Government officials regarding this matter?
- 3- Can we make a campaign for this and design educational program for this?

I will use maximum white board, draw one or two diagrams, because in the beginning I will introduce the ABCD and funnel and then I will put example of pollution so that why they will understand the ABCD and funnel through this example and at the end I will ask some questions for survey like:

- 1-Is this method is easy for problem solving at school level?
- 2-How can we reach systematic thinking by meaning of ABCD process to sustainable society?
- 3-Any question

Lesson three

Five level framework

Summary: This lesson was designed with the aim to gain the students a systemic approach for planning within the business sector for achieving sustainable results and to add more tangible results to sustainable world. Make the teaching subject clear and understandable, we used student success story as an example to make the teaching subject familiar for student, after this examples student were waited to understand the teaching subject and take a role in the application of the systemic approach of the framework to the our second example, which designed as a company by the teachers.

The managers of the company have been seeking a way to increase its market share in along and sustainable way.

KEY TERMS: Five level Framework Sustainability, Strategy

Objective: by knowing the importance of system level in five level framework, to explore the system level in detail to get a thorough understanding of its working conditions and the environment affecting the system externally.

Procedure:

An example of student success story mainly deals with someone who wants to be successful in his high school education. Besides, we know that students involvement into process becomes more effective if he/she feels more familiar the subject that we teach.

As part of the learning and teaching process, we started to warm-up by asking simple types questions about student life. Actually, it was starting of investigation to create a baseline for the system level of five level framework.

The questions sequence was from system level to tool level.

Discussion questions

After giving some clear examples and exploring the first example by the question lying down , we changed our direction into building phase of our specific five level framework for our company wanting a produce a car in a sustainable way and by employing five level framework regarding planning its sustainability point of view all around the company.

Level 1: System level

System level

Student success story example	Company example
Do you like being a student?	What first comes to your mind when we start to talk about this factory?
Do you think that being a student sometimes makes you feel bored and why?	What modes of transport, materials, and energy does the company depend on?
How many of you like reading a book, doing homework, making research?	What does the company deliver and produce?
When we talk about the student life which things come first to your	What types of wastes are left?

mind?

Success level

Can you define a success in your student life? e.g. having a good grade

The company produces some kind of products that cause some environmental problems in the long run, even in a short term company gets a big profit, does the company is successful enterprise?

if you want to be successful student If the company does not behave which kind of things are mandatory ethically and contribute to economic to be done ? development while improving the quality of life of the workforce and their families, as well as of the local community and society at large.” is it successful?

Strategy level

If you do not attend the class your In order to apply sustainability success level can go down? principles throughout the company, do Regularly doing homework and you need some changes in the studying hard are a good way to be a production techniques of the successful in the class. company?

Team work can inspire you in some Do you need to inform the consumers ways? about the consumption of the Can you also learn something from company product in a sustainable your classmates? way?

Action level

What should be done to be a Can you suggest some ways for the successful student? e.g. regular company in the transition to a attendance, team work sustainable company?

Tool level

Having a good grade can be sign of Should we encourage all employees to the success? participate in continuing educational opportunities?

Do we prepare some surveys to learn

health and welfare impacts of company products and services?

Survey question

1- How can we describe sustainable company within sustainability constraints?

Lesson Four

Summary: Planning and understanding of problems through ABCD methodology is not a tough job. It's easy and interesting method. Obviously it's impossible to predict 100% about future but through this method we create a mental model regarding future and also priorities some actions for our goal. And we can shape the future with our actions. And this lesson designed to show how we can do this.

Key terms: ABCD, back casting, funnel

Objective: Make the students sure that what will be the use of ABCD in daily life, and also student will know back casting with ABCD methodology and also they will know the effect of air pollution and how we solve it through this method

Essential Questions

- 2- What's a meaning of ABCD?
- 2- How we use this for planning

Procedure:

First of some talk about just common things like how are you and what are your activities etc etc and then I will put an example of air pollution due to this they will understand ABCD methodology and funnel.

Opening discussion questions:

It's will my first lesson so I deliver a lecture regarding above topic, first I will discuss about environment and air pollution like I will ask these questions

- 6- What you think about our environment?
- 7- What you think our air is good or bad?
- 8- If it is bad what is the reasons?
- 9- When you look before five years is air was the good as compare to today?
- 10- Is air effects daily life of animals and plants?

And then about current situation of the earth regarding natural resources and demand through funnel, and here also I will ask some questions regarding this like

- 1- What you thing that our resources are increasing or decreasing?
- 2- Use of fissile fuels is good or bad?
- 3- Are fossils fuels are the cause of pollution?

Here I will turn towards the C level questions like

- 1- In your point of view what should our environment looks like?
- 2- If we use bio fuels is it good for our environment?
- 3- What will the criteria that we can achieve the goal of good environment?
- 4- How can we solve our problems in sustainable way?

And then I will ask some question about actions for achieving this goal like

- 1- How can we reduce pollution?
- 2- Can we meet with Government official regarding this matter?
- 3- Can we put a complain for this and design educational program for this?

I will use maximum white board, draw one or two diagrams, because in the beginning I will introduce the ABCD and funnel and the I will put example of pollution that why they will understand the ABCD and funnel through this example and at the end I will ask some questions for survey like

- 1-Is this method is easy for problem solving at school level?
- 2-How can we reach systematic thinking by meaning of ABCD process to sustainable society?
- 3-Any question

Lesson Five

Summary:

Human Scale Development is defined as "focused and based on the satisfaction of fundamental human needs, on the generation of growing levels of self-reliance, and on the construction of organic articulations of people with nature and technology, of global processes with local activity, of the personal with the social, of planning with autonomy, and of civil society with the state." So there are need to the understanding of basic human needs and the distinction made between needs and satisfiers. Human needs are seen as few, finite and classifiable

Key terms: Basic needs, Human need matrix, satisfiers

Objectives: Student will understand basic needs and the class will be made to understand the human needs and with the help of Max -Neef concepts they will be made a viable connection between human needs and society. They will also be tell that how to create a sustainable society and moral systems where all the individuals are provided with the basic needs of life. The whole lesson will be deliver in a quite an interactive way, where all the students can participate I hope they will respect these needs after this lesson

Essential Questions

- 1- What are the human needs?
- 2-What are the basic human needs according to max neef?

Procedure:

First student will warm up with some talk, like

- 1- How are you
- 2- How's your week end?
- 3- What you did during the week end? etc etc

Then I will put some easy questions like

- 1- What do you think about basic needs?
- 2- Is these are necessary?
- 3- What are your basic needs?

- 4- Your needs are the same?
- 5- And your needs are the same since the childhood and today?
- 6- Do you think that all children's needs a good start?
- 7- What are the difference between needs and satisfiers?

Then I introduce the max need matrix and I will explain the matrix

- 1- SURVIVAL – satisfied by the action of eating, being given shelter and so on.
- 2- PROTECTION – actions taken to keep children safe from abuse, neglect and preventable accidents
- 3- AFFECTION – receiving and giving expressions of love and friendship
- 4- UNDERSTANDING – studying, analyzing, investigating and exploring
- 5- PARTICIPATION – cooperating, accepting responsibilities and duties, expressing opinions
- 6- LEISURE – playing, taking part in sport or cultural activities, reflecting
- 7- CREATION – inventing, building, designing (art and music and drama ...)
- 8- IDENTITY – getting to know oneself, developing self esteem
- 9- FREEDOM – making choices, agreeing or disagreeing. A tenth is added by some:
- 10- TRANSCENDENCE – the need to express wonder, and awe – to feel a unity with creation, with the universe.

And then I put some question related to this matrix like

- 1- Do you think that these are basic needs or not?
- 2- Do you think that these needs are reflect all age groups or not?
- 3- Do you think that due to these needs there will social sustainability occur?

Then I will discuss that how we will achieve these basic needs like

- 1- What you think who are the responsible to provide these needs?
- 2- What you think that what are your duties according to theses matrix?
- 3- What you think that can we achieve social sustainability due to achieve these needs?

And at the end some question will give them for survey like

- 1- According to your mind are your society fulfill your basic needs?
- 2- How you take care these basic needs for other?
- 3- Any question?

Lesson Six

Key Remediation:

Reference to mining lesson for understanding of our environment

Lesson: LCA

This lesson linked previous information like the sustainability principles and work on the mineral cycle during which we established the concept of closing the loop and discussed ideas of reducing demand on toxic materials, reusing toxic materials, and researching the use of less harmful materials in industry. These concepts were used as a contextual base for discussing the topic of LCAs. In the lesson, an LCA for cell phones was developed, and once done, ideas for reducing the waste involved with cell phones were discussed.

Questions:

Questions varied from rapport questions (it was necessary to re-establish contact after a week off from school), content questions from previous lessons and content questions to verify learning throughout the lesson. Finally, there were also questions used to synthesize new information by combining new information from the SSD curriculum with previous information.

Impressions:

The scope of the lesson was smaller than previous lessons. Also, the time for presentation was smaller than usual. Class usually has no limit, but today, we had less than 30 minutes, thus the smaller scope of the lesson. Usually, two topics or lesson plans can be put together into a session for the purpose of maximizing the time with the students. This time, the smaller scope had the effect of increasing focus. As well, a greater opportunity for developing or redeveloping contact and rapport with the students was afforded. As well, the tone and mood of the meeting was lighter than usual,

perhaps again a result of having less to cover. Still, though the topic could have been covered more thoroughly, something was gained in shortening scope and spending more time in the social aspects of working with the students and teaching. The results from the class surveys show a good level of comprehension with a strong comprehension of previous lessons shown.

Survey Responses:

1. What information from the previous lessons did you apply to this lesson?
 - a. The four principles (Simon, Sebastian, Irene)
 - b. The four laws (Elise)
2. How does an LCA help in our decision-making?
 - a. It gives a clear view of our environment, and how the energy is disbursed.
 - b. You get an overview and make better plans.
3. How can you apply today's information elsewhere?
 - a. By taking more responsibility of our actions when it comes to our environment and health. You can look back on what we've learned and see what you can do to change the situation.
 - b. Same

Lesson Seven

Key Remediation:

Short-term and long-term goals and how we reach them are used to explain the idea of backcasting. These goals are used to show explore the behaviors we employ to reach a certain outcome.

Lesson: Backcasting

This lesson is designed to be delivered early in the curriculum to explain how the sustainability principles were created, but more importantly, it is used to lay a foundation for understanding planning in a complex situation. The lesson is based on the idea that there are several ways to get from point A to point B, and several unforeseen factors may emerge. This makes planning understandably difficult. Backcasting offers not the direct way to achieve anything (in this case sustainability) but it does offer the idea of a framework of rules within which one must operate to achieve his goals. Instead of saying this is what a person must do in order to achieve a goal,

which is impossible with constantly changing technology and circumstances, one can say what things are to be avoided, along with some general rules, and this will make achieving a goal more possible.

Questions:

Questions dealing with prior knowledge asked students to pick a short-term goal and a long-term goal. This was followed by a discussion about the behaviors needed to achieve the goal.

Impressions:

This was a difficult topic to cover, and some revision for the lesson could be made. Perhaps this is a result of the lack of resources. Meetings with Hanna take place in the library and thus no white boards are available. This severely diminishes the ability to remediate, the lack of diagrams. Also, lessons with Hanna must take the form of a conversation more than a traditional lesson. This makes the remediation and the questioning very different, since verification centers on only one person rather than an entire class. There will be remediation of this topic before trying it again.

Survey Responses:

1. Why in negative? You know what you should not do.
2. **Q: Who invented the four principles?**

Lesson Eight

Key Remediation:

Foil balls, paper balls and paper towel balls are used to represent toxic, less toxic and innocuous materials. These are then manipulated by the students to show the natural mineral cycle. This cycle is then altered to represent the effect of anthropogenic alterations of the cycle.

Lesson: Mining

This lesson is designed to build on the ideas presented in the first lecture that Hanna received that was used to canvas for volunteers for research. The original lecture introduced the idea of sustainability and the concept of strategically intervening in a system. This lesson's key remediation involves using manipulables (balls of foil, paper, and paper towel) to represent mineral deposits moving through the techno sphere. First, the natural cycle and rates of mineral release and remineralization are shown.

Later, the cycle affected by anthropogenic demands is shown. Differences are noted as well as unsustainable practices. Then suggestions for ameliorating the situation are asked.

Questions:

Initial questions dealt with recalling the sustainability principles and the importance of each one. Follow up questions during the lesson dealt predominantly with gauging whether the student understood the importance of the natural mineral cycle for the purpose of providing a point of comparison of the natural cycle to the one created by human demands. Final questions dealt with creating strategies for improving the present situation: What could a regular citizen do to fix this situation? What could someone in the government do? What could someone within the industry do?

Impressions:

Again, the conversational setting of this plan makes the lesson different from how it would be delivered to an entire class. If Hanna does not understand something, the silences are more pronounced and remediation and follow up questions must be formulated much more quickly. Still, Hanna was able to activate knowledge from previous experience and lessons to provide some good suggestions to the problems concerning our mineral cycle.

Survey Responses:

1. Give one strategy to reduce toxic materials being mined. Use less toxic materials instead.
2. Which of the substances appears most naturally? Least toxic.
3. Q: None

Lesson Nine

LCA:

Questions

This time running through the lesson, I made sure to ask whether Hanna's understanding of sustainability had been amplified. Questions otherwise followed the same path as the previous time through this lesson.

Impressions:

Hanna is developing a strong understanding of sustainability.

Survey Responses:

1. How can LCAs help in decision-making? You get a picture in front of you which makes it more clear to see for instance how much energy is wasted to produce a cell phone.
2. What information from previous lessons did you apply today? Using materials from the crust that you don't need to put at the dump. Recycle materials and send them back to the factory instead.
3. How can today's information be applied elsewhere? When we're donating money to help-organizations, I think there's a lot of money getting wasted at unnecessary things instead of the money directly going to the people. If you would draw an LCA diagram over the money's way you might find unnecessary stops.

Lesson Ten

Entropy and Causal Loop Foodchains

Questions:

What happens to a pile of dust left in a room? What happens to your notebook if you do not make sure that it stays neat? What happens to a car after you own and use it for a few years? What are the sustainability principles, emphasizing 3?

Impressions: This lesson moved well, but again the flow seemed too easy partially because Hanna is so smart and because it is a class of one student and the need for wait time and source of answers is so different from a regular class. With the flow being so easy, we were able to complete two lessons, Entropy and Causal Loop Foodchains, in one session. Hanna was able to see the interdependence between man and plants, and the importance of plants on the biosphere, then the interdependence of all animals, in a chain of Causal Loop Diagrams, to plants. This was a divergent moment where the decision to combine the lessons occurred almost on the spot.

Survey Responses:

1. What applications do you see for this information? It is helpful in the way we're fishing only one fish or just a few different kind of fish which will lead to an unbalanced area, which the chain shows.

2. What information from previous lessons did you use here? I think this was more different from the other lessons and there were new ideas.

Lesson Eleven

Backcasting and Mining

Key Remediation:

The backcasting lesson was revised in this case to explain backcasting in terms of personal success stories. We recalled personal success stories and asked whether following one person's success story would result in the same for everyone. This remediation results in the idea that the exact steps do not matter as much as the principles and rules that a person implements in reaching success. There is a great difference between drinking Gatorade because an athlete drinks it, and rehydrating during contests to get maximum performance, between eating vegetables and ensuring one gets the proper nutrition, and this lesson works to elucidate this fact to help the students understand the creation of a framework of rules for backcasting.

Questions:

What were the most important steps in your life towards becoming a successful student? Would these steps necessarily make anyone successful as a student?

Impressions:

Survey Responses:

Thursday, February 16, 2006:

Class: Karro, Verena, Yasmin, and Sevil

Lesson: CLDs and Positive Feedback Loops

Key Remediation:

Cases of drunk drivers and at risk students are diagrammed in CLDs to show the working of natural systems. In both of these cases, subjects can completely avoid catastrophe, but a complete collapse can also occur at any time. This fact is shown in diagramming both situations. This is a strong parallel to lake systems which undergo eutrophication; they can exist and

function on the edge of collapse, but when a threshold is passed, complete collapse occurs and returning to the original state may be impossible.

Questions:

Where are the places to intervene in the CLD of the at risk student? Do these behaviors, at risk behavior or drunk driving, necessarily mean that something terrible will happen? What kind of complexity exists in the real world? Can we totally predict what will happen? What is the danger of positive feedback loops?

Impressions:

The students began to understand the complexity of reality a little more with this lesson. They saw in this lesson that a person could drink and drive for years and suffer no consequences, but that same person could drink and drive once and suffer catastrophe. There is a great possibility for variety of outcome. What can be affected is the likelihood of catastrophe.

Survey Responses:

1. Why are positive feedback loops dangerous? They are loops which add to the problem and move us towards a collapse.
2. Do natural systems collapse slowly or quickly? Quickly
3. **Q: How can I apply psychology to sustainability?**

1. Why are positive feedback loops dangerous? Because they increase the bad things.
2. Do natural systems collapse slowly or quickly? Quickly
3. **Q: Why are you here giving class to us, and why the IB program?**

1. Why are positive loops dangerous? Maybe we miss the important points ?
2. Do natural systems collapse gradually or quickly? Quickly
3. **Q: None**