The History of a Curricular Technology: An Exemplar in the Use of Science &Technology Studies as a Research Lens

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Abstract: This paper presents an exemplar in the use of Science and Technology Studies as a research lens for studying teacher practice. To demonstrate our approach, we present findings from two overlapping research studies following the occurrence of a particular curriculum technology. In doing so, we find that, akin to traditional technologies, the curriculum undergoes significant reconfigurations at each occurrence. This challenges common assumptions about the stability and uniformity of curriculum across different teachers and different implementations. We offer four categories of technological reconfiguration, applicable to both curriculum and technology in general.

Introduction

In the last decade, work in Science and Technology Studies (S&TS) has gained increasing interest in the science education and science education research community. Such work has primarily fallen into two areas. The predominant area has been to use the findings of S&TS to expand the traditional content domain of science to include areas generally termed "Nature of Science" (NOS). This involves the inclusion of understandings from laboratory studies (cf. Collins 1985; Latour and Woolgar 1986) where issues of messy data, inscriptions, fact generation, and negotiations between and among scientists are divulged. This has included research into students' understanding of NOS, teachers' understanding of NOS and inclusion (or exclusion) of NOS themes in curricula (cf. Gess-Newsome and Lederman 1993; Abd-El-Khalick, Bell et al. 1998). A second area of inquiry has been the investigation of the classroom as a microcosm of scientific discourse and inquiry. Such research has included investigations of student-to-student and student-to-teacher interaction (cf. Kelly and Crawford 1996; Hogan 1999). Both areas have been cognizant of the contextual nature of knowledge, and the roles that social interaction plays in the formation, change and propagation of knowledge. However, the first area has limited the role of those themes to content matter, and the second area has limited the domain of study to the classroom. What has not been done is to apply these same perspectives on the practice of scientists to the practice of teachers.

We believe the lens of S&TS has the potential for establishing a powerful and productive research program in the study of teacher knowledge and practice.

In this paper, we aim to provide an exemplar of this research program by following the history of a particular curricular technology. In doing so, we illuminate the manner in which curricular ideas develop and propagate, and reveal the sociological nature of teacher knowledge and practice. In particular, we challenge the taken-for-granted stability in curricular content by demonstrating the manner in which curriculum is conceptualized differently by various actors, and reconfigured in different instances. Furthermore, we find that the broad definition of technology and technological reconfiguration found in S&TS significant for the examination of educational practice. In particular, we propose four categories of technological reconfiguration: reshaping and restructuring technologies, changing the role of a technology, having an alternative interpretation and acting on that interpretation, and modifying the boundary of a technology. This expansion is significant because it incorporates the effects these various reconfigurations plays on the technology's relationship with other technologies, identities, and community participants.

Theoretical Framework

This work applies the perspective of Science and Technology Studies, particularly the sociologically based Sociology of Scientific Knowledge (SSK) (for two reviews, see Collins 1983; Shapin 1995) and Social Construction of Technology (SCOT) (see Bijker, Hughes et al. 1999), to the realm of teacher knowledge and practice. A foundational principle in SSK research is that empirical data alone cannot determine scientific knowledge (cf. Bloor 1973). Scholars in this field have examined and described the ways in which social negotiation plays critical roles in the formation of knowledge and practice (cf. Collins 1981; Pinch 1985; Latour 1987). Detailed studies of the histories of scientific investigations have shown periods of interpretive flexibility, where multiple explanations exist for certain empirical data. That initial variation is then reduced through different social mechanisms, until the community's conception stabilizes on a particular interpretation.

Likewise, research in SCOT has shown the technological design process to be quite different from its assumed linear progression. Similar to the development of scientific knowledge, the development of a technology can often be shown to cycle between periods of variety or interpretive flexibility, and periods of stability or closure (cf. Pinch and Bijker 1987). For example, Kline and Pinch (1996) show how social groups interacted with both each other and the technology to effect the interpretation of the rural car. Although the designers had a major influence on the form of the artifact, the artifact was reinterpreted and changed upon reaching the users. For example, many farmers reconfigured the technology, sometimes using commercial kits, for use with farm and domestic work, including as a stationary power source, truck and tractor. As Ford itself released new tractor and truck products, closure began to occur. At this point, Ford began to publicly discourage both the alternative uses for the cars as well as the selling of kits

informing dealers that the warranties for cars sold with kits would not be honored. In time, the reconfigured use of the car is shut down and different forms of the automobile (such as the newer truck) take over. Hence, the artifact becomes re-stabilized and closure is said to have reoccurred.

Various relevant social groups interact with a technological artifact through their own particular technological frame (Bijker 1987). "[This encapsulates a] series of practices, and values that get built around a technology that also includes the ways in which technologies get used and consumed" (Pinch and Trocco in press). In Pinch's case of the Moog synthesizer, two inventors had contrasting technological frames in relationship to the music synthesizer. Buchla considered the technology to be limited to use by avante-garde musicians, such as himself. "Moog's technological frame was to mass produce and market a well-engineered, reliably serviced, product that was responsive to the needs of users" (Pinch and Trocco in press, p. 408). Each frame guided the actors' design and interaction with the technology, and can serve to explain differences in their actions.

Researchers in SCOT also take a wide perspective in their definition of "technology", including processes, relationships, devices, and so on (Shapin and Shaffer 1985).

> By using *technology* to refer to literary and social practices, as well as to machines, we wish to stress that all three are *knowledge-producing tools* (Shapin & Schaffer, 1985, P. 24).

> That 'technology' comprises more than machines… 'Technology' can include social arrangements as diverse as the postal system, transportation, refuse collection, voting mechanisms, education, and so on (Woolgar, 1991, p. 94)."

In designing an artifact with a particular user in mind, designers co-construct the user with the technology (Akrich 1992; Lindsey 2000). They "configure the user" (Woolgar 1991) in a context where knowledge and expertise about the user is socially distributed. As a result, the technology becomes its relationship with the users. Consequently, the technology provides the boundary between the insiders and the outsiders. This connection can also be reversed. When users then interact with the technology, they become agents of technological change. By following a technology throughout its life cycle—into the hands of the user—we can see the many different iterations of technology reconfiguration and user identity reconfiguration that occur in the process (Lindsay 1999; Lindsey 2000). Thus, we are privy to the nuances surrounding these incessant variations (Ackrich, 1992) that occur between the technology, the user, and the designer.

S&TS researchers strive to be explicitly attentive to the taken-for-granted. They seek to provide a full accounting of the development of science and technology, including the relatively mundane work that is still necessary for work to be done. For example, Pinch (1985) provides an illustration of the long chain of assumptions necessary to turn "splodges on paper" into data on solar neutrino emissions. In doing so, he brings to the forefront the background details that often go unmentioned. Thus there is special attention paid to the use of *black boxes* – entities whose internal structure is taken as valid without re-examination. Like technology in general, a wide view of black boxes is used, encompassing devices, procedures, relationships, standards, concepts, etc.

S&TS thus provides a framework that is attentive to the situated nature of knowledge and practice. Furthermore, it is a endeavor that "'studies up,' that aims to interpret a culture far more powerful and prestigious than itself, and that offers accounts at variance with that culture's official myths" (Shapin 1995, p. 272). In doing so, it has developed repertoire of practice that makes it attentive to the subtleties of knowledge and practice construction. It thus is an effective tool for studying phenomena where questions of nature and status of knowledge are forefront.

We thus conceptualize the development of teacher knowledge and curriculum as akin to the development of scientific knowledge and technology. Curricula are technologies insofar as they are tools used to do educational work. The design of curricular technology is not deterministic. There is a range of possibility in the nature of curriculum content – including its content, conceptual meaning, and means of demonstration. This interpretive flexibility does not last indefinitely – something specific happens in the classroom. As with traditional technologies, social interaction amongst relevant actors and artifacts (e.g. teachers, curriculum guides, policies, students, schedules, etc.) eventually affects closure.

Conceptualizing curricula as technologies, we see the importance of considering teachers' identities as a part of those technologies. Curricula are designed with an end user in mind, thereby constructing widely varying identities of the teacher. Some curricula conceptualize the teacher as a near robotic implementor of the technological artifact, intending for the teacher to follow a formulaic procedure. Others conceptualize the teacher as an active participant, inviting them to play a part in shaping the learning process. However, just as with other technologies, the end users often take initiative to reconfigure both their identity and the technology as a whole. Some teachers make significant alterations to formulaic technologies. Other teachers adopt the mantel of a straightforward implementor, thereby altering a technology that originally intended a more diverse implementation.

By following a curriculum technology through multiple manifestations, we aim to illuminate the mechanisms by which curricular technologies change as a result of interactions with various actors.

Context and Data Sources

This research is situated in the work of the Environmental Inquiry (EI) Project. EI is a multifaceted professional and curriculum development project focused on promoting sociologically authentic science in secondary schools. The project has involved university scientists and science educators and inservice and preservice teachers. One of the outcomes of this endeavor has been the development and varied use of bioassay experiments as one of the major curriculum units with the Toxicology section. The Bioassay unit was created over a four year period by several inservice teachers and Cornell educators and scientists. It has been piloted and reconfigured several times. The bioassay protocol has since been incorporated into two preservice projects, one connected

with the student teaching practicum, and one within a curriculum design course. In addition, it has become part of several inservice teachers' school science curricula. In this paper, we combine two overlapping research endeavors in order to follow the history of this curricular technology from its origins, through various manifestations.

Data sources include: questionnaires, interviews, recorded group sessions and weekly meetings, ongoing conversations with participants, and classroom observations (notes & video). Grounded theory, constant comparative analysis, and the case study method are used as a common qualitative approach (Glaser 1969; Strauss 1987; Yin 1994).

History

Original design

The bioassay unit is the main part of the EI toxicology curriculum unit (Trautmann 2001; Trautmann 2001). It was created as a research protocol whereby teachers and students would learn to use this research tool to understand the LD 50 (lethal dose of a toxin needed to kill 50% of the population) for various organisms. The idea grew out of shortcomings with existing water testing kits experienced by teachers in summer residential professional development programs. Thus, the bioassay was configured with this specific type of teacher in mind, and to meet this specific problem. Once this skill had been demonstrated, the EI curriculum encourages teachers and students to explore the use of bioassays further by testing other potential toxins and organisms beyond those outlined in the text.

Andy's Reconfiguration

Andy has about a six-year history in the EI program. He participated in the earlier, more structured form of the program as well as in the later, more open portion of the program that focused on curriculum development. He has served at different times as both an EI technology designer or maker and a technology user. His first interaction with the bioassay was in the capacity of a user. In the initial classroom implementation, he utilized the bioassay in its original format. He has used the bioassays in several of his basic level science courses (9th grade, 11th grade, and 12th grade). (It is important to note that all of his classes work collaboratively on a large research project and communicate their individual experiments to the other classes). In the course of this first year, he soon changed the procedure by eliminating a step that involved rinsing lettuce seeds with a chlorine solution used to prevent unwanted fungal growth on the lettuce seeds. He claimed this 20-minute procedural step unnecessary and not a good use of class time. This was a result of one class's work where several experiments were set up and the seeds didn't receive the bleach treatment and they did not develop fungal growth. In the subsequent classroom implementations, this step has been removed.

During the second year, he began to use the bioassay as a subprocedure in a larger research project on acid rain and aluminum toxicity. This project was part of his larger

stream study unit. In order to appreciate how this technology is reconfigured, its significant to point out that in Andy's classroom, part of the repertoire includes a "subcontracting" out of technical labwork to the younger students. Thus, although the bioassay of lettuce seeds may be a more significant component of the 9th grade curriculum, it is reduced to a lab result for 12th grade class. The bioassay served to fill a niche in his classroom research agenda as well as serve as a widely applicable tool for general research. During the third year, the bioassay was fully assimilated as a subprotocol in yet another larger classroom research project on chromium uptake in plants.

Terry's reconfiguration

In contrast to Andy, Terry followed the bioassay protocol to the letter. It was used within the context stream studies in his basic environmental science class. However, this is not to say that his use involved no reconfiguration. Whereas the designers intended the students to direct much of the research, choosing samples to test based on their own interest, Terry selecting the samples himself and took a strong hand in directing the class. Furthermore, arguably his lack of innovation was itself an alteration. The original intention was for the bioassay to be a stepping off point for teachers to enter into toxicology research on a broad scale. Teachers were strongly invited to tinker with the technology. In contrast, Terry took his pilot testing responsibility to entail very exact implementation of the bioassay curriculum.

Preservice Reconfiguration

The final manifestation of the bioassay discussed here occurred in a preservice curriculum design course, and provides an opportunity for a more microscopic examination of technological change. The course involved students working in design teams to construct curriculum for a cooperating high school. The bioassay became involved during the second quarter of the course, when the class worked in three teams to design a three day unit. Previous visits to the high school had identified pollution in the city river, particularly by one company, as a major environmental concern amongst the students. Bioassays were not part of the original concept for the unit, but became introduced through three sources: Three students in the class had been involved with a bioassay project during their student teaching the previous semester; an inservice teacher who has been heavily involved with the EI project was spending a sabbatic semester on campus and interacted with the class; drafts of bioassay teacher and student guides were among the curriculum materials available to the class.

The original structure of the unit was as follows: Day 1, an overview of the river pollution focusing particularly on the concept of runoff on; Day 2, a lesson focusing on concentration; Day 3, an activity involving physical modeling. This was in keeping with a loose theme of urban ecosystems modeling underlying the course. This soon changed as both the Day 1 and Day 3 teams had difficulty finding specific information about how contaminants were entering the river. This precipitated a shift from a focus on the pollution process to the challenge of cleaning up the river. This change had little effect

on Day 2. This group was struggling with determining exactly what concentration concepts to address and how to connect it to issues of toxicity and pollution. Without much resolution, they put forth and considered a variety of ideas, most of which revolved around either a physical manipulative model using something like M&M's or an activity involving the preferable strength of Kookaid.

The idea to incorporate a bioassay experiment actually happened simultaneously in two groups. The Day 2 group was tossing back and forth a variety of ideas and issues, without much focus. Most of the participants' notions of covering the concept of concentration included some sort of ratio notation (and in one case a fixation on "ppm") and the idea of a critical level (a lethal level in the case of a toxin, but the possibility of an optimal level, such as in the case of Koolaid). But this was not explicitly stated, and they were having trouble reaching any sort of stability on how to cover these goals. At several points, in particular promoted by Darrin, one of the students who had done bioassays in his student teaching, they would bring up the question of concentration's relevance to the overall unit, and its connection with toxicity.   While their previous discussion of using Koolaid included having students make a preferred concentration or various dilutions, Darrin eventually suggested using the Koolaid (perhaps determined by students' preference) on daphnia. Rather than instigating any closure, however, this idea was simply added to the variety they were already considering.

Meanwhile, the Day 3 group had an extensive conversation with Nigel, an experienced teacher who, like Andy, had a long history of work with the EI project, and was spending a sabbatic on campus as a visiting scholar. Nigel was spending the class period floating between the three design groups and the Day 3 group had continued to struggle with how to model clean up. (It should also be noted that it is not clear how much Nigel understood some of the circumstances of the class, specifically, that each group was designing a single day's lesson, and that this was an exercise in curriculum design rather than instructional method.) Because of the issue of toxicity, Nigel very quickly put forth the idea of doing bioassays. However, both the group and the instructor (the second author) rejected doing a straightforward bioassay, in favor of creating something at least partially original or even altogether original. At this point, the exchange shown in Appendix A occurred, containing a very fast development of ideas and starting with a reference to the watershed model the Day 1 group was working on.

As Nigel's last comment illustrates, there is still a considerable degree of interpretive flexibility. However, all the elements of their final curriculum were now there. Nigel's question about how the Koolaid runoff was to be created prompted Kate to be concerned with the possibility that the students would be testing an ambiguous concentration, rather than a formally prepared sample. In response, Eric suggested having both: simulate runoff in some manner and create a known set of concentrations that can be compared by color. Eventually, they formulated a plan to do a bioassay in parallel to the three day lesson: Day 1 would remain as an introduction; Day 2 would create a serial dilution as part of their concentration lesson, and a daphnia bioassay would be started with those known concentrations; Day 3 would first evaluate the daphnia bioassay, then create runoff, and finally compare that runoff according to color with the known set. They

proposed this to the other groups, who accepted it. The alignment between what the Day 3 group proposed and what the Day 2 group was considering served to stabilize the Day 2 plans.

Discussion

We found, much like researchers in technological development, that the original configuration of the bioassay was not the last word. In particular, we propose four categories of reconfiguration, summarized in Table 1 and discussed below. Furthermore, we found in the development process that innovation often came as a response to barriers, emphasizing Pinch and Bijker's criticism of linear models. Finally, we find the concept of technological frames useful for illustrating and explaining the variation in conceptions of technology found amongst various actors.

	TRS-80 & RS Co-Co	EI Bioassay
Reshape & restructure	- Added components - Made machine faster - Used the Co-Co as a processor	- Broken down into smaller units - Change procedure
Change role	- More than a home PC - Use it now days for email & internet	- Subsumed by a larger research project - Use to create standard
Interpretation & action	Co-Co used in fire range project	*Mis*interpretation of inquiry intention
Modify boundary	User went in—needed to know enough about internal workings of machine to add peripherals	User passing up invitation to alter curriculum

Table 1

Reshaping & Restructuring a Technology

Reshaping or restructuring a technology entails the user altering the physical structure or appearance of the artifact. For example, in the case of Lindsey's computer users, different user groups reconfigured both the TRS-80 and the CoCo technologies by adding components to make the machines faster thus changing the physical structure of the machines. With the bioassay, users changed portions of the protocol's procedure. Andy eliminated the step that involved rinsing the lettuce seeds with a bleach solution prior to setting up the petri dish growing stations. The preservice students changed the toxin from traditional choices (salt, ammonia) to Koolaid, and added setting aside a sample of each dilution to create a color scheme.

Changing the Role of a Technology

In changing the role of a technology, users recognize the designers' original role of the technology and intentionally change it. For example, in the case of current day TRS-80

users, they employ the machine as a device for accessing the internet and for email and not as a home PC. Rural car users added devices so that it could be used as a stationary power source for completing various farm and domestic chores. With the EI technology, Andy uses the bioassay as a sub-protocol within by a larger research unit on acid rain rather than employing the bioassay as the main activity in the EI toxicology unit. Furthermore, in subsequent years, he has knowingly assimilated the bioassay protocol into a subprocedure within a larger overarching chromium research project. The preservice students used the bioassay to create a standard scale, rather than as a direct test of a field sample.

Alternative Interpretation & Action

Users can have alternative interpretations of a technology and act on these alternative interpretations. In this scenario, users clearly perceive a technology fitting into a different architectural context than originally anticipated by the designers. This *mis*interpretation[i] occurs in part because users are not aware of the technology's original intent. Thusly, reconfiguration is not deliberate and occurs as a result of this *mis*interpretation. Since this seems to be a rare form of reconfiguration, is important to recognize it and examine it because its significance may lie within the ramifications of users' acting on alternative interpretations. It opens up and exposes the danger of taken-for-granted assumptions by designers as they configure users and assume their technologies will be used as they projected them to be. This is frequently the case in educational systems where curricula designers or policy makers assume that curricula disseminated over a broad area will result in homogenous implementation in all contexts. Thus, actualizing this particular form of reconfiguration challenges designers' assumptions and brings to light an alternate and possibly unexpected use of technological artifacts. Terry's interpretation of inquiry based learning and the bioassay as a means to inquiry learning differed from that of the bioassay designers. He saw going beyond the samples in the text and testing a sample whose results were not known as fulfilling the intentions of inquiry learning. By contrast, the bioassay curriculum was also intended to involve significant direction from the students. His alternative interpretation resulted in the implementation of a reconfigured technology.

Modifying the Boundary of a Technology

Woolgar (1991) has claimed that a technology creates a boundary between insiders or designers and the users. Initially, this has utility in talking about the ways in which engineers configure users in the technological design process. However, it falls short on two accounts. First, it does not take account what happens when a technology gets into the hands of the user. In following a technology throughout its life cycle, we find that users interact with technologies at all levels of the life cycle—in the design phase and after closure was thought to have been achieved (Kline and Pinch 1996; Lindsay 1999; Avery 2000; Lindsey 2000).

Second, Woolgar fails to account for two other occurrences: the extent to which some designers invite the user in to interact with the technology; and, the degree to which,

without an invitation, users will open the black box of technology nonetheless. Access to a technology is a function of the original designers' intent (e.g., whether the technological design itself is opened for the user) or the users' ability or willingness to pry "open" the black box of a technology. For example, Lindsey describes the TRS-80 user:

> [T]o be successful, the TRS-80 user must know enough about the internal workings of the computer to correctly select and plug in the peripherals (screen, tape player, printer) to the TRS-80, and also to be able to program efficiently using the limited resources. The 'gray box' of the TRS-80 could not be kept closed if it were to be a successful product (Lindsey 1999, p. 9).

Thus, while part of the original design of a technology includes the degree to which users are allowed to change its inner workings, users may significantly reconfigure a technology by changing that degree of access. Often this is in the direction from less access to more access, as in the case of the TRS-80 users, but it need not be. In the case of the EI technology, the EI engineers specifically invited the users in by asking them to pilot the curricular materials in their classrooms and give feedback to the designer team. In this circumstance, designers promote and encourage users' opening the EI black box of technology. Sometimes, however, the invitation isn't acknowledged or accepted, as in the case of Terry. What comes in to play is the user's identity or their relationship with the technology that can influence the degree to which a technology is reconfigured. Andy, in contrast to Terry, sees himself as a facilitator of students' research processes. This role allows for adaptation of curricular technologies to serve the specific needs of students.

It should also be noted that these categories are not mutually exclusive. For example, change a role will likely require some restructuring, and might also be, by definition, a modification of the boundary. The preservice students added the steps to create the standard color scheme, but this was also a change in the role of the bioassay. Reconfigurations also have ripple effects.

Innovation as solution to problem

In contrast to traditional views of curriculum, where curriculum is systematically and orderly built from content standards and goals, we see that the significant innovations in the curriculum technologies come about in response to problems. For the curriculum course students, the use of bioassays itself was a solution for the problem of both how to present issues of concentration, and how to connect those issues with both toxicity in general, and the river pollution specifically. Once the general idea of bioassays had been adopted, their more unique timing sequence was a response to the logistical realities they faced in pilot testing their work.

Technological Frames

The notion of a technological frame is useful in showing that uniformity amongst actors notions of content cannot be assumed. Andy, for example, approaches any curricular issue with an eye towards interconnections amongst topics and activities, and even between his classes. It was therefore not a surprise that he would view the bioassay technology not as a stand alone activity, but as an interchangeable part to be fit into a

larger picture. Darrin's frame was significantly impacted by his experience both in general (he was the only one in his group to have done student teaching) and specifically with the bioassay. His view of the bioassay included the pragmatic logistics of which he had knowledge. He also was focused on relevance: he was often concerned that the group address the question of why the concepts they wanted to teach mattered. Erin, a doctoral student in microbiology, was focused on the "ppm" notation. For her, understanding concentration meant being able to use this routine. The Day 2 group was also an interesting example in terms of the degree of common conception. While there were significant overlaps in actors' notions of what a concentration unit would cover, it was not enough to cause quick stability. Arguably, the separation in their notions was in a middle range: not divergent enough to bring differences quickly out in the open, nor aligned enough to cause quick stabilization. Stabilization was, in fact, greatly assisted by the outside actions of the other group.

Implications

Educational research has long been dominated by a psychological foundation. Therefore, we believe the application of Science and Technology Studies, with its predominately sociological foundation, can be quite illuminating to the study of teacher knowledge and practice. Specifically, we believe it has the potential to reveal the numerous taken-for-granted notions present in the institution of science teaching. This study articulates a different view on learning where social participation and community membership provide the vehicle for learning science as it's practice in the real world. By tracing the life cycle of a technology from the design phase into the hands of the users (teachers), we uncover interesting ways in which technologies and identities are configured and reconfigured.

This exemplar also calls into question assumptions of stability and uniformity across curriculum implementations. Despite the manifestation of the bioassay curriculum as a complete piece of technology, it was significantly altered on each instance of its use. It should be noted, of course, that this was a significant intention of its original designers. Further studies may address instances where this was not part of the original designers' plans. This lack of uniformity and stability has implications policy as well as research. Designation of a curriculum by policy makers will not result in the uniformity of instruction they may assume.

Eric	Gina	Kate	Nigel	Multiple/Unknown	Dan
What does the model look like?					
Is there any way we can get like different, um, kinda pools or reservoirs					
And that way we can better, kinda, set up the variation in the evironment and have different concentrations of koolaid, and then test those that are like filter into the reservoirs				That's great, that's great	
Cuz then, that would be, kind of, what really happens is not the same concentration as the other place.	Right.				
I don't know how the model really			You wouldn't		
			You probably wouldn't be able to come up with different concentrations, though		
			But what you could do, is create different concentrations by having it run through different things.		
			In other words have in run through soil		
Yeah, right				That's good.	
				That's very good	
					That, that would also give the students something to do
			And they take it directly out of that pool, put it on daphnia, look at their heart beat, and see what happens		
Instead of like,		Yeah			

doing test tubes and graduated cylinders and doing the serial dillutions ???			
	Or even just color index, color index		
	Cuz that would be something more immediate		
	And if we're doing this in fifteen minutes, we should, you know		
??	If we had a color index, and then		Hmm
			They could actually create that color index as part of the Day 2
		Ah hm	
	And we can give them sand, and soil,		
	Maybe some soil with roots in it		
	I mean, you know, some sort of potting stuff.		
	Charcoil		
		And when you put the	
		You're think about having like a,	
		a, spill of Koolaid or something or what ever it you use	
		Say Koolaid for the sake of argument	
		And then have, areas of sand or soil or stuff around it, or would you put the Koolaid in sand, Koolaid in soil, Koolaid in	
		And then run water through it	

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[i] This is not to be perceived as having a negative connotation.