Secondary students' use of social and natural world information in a land use decision context

by

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Introduction

> "A basic premise of education for sustainability is that just as there is a wholeness and interdependence to life in all its forms, so must there be a unity and wholeness to efforts to understand it and ensure its continuation. This calls for both interdisciplinary inquiry and action. It does not, of course, imply an end to work within traditional disciplines. A disciplinary focus is often helpful, even necessary, in allowing the depth of inquiry needed for major breakthroughs and discoveries."
>
> -- United Nations Educational, Scientific, and Cultural Organization (UNESCO) (1997) *Educating for a Sustainable Future: A Transdisciplinary Vision for Concerted Action*, paragraph 89.

> "In the long run, it is the application of [scientific] knowledge in social, economic, and political systems that determines our society's success or failure."
>
> --NSF Director Neal Lane, 1996

Both of these quotations recognize the need for individuals to integrate information from a variety of disciplines and to apply such knowledge to societal institutions and daily actions to achieve a sustainable society. Sustainability has three generally accepted dimensions: ecological, economic, and social. Because economic systems are societal constructs, we can further reduce sustainability to human and ecological systems, and thus actions that contribute to the future health of both human and ecological systems would be termed sustainable. In reality, these two systems are complexly intertwined into one earth system. In secondary schools, students tend to learn about these human and ecological concepts through separate social science and natural science courses, a compartmentalization that makes an intertwined systems approach to teaching and learning difficult. Yet even in separate subject assessments, student performance in science and social studies is lacking. How students are faring on such assessments, and how compartmentalization of schooling might be detrimental to students, are issues we turn to next.

Underperformance in science is heavily lamented by science organizations and the media and was recently underscored by the first "World Science Festival" in New York City in spring 2008, an effort led by concerned scientists to cultivate public interest in science (Richburg, 2008). Beyond decreased funding for scientific research, average science scores on national assessments between 1996 and 2000 declined at grade 12 and less than one-third of 12th grade students reached the proficient performance level in science; adults' survey scores have generally not improved since the 1990s (National Science Board, 2006). Civics education results are equally disappointing (Graham, 2008; Hathaway, 2008), with no improvement in scores of 8th and 12th graders between 1998 and 2006: only 22% of 8th graders and 27% of 12th graders scored at or above proficient level in 2006 (National Center for Education Statistics, 2006). While public scientific and civic knowledge stagnates, the complex sustainability problems and decisions we face—such as land use—multiply. Even if citizens grasp natural world concepts, a question remains as to whether they can apply such concepts to decisions and actions in the social realm. If they cannot, what purpose does understanding the natural world serve? Helping future citizens understand the multi-disciplinary, non-compartmentalized dimensions of such problems and how our individual and collective decisions play into them is an essential undertaking. Schools are an obvious institution for such a task.

Yet our understanding of how individuals, including youth, bring natural world knowledge to bear on the social world, and vice-versa, is limited. Research on learning tells us that we should connect new concepts to concepts that already exist in students' mental maps (National Research Council, 2005). But few researchers have examined students' mental maps in ways that might illuminate how students use and integrate information from various subjects or disciplines. Only a few studies have attempted this by examining how students make socio-scientific decisions (i.e. decisions comprised of natural science and social science elements). One study of secondary students has shown a preference among many students for either natural science or social science information (Yang & Anderson, 2003). Fleming (1994) and Turiel (1983) suggest cognitive structures underlying such preferences: information about the physical world is found in "nonsocial cognitive structures" and information about the human world is contained in "social cognitive structures". Students in Fleming's (1994) study showed a strong dominance in social cognition for their reasoning on two socio-scientific issues. On natural science cognition, the study found that students did not use their school knowledge about the physical world, and students felt that natural scientists were not interested in human affairs. Because of the strong student preference for social information, Fleming recommended social cognition as a starting point for teaching secondary science. Such teaching approaches manifest themselves in recent trends towards Science, Technology, and Society (Yager & Lutz, 1995; Fourez, 1995) and using Socio-scientific issues in natural science classes (Sadler, 2004; Zeidler, Sadler, Simmons, & Howes, 2005). Focusing on the social or human side as a starting point has also been successful in teaching the theory of evolution and the scientific process to a diverse group of undergraduates (Sloan Wilson, 2005).

None of the above research, however, examined whether and how an integrated curriculum—one featuring elements from multiple subjects, in this case both natural and social world concepts—might impact students' abilities to apply both types of information to a decision.[1] Nor have prior studies compared results for secondary students across social studies and science courses. The study reported in Chapter 1 addresses these topics, hypothesizing that an integrated curriculum can help students bring integrated thinking to a land use decision. Over 500 science and social studies students and their teachers participated in a quasi-experiment that examined student requests for natural and social world information to make a land use decision. Students were tested before and after participating in an integrated social studies-science land use curriculum. Additional data included student and teacher interviews, classroom observations, and teacher logs. Results indicated that students used social world information more often than natural world information in a land use decision both before and after a curriculum intervention. In spite of this relative preference for social world information, all students increased their requests for natural world information following the curriculum intervention, suggesting that their knowledge structures had changed to enable them to see the relevance of natural world information in the decision. The type of course also had a clear relationship with the information that students requested to make the decision, an unexpected result, suggesting that students' knowledge use was filtered through the lens of the course subject. Finally, girls requested more information about animals than boys did at pretest, though at posttest boys had closed this gap.

[1] "Integrated" from here on out refers to integration of natural and social world concepts and information.

Chapter 2 takes integrated thinking to the level of action knowledge and behavior: we know little about how high school students might apply social and natural world concepts to individual or collective actions in society. This chapter again compares social studies and science students (n=500) to see how their understanding of actions in support of sustainable land use changes with (or in absence of) an integrated curriculum or differs across these subject areas. Results here demonstrated that students had a very limited repertoire of action knowledge related to sustainable land use both before and after the curriculum intervention, largely limited to individual actions (rather than group action) commonly known, such as recycling and trash pick-up. Social studies students, however, demonstrated increased knowledge of many types of actions ranging from ecomanagement to political, consumer, and information sharing after experiencing the curriculum. Here again, an association between student thinking and the type of course emerged.

Chapter 3 steps away from the empirical work to introduce a model that can help educators create a supportive learning environment that incorporates action in the form of meaningful participation. The Reasonable Person Model offers a tool for educators and others to think about how curriculum elements work together holistically to bring out the "best" in students, including outcomes routinely assessed on standardized tests and those ignored in such assessments but touted nonetheless as important educational objectives. The model helps illuminate some of the cognitive dimensions that seem to underlie results found in chapters 1 and 2.

The concluding chapter provides an overview of the research and framework that comprised the first three chapters and a brief analysis of the connections among the chapters. The thematic story is one of assisting students in forging cognitive connections both among subjects and between the classroom and the world outside. Taken together, these chapters raise rich possibilities for future research and practice.

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Chapter 1:
People matter: secondary students' social and natural world knowledge use in a land use decision

Environmental decisions and challenges require information and skills from diverse disciplines. For example, decisions related to land use impact both the natural world (How will it affect the watershed? Will plant and animal species be adversely affected?) and the human or social world (Will the chosen land use contribute to our economy? Will it impact traffic patterns?). Yet at the secondary school level, we provide few opportunities for students to learn or to practice such integrated thinking; high school learning generally occurs in single-subject classrooms. Courses are driven by content standards specific to each discipline developed by states and by professional organizations. At the same time, however, we expect students to apply classroom learning in contexts that are rarely as circumscribed as those in a single-subject classroom. Does the compartmentalization of learning at the secondary level impact students' abilities to recognize complex decisions—with complexity referring to a perspective that recognizes social and natural world elements? Can we expect students to integrate knowledge from multiple courses into decision-making after graduation if they do not practice doing so in high school?

I explored these questions in a quasi-experiment with students in grades 9-12 science and social studies classrooms in the context of an environmental education (EE) curriculum on land use. This study hypothesized that an integrated curriculum intervention could alter students' knowledge structure as observed through changes in their requests for certain types of information after the intervention. Before discussing the specific methods and results of the inquiry, I turn to the literature on decision making, student information preferences, and knowledge use to outline a theoretical background.

Decision-making: a shared theme in science, social studies, and environmental education

Socio-scientific issues or decisions involve both social and natural world aspects. Examples include issues related to land use, climate change, genetic engineering, water use, and nearly any other natural world issue that impacts society. The ability for students to undertake socio-scientific decision making (DM) is expressed in both the national science education standards and in curriculum standards for social studies (National Academy Press, 1996; National Council for the Social Studies, 1994). Citizenship skills and decision making are also important objectives for environmental education (NAAEE, 1996, 2004). In Michigan, the site of this study, the vision statements for both science and social studies include DM as primary goals for high school graduates (Michigan Department of Education, 2000a, 2000b). Therefore, an investigation of student DM in science and social studies courses in the context of an environmental education (EE) curriculum is appropriate.

While the literature on DM is extensive, particular attention to formal education has been sparse. In the context of DM curricula for secondary school students several authors have suggested ways to categorize the DM process (Gregory and Clemen, 1994; Kendall and Marzano, 1996); but in fact, categorizations and decision steps tend to oversimplify the process by focusing on the "decision event" while ignoring important sub decisions such as option generation (Hoffman and Yates, 2005). To generate options, one must first decide what data and information to seek out in order to generate such options. Joseph Schwab (1978) explains it thus:

> The buried four-fifths of enquiry consists of maneuvers which precede the collection of data and define what data are relevant. These maneuvers, we can summarize, for the moment, as consisting of certain hidden steps which the old story of stepwise scientific method omitted. (p. 239)

Yet these preliminary maneuvers, in spite of their large role in the DM process, are often neglected in DM studies. This study seeks to address this gap by focusing on the preliminary issue of how decision-makers determine what data and information bear relevance to a problem; it does not focus on the decision outcome. While some studies have examined high school student decision-making (e.g. Ratcliffe, 1998; Sadler &

Zeidler, 2004a, 2004b; Grace & Ratcliffe, 2002; Sadler & Fowler 2006) few to none hone in on such preliminary processes.

Examining the preliminary part of DM can provide insight into how students build mental models of concepts and what students perceive to be their informational needs. Understanding how students think about data and information collection can provide valuable insight into how students understand and apply what they know, how students make sense of complex problems, and how students use knowledge for decisions.

Student information preference and use

Given the common goals of science, social studies, and environmental education regarding socio-scientific decision making, the scarcity of empirical work in this area is surprising. For example, only two empirical studies were found that look at student information preference and use in the DM context. A 2003 study by Yang and Anderson compared reasoning modes of 182 Taiwanese senior high school students enrolled in either a science-oriented or social science-oriented curriculum based on interviews and surveys with close-ended questions. Their results showed that most students "were open to both types of information" while smaller groups of students showed a preference for natural science or social information (p. 233). In the other empirical study, using semi-structured clinical interviews with 38 adolescents (mean age 17 years), Fleming (1986a, 1986b) examined students' reasoning modes when making a socio-scientific decision and found that reasoning was based largely on social cognition rather than non-social cognition. He determined, "Knowledge of the physical world is rarely, if ever, used when analyzing and discussing socio-scientific issues" (Fleming, 1986b, p. 696). Based on these results, he recommended that science curricula recognize and emphasize the human dimension; indeed, in the past two decades science education has moved towards integrating social concerns in the form of science, technology and society and socio-scientific issues (Sadler, 2004). Interestingly, Fleming's work is possibly the only empirical study supporting this trend in science education. Both studies used hypothetical socio-scientific issues related to a nuclear power plant, while Fleming included an additional scenario related to genetic engineering.

Beyond information preferences, the current study and those discussed above are inquiries into students' "knowledge in use": their knowledge utilization in a decision, which includes problem construction and knowledge need determination (Holzner & Fisher, 1979). In a study of 574 grades 6-12 students, Todd (2006) found that students who participated in an instructional program to help them find and use library information for a research topic came to know more about the topic as a result. Additionally he found that students were focused on finding and knowing a set of facts, rather than integrating or analyzing information. This would suggest that students' problem construction led them to emphasize finding the correct facts rather than integrating knowledge use. It begs the question as to how students might view a problem that is purposely integrated, such as a socio-scientific one.

The study presented here builds and expands on this question and previous studies in several ways: by taking a comparative approach to examining DM and knowledge use in science *and* social studies classrooms, by using a pre-post test design with an intervening curriculum that integrates both science and social studies, by analyzing a larger sample (n=500), and by using a predominantly open-ended written instrument to get a clearer picture of internal cognition. The data presented here investigate the following specific questions: what information do students request when making a complex land-use decision, and does the information they request change after participating in a curriculum that integrates science and social studies concepts? Given the increasing role of information in society (Castells, 1996; Day & Koorland, 1997), this is an important question with regards to our future citizens. I also investigated whether the type of information sought differed with the course in which the curriculum was experienced (science or social studies) or student gender (male, female).

Specifically, the study explored how students viewed natural and social world information needs in the context of a land use decision. The curriculum intervention aimed to alter the student's knowledge structure related to the decision, which was then measured through analysis of student natural and social world information requests from pre- to posttest. This follows Brookes' (1980 in Todd, 1999) conceptualization of how information changes a person's knowledge structure, where what people already know changes through selectively taking in information, changing one's knowledge structure.

Methods

I utilized a mixed-methods approach with quantitative and qualitative methodology employed at different phases in the study (Tashakkori & Teddlie, 1998). The pre/posttest included closed- and open-ended questions, with the latter qualitatively content coded before transformation into numerical values for quantitative analysis. Semi-structured interviews provided additional qualitative data for triangulation (Greene et al., 1989).

Participants included nine teachers and their approximately 500 students in grades 9-12. The teachers were among the participants in a professional development workshop that introduced a land use curriculum to secondary science and social studies teachers from a Southeast Michigan county in January 2006 or February 2007. The nine teachers who agreed to participate represented six of the county's ten independent school districts. Three of the teachers taught social studies (government or law classes) and six were natural science ("science"; earth science, ecology, or freshwater biology classes) teachers. Two of the science teachers provided comparison classes as well. All teachers were Michigan certified for their subject, with teaching experience ranging from 5 to 34 years. Seven teachers held advanced degrees and two had advanced degrees in progress.

The curriculum, "Lessons from the Land: Land Use and Decision-Making in Southeast Michigan", was chosen for this study because it was explicitly designed for and integrated concepts from both science and social studies at the secondary level, and the schools using the curriculum represented a fairly diverse group of students from the same independent school district and county (see Appendix I for details).[2] For this study, "integrated" refers to curriculum content that draws from science and social studies concepts and is designed to meet state or nationally defined standards from both science and social studies (such as earth science, biology, civics, geography, and government).

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[2] While the curriculum was largely completed by the time of the author's involvement, the author marginally assisted in curriculum content by creating the science lab activity. Additional involvement included editing and revising and co-leading teacher professional development for the curriculum.

The curriculum specifically aimed to improve students' abilities to make land use decisions drawing from both science and social studies knowledge. For example, a community land use decision role play (see lessons 5 and 7 in Table I) specifically required students to integrate science concepts such as land surface type and runoff with social studies concepts such as zoning. The role play also required students to practice decision-making skills by coming to a decision for the given scenario.

"Lessons from the Land" is rooted in the local county's land use plan and is thus locally themed. To be included in the study, teachers had to spend a minimum of two weeks on the unit during the spring semester of 2007; in practice teachers spent from 2 to 5.5 weeks on the unit, with a mean of 2.8 weeks. See Table 1 for the science and social studies curriculum outline (teachers were not provided with outlines in this side-by-side format). With one exception, all teachers participated in a two-day professional development seminar. All teachers received the same lessons and materials. Seminar sessions for common content (science lessons 1, 2, 4, and 5) were held jointly while two separate break-out sessions covered non-overlapping science and social studies content.

Table 1. Curriculum outline of science and social studies lessons. Bold lesson titles indicate those appearing in both curricula. Bulleted items indicate lesson activities. (See Appendix II for the full table of contents.)

<table>
<tr><th>Science</th><th>Social Studies</th></tr>
<tr><td rowspan="2">1. People, places, land, and water:
political boundaries, watershed boundaries, land cover, demographics
• take a neighborhood inventory
• interview a classmate about the community
• survey residents about the community</td><td>1. People, places, land, and water:
same as science</td></tr>
<tr><td>2. How zoning shapes a community:
zoning and why it matters
• inventory of student transportation options
• design a community</td></tr>
<tr><td rowspan="2">2. County Trends:
population and housing, projected population trends, school enrollment trends, land per household, farmland conversion, watershed water quality</td><td>3. Personal narratives of community history:
historic events shaping the county
• interviews and oral histories with citizens</td></tr>
<tr><td>4. County Trends:
same as science</td></tr>
<tr><td>3. Land use and water:
land use and water on a newly constructed site, sources/sinks/sustainability, historic and recent land transformations, impacts of land use on water quality and quantity, land use change and waterway pollution in the county
• lab: water runoff on pervious and impervious surfaces</td><td>5. Causes and effects of current trends:
history of the American Dream, effects of development trends on schools, water quality, pervious/impervious surfaces, air quality, history and current trends in transportation, agriculture and land use
• making connections among land use issues
• developing historical hypotheses
• analyzing different positions on land use</td></tr>
</table>

4. What future for the county? Two future scenarios, what is sustainability?, land use strategies to promote sustainability, actions to ensure a sustainable watershed • redesigning your community for sustainability	***6. What future for the county?*** same as science
5. Planning process at the local level: the master planning process, zoning, wetland regulation • role play on planning proposal • research and evaluate planning issue in your community	***7. Planning process at the local level:*** same as science

Curriculum enactment

Each of the teachers enacted the curriculum in one to four separate classes, with a mode of two classes. While none of the teachers enacted every curriculum component, nearly all teachers used at least part of every lesson in the classroom or for homework; the only exception was lesson 3 for social studies classes, used by only one of the three teachers. A breakdown of the overall portion of the curriculum used by teachers and the portion of curriculum relevant to natural world dimensions is provided in Table 2 below (each lesson contained several components).

Table 2. Portion of curriculum used by teachers.

	Total components	Range of components used in classroom or for homework	Total components with natural world references*	Range of natural world components used in classroom or for homework
Social studies curriculum (3 teachers)	24	14-15	10	7-8
Science curriculum (6 teachers)	19	12-18 (mean 15)	11	8-11 (mean 9.7)

*All components contained social world references.

Thus all teachers enacted curricula containing natural world information as well as social world information within a fairly close range. Classroom observations and teacher interviews indicated that teachers often uniquely adapted curricular components and that some teachers were more comfortable with certain activities than others; these differences seemed to partly intersect with subject area as discussed later.

In addition, three science classes served as comparison groups. Two of these were biology classes taught by one of the teachers and one was a fundamental physics class taught by another teacher. The comparison science students were only to take the pre- and posttest without receiving a curriculum intervention; however, parts of the curriculum were used in two of the comparison classes along with other activities relevant to the curriculum (such as local stream water testing, watersheds, and erosion).

Data collection

This study included student pre and post tests, classroom observations, and semi-structured interviews with some students and all teachers. The student pre/post test aimed to measure student requests for natural world and social world information and was field tested twice and adjusted to improve validity. All students present on the day of administration were asked to complete the pre/post test and only students who had completed both the pre and post-test were eligible for interviews. All students completed the same pretests and posttests based on a fictional yet realistic land use decision (see Figure 1 for scenario, full survey instrument provided in Appendix III). Students were asked to complete two open-ended items indicating questions they wanted answered prior to making the decision. For the first item students were not given any prompts as to the number of questions they should ask; in the second instance they were asked to list only their top four questions and to indicate whom they would want to consult. A question that intervened between the two open-ended items included 13 social science or natural science professionals, officials, stakeholders, or others who could be pertinent to consult in gaining answers to a range of land use questions. Students were to indicate for each of these how likely they would be to consult such a person using a 5-point scale (1=extremely unlikely; 5=extremely likely). In answering the second open-ended item the students were asked to refer to the expertise groups included in the prior question. In addition to the written responses from all the students, semi-structured follow-up interviews were conducted with a sub-sample of 52 students and all teachers for purposes of ground-truthing survey items and probing both student and teacher experiences. With the exception of post tests for three classes which were teacher-administered due to scheduling, all survey administration and interviewing was conducted by the author.

Figure 1. Land use decision scenario.

In recent years, Rivertown has been growing significantly. One of the elementary schools located near downtown Rivertown has recently closed. Its students now attend a new, larger elementary school that is located elsewhere. The old elementary school property includes a large wooded section of land along the river which community members often use for walks and recreation, in addition to a small field and playground that is also used by community members outside of school hours. This morning you read an article in the paper stating that due to the prime location of the school, a developer has proposed to buy the school property and build a shopping center there.

Imagine that you are responsible for deciding whether to allow the site to be converted to a shopping center. Please answer the following questions:

<u>Coding</u>

Open-ended student responses were recorded and entered into NVIVO 7, a software coding program. Each response was coded according to the type of information desired. Once all responses were coded, these codes were grouped thematically according to natural world information, social world information, and other information. Natural world questions included ecosystem questions (such as those about flora, fauna, or habitats), water questions (such as those about the river, runoff, or water pollution), land questions (such as those about erosion or the soil), and general environment questions (such as those inquiring about "environmental impacts"). Social world questions related primarily to humans. These questions included questions about recreation opportunities, community related questions including the opinions of residents, stores in the proposed building, schools, the economy, traffic, use level of the site, and transportation. Questions coded as "other" could not be coded as either natural or social world type questions. These questions included the size of the building or the land, values questions that often restated the primary decision (such as "should we replace a school with a shopping center?"), development questions (such as "how long it would take to build?" or "what about another location?"), and questions of a general nature ("Why?", "What are the advantages/disadvantages?", "Should we do this?"). The analysis here does not include the "other" questions since these questions did not share an identifiable theme. Table 3 provides common examples of actual student questions by coding category.

Table 3. Common examples of student questions by coding category.

Natural world questions	Social world questions	Other questions
• "Will animals be hurt?" • "What would happen to the river?" • "Would you cut down all of the wooded section of land?" • "How will it effect [sic] the ecosystem?"	• "How much would it cost to build?" • "What kinds of stores will be there?" • "How do the fellow community members feel about it?" • "Will there be a new place for meeting and recreation?"	• "Is this really necessary?" • "How large is the shopping center going to be?" • "Is it more of a positive or negative?" • "Is there any other place they could put it?"

Upon coding completion, the query feature in NVIVO was used to create a matrix for each student showing the number of natural world, social world, and other questions asked on the pretest and on the posttest. The matrix was exported to SPSS for quantitative analysis. Students who did not respond to an item were not included in the analysis (for example, 23% of students at pretest and 21% of students at posttest did not provide a response to the first item) because the type of question was the variable of interest rather than whether a student responded to the item.

Interrater reliability

A random sample of 13% of pretests and matching posttests (50 pairs of 378 total) was drawn, and two raters independently coded the first open-ended item.[3] Coding software generated a coding comparison report for each survey that calculated the agreement between the coders; overall mean agreement between the two raters for natural world and social world categories was 90%.

Results

The mean number of questions asked by each student was relatively small and decreased from pretest (mean 3.13) to posttest (mean 2.87, t=2.7, p=.007), an expected decline based on pilot testing. Although the number of questions asked declined, the

[3] Because the second open-ended item used the same categories as the first, a separate interrater reliability was not assessed for this item.

percentage of questions germane to natural world or social world did not change from pre- to posttest: students wrote fewer "other" questions at posttest compared to pretest (t=2.48, p=.014). Thus the number of vague or general questions declined at posttest.

Student information requests: natural or social world?

To determine whether the number of students' requests for social world versus natural world information differed, paired t-tests were conducted for the full sample of students and for sub-groups by course, intervention, and gender. On both open-ended measures, for all sample groups tested, students asked more social world questions than natural world questions at pre- and at posttest on average (for all, $p \leq .002$). Thus students demonstrated a strong interest in the social aspects of the land use issue compared to the natural world aspects. Tables 4 and 5 provide results for the first open-ended item. With one exception, no differences in the mean number of questions asked existed between groups at pre- or posttest by course, intervention, or gender. Social studies students were the exception, asking more social world questions than did science students on the first item at pre and posttest.

Table 4. Pretest results, first open-ended item comparing natural (NW) and social world (SW) questions. Table excludes items coded as other and therefore percentage sums are less than 100.

	Mean number of pretest questions asked:				paired t-test p value comparing SW and NW questions	total mean questions
	SW questions	% of total	NW questions	% of total		
All students (n=385)	1.62	51.8%	.63	20.1%	<.001*	3.13
All students in science courses (n=317)	1.56	49.7%	.67	21.3%	<.001*	3.14
Students in Intervention science courses (n=269)	1.52	49%	.68	21.9%	<.001*	3.10
Students in comparison science courses (n=48)	1.79	52.6%	.56	16.5%	<.001*	3.40
All students in social studies courses (n=68)	1.88	60.8%	.47	15.2%	<.001*	3.09

* *results significant at .05 level*

Table 5. Posttest results, first open-ended item comparing natural and social world questions.

	Mean number of posttest questions asked:				paired t-test p value comparing SW and NW questions	total mean questions
	SW questions	% of total	NW questions	% of total		
All students (n=394)	1.36	47.4%	.7	24.4%	<.001*	2.87
All students in science courses (n=295)	1.26	47.2%	.71	26.6%	<.001*	2.67
Students in Intervention science courses (n=248)	1.23	46.2%	.71	26.7%	<.001*	2.66
Students in comparison science courses (n=47)	1.38	50.7%	.7	25.7%	.002*	2.72
All students in social studies courses (n=99)	1.67	56.6%	.68	23.1%	<.001*	2.95

* *results significant at .05 level*

Analysis of the second open-ended item revealed the same preference for social over natural world information among students. Summary results are provided in Tables 6 and 7 below.

Table 6. Pretest results, second open-ended item comparing natural and social world questions.

	Mean number of questions asked:		p value
	Social world questions	Natural world questions	
All students (n=373)	1.75	.84	<.001
All students in science courses (n=307)	1.65	.87	<.001
Students in Intervention science courses (n=259)	1.61	.89	<.001
Students in comparison science courses (n=46)	1.87	.72	<.001
All students in social studies courses (n=66)	2.18	.71	<.001

Table 7. Posttest results, second open-ended item comparing natural and social world questions.

	Mean number of questions asked:		p value
	Social world questions	Natural world questions	
All students (n=379)	1.84	.85	<.001
All students in science courses (n=286)	1.67	.86	<.001
Students in Intervention science courses (n=242)	1.65	.87	<.001
Students in comparison science courses (n=44)	1.75	.80	<.001
All students in social studies courses (n=93[4])	2.37	.83	<.001

Differences in student information requests based on course, curriculum intervention, and testing point

Beyond students' relative requests for natural versus social world information, I was interested in how students' requests for one or the other type of information might vary according to type of course, curriculum intervention, and testing point (pretest versus posttest). For these analyses Poisson regression models were used because of the low frequency of responses[5]. These models sought to address two primary questions: whether the curriculum or type of course impacted students' requests for natural world information and whether the curriculum or type of course impacted students' requests for social world information. A third question, whether the curriculum or type of course impacted students' requests for both types of information, was addressed using McNemar chi-square tests. These three questions will be addressed in turn.

[4] Students who did not write any questions on pretest or posttest are not included in sample sizes. A larger number of students did not write questions on the pretest than the posttest, hence the discrepancy in sample sizes between pre- and posttest.

[5] The modal number of natural science responses was zero, with one response the next most frequent. Poisson regression models are recommended with such highly skewed distributions.

Changes in students' requests for natural world information

Regardless of curriculum intervention or testing point[6], students in science courses had higher rates of writing a natural world question than students in social studies courses, although the difference was only marginally significant (p=.056, odds ratio 1.24, confidence interval 1.00, 1.55). Interestingly, all students had higher rates of writing a natural world question at posttest than at pretest (p<.001, odds ratio 0.78, confidence interval 0.68, 0.89), suggesting that intervening class activities changed these rates. This was even true for the comparison groups. However, all comparison students were in science classes and were exposed to some of the same material and activities as the students in the experimental group, thus this group did not adequately control for the curriculum exposure variable.[7] While an increase in natural world questions might be expected in science students given the emphasis of science on the natural world, that the same change was observed among social studies students is somewhat surprising and is addressed in the discussion section.

The observed change among social studies students merited a closer look at their use of natural world questions. For social studies students, girls were much more likely to ask natural world questions at pretest than boys; this was particularly true with respect to responses about animals. Among boys, 3% wanted more information about animals at the pretest while 14% of girls did (Pearson chi-square value 4.71, 1 df, p=.03). At posttest, however, boys increased their questions about animals, closing the gap with girls on natural world questions. Based on this result, inquiries about animals were analyzed for the full sample of students. Indeed, the data show that girls were more likely to ask about animals, not only among social studies students but among all students. Results for the full sample of all students (n=500) show that girls asked about animals more often than boys did on the pretest with only 7% of boys asking about animals while 14% of girls wanted information on this topic (Pearson chi-square value 6.56, 1 df, p=.01). This difference no longer existed at posttest. These results are in line with other studies showing that girls have a stronger preference for animals than boys do. Interestingly, the

[6] The regression analysis examines the effect of course while controlling for curriculum intervention and testing point.
[7] Students posttest results could have been impacted by taking the pretest, although this seems unlikely in comparison groups where two-thirds of these students experienced the largest time gap between the two (14 weeks between pre- and posttest administration).

scenario provided to students did not make any reference to animals, and the written curriculum also devoted little attention to animals (social studies curriculum had 14 references and science curriculum 25[8]).

Analyses based on the second open-ended item (requesting no more than four questions and an indication of the type of expertise that would be pertinent) did not reveal a relationship between course, intervention, or gender and the rates of writing natural world questions. The intervening Likert items that referred to natural scientists (such as a biologist, ecologist, chemist, and geographer) could have primed students for natural world information.

Changes in students' requests for social world information

Analyses based on the first question with respect to response rates for social world information showed that students in social studies courses had increased rates of writing a social world question compared to students in science courses, both at pretest and posttest ($p<.001$, odds ratio .82, confidence interval 0.74, 0.91).

For the second open-ended item social studies students again demonstrated higher rates of asking for social world information compared to science students. Social studies students also showed a positive change in the total number of questions asked at posttest compared to pretest on this item ($n=55$, $p=.03$, 95% confidence interval -0.69, -0.04), whereas intervention science students did not exhibit an increase.

Changes in students' requests for both natural and social world information

In typical land use issues, both natural world and social world information are essential for a fully informed decision. Therefore, an important question to ask is whether students were more or less likely to include both natural world and social world questions after experiencing the integrated curriculum. McNemar chi-square test results showed no difference in the percentage of science students writing both types questions at posttest compared to pretest, but the number of social studies students asking for both types of information increased from pre- to posttest (see Table 8). These results were for the first open-ended item only. Results for the second open-ended item did not show an

[8] Based on word sum for appearances of "animal", "wildlife", "organism", and "fish" in the curriculum.

increase for any students, although social studies students showed an upward trend from 47% to 58% of students asking for both natural and social world information. These findings, where social studies students more commonly tended to ask for both types of information, are intriguing and are discussed later.

Table 8. Percentage of students asking both natural world and social world questions at pre and posttest and McNemar paired data test results.

Group	Percentage of students with mixed questions at pre	Percentage of students with mixed questions at post	p value (McNemar test)
Comparison science students (n=37)	46%	35%	.34
Intervention science students (n=206)	36%	37%	.91
Intervention social studies students (n=57)	37%	51%	.02*

*significant at .05 level

<u>Consultations for the land use decision</u>

What types of individuals do students wish to consult on the land use issue—natural scientists, social scientists, stakeholders, officials, or others? Students were asked to indicate how likely they would be to consult with each of 13 professionals as well as local government officials, local residents or others. In addition to the five-point scale (1=extremely unlikely to 5=extremely likely) the question included the option of "I don't know"; only 3% of pretest and 2% of the responses at posttest indicated this option.

The original principal components analysis of the 13 Likert items revealed three factors with Eigenvalues greater than 1 accounting for 51% of the variance. However, because the first two factors accounted for the bulk of the variance (42%) and because of issues associated with two items that loaded above .45 only on the third factor, a decision was made to conduct the principal components analysis omitting these two items.

The two items that loaded above .45 exclusively on the third factor were historian (.839) and landscape architect (.522). Geographer also loaded above .45 on the third factor (.513) as well as the second factor (.532) and thus was retained for the final analysis. Both the historian and landscape architect were, however, removed from the final analysis. This is because students did not perceive historians as useful to consult on land use issues. Historians received the lowest mean value (2.09 and 2.26 on the pre- and posttests, respectively). Students were also unclear about landscape architects. Although the questionnaire included a description of landscape architects, students' responses to another question on the survey revealed they did not distinguish between landscape architects and architects. Both the historian and landscape architecture option were therefore removed from the final analysis.

As hypothesized, exploratory factor analysis on the remaining 11 items using principal components analysis with Varimax rotation revealed two factors with Eigenvalues greater than 1 (Table 9). The professionals and individuals identified as part of the first factor related to the "people" or social side of land use issues (such as economics, infrastructure, population, government) and those identified as part of the second factor shared a focus on aspects related to the natural side of land use (such as animals, ecosystems, chemical properties, physical features). For simplicity, the first factor is termed "social scientists" and the second factor "natural scientists."

Table 9. Students' preferences for professionals and individuals to consult on land use issues: Factor analysis results

	Component	
	Social scientists & stakeholders	**Natural scientists**
City Planner	*.73*	
Civil Engineer	*.71*	
Demographer	*.71*	
Developer	*.67*	
Economist	*.64*	
Local government official	*.60*	
Local residents	*.53*	
Biologist		*.88*
Ecologist		*.70*
Chemist		*.69*
Geographer		*.61*
Cronbach's alpha	*.78*	*.73*
Mean rating	*3.88*	*3.10*

Extraction Method: Principal Components Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Paired *t*-tests revealed that on average students preferred to consult with social scientists over natural scientists on both pre- and posttest, regardless of what courses students were in and whether or not they were in the intervention or comparison groups (all p values ≤ .02).

Interviews: students' perceptions of problem complexity

Pre- and posttest results show that students increased their understanding of the complexity of land use issues—with complexity referring to a perspective that recognizes social world and natural world elements of land use—as shown by their increased requests for natural world information to make the decision. Did students and teachers themselves think students had improved in understanding the complexity of land use? To answer this question, during follow-up interviews students were asked whether and how their perspective of the scenario and their ability to make a land use decision had changed at posttest compared to pretest; teachers were asked for their impressions of changes in students' understanding of complexity after experiencing the unit.

Students' thoughts

Two to four students were interviewed from each classroom (52 intervention students total) using a semi-structured protocol. Analysis of the pretest consultation item was used to guide student interview selections with an attempt to interview at least one student who showed a stronger preference to consult natural scientists and one student who showed a stronger preference to consult social scientists and stakeholders. Interviewed students completed both the pre- and posttests and were present on the day interviews took place. In all cases, students were interviewed during class in a separate room, soon after completing the posttest.

Among intervention science and social studies students, 37 of the 45 who answered this question indicated that their view of the scenario had changed from pre to posttest. Comparison students had greater response diversity, with two of six responding yes, two no, and two who were unsure. Comparison students' did not clearly articulate what had changed, with one stating, "like after I took it the first time I thought of things differently, about things the way they could have been, instead of, like just different" and the other responding, "Yes, [I saw it] a little [differently]. But I still answered my questions, so it's basically the same, too."

Intervention students had more specific notions of their changed perspectives and referenced four main themes (numbers of students making references in parentheses): specific new natural or social world perspectives (n=18), a general increase in knowledge or ability to see more than one side of land use issues (n=11), processes of land use decision-making (n=6), and in a small number of cases, actions for sustainable land use (n=2). Following is a discussion of the four themes.

When speaking about new natural or social world perspectives, some students indicated a lack of one perspective or the other at pretest compared to posttest. According to one science student,

> "Like, the forest area, the first time I didn't really care about the forest, like I was like, why is there, why do I even care if there's forest over here, I mean. And the stream, I didn't really get the part about the stream, but I got that it gets polluted and stuff."

Another science student echoed this:

> Interviewer: Can you think of an example of how you first saw it and how it is different now?
> Student: It's like first I thought it was just like, um, a shopping center that wanted to come in and build. Uh, you know, big deal. But then the second time it's like but then there's the stream and there's the woods and everything else

One social studies student indicated the opposite perspective change, seeing the social world side:

> "The first time I looked at it and I saw it as just completely bad, because I didn't think, oh, how it could help the community in terms of jobs and stuff, I just looked at the negative impact because of like the environmental stuff. So, I did look at it a lot differently the second time around."

Four of the 12 social studies students indicated that learning about zoning during the unit added to their posttest perspective, adding comments such as:

> "And I didn't really realize that, and because, you know, just about how we're zoning and where they put people and where they put things. I never really figured there was that much work put into it. I figured they'd just put things wherever they wanted, but there's a lot of work that goes into doing it."

Some science and social studies students made references to both natural and social world perspectives. One student concisely stated, "I have better information about, I see like how it affects the whole community, even the nature around it and everything, so."

Students also spoke more generally of improved understanding or of seeing multiple perspectives:

> "Um, there were a lot of things that I understood better, words that I knew better, and different variables that changed the land and the water quality and the people and population, so I could make better judgments and decisions and ask better questions. I knew more." (female science student)
>
> "I feel like I can view on both sides after we learned all this stuff. Because I can see why people want to build it and I can see why people don't want to build it. But before, the first time I took it, I felt like I could only feel the way I really felt; I couldn't side on the other side." (male social studies student)

Several students indicated that their understanding of the land use decision-making process had improved.

> "Like after doing the unit and everything like, I definitely know a lot more, like how the city council works and all that stuff and like how they like make decisions and plan it, you know." (female science student)
>
> Interviewer: do you think you have a better idea now that you've done the unit about the types of information that you need to make a decision like that?
> Student: Yeah, for sure, definitely, because I would have never thought about half the stuff, I would have just like thought that people think of the land to build, but now like there's actually a process that you have to go through, you have to learn more about it than just building something. (male science student)
>
> "Yeah, yeah, cause it like made me more aware of how decisions are made and stuff like that." (female social studies student)

Finally, two students indicated a better understanding of how their actions could positively or negatively impact land use.

> "Well like, I know which ways I can, I know how I can go about changing my lifestyle to prevent less pollution and stuff. Like walking more instead of relying on a car to go to a store and stuff. Actually I didn't think it would produce that much damage to the sky and all that, using a car. I didn't think it would produce all that pollution and stuff." (female science student)

Teachers' thoughts

The nine teachers were interviewed individually soon after completion of the unit based on their availability. All teachers perceived that students had increased their understanding of complexity after completing the unit, both in terms of students' abilities to see both natural and social world elements of land use and students' recognition of the complexity of land use decision-making, though some qualified this more than others.

Teachers brought up three main themes: enhanced understanding of the complexity of land use decisions, student resistance to covering "non-science" concepts in science class, and students' abilities to connect the science concepts to daily life.

All five teachers (four science teachers and one social studies teacher) who completed the land use decision role play credited this activity for advancing students' comprehension of the complex decision-making process. Teachers reported that students found it difficult to compromise on a decision given the diverse perspectives. As two teachers described it:

> "Um, I think that's actually one thing that having the social science and the science perspective kind of blend together gave them a perspective. In the role play, part of, you know, some of their confusion in being in that situation was that there wasn't really an easy answer and that there were all these different perspectives. And that was in one respect good for them to see, because they realized that, you know, you're not, if you are an environmentalist you're not going to get it 100% the way you want it and if you're a developer you're not going to get it 100% the way you want it, so you have to blend the two."
>
> --Science teacher

> "Even in the role plays where they had to come up with an agreement on how to develop an area, um, they ran into complications and I think they realized, it is HARD to be able to resolve problems. Even if it's a debate, or if it's, when you have a group of people and all of them have different interests, it always complicates the results. So, I think they are aware of it, to what extent, I really couldn't measure that."
>
> --Social studies teacher

Interestingly, three of the six science teachers described student resistance to incorporating "social studies" in a science class:

> "At first a lot of the questions I got were, "this isn't earth science". You know, and I'm like, it kind of isn't, especially when we were talking about like housing styles. I think it took them awhile to realize, to get that understanding between you know, the types of housing and types of development and the effect it has on the earth and stuff like that."

> "But they'll never think about something as detailed as, where you should buy a sweater from, you know, like on that kind of a level. And they're like, what does this have to do with anything that could possibly connect with this class? … I don't think they're that used to doing it on a detailed basis, like really specifically. Um, and I don't think they perceive that stuff as science. It's an ecology class, a science class, and I think they don't think that's where, they might not be sure that's where we want the conversation to go. And so, I think that's part of it."

Thus the unit on land use included more social world concepts than students typically encountered in science class. Social studies students did not have the reverse complaint, possibly because, as all three social studies teachers reported, they did not spend much time on the "science" curriculum content.

Two science teachers commented on students' abilities to connect the material to their daily lives. One teacher found that she had to push students to make such connections, while another was surprised at students' abilities to make connections in this way.

> "Yeah, in some of the discussions when we really started connecting it to some of the everyday stuff, it was hard to get them to go there, like they just really resisted connecting the content to their everyday lives. But if I could get them to go there, then suddenly all the sudden they had all these things to say, that really took like, some extensive discussions and prompting on my part to really get them to see some of that."

> "I am very impressed with the new school, that activity, when we did that as teachers, you know we did all that stuff, and we're like but we don't expect that kids will give this kind of answer. They won't necessarily be able to connect this with global warming, and erosion, and you know, they did. They wowed me on that activity. And they loved it, because they were all going, "oh wait a minute, this is what the new school is going to look like. Why is it so much space? What's going on? Oh they've gotta have a gym and a parking lot, I forgot about that…" And they really, really got into it. So again, when it applies to them, they are able to make big picture connections, and that activity they wowed me on."

These teacher thoughts lead to some interesting questions that will be discussed in the next section: if students have a strong preference for the social world, can bringing the social world into science class help them see the relevance and application of science concepts? And does the compartmentalization of single subjects make it difficult for students to integrate their silos of knowledge?

Discussion

Several interesting results emerged from this study. First, students requested social world information at a much higher rate than natural world information regardless of course type, curriculum intervention, or gender. Second, results indicated that an integrated land use curriculum enacted in social studies and science classrooms increased students' requests for natural world information in the context of a land use decision. Third, after the curriculum intervention social studies students were better able to integrate both natural and social world information requests. Fourth, the course served as a lens through which students interpreted the land use decision, with social studies students showing a trend towards asking for more social world information than science students and science students asking for more natural world information than social studies students. Finally, at pretest girls more frequently requested information about animals than boys, although by posttest boys closed this request gap. A discussion of each of these results in turn follows.

In both their consultation choices and their requests for information, students showed robust preferences for social scientists over natural scientists and for using social world over natural world elements, a finding that supports Fleming (1986a, b) and contrasts with Yang and Anderson (2003). That the results of this study are consistent with the former study is not surprising given that both studies included open-ended responses rather than exclusively close-ended ones. The use of open-ended questions here, in contrast with Yang and Anderson's approach, could make these results a more accurate representation of students' cognitive maps. Because the Yang and Anderson study took place in Taiwan, cultural differences could also be a factor. Finally, their purposive sample—where approximately half of their subjects followed a social science course of study and half of them a natural science one, presumably by choice—could also have contributed to the overall balanced outcome that they observed. In fact, the balanced sample and result makes sense in light of another finding in this study discussed below, that the course type frames how students perceive and respond to the task.

Why might students show a bias towards social world information? While children interact with the natural world from a young age, most children have far more exposure to social institutions and contexts, thus constantly developing social cognition (Solomon,1983). Similarly, Dewey (1931) reminds us that compared to social institutions, the scientific approach to knowledge is relatively nascent. As a species, our systematic knowledge of the natural world has only recently begun. Turiel suggested that we develop social cognition separately from nonsocial cognition (1983), writing:

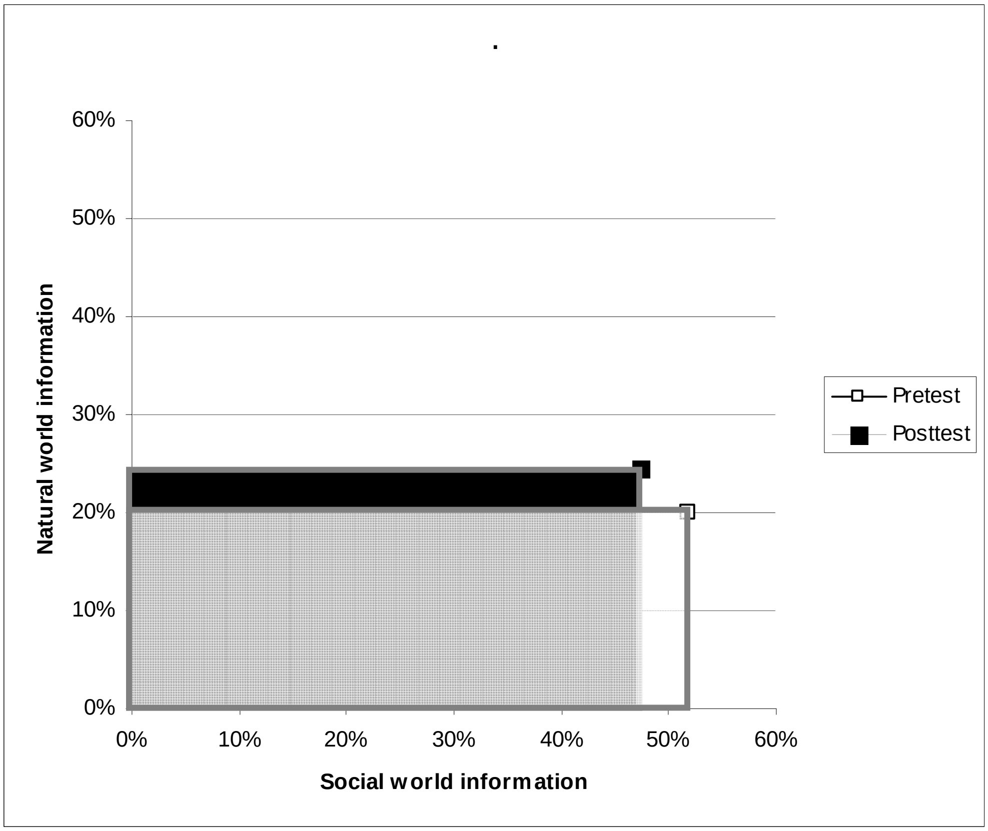
> "In coming to understand social systems, people act like social scientists, attempting to observe regularities and explain their existence….In other words, social life is not detached from thought processes" (p. 4).

The implication being that thought about the natural world *is* perhaps detached from daily thought processes. Perhaps putting people into the equation in the form of the social world content could help students connect natural world concepts to socio-scientific decisions. Indeed, previous research has suggested that a person's environmental attitudes are connected to the extent to which she perceives herself to be part of the natural world (Schultz et al., 2004) rather than separate from it.

This study also explored whether an integrated curriculum could help students expand their requests and consultation choices beyond initial social world and social scientist preferences. While no change was observed for consultations, science and social studies students demonstrated increased rates of asking for natural world information at posttest[9] suggesting a change in student knowledge of the natural world decision component. This is an important and interesting finding that again contrasts with Yang and Anderson's (2003) conceptualization of preferences, which used a scaled continuum model to explain information preferences. The limitation of such a linear scale model is that it assumes that preference gained for the natural world implies preference lost for the social world and vice versa. This is where the notion of knowledge use enters: while preferences might be viewed as zero-sum, there is no reason to believe that gained natural world knowledge must come with a one-to-one exchange for social world knowledge. I have demonstrated this by applying the pre-post percentages in the above tables to a two-dimensional figure below:

[9] This includes comparison science students who were not supposed to experience the curriculum, however, many of these students did experience parts of the curriculum and also covered relevant topics.

Figure 2. Student requests for social and natural world information[10]



One can compare the areas of the non-overlapping white rectangle with the non-overlapping black rectangle to see the net difference between pre- and posttest. In this case, the pretest rectangle has an area of 88 while the posttest rectangle area is much larger, at 204, demonstrating that such a one-to-one tradeoff did not occur. These findings suggest that students' knowledge structures of the decision changed over the course of the intervention, enabling them to expand their natural world knowledge use in the decision context.

In a land use decision such as this one, ideally students would request both natural and social world information. Few students requested both types of information, but interestingly, at posttest the number of social studies students drawing from both types of information increased, a change not observed among science students. This result, combined with the observation that social studies students showed a trend towards

[10] This figure includes data from comparison science students who did not adequately control for the curriculum exposure variable since at least two-thirds of these students did complete parts of the curriculum and relevant activities.

requesting more social world information than science students and science students requesting more natural world information than social studies students, indicates that the course served as a lens through which students interpreted the decision. In other words, the course context served as a "frame of reference" for students through which they viewed the decision (Holzner & Fisher, 1979). This raises the question as to how students might approach a search for information in the absence of a course context, such as in the daily life. Given the strong overall requests for social information, one might conclude that tendencies to ask for natural world information would be weaker in such context.

The underlying reasons for the observed association with subject could be many: a human-centric lens, such as that provided by social studies, could help students to make broader connections, or perhaps the teaching/learning culture of social studies helps students incorporate multiple perspectives and ask more questions (or different types of questions) compared to science. Social studies courses tend to take an integrated approach: a civics course is likely to include content from history, economics, and other disciplines. Science courses, however, do not do so as often; a biology course does not contain much content from physics, chemistry, or other science disciplines. Students could be interpreting course culture, such as consideration of course "boundaries" and degree of integration, to help decide what questions are appropriate. While we can hardly expect students who have been steeped in years of subject compartmentalization to think across those subjects after a brief intervention, surprisingly, they did in this study. This finding suggests that providing students with opportunities to integrate knowledge through curricula and classroom activities can improve students' abilities broaden their conceptualization of a land use decision to include natural and social world dimensions.

Finally, on the gender front, this study did not find a difference in requests for social or natural world information. However, looking only at natural world information sought by students, we found that girls more often sought information about animals compared to boys prior to the curriculum, a gap that boys closed at posttest. Female preference for biology topics including animals and living creatures has also been shown in other studies (Johnson, 1987; Taber, 1991; Qualter, 1993).

Implications and future directions

This study's findings have several implications for classroom teaching and curricula. Ignoring students' social world preferences could be problematic both for capturing and keeping their interest and for enabling them to connect natural world concepts to the social world they live in. Having students learn social concepts in one class and natural world concepts in another may not be enough to help them identify complexity across the social-natural world that they inhabit. Classroom opportunities for applying integrated knowledge must be provided; if we want students to be able to apply social and natural world knowledge in an integrated manner, curricula must give them guidance and practice in doing so within and beyond science classrooms. For environmental educators, the value of expanding curricula to social studies classrooms is clear.

Perhaps the most interesting result is that such a short intervention that was selectively adapted by teachers and enacted across grade levels demonstrated a change in student information use. Interviews with students suggest that these results, beyond reflecting a change in information use, reflected an expanded perspective on the decision problem. What results might we see with a more extended, comprehensive intervention?

Additional avenues for research include a closer analysis of the teaching and learning culture in school subjects or a similar randomized study with larger comparison groups to more effectively control for the curriculum intervention. In a natural setting such as the one used here, equivalent comparison groups are difficult to arrange (Campbell and Stanley, 1966); teachers are understandably hesitant to use precious course time for research purposes. Therefore another possibility might include an experiment in a lab setting that provided either single-subject, integrated multiple-subject, or no new information related to a land use decision. Secondly, this study sought to understand a more "typical" group of students and did not include honors or AP courses; investigating whether and how "high achieving" students might differ from more typical students would also be of interest. Perhaps some students have greater facility making connections between the human and natural world. Additionally, a comparison of student responses in the context of a class versus a context outside of class (whether in study hall or outside of school) would shed light on how students might approach such decisions outside of a specific course. Finally, a study looking closely at teacher enactment of integrated curricula would provide insight into how this important variable impacts student use of integrated knowledge.

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Chapter 2:
Students of action? An investigation of secondary students' action options

In education, we are encouraged to think of outcome objectives in terms of what students "should know and be able to do" and then to design learning opportunities that meet these objectives. The "able to do" implies using knowledge through doing or action: it could refer to being able to write an essay or to solve an equation, or it could refer to the ability to participate in civic organizations or to take action to address a social issue. While high school classrooms tend to focus on the former, this paper focuses on the latter objectives. Although an often cited primary goal of public education is to create engaged citizens, our system of formal schooling does little to prepare students for taking such actions, evaluating their actions, or even understanding how their knowledge might guide their actions (Hargreaves, 2001). We rarely provide students with opportunities to analyze how classroom learning might apply to daily actions or assist students in developing knowledge regarding the many types of action they can and should take as citizens.

Environmental education (EE) has historically focused on student knowledge, attitudes, and behavior. Of these three areas, the behavioral emphasis differentiates it from traditional school subjects and is the focus of this paper. In many cases, EE curricula explicitly aim to increase positive environmental actions among students. EE also aims to help students use learned knowledge to inform environmental behavior, even while recognizing that knowledge alone is insufficient behavior change (Hungerford and Volk, 1990). Given the focus of EE on actions, it could provide useful guidance for how formal schooling might meet the objective of "able to do" in terms of public action and participation. Since EE curricula are most often enacted in science or social studies classrooms (National Survey of EE Usage, 2001), these classrooms are the focus of this paper.

Can an EE curriculum that integrates social studies and science content and is enacted in secondary social studies and science classrooms help increase positive environmental actions among students? Can it expand students' knowledge of environmental actions, and does such knowledge have a relationship with the type of course (science or social studies) or participation in the EE curriculum? I sought to address these questions in the context of an integrated sustainable land use curriculum for secondary science and social studies students. I hypothesized that such an integrated curriculum would positively impact students' action knowledge, especially if classroom opportunities for action were provided. Understanding how we can improve students' abilities to apply classroom knowledge to daily actions is essential if, as our standards suggest, we hope to have students use classroom knowledge beyond graduation, especially in civic contexts. Before describing the study method and results, I examine how science, social studies, and EE approach the question of what students should "be able to do".

Taking action: social studies, science, and environmental education

In most high schools, social studies provide the primary means for developing citizenship skills. According to the National Council for the Social Studies (1994), social studies is unique because its primary goal is to promote civic competence. Similarly, according to the State of Michigan (Michigan Department of Education, 2007),

> "The purpose of social studies is to develop social understanding and civic efficacy (the readiness and willingness to assume citizenship responsibilities and to make informed and reasoned decisions for the public good as citizens of a democratic society.)"

Social studies shares a focus on behavioral outcomes with environmental education (EE). As early as 1975, the Belgrade Charter suggested that EE focus on concern, knowledge, and actions on behalf of the environment:

> "The goal of environmental education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivation, and commitment to work individually and collectively towards solutions of

> current problems and the prevention of new ones." (UNESCO, 1977, p. 15).

More recently, the North American Association for Environmental Education developed guidelines for PK-12 EE learning that affirm this behavioral focus and aim for a democratic society with participative citizens (NAAEE, 2004). Researchers Chawla and Cushing (2007) suggest that environmental educators can learn from social studies research, arguing that environmental educators should pay particular attention to research on the political development of youth to help prepare them for public action. In sum, the ultimate goal of EE has been to help both individuals and society act in an environmentally responsible manner, and civic education—with its emphasis on civic participation and decision-making—is one means of doing so.

While both social studies and EE share a focus on developing civic-minded citizens, in most formal schooling at the secondary level where EE is present, it is incorporated into science classrooms (National Survey of EE Usage, 2001). In science education, the focus on citizenship behavior historically has been less prominent, although it has experienced periods that focus on social relevance in the 1920s and again in the 1970s and 80s (Deboer, 1991). Three of the four stated goals in the National Science Education Standards explicitly or implicitly refer to how an individual can use science in the private spheres of her life. One goal includes public citizenship elements: students should be able to "engage intelligently in public discourse and debate about matters of scientific and technological concern" (National Academy of Sciences, 1995). As evidenced in these standards, science puts less focus on citizenship skills than does social studies and environmental education. Thus, one might expect different knowledge and behavioral outcomes for an EE curriculum used in a science classroom compared to a social studies classroom.

Studies comparing secondary science and social studies with regard to environmental actions and knowledge of actions are not common in the literature. Through 1999, very few studies examining environmental behavior had been undertaken at the secondary level (Zelezny, 1999; Leeming et al, 1993). Zint and colleagues (2002) reported that student participants in 1 day, 3 day, or 2 week Chesapeake Bay educational field trips (some of whom were high school students) improved in perceived knowledge of actions, skill in actions, and/or intention to act relative to comparison students who did not participate; they found little evidence of such impacts for students who completed a Chesapeake Bay ecology/conservation curriculum without the field trips. Field trips included activities such as fishing, water testing, canoeing, traveling tributaries, and staying on Chesapeake Bay islands. Although curriculum-only classes were to engage in one of three service learning projects as part of the curriculum, only 16% of teachers reported doing so, a factor that researchers felt contributed to lower performance of curriculum-only students compared to field-trip participants. While the Zint et al. study did not compare across school subjects or focus exclusively on secondary students, importantly, it suggests that curricula absent action (in this case, service learning projects) are not effective in increasing students' knowledge of actions. This paper will contribute to the small number of studies examining secondary student environmental behavior; it will also help us understand what types of actions secondary students see as salient, and how a curriculum intervention in different subjects might impact their knowledge of actions and actions.

Methods

I utilized a mixed-methods approach with quantitative and qualitative methodology employed at different phases in the study (Tashakkori & Teddlie, 1998). A pre/posttest employed open ended questions which were qualitatively content coded before transformation into numerical values for quantitative analysis. Semi-structured interviews provided additional qualitative data for triangulation (Greene et al., 1989). The open-ended questions allowed for more direct insight into students' cognitive repertoire of actions while quantitative analysis allowed for pattern identification across subjects.

Nine teachers were recruited from professional development workshops that introduced a land use curriculum to secondary science and social studies teachers from a Southeast Michigan county in January 2006 or February 2007. Participants represented six of the county's ten independent school districts. Of the nine teachers, three were social studies teachers (government or law classes) and six were natural science teachers ("science"; earth science, ecology, or freshwater biology classes). Two of the science teachers also provided a total of three comparison classes. All teachers were Michigan certified for their subject, with teaching experience ranging from 5 to 34 years. Seven teachers held advanced degrees and two had advanced degrees in progress. Approximately 500 students in grades 9-12 participated in the study. This research study was part of a larger study that also examined students' information requests to make a land use decision.

The curriculum, "Lessons from the Land", was chosen for this study because it was explicitly designed for and integrated concepts from both science and social studies at the secondary level, and the schools using the curriculum represented a fairly diverse group of students from the same independent school district and county (see Appendix A for details). The curriculum is rooted in the local county's land use plan and is thus locally themed. To be included in the study, teachers had to spend a minimum of two weeks on the unit during the spring semester of 2007 (see Appendix B for science and social studies curricula table of contents). The curriculum was designed to improve students' abilities to take action and to make decisions in support of sustainable land use, ranging from political action (such as participation in a planning commission meeting), to consumer action (using alternative forms of transportation), to information sharing (educating the public about sustainable land use), and ecomanagement action (keeping storm drains clean, washing cars over pervious surfaces). The curriculum largely focused on actions that students could take individually, although some actions—such as participating in planning meetings—were by nature group activities (one cannot have a planning meeting without others). The curriculum also aimed to improve students' action knowledge through activities such as a group community land use decision simulation and by applying concepts to their own neighborhoods and communities.

Data collection

Employing a quasi-experimental design, students were surveyed prior to and following a curriculum intervention and a smaller sample of comparison students (science students only) completed the surveys without a classroom curriculum intervention. Students were asked to complete two open-ended items indicating a) actions they had taken in the past month that could help contribute to sustainable land use and b) actions they could take in the future to contribute to sustainable land use in the community. These items gauged students' self-reported actions and knowledge of actions. Following the curriculum, semi-structured follow-up interviews were conducted with a sub-sample of 52 science and social studies intervention students and all teachers. Teachers were asked to comment on the likelihood of students taking future action in support of sustainable land use.

Open-ended student responses were recorded and entered into NVIVO 7, a software coding program. Each response was coded twice according to the type of action taken. First, each action was coded as an individual action (done alone, such as voting) or group action (by its nature a group activity, such as attending a planning meeting), in keeping with the Belgrade Charter (UNESCO-UNEP, 1977) that citizens have knowledge and skills "to work individually and collectively" towards solutions. While coding the actions as public sphere or private sphere is suggested by some (Chawla and Cushing, 2007), this distinction can be difficult to make; for example, while voting occurs in the public realm, the process itself is strictly a private one. An additional sub-coding scheme was adapted from an empirical study of 7th and 8th graders by Culen and Volk (2000) and further coded the action as political action (related to government or politics, such as "sign a petition"), consumer action (related to consumption, "carpooling" would be an example because it represented a decrease in gas consumption), information sharing (exchanging or receiving information, such as "talk to others about land use"), and ecomanagement (physically managing the environment, such as "plant trees" or “clean up litter”). Because the information sharing category implies sharing between people, it was always coded as a group action. Every action listed fell into one of these seven categories (2x4 matrix minus information sharing), with the exception of responses too general for coding or analysis, such as “community service.”

Upon coding completion, the query feature in NVIVO was used to create a matrix for each student showing the number of actions listed in each of the seven categories for the two items. The matrix was exported to SPSS for quantitative analysis. Student and teacher interview responses to questions about actions provide additional insight into student knowledge of and behaviors for sustainable actions related to land use.

Interrater reliability

A random sample of 13% matching pretests and posttests (50 matched pre-posttests of 378) was drawn, and two raters independently coded the second open-ended item (actions they could take in the future).[11] Coding software generated a coding comparison report for each survey that calculated the agreement between the coders; overall mean agreement between the two raters for ecomanagement and non-ecomanagment categories was 85%.

Results

Survey items measured students on two fronts: reported actions taken and knowledge of actions. Responses were evaluated for type of action, number of actions listed, and the number of blank and “I don’t know” responses. In general, students listed more actions that they could take (knowledge of actions) rather than actions that they had taken, which is to be expected given the many demands on high school students’ time. Asked on pre- and posttests why they didn’t take any action in support of sustainable land use, students most often cited being too busy or lacking time, followed by not knowing how to do so (on both pretest and posttest).

[11] Because the first open-ended item used the same categories as the second, a separate interrater reliability was not assessed for this item.

Results must also be viewed in light of curriculum enactment which revealed that teachers put little emphasis on action content in the curriculum, nor did they often engage students in actions suggested by the curriculum.

Curriculum enactment

Classroom observations, teacher logs, and teacher interviews comprised curriculum enactment data. In terms of the curriculum, all teachers received full copies of both social studies and science curricula materials, though none of the teachers reported using materials from the other subject area curriculum. The two curricula, however, shared many lessons in common: for a full description see Appendix C. Of the seven main curriculum activities provided for science class, science teachers enacted a mean (and mode) of five. Only two teachers used the two more in-depth civic based activities: redesigning part of the community for sustainability and researching/evaluating a planning issue in your community. And although five teachers completed the water quality/quantity lab in class (see Appendix C), only one of them required students to write up the full lab as described in the curriculum. Social studies teachers enacted from six to seven of the twelve activities contained in the social studies curriculum. Looking at the same two civic-based activities that also appeared in the science curriculum, one social studies teacher gave students an extra credit option of redesigning the community for sustainability and none of the teachers had students research/evaluate a planning issue in the community.

While written curricula included both individual and group activities and actions, as enacted by teachers, the curricula content and activities tended to focus on individual rather than group activities and actions. Curricula included action options such as redesigning part of the community for sustainable land use and presenting results to community members or local planning officials, or educating others through written materials or a website. Options also included presenting the proposal to the local planning commission or writing a letter to the editor. The curriculum did not designate whether such assignments were to be done individually or in groups, leaving the decision to teachers. Beyond grouping students to complete the lab in science class and completing the land use decision simulation in groups, teachers generally made assignments individual based.

In addition to these intervention classrooms, three science classes served as comparison groups. Two of these were biology classes taught by one of the teachers and one was a fundamental physics class taught by another teacher. The comparison science students were to only take the pre- and posttest without receiving a curriculum intervention; however, parts of the curriculum were used in two of the comparison classes along with activities relevant to the curriculum including testing and studying local streams and watersheds.

Although the curriculum suggested several specific activities for student engagement as described above, interviews and teacher logs showed that few teachers directly involved students in actions related to sustainable land use. Because most teachers were science teachers, ecomanagement actions (such as recycling, keeping ecosystems clean, and planting trees) related most directly to the curriculum. While most teachers hoped that the curriculum would impact student thinking, and many teachers brought up non-ecomanagement actions in the classroom (such as consumer, political, or information sharing actions), they did not assign their students to engage in or to practice these actions on a substantive level. Several teachers, however, did require students to complete an information sharing assignment in which they had to interview three neighborhood residents about their land use opinions. One social studies teacher reported that he had stressed to students their ability to impact society through economic choices, although relatively few students brought up this perspective in surveys or interviews. In some classroom observations, it was clear that science teachers were less prepared to improve students' civic knowledge related to action. For example, during one lesson observation, students lamented the projected future land use in the community; the teacher responded with a statement on the importance of voting. This statement simplified a complex reality: normally citizens of this county do not vote directly on land use decisions. At best, citizens elect city council members who appoint a planning commission or zoning board. None of the teachers had students write editorials, attend local planning meetings, interact with local officials, or otherwise embed themselves in non-ecomanagement actions related to land use. At the same time, students also engaged in few ecomangement actions as part of the classroom: the closest example would be the few classes that engaged in stream water testing.

Group and individual actions taken and knowledge of actions

Students listed more individual actions that they had taken or could take compared to group actions. Individual actions listed on pre and posttests combined totaled 273 for actions students had taken and 447 actions they could take, while group actions totaled 15 and 46 respectively. Group actions listed were so few that statistical analyses in this category were unsuitable. Others have noted that group competencies are often neglected in EE and recommend that environmental educators promote student competencies in working with a group (Chawla and Cushing, 2007).

Ecomanagement and non-ecomanagement actions

Overwhelmingly, regardless of course, gender, or other grouping, students tended to list actions that fell into the ecomanagement category. The most frequently mentioned ecomanagement actions included recycling and picking up trash. The low numbers in the information sharing, political, and consumer categories were unsuitable for statistical analyses. Therefore, these three categories were merged together into one "non-ecomanagement" action category.

Reported actions

To ascertain whether the rates of listing an ecomangement or non-ecomanagement action changed with course type or the curriculum intervention, a Poisson regression model for Poisson[12] distributed data was employed. Analysis of reported actions that students had taken in the past month did not indicate any change in rates of action based on course type or curriculum exposure.

12 Data exhibited a Poisson distribution with a low number of actions listed for the majority of students.

Knowledge of actions

One measure of student knowledge includes whether or not they responded to the items. During administration, students often asked what “sustainable” meant (they were instructed to do their best to interpret the question). Therefore, changes in the numbers of blank and “I don’t know” responses, even for past actions taken in support of sustainable land use, were interpreted as changes in knowledge rather than actual changes in action levels. Three significant relationships were detected for blank and “I don’t know” responses. First, for the overall sample of students, the number of blank and “I don’t know” responses for actions taken and possible actions decreased from pre- to posttest (Wilcoxon signed-rank test for related samples, $z=-4.12$, $z=-11.58$, with $p<.001$ for both items). Second, on both measures (past actions taken and future possible actions), social studies students were less likely than science students to offer blank or “I don’t know” responses at pretest, but no difference between the two groups existed at posttest. This finding could be attributed to the previously mentioned emphasis of social studies education on civic actions compared to that of science education. Finally, at posttest comparison students more often left these items blank or responded “I don’t know” than did the intervention students. Thus being exposed to “Lessons from the Land” clarified actions related to sustainable land use in students’ minds. Results are summarized in Table 10.

Table 10. Analysis of blank and "I don't know" student responses.

Group or comparison	**Pre-/post- test percentage of blank and “I don’t know” responses**		**Significant finding**
	Item: actions taken	Item: possible actions	
All students	19/11	40/7	**All students had fewer blank or “I don’t know” responses on posttest** *(p<.001 for both , Wilcoxon signed-rank test)*
Social studies (n=113) v. science (n=387)	12/8 v. 21/11	31/5 v. 42/7	**Social studies had lower rates of blank or “I don’t know” responses than science students at pretest on both items** *(p=.032, p=.036 Mann-Whitney test)*
Comparison (n=64)	30/19		**Intervention students had lower**

v. intervention (n=436)	v. 18/9	47/13 v. 38/6	**rates of blank or "I don't know" responses than comparison students at posttest** *(p=.023, p=.042 Mann-Whitney test)*

Analysis of student responses of future possible actions revealed three interesting relationships. First, only social studies students showed increased odds of listing ecomanagement actions at posttest compared to pretest (p=.032, odds ratio 0.55, 95% confidence interval 0.32, 0.95). While social studies students listed far fewer ecomanagement actions at pretest than did science students, on posttest the two groups did not differ in rates of ecomanagement actions listed. After the curriculum, social studies students "caught up" with science students in listing ecomanagement actions. The second and third relationships emerged in analysis of non-ecomanagement actions (political, information sharing, consumer), where odds changed with both the type of course and curriculum exposure. Specifically, the odds of science students listing non-ecomanagement actions at posttest decreased (p=.03, 95% confidence interval 0.06, 0.84) and the odds of social studies students listing non-ecomanagement actions at posttest increased (p<.001, 95% confidence interval 1.56, 4.64). As seen among all science students, comparison science students had decreased odds of naming non-ecomanagement actions at posttest (p=.03, 95% confidence interval 0.06, 0.84) while students who were exposed to the curriculum showed no statistical change in identifying these actions at posttest. This result could be due to science teachers putting less emphasis on non-ecomanagement actions more commonly covered in social studies courses, such as political, information sharing, and consumer actions, As noted above, science teachers could be less comfortable with discussions related to political actions than those related to stream water testing or invasive species removal, for example. Survey results for non-ecomanagement actions are summarized in Table 11.

Table 11. Interaction results for student odds of listing possible non-ecomanagement actions (by course and intervention.)

Significant model factors	Pretest mean	Posttest mean	Odds Ratio	95% confidence interval	p value
Pre-post*course	n.a.	n.a.	.32	.17, .62	p=.001
Pre-post science	.20	.09	.23	.06, .84	p=.03

Pre-post social studies	.12	.31	2.7	1.56, 4.64	p<.001
Comparison*pre-post	n.a.	n.a.	3.77	.99, 14.43	p=.052
Pre-post comparison	.20	.05	.23	.06, .84	p=.03

* denotes interaction terms

To summarize, while social studies students increased listing rates of both ecomanagement and non-ecomanagement actions from pre- to posttest, both intervention and comparison science students showed no change in ecomanagement actions listed and a decline in rates of non-ecomanagement actions listed. This suggests that the type of course had an association with actions that students identified, a result analyzed more fully in the discussion section.

Interview data

Of 52 interviewed students, 46 were asked about their likelihood to take actions to support sustainable land use in the future. Four said "no" or" maybe," six responded with "I don't know," and the remaining 36 responded affirmatively. However, 23 of these 36 qualified their answer with expressions such as "I hope so," "I think so," "Probably," or "If I have the opportunity." Others mentioned that they would do so in specific contexts:

> "Probably, yeah, probably. I mean I do community service like, I don't know. You know, picking up trash and stuff like that. Mostly for community service for college. I'll do it during the summer to put on my application. Um, other than that, I'm not really sure."

Several students mentioned that they would take action if they were personally affected.

> "Well, I'll do like, if there's something like really big, like maybe uh, like there's no way I could stop the rainforest or anything like that. But I mean, if there's something like really big that affects me and my community or something. It's just that I don't think I'll go *out of my way* to do it. But if there's something in our community that I think is important, yeah, I'll do anything I can."

Some students expressed sentiments of not being able to tackle the problem alone, stating that they would be more likely to take action if others did also. "Um, after doing this, just a little bit [referring to increased likelihood to take actions], but it's like, not much I can do by myself, so." Suggesting that a group approach would make it easier to take actions, one respondent referred to family: "Oh boy. If I could convince everybody else in my family to do the same thing. Or neighbors and stuff, so I don't feel like I'm just doing this alone." While another referred to the community:

> **Interviewer**: Ok. What would make it easier for you to take actions towards sustainable land use?
> **Student**: If people like, people in that area, like help protest
> **Interviewer**: So other people in addition to yourself?
> **Student**: Yeah
> **Interviewer**: Ok. So participating with a group.
> **Student**: Yeah
> **Interviewer**: So anything else that would help?
> **Student**: Talk to like the city people about it

This student's example of talking to the city about the issue was one of very few non-ecomanagement actions mentioned and the only one that suggested interface with city officials. Beyond this, two students suggested willingness to sign a petition while another suggested a willingness to donate money to improve water quality. In general, when asked for examples of the type of actions they might take, students referred to recycling, picking up trash, or decreasing personal contribution of environmental pollutants:

> "Yeah, recycle more, and like I always throw stuff out the car window. I'm too lazy to throw it in a trashcan. Stop things like that, and then, like when I have my car leaking or something, take care of that sooner than later, stuff like that."

Rather than providing examples, some students stated that they were certainly more aware and would think about issues more often.

> "Just thinking about like, when they have, when they want to build a new school or they want to build stuff in your community just thinking about maybe if it was a good idea or a bad idea; just general thinking about it."

Teacher interviews also provided insight into students' actions. None of the teachers expressed certainty that students would take future actions in support of land use. Eight responded that they did not know or that they hoped it would impact future actions. One expressed confidence that at least some students would take more actions in the future. Teachers' responses were often grounded in the realities of adolescence:

> "Like so, in the future, I don't know. We are talking about 16 and 17 year old kids right now. Do I think they are going to drive less? No. They want to drive their car. Do I think that they're going to you know, buy different products at the store? Probably not, they're not the ones buying most of the products. Do I think that they're going to buy a smaller house? No, they're not the one buying the house."

Three teachers spoke of increased awareness among students and two others about increased student thinking about impacts. Some also referred to information sharing.

> "You know a lot of them said that, you know, things did matter to them and they were, you know, gonna think more about decisions and choices that they were making. So I mean at least if they do that they bring in awareness or talk, you know some of them actually have come back and said you know, I told my mom or dad about that and we talked about that last night. And to me, that's a step, too, because they are bringing more awareness maybe to parents who don't know about it and maybe they'll spread it along. So, I think individually they all will probably have some little impact or even they'll use it. Some of them you know will go on to make bigger impacts and just choices about what they themselves or doing or what they want to vote or…"

Like students, teachers also brought up the notion of student lack of power to change the situation. According to one, "They don't think they have any say or impact, so I doubt that they'll do too much." And another, "They want to make a change, but again, they are kids and they feel kind of powerless."

Thus, interviews generally confirmed pre- and posttest results: students have limited knowledge of what they can do in the realm of action related to land use. Students most often discussed individual ecomanagement actions, although they also expressed a desire for group actions. As mentioned previously, these results could be partly explained by curricular enactment that focused on individual activities and actions as well as an emphasis on ecomanagement actions in science classrooms.

Discussion

The group of public high school students studied here had taken limited actions and had limited knowledge of actions supporting sustainable land use. These results are similar to those found by Conover and Searing (2000) in a study of high school students' political socialization where students had minimal knowledge of citizenship and conceived of citizenship in passive terms. Both studies suggest that students have narrow views of citizenship actions comprised largely of individual actions that rarely require initiative beyond one's daily routine.

Main results of this study included: students rarely identified group or collective actions, students more often listed ecomanagement types of actions rather than non-ecomanagement types of actions, social studies students demonstrated positive changes in action knowledge after the curriculum while science students did not, and perhaps most importantly, teachers did not often enact action components of the curriculum. A discussion of each result follows.

Group or collective actions are simply not salient for students; they tend to think of actions in terms of individual behavior. Given the collective nature of many environmental and social problems and solutions, this is a disheartening finding, yet also an opportunity to emphasize the role of groups in civic actions. Some barriers to teaching such actions are obvious: curriculum standards rarely spell out group or collective action, and teachers might see encouraging group action—especially of a political nature—as overstepping their bounds. From the student perspective, limited time and know-how makes taking action (especially group action) difficult, and taking part in such actions is rarely a requisite for course success.

On another level, students' emphasis on individual actions could be tied to either the egocentric nature of adolescence (Piaget and Inhelder, 1969) or to larger American cultural forces that emphasize "rugged individualism" (DeToqueville, 1835/1969; Lukes, 1973). In a study of how adolescents viewed historical change, Halldén (1986) found that even after explicit instruction, students tended to attribute historical changes to individuals rather than to structural causes. Another example includes certain well-known environmental media campaigns, such as the "Keep

America Beautiful" campaign, which put on a strong emphasis on individual responsibility for trash pickup and recycling rather than emphasizing collective individual and industry responsibility (Strand, 2008; Williams, 1990). Regardless of the reasons behind this observation, it is clear that without explicit instruction, students are unlikely to understand or to participate in collective actions.

In relation to ecomanagement versus non-ecomanagement actions for sustainable land use, students tended to recognize ecomanagement actions but either are not as aware of or do deem less relevant actions of a political, consumer, or information sharing nature. Even within the ecomanagement category, students listed a narrow range of actions largely focusing on recycling and litter removal, actions that one is readily exposed to outside of the classroom. Teachers rarely focused on, demonstrated, or engaged students in non-ecomanagement actions. In spite of this, after the curriculum intervention, social studies students' awareness of possible actions expanded both within and beyond ecomanagement to include political, consumer, and information sharing behavior. Additionally, the curriculum seemed to help student knowledge of "sustainable" land use actions among all intervention students given the larger non-response among comparison students at posttest.

Because social studies students who experienced the curriculum were able to identify a broader range of actions than science students, this suggests that the subject itself plays a role in student cognition related to actions. Furthermore, at pretest social studies students listed far fewer ecomanagement actions than did science students, though at posttest social studies students closed this gap. These results could be a function of the subject serving as a "frame of reference" through which students viewed the questions (Holzner & Fisher, 1979). Given the more "human-centric" nature of the non-ecomanagement category, it is not surprising that social studies students would show an increasing trend in these types of responses while science students would be less likely to do so. This trend also might be expected given that stated goals and objectives of science education put far less emphasis on civic actions than do social studies goals and objectives. Moreover, ecomanagement actions such as recycling, keeping drains free of litter, or removing invasive species tend to be more natural world focused and included in science curricula. The implication here for environmental educators is important: incorporating EE into social studies courses could improve the breadth of student outcomes in terms of knowledge of actions and actions in political, consumer, and information sharing realms.

Finally, interview, observation, and curriculum log data indicate that teachers placed little emphasis on action content. It is therefore likely that such limited curriculum enactment played a role in students' identification of individual, quotidian actions. With few exceptions, teachers rarely asked students to participate in group actions or substantively discussed the role of group actions. Nor did the curriculum itself guide teachers towards doing so. The curriculum did provide some guidance on non-ecomanagement actions, but teachers did not often engage students in such activities. While social studies students showed increased knowledge of non-ecomanagement actions, this could be due to the aforementioned culture of the subject of social studies where they more often learn concepts related to political or other non-ecomanagement actions. Stodolsky (1988) found that elementary teachers altered their teaching practice depending on the subject matter being taught, suggesting that the subject taught can impact curriculum enactment.

Several opportunities for future research are apparent. First, direct observation of student behavior rather than self-reporting could provide additional accuracy and depth to our understanding of secondary student knowledge of actions and actual actions. Second, a comparative study in which science and social studies teachers substantively engaged students in a variety of land use actions would allow for additional comparisons and insights into subject culture and student actions. Third, while the open-ended response items in this analysis provided more direct insight into student cognition than studies that limit students to pre-selected possibilities and scales, a larger sample of in-depth student interviews might contribute important perspectives. Probing students in greater depth about their action choices and limitations would contribute additional insight into these results.

Implications and future directions

Scant research has been conducted among secondary students to investigate what they "know and are able to do" along the lines of individual and group actions to impact environmental and social issues. Stated objectives and standards for subject areas suggest that such knowledge is valued by our educational institutions. If we are serious about enhancing students' future participation in a democratic society beyond voting, then we need to devote classroom time to helping them be aware of and practice such actions. And this must go beyond social studies courses to include science courses and others to help students make connections between course concepts and daily civic life.

The suggestion that schools connect classrooms with actions outside the classroom is not unique, and in fact, Conover and Searing (2000) found that these connections are already happening with some frequency in English courses. Kesson and Oyler (1999) further report an English program in Oklahoma that extensively involved students in learning about and taking extensive actions within the community to address toxicity of a local watershed. Such classroom based action programs have even shown success with improving student attendance, academic achievement, and retention rates (Joselowsky, 2007).

If teachers are to work towards incorporating behavioral learning along the lines suggested here, it is clear based on enactment observed in this and other studies (Zint et al., 2002) that curricula, professional development, and perhaps our educational institutions in general must explicitly assist teachers in doing so. Although students' knowledge of environmental or other civic and social actions are rarely directly assessed in high stakes testing common today, there is reason to believe that teaching these actions can support tested content and overall educational objectives (Kumler, 2009).

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Chapter 3:
Bringing out the best in students by refocusing on the big picture

Of late, much attention has been paid to test scores, graduation rates, and reading ability of our public secondary school students, with most measures indicating that outcomes are flat or declining (Greene, 2002; NAEP, 2004; National Science Board, 2006; U.S. Department of Education 2007; Habash, 2008). The No Child Left Behind legislation in the United States has put renewed emphasis on math and literacy test scores (No Child Left Behind Act, 2001). While performance measures and accountability are necessary, our singular focus on such outcomes has cast aside—and at times worked counter to—other important aims of education such as student motivation, lifelong learning, and self-sufficient and responsible citizens. This paper suggests that our students and society have much to gain by expanding the conversation to think about how we might provide a learning environment supportive of students' needs that works towards meeting student learning goals as well as societal goals ranging from higher test scores to participative citizens. The discussion will begin with an examination of some of the more commonly expressed aims of public education, how we currently work to achieve those aims, and the limitations of these current methods. I will then introduce the Reasonable Person Model, a framework that sheds light on how we might think about balancing these outcomes through supporting student cognitive needs

What does public education aim to do?

The response to this question depends on where we look: to our formal written standards, educational policies, educational philosophers, economists, or others. Here, the first three will be considered. Formal standards, whether individual state standards or national standards developed by professional organizations, provide specific guides to concepts and knowledge that students must master. The amount of information and skills covered in the many standards documents is far too much to cover in the time allotted to K-12 schooling (Marzano et al, 1999). Furthermore, a recent study of college students demonstrated that coverage of a large quantity of concepts compared to emphasizing a smaller number of key concepts results in far less knowledge only a few months after taking the class (Guess, 2007). Standards themselves are generally provided in the context of broader goals, such as the eight that are identified in the 1999 National Education Goals Report. The report included goals such as U.S. students being first in the world in science and math achievement, increasing parental involvement, increasing graduation rates, and ensuring teacher access to professional development. While laudable, these goals are notable for what they fail to promote. For example, they do not address cultivating an interest in learning, increasing student motivation in school, or fostering a participative citizenry.

The federal No Child Left Behind Act (or NCLB, PL 107-110) shows comparable priorities and omissions. This major piece of legislation that impacts school funding and drives outcomes-based education, focuses on basic literacy and math skills for all students measured by state-administered standardized tests. In the end, NCLB focuses on student test scores while generally ignoring other educational outcomes. On the other hand, educational philosophers such as Alfred N. Whitehead and John Dewey tended to emphasize other educational outcomes that now seem to be neglected. Whitehead insisted that education must be useful in daily life to those being educated, an outcome that our current policies generally ignore. He defined education as “the acquisition of the art of the utilization of knowledge” (Whitehead, 1929, p. 4). He warned against overemphasis on knowledge acquisition without the ability to use it:

> “In training a child to activity of thought, above all things we must beware of what I will call ‘inert ideas’ –that is to say, ideas that are merely received into the mind without being utilized, or tested, or thrown into fresh combinations.” (p. 1)

Rather than referring to formal tests, “tested” here implies application. Whitehead’s emphasis on utilizing knowledge is particularly apt in our current day and age in which understanding how to find and apply information is more important than possessing vast reservoirs of information in one’s head (Castells, 1996).

For Dewey the aims of education are inextricably tied to the process of education, with our very democracy depending on the success of the educational process. In his view, education must focus on conditions that enable continued individual and community growth through self-renewal (Dewey, 1916). Dewey and Whitehead hit on the essence of what our current conversations tend to omit: how can we meet student's individual learning goals and collective social goals without sacrificing performance? These various goals and objectives are not mutually exclusive. On the contrary, if we hope to improve graduation rates and school attendance, students must enjoy and find value in the process of learning. Consider the findings of a recent study of MBA students indicating that those who set personal learning goals (along the lines of skills and knowledge desired) rather than specific high end result goals (such as earning an A) had both higher GPAs and self-efficacy (Latham and Brown, 2006). In other words, including students' own learning goals in the process can enhance both personal outcomes, such as self-efficacy, and achievement outcomes that we more commonly measure, such as GPA. From a student's perspective, graduation rates, school attendance, and test scores in themselves are unlikely to enhance the quality of life or the educational experience.

Other research has shown that the emphasis on standardized testing can also undermine students' motivation to do well on tests and even to learn (Makara, 2008; Paris & Cunningham, 1996). In their book, *Collateral Damage*: *How high stakes testing corrupts America's schools*, Nichols and Berliner (2007) illustrate the many adverse effects of high stakes testing, including negative impacts on students' mental health, passive students sitting through dull classes focused on test preparation, and teachers fleeing the profession. Standardized tests have also been shown to contribute to increased dropout rates (Haney, 2000; Futrell and Rotberg, 2002; Hayward, 2002) and promote low-level thinking over high level thinking (Paris, 2000).

Clearly, high stakes testing does not provide students with the long term skills and education they need, yet the goal of high test scores dominates conversation and thinking about education. How else might we think about education, and how might we reconcile many competing educational goals? The Reasonable Person Model can guide us towards a new conversation that reconciles many objectives and can assist educators with providing a meaningful learning process by creating an environment supportive of student cognitive needs. In doing so, it can help educators bridge the gap between results demanded by policymakers or the public and students' cognitive needs. After introducing the model, I will illustrate it using some existing examples of teaching and learning.

An introduction to the Reasonable Person Model (RPM)

RPM is a cognitive model based on the belief that it is possible to bring out the best in people by creating environments that are supportive of their informational needs (S. Kaplan & Kaplan, 2003). As such, the RPM has been applied to a wide range of contexts from environmentally responsible behavior to public health and more recently, service learning (S. Kaplan & R. Kaplan, 2003: Covitt, 2005; Corbett, 2005; Kaplan and Kaplan, 2008; Bardwell and Kaplan, 2008). It also provides a useful tool for educators to think about how to provide a supportive learning environment.

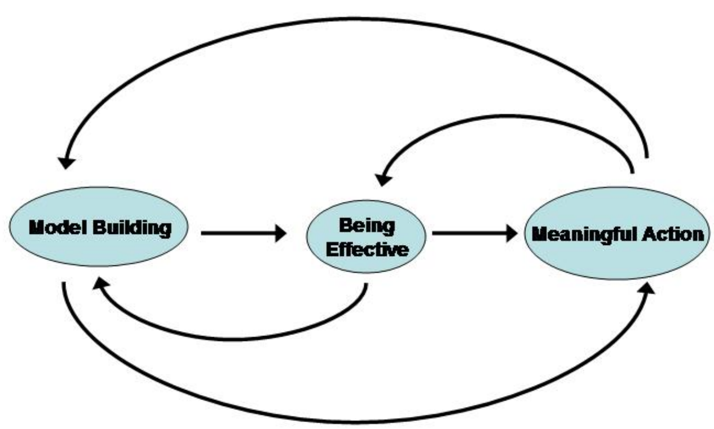
RPM focuses on three types of informational needs: model building, being effective, and meaningful action. Model building consists of building conceptual understanding—a mental model—and is often accomplished through exploration, whether exploring ideas or taking a trial and error approach. As information-seeking creatures, humans are motivated to understand and explore their world, to avoid the pain of not comprehending (White, 1959; Kaplan & Kaplan, 1982). Through exploration, students gain information needed to build a model of the concept they are studying; in the process they also may be building models about themselves in terms of their own knowledge base.

In gaining understanding, students build confidence in their ability to explore, reinforcing their desire for additional explorations. This leads into the second element, being effective or being competent. Competence, too, is a powerful human motivator (White, 1959). While tests might measure one's competence in demonstrating knowledge, we do not test students for self-confidence or self-efficacy. Yet often, one's ability to use knowledge is tied to confidence in applying and using it (Rimal, 2000). High test scores perhaps increase one's confidence in achieving high test scores, but what happens when one needs to invoke knowledge to address an actual problem in the world? It should be no surprise that students who can correctly identify the origins and meanings of the first amendment in a multiple-choice context do not necessarily understand how to exercise this amendment in an applied context that is meaningful to them.

This brings us to applying knowledge in a meaningful context. Meaningful action refers to participating in some activity that has an impact, or the ability to make a difference in the world. Thus it can be construed as the opposite of helplessness. While GPA can be meaningful, it does not have an impact on the world *per se*. Examples of meaningful action are common in service-learning projects and extracurricular activities, both of which have shown positive benefits for students. For example, in one study of 1000 high school students, those involved in service-learning had stronger intentions to vote and enjoyed school more than students not involved (Billig et al, 2005).

As Kaplan and Kaplan (2008) point out, these three areas have considerable overlap and interaction: understanding a concept can help us feel competent in using the concept in other domains, and having developed confidence, we are more likely to feel in a position to take meaningful action. Figure 1 provides a schematic of the three elements and interactions.

Figure 3. Reasonable Person Model (R. Kaplan and S. Kaplan, 2008)



Each element reinforces the other, and no particular element is deemed a starting or ending point.

Within RPM, this paper emphasizes the meaningful action or participation component. This is because in high school classrooms, efforts are primarily directed at model building and a narrow emphasis on being effective (i.e. standardized test competence), with little attention given to meaningful action and participation (Kumler, 2009). By meaningful action and participation, I mean activities that can have a positive impact on and are valued by students and often by larger communities beyond the classroom. What could meaningful action contribute to students' model building and competence? What could meaningful action contribute to a larger aim of education, to produce an involved, participatory citizenry? Finally, can this model help educators think about balancing students' cognitive needs with desired institutional outcomes? In discussing these questions, I will start with an examination of the literature related to meaningful action before discussing where participation fits into the current social studies and science standards (subjects which tend to incorporate action more than others). Michigan standards will be used as a basis for this discussion. I will then provide an example of how curricula and schools might include meaningful action and describe possible benefits to students.

Norms, standards, and student participation

While Putnam (2000) pointed out that 1990s youth demonstrated a stronger commitment to volunteering than their predecessors, such activities are rarely formally linked to the classroom. The lack of connection between societal participation and formal learning is a missed opportunity. As Dewey (1916) put it,

> "As a consequence of the absence of the materials and occupations which generate real problems, the pupil's problems are not his; or, rather, they are his only as a pupil, not as a human being. Hence the lamentable waste in carrying over such expertness as is achieved in dealing with them to the affairs of life beyond the schoolroom." (*Democracy and Education*, p. 183).

Educators must recognize that all students actively participate in their education. After all, ultimately, it is the student who decides what and if she will learn (Olson, 2003 in Kuhn, 2005). The task, as Dewey suggests above, is to help students participate in positive action that is meaningful to them and is connected the classroom in ways that promote many of the aforementioned educational goals. In pursuing action meaningful to them, students also can work towards their own personal and educational goals. Simultaneously, students will be both building on their mental models (gaining knowledge) and developing confidence. Service learning has shown promise towards this end (Billig, 2000; Markus et al 1993), although it is only one means of achieving participation. Also, service learning is sometimes viewed as yet another separate school obligation to fulfill rather than a self-directed, meaningful experience that is an integral part of the classroom. A large study with undergraduates indicated that service learning that is both part of a course and well connected to course material enhances academic outcomes such as GPA, writing skills, and critical thinking skills (Astin et al, 2000), a recommendation also provided by Barber (1992). If we ignore participation meaningful to students, we risk losing them to other activities where they can pursue their goals. In some cases this could mean that students drop out to pursue their goals, in other cases, students pursue personal goals via school activities.

Extra or co-curricular activities, such as sports or clubs, provide an opportunity to participate and to be part of a community. Studies in the U.S. and abroad have shown a positive relationship between participation in such activities and school attendance, grades, and feelings of connectedness with school (Lindsay, 1984; Fullarton, 2002; Eccles & Barbar 1999; Klesse, 2004; Joselowsky, 2007). Bringing participation and meaningful action to classroom curricular activities should have similar positive effects, enabling students to connect personal goals with classroom activities, reinforcing positive associations with their classroom experience.

Why is student participation not taken more seriously by schools given the many positive benefits? As previously mentioned, such activities are rarely included in curriculum standards or covered by standardized tests, increasingly the measure of success for schools, teachers, and students. Where student participation does happen in schools, it is usually in social studies or civics education. Even in such courses it often receives short shrift. In Michigan social studies content expectations, for example, three out of 96 standards include elements of student participation (all of them falling under content standards for civics). These three standards explicitly call for students to:

> "6.2.4 Participate in a real or simulated election, and evaluate the results, including the impact of voter turnout and demographics.
> 6.2.7 Participate in a service-learning project, reflect upon experiences, and evaluate the value of the experience to the American ideal of participation.
> 6.2.10 Participate in a real or simulated public hearing or debate and evaluate the role of deliberative public discussions in civic life." (Michigan Department of Education, 2007)

Such participative opportunities, if incorporated into the classroom, have the potential to powerfully complement and reinforce students' understandings of and competence in participating in elections, government decisions, and service. Furthermore, these experiences would constitute a base of practice upon which students can build, rather than hoping they will "cold call" participate in community life upon graduating based on honed paper-and-pencil skills. Yet with only three of 96 standards in one specific course, the likelihood of classroom enactment is slim.

Turning to science standards, Michigan science content expectations broadly refer to participation in the umbrella description of each standard for earth science, biology, physics, and chemistry in the following repeated sentence: "They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions" (Michigan Department of Education, 2006). Since standardized testing does not measure application of knowledge as described here, we can guess that far less classroom time is devoted to it. Perhaps there is little reason for teachers to believe that time spent on meaningful action will support academic outcomes, and this is where the RPM can help clarify how meaningful action, model building, and being effective synergistically support cognitive needs. Accordingly, two examples will be used to illustrate the RPM.

Applying RPM to the classroom

A hypothetical example here will illustrate some basic principles of the model, in this case in the context of an environmental land use curriculum in a social studies course. Ms. A is a social studies teacher enacting a unit in her 9th grade government class. Most of the course focuses on state and national level government, but she feels it is important to cover local government as indicated in the district standards. While designed for civics, and meeting many civics curriculum standards in her state, the unit integrates many land use concepts closely related to science, such as pervious and impervious surfaces, stormwater runoff, and some ecological impacts of land use. It also covers historical land use in the region, economic impacts, and social impacts.

The unit begins with an overview of the place where the students live, including watershed boundaries, then progresses to lessons on zoning, transportation, how land use decisions are made, and concepts of sustainable land use. Students completed activities including interviewing local citizens about past and present land use, learning about actions they can take towards sustainable land use, evaluating the impacts of new high school construction on the community, and finally, participating in a role play to decide whether to allow new homes to be built in place of a wetland in a fictional community. The five week unit is abridged to fit into three weeks.

Stepping out of the example, we can examine it in the context of the RPM.

Model building

What has the unit offered to students in terms of model building and understanding? The unit seems to have covered the main concepts of land use and local government in terms of structure and function. The local nature of the curriculum enables students to build on and revise cognitive maps already in place. For example, students evaluate how they typically get around and how their modes of transportation might be improved upon, they get to know their neighbors while finding out more about the history of the community, they have the opportunity to learn more about construction of the new school which has been a media focal-point. Although teachers did not focus as much on natural world or science-type elements in the curriculum, integrating these concepts likely helped students to develop and explore understanding of natural world land use concepts (Kumler, 2009).

Being effective

Students likely gained some competence in understanding land use in the community, interacting with community members through the interviews, and applying their knowledge in the land use decision scenario. Practicing community interactions and making decisions likely also contributed to their confidence in these skills.

Meaningful action

Some of the actions taken in the course of the unit, such as interviewing community members and participating in the land use decision scenario, required students to participate in the community and classroom. Yet it would be a stretch to say that through these actions students had a sense of making a difference in the world. Although learning about actions is important, Kumler (2009) found that simply learning about actions had little impact on high school students' abilities to even identify actions that they might take beyond the usual recycling and trash pick-up. To improve on this, students might have chosen a land use issue of interest and developed then implemented a plan to act upon it. Taking earlier examples a step further, after choosing a local land use issue to explore (perhaps in pairs or small groups), students could devise and implement a plan to address the issue. After exploring the sustainability of the school grounds, students could present recommendations to the school board and community, raise money to implement some recommendations, or develop a program to educate others about sustainable land use.

RPM in other subject contexts

Additional examples exist where educators meet students' cognitive needs for exploration, competence, and meaningful action. Two examples from an environmental education context follow.

For the past six years, science students and their teachers at High Tech High School in San Diego have created field guides to the city based on student-identified environmental priorities (Students of High Tech High, 2008). The guides are created as part of biology classes at the school—in some conjunction with humanities and math classes—and are researched and written by students. They cover topics ranging from the history of the bay to an assessment of present day bay resources. Students conducted original bay research via scientific investigations, interviews, and on the ground assessments. To date, four of these guides have been published and are available for sale (two via Amazon): *Two Sides of the Boat Channel: A Field Guide* (2005), *Perspectives of San Diego Bay: A Field Guide* (Next Generation Press, 2006), *San Diego Bay: A Story* *of Exploitation and Restoration* (California Sea Grant Press, 2007), and *San Diego Bay: A Call for Conservation* (California Sea Grant Press, 2008).

This project is an excellent example of RPM in practice. Students are provided with the opportunity to integrate knowledge and interests from a variety of disciplines (history, biology, math, ecology, public policy) and to explore and build on their personal models of the bay. Students likely gain competence and confidence in a wide variety of skills, from researching and communicating to writing, editing, and working with others towards a goal. Students have undertaken meaningful action, not only in conducting actions of interest defined by them, but in being useful beyond the classroom for the book audience of policymakers, scientists, and the lay person.

Another example comes from a small high school in northwestern Oklahoma, where students live in one of the worst hazardous waste sites in the United States. Over time, mines have severely contaminated the land and a local creek. A group of teachers decided to coordinate a unit around the creek. In English class, students connected their community with a play being read in class. After a field trip, students became concerned about the problem and wanted to take action; they realized that scant information was available to the public on the topic. What started out as student concern became much larger, as students compiled a book about the creek highlighting its history and connections with the community over time to increase public awareness. The book was locally published. Beyond this, students involved themselves in raising money to post warning signs, writing articles for the local papers, participating in city council meetings, and more. Teachers reported increased student motivation and engagement towards research, writing, community involvement, and school in general (Kesson & Oyler, 1999).

These examples demonstrate how RPM can help to think about supporting students' cognitive needs while complementing many educational aims regarding citizen preparation, citizen participation, student motivation, and even measures of achievement.

Conclusions

The Reasonable Person Model provides guidance and a rationale for how we might bring out the best in students by providing a learning environment supportive of their informational needs. Our current emphasis on traditional outcomes such as standardized tests has been shown to bring out less than the best in students, ranging from poor motivation to a focus on lower-level thinking skills (Makara, 2008; Paris & Cunningham, 1996; Paris, 2000). While RPM elements like model building and becoming competent in certain capacities (such as literacy or numeracy) are incorporated into most classrooms, such efforts are often incomplete, especially without an opportunity for meaningful participation. In many cases, curriculum standards already ask that teachers incorporate meaningful participation into the classroom; however, currently teachers have little guidance on what this might look like and how it can contribute to students' mental models and competencies as assessed by standardized tests and otherwise.

On a practical level, educators might ask how they can possibly fit in "extra" material. Tacked on as "extra", efforts at meaningful participation become onerous and disjointed. The purpose of the model is to demonstrate the inherent and mutually reinforcing connections among the three components. Participation need not be complex: it could be as simple as involving students in setting their own learning goals or exploring their own topics of interest. If physically taking the class off campus is bureaucratically and financially fraught with difficulties, many types of meaningful participation can be conducted on campus. To use a science example, a nearby river may be too far to get to, but the school grounds offer many lessons in terms of runoff, impervious surfaces, and infiltration that students can investigate and provide recommendations on to school officials.

If we hope for better student performance, we must provide the conditions necessary to motivate, engage, and enable students to build on their knowledge. A singular focus on standards and testing risks classrooms infused with inert ideas resulting in inert students. The Reasonable Person Model offers a cognitive-based guide for how any classroom or curriculum can incorporate relevance, participation, and motivation which in turn may contribute to improved traditional results such as grades and test scores.

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Conclusion

The evidence presented in these three chapters suggests that as educators we need to rethink how to approach teaching, learning, and assessment if we seek to prepare secondary students to use academic learning beyond the classroom in a range of decision and action contexts. As noted in the introduction and the three previous chapters, our educational standards and rhetoric suggest that we care about such outcomes. Yet in practice our educational institutions do not assess how well students can apply, synthesize, and act on school learning outside of the classroom and tend to devote little classroom time to them.

We need to engage in a new conversation regarding how to meet our subject standards while avoiding strong subject compartmentalization. The previous chapters have drawn attention to how such compartmentalization makes it difficult for students to draw on school learning for integrated problems and issues beyond the classroom (such as sustainable land use). They also suggest possibilities as to how we might work towards meeting subject standards while avoiding compartmentalization of classroom learning: providing opportunities for students to integrate subject knowledge, to participate in projects with relevance beyond the classroom, and through supporting students' cognitive needs. Following a summary of chapter findings, I will conclude with some implications for practice followed by future research directions.

Chapter 1: People matter: secondary students' social and natural world knowledge use in a land use decision

This study added to the literature on student information use in the context of socio-scientific decisions, confirming that secondary students requested social world information over natural world information (Fleming 1986a, 1986b) and preferred to consult with social scientists and stakeholders over natural scientists. It took the investigation a step further to see whether students' knowledge use could be expanded through a curriculum that integrated both natural and social world information and whether course type predicted information use. Results suggested that experiencing an integrated science-social studies curriculum increased students' requests for natural world information relevant to the land use decision. Most interestingly, this effect occurred even among social studies students whose teachers reported putting scant emphasis on the natural science curriculum content. Furthermore, the type of course in which students experienced the curriculum predicted student information use, essentially acting as a lens through which students viewed the decision. Social studies students tended to ask more social world questions than did science students, and science students asked more natural world questions than did social studies students.

Students' strong tendencies to request social world information over natural world information suggests that they have stronger social world associations. Connecting natural world concepts to social world associations, rather than focusing exclusively on social or natural world concepts, may better enable students to recognize both natural and social elements in complex decisions such as land use. In terms of consultation preferences, students deemed natural scientists as less relevant to the decision. Previous studies, such as the "Draw a scientist test" conducted in numerous studies over many decades, have also shown that students see scientists as irrelevant to or disconnected from human affairs (Finson, 2002). Finally, the subject area or "compartment" in which students learn material matters, while course type predicts students' information use. This begs the question as to how students might use subject-specific information outside the classroom context.

Chapter 2: Students of action: investigating and expanding students' action options

Environmental education, social studies education, and science education share common student behavioral objectives (NAAEE, 1994; NCSS, 1994; National Academy of Sciences, 1995) including outcomes in which students apply classroom learning to decisions and actions beyond the classroom. However, we have little insight into whether such objectives are being met at the secondary level and how students understand the connections between classroom learning and everyday or civic actions. This study examined high school students' understandings of actions and self-reported participation in actions in the context of an EE land use curriculum enacted in science and social studies classes. Results indicated that students had a very limited repertoire of actions both in terms of knowledge and participation. Moreover, the curriculum had a limited impact on both of these, possibly because few teachers engaged students in actions during the unit. Students tended to undertake and think of actions on an individual level rather than a group level. Types of actions were generally limited to "ecomanagement" actions such as recycling and trash pick-up, with far fewer in non-ecomanagement realms including political, consumer, or information sharing. While the curriculum increased social studies students' knowledge of ecomanagement and non-ecomanagement actions, it did not bring the latter levels on par with the former, and it did not have a measurable impact on actions students had taken recently. Science students showed the opposite trend, with a statistically significant decrease in non-ecomanagement actions after the curriculum. As with Chapter 1, these results indicate different outcomes for students based on subject area or compartment.

While social studies students demonstrated some increased knowledge of actions, overall students' action knowledge did not seem to be drawn from academic learning. Students are exposed to recycling, trash pickup, and other ecomanagement actions outside of school through media messages, local government ("please pick up after your pets"), and non-profit organizations. When provided with curricular action materials, teachers did not seem to use them. Perhaps this is not surprising given the limited emphasis on action in most federal, state, and local subject standards and on standardized tests. Integrating action elements into classroom learning, and assisting teachers in doing so, might help students expand their action knowledge and connect school learning with actions outside of school (Community Network for Youth Development, 2001). At the same time, as Chapter 3 suggests, incorporating action components into the classroom can help teachers meet subject knowledge requirements.

Chapter 3: Balancing student cognitive needs and institutionally mandated outcomes: an introduction to the Reasonable Person Model (RPM)

Led by No Child Left Behind, the current educational emphasis is on improving educational outcomes as measured by test scores. This emphasis on test scores can often work against other educational goals, including student attendance, interest in school, and developing student agency that can contribute to active and engaged citizens. This chapter introduces the Reasonable Person Model (Kaplan & Kaplan, 2008) as a tool to help us think about how we can bring out the best in students, in terms of multiple important outcomes, by supporting students' cognitive needs. The primary components of the model—being effective, model building, and meaningful participation—work together synergistically to support human informational needs. In the context of education, the "meaningful participation" component is given particularly little attention in high schools. The chapter suggests that providing students with opportunities for meaningful participation can improve their mental models of concepts and their skill competencies: it can also enhance student interest in school and learning which in turn can have positive impacts on student learning and test scores.

Synthesis and Implications

Together, these three chapters provide an interesting picture of how we might rethink the predominant compartmentalized approach to secondary education. First, we can see that students' existing mental structures frame how students perceive information and apply knowledge. Students demonstrated strong application of social world knowledge over natural world knowledge in a land use decision, regardless of course type, gender, or curriculum intervention. This suggests that students have more developed mental connections to social world rather than natural world concepts. After experiencing an integrated social-natural world curriculum, students increased applications of natural world concepts. In this case, therefore, presenting natural world concepts in the context of the social world seemed to help students strengthen natural-social world connections. Chapter three's Reasonable Person Model (RPM) also supports this notion: students develop their mental models through exploration, and giving them more than one subject area as an entry point to their model may facilitate connecting new information to one's existing model. Providing opportunities for students to apply classroom knowledge to non-disciplinary real life situations is also important to facilitate mental connections between classroom learning and the world beyond.

Second, high school students seem to have very little variety in knowledge of group or individual actions that they might take in support of sustainable land use. Here, classroom learning did not seem to inform students' actions outside of the classroom, and students drew from actions widely promoted by non-school media sources. Again, students struggled to link classroom learning with actions beyond the school. Based on teacher reports in this and other studies, few secondary classrooms provide students with an opportunity to take meaningful action. Incorporating possible actions in curricula does not mean they will be enacted by teachers, and as such, does not seem adequate for enhancing students' repertoire. Helping educators see the mutually reinforcing synergy among meaningful action connected to the classroom, multiple learning goals (such as meeting subject standards and increasing test scores), and students' cognitive needs could help educators increase enactment. The RPM provides a framework that can assist educators in thinking about this cognitive synergy. The classroom examples provided in Chapter 3 hold promise for engaging students on a behavioral level and positively reinforcing their conceptual cognitive understandings. Beyond ecomanagement actions, the examples in Chapter 3 engaged students in information sharing (published works), consumer action (raising and spending money), and political action (attending government meetings, presenting to local officials).

Third, both chapters 1 and 2 find that the context of the subject itself, in this case social studies or science class, is associated with how students apply natural world, social world, and action knowledge. This begs the question as to whether and how students use knowledge outside of the subject context. It also suggests that the compartmentalization of high schools has an adverse impact on students' abilities to integrate information from multiple subjects, especially in the absence of integrated curricula.

The above implications further suggest that educators and teachers must find ways to integrate natural world concepts, social world concepts, and behavioral concepts into the classroom. In current practice, such integration is the exception rather than the norm, perhaps due in part to the driving emphasis on standardized test scores. If we can refocus our sights on enabling students to access, to integrate, and to use classroom learning outside of the classroom, now and in the future—in ways meaningful to them—we may well find that test scores take care of themselves.

Environmental education (EE) and education for sustainability (EfS) have much to offer along these lines. By nature, EE and EfS integrate natural and social world concepts, connecting them to actions within and beyond the classroom. Already, schools have taken note of this, with some elementary, middle, and even secondary schools embracing EE in an effort to engage students and improve outcomes (Stone, 2008; Lieberman & Hoody, 1998).

The bigger picture in all of these chapters is not just thinking about what students learn based on standards and testing, but about how they can use learned knowledge, why they might want to learn, and how consideration of these questions might improve our approach to education.

Future directions

Several possible future research directions emerge from this project. A closer examination of how students use classroom information outside of formal schooling, ideally in a longitudinal study, would be invaluable for understanding how school subject matter is accessed and applied in everyday decisions. Second, students' strong preference towards use of social information over natural world information merits additional investigation: do humans in general have stronger social world than natural world cognitive connections? And if so, what implications does this have for communicating science to non-scientists? What implications does this have for humans understanding and creating an ecologically, economically, and socially sustainable future? Third, a closer investigation of meaningful participation by secondary students (including and beyond service learning), in terms of where it occurs, how it occurs, and what educational impacts it might have would contribute towards understanding the role of meaningful participation in education. Finally, we need to look closely at the compartmentalized nature of our institutions and disciplines to understand their strengths and weaknesses for both educators and students.

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Appendices

Appendix A: Student demographics

The science and social studies classes did not differ in size; with a mean number of 25 students. Tables 1 through 3 provide descriptive information about the student sample.

Table 12. Numbers of participating teachers, classes, and students by class type.

	Science	Social studies	total
Teachers (n)	6	3	9
Classes, intervention	14	4	18
Students, intervention	323	113	436
Classes, comparison	3	0	3
Students, comparison	64	0	64

Table 13. Number of students in different grades by class type.[13]

	Science	Social studies	Total number	Percentage of total
Grade 9	2	45	47	9%
Grade 10	112	6	118	24%
Grade 11	190	49	239	48%
Grade 12	80	12	92	19%

Table 14. Student race by class type.[14]

	Science	Social studies	Total number	Percentage of total (county)
White	218	81	299	60% (68%)
African-American	82	31	113	23% (19%)
Asian	11	8	19	4% (6%)
Other	45	21	66	13% (6%)

Table 15. Students living in urban, suburban, rural neighborhoods.[15]

	Science	Social studies	Total number	Percentage of total
Urban	108	22	130	29%
Suburban	159	70	229	51%
Rural	70	16	86	19%
Total	337	108	445	

[13] Some students neglected to indicate grade level.
[14] This question was optional for students.

[15] Some students did not answer this item; students with more than one home could count under two categories.

Appendix B: Social Studies and Science Curricula Table of Contents and Front Matter

"Lessons from the Land" Table of Contents

I. WHAT DO WE VALUE ABOUT OUR COMMUNITY? WHAT IS OUR VISION OF IT FOR THE FUTURE?

II. HOW HAS THE COMMUNITY CHANGED OVER TIME?

III. WHAT ARE THE CAUSES AND IMPACTS OF THESE CHANGES?

IV. HOW CAN WE CREATE A SUSTAINABLE FUTURE?

"Science Lessons from the Land" Table of Contents

I. WHAT DO WE VALUE ABOUT OUR COMMUNITY? WHAT IS OUR VISION OF IT FOR THE FUTURE?

II. HOW HAS THE COMMUNITY CHANGED OVER TIME?

III. WHAT ARE THE CAUSES AND IMPACTS OF THESE CHANGES?

Science Lessons from the Land: Land Use and Decision-Making in Washtenaw County
2007 Washtenaw County Department of Planning and Environment/Creative Change Educational Solutions
Developed with support from the Ann Arbor Area Community Foundation.

IV. HOW CAN WE CREATE A SUSTAINABLE FUTURE?

Credits and Acknowledgements

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- Washtenaw County Department of Planning and Environment
- US Environmental Protection Agency
- James A. and Faith Knight Foundation
- Ann Arbor Area Community Foundation
- Washtenaw Intermediate School District

Additional data was obtained from the following organizations' websites:

- The Huron River Watershed Council
- The Michigan Land Use Institute
- The Southeast Michigan Council of Governments
- National Association of Home Builders

In addition to the works cited throughout the curriculum, the following documents were consulted for content and data:

- A Comprehensive Plan for Washtenaw County: A Sense of Place, A Sustainable Future. Washtenaw County Department of Planning and Environment. September 2004
- *Michigan's Land, Michigan's Future: Final Report of the Michigan Land Use Leadership Council.* August 15, 2003.
- *Urban Sprawl and the Michigan Landscape: A Market-oriented Approach.* The Mackinac Center for Public Policy and the Reason Public Policy Institute. 1998.

Creative Change would like to express its gratitude to Washtenaw County government for making this work possible. Its leadership on sustainability and support of education programs will bring long-term benefits for the students and teachers of this community.

A very special thanks to the teachers participating in this program!

The Context of "Lessons from the Land"

Washtenaw has experienced rapid changes over the past few decades. Key trends include an increase in population and the spread of new housing development, particularly in outlying areas and rural townships.

What will happen if these trends continue? Some people say that the increased growth is good, but others worry that the wrong kind of growth will bring environmental, economic, and social problems, especially if there is more growth in rural areas at the expense of urban areas such as Ypsilanti.

These concerns have become a major focus for lawmakers, citizens, and community leaders at the local and state levels. Over the past decade, communities across the region have faced tough decisions and questions related to land use trends and the future. In 2003, Governor Granholm convened the Michigan Land Use Leadership Council, which put out a comprehensive study on the causes, impacts of current trends, and recommendations for land use policy in the future.

Within Washtenaw County, the County government's Department of Planning and Environment undertook a multi-year process of surveying residents and local community leaders about their vision for the future of the region. Based on this input and the recommendations of land use planners, the Department of Planning and Environment wrote a comprehensive report outlining the County's strengths and the impacts of the changes taking place. This document, "A Comprehensive Plan for Washtenaw County," also makes recommendations for using land in ways that preserve and sustain the character and vitality of the region. **"Lessons from the Land" is based on the recommendations of the Comprehensive Plan for Washtenaw County.**

The Comprehensive Plans reflect the concept of **sustainability**. Sustainability means "meeting the needs of the present without compromising the ability of future generations to meet their needs." A sustainable community is one in which development decisions balance the interests of the community, the environment, and individual citizens.

> **Sustainability** means "meeting the needs of the present without compromising the ability of future generations to meet their needs."

Sustainable communities are not 'frozen' communities that never change. Rather, sustainability requires thinking about how today's development decisions affect tomorrow's generations.

Assumptions underlying this curriculum

- Washtenaw County is a special community. It features beautiful natural areas, abundant fresh water, a diverse population, a rich history, outstanding educational and cultural opportunities, and strong community character within its cities, villages, and townships.
- The region is at a crossroads. The land use decisions made today will impact generations to come.
- Sustainability is a path that has the potential to simultaneously create a thriving economy, a strong social fabric, and a healthy environment.
- Individual rights and the common good are two democratic values that must be balanced in land use decisions.
- Land use decisions should be evaluate through the lens of sustainability, and should take into account the full costs to the community and the environment.
- Citizens, governments, nongovernmental institutions, and businesses all have a stake and a critical role in the determining the future of the region.

Appendix C: Pretest/posttest instrument

Date: ___/___/___

This survey is designed to look at information use as it relates to a land use decision. Please answer the questions as thoroughly as you are able.

- **Last four digits of your phone number**:______
- **Birthday**: month:____ day _____ year:_______
- **Gender**: Female Male
- **Grade level**: 9 10 11 12
- **Race/ethnicity** (optional): Caucasian African American Asian Other
- **Course name**:________________________________
- **How you would describe your neighborhood**: urban/town/village suburban rural

***Scenario**:*

In recent years, Rivertown has been growing significantly. One of the elementary schools located near downtown Rivertown has recently closed. Its students now attend a new, larger elementary school that is located elsewhere. The old elementary school property includes a large wooded section of land along the river which community members often use for walks and recreation, in addition to a small field and playground that is also used by community members outside of school hours. This morning you read an article in the paper stating that due to the prime location of the school, a developer has proposed to buy the school property and build a shopping center there.

Imagine that you are responsible for deciding whether to allow the site to be converted to a shopping center. Please answer the following questions:

Scenario Question A. List the specific questions you would want answered prior to making such a decision.

<u>Scenario Question B</u>. Assume you could consult anyone you want to help you in your decision. Below is a list of experts from various fields (assume each one has **local expertise** in his/her field) and groups. For each of the lettered items below, indicate on the scale how likely you would be to ask questions of the expert/groups listed (with 1 being "extremely unlikely" and 5 being "extremely likely"). For blank letters, add any other persons or groups not listed who you would want to consult.

EXPERT OR GROUP	YOUR LIKELIHOOD TO CONSULT					
	Extremely **UNLIKELY**				Extre mely **LIKEL Y**	
A. Biologist	1	2	3	4	5	don't know
B. Chemist	1	2	3	4	5	don't know
C. City planner (someone who helps to plan the layout/design of cities)	1	2	3	4	5	don't know
D. Civil Engineer (someone who looks at building of infrastructure such as roads, dams, sewers etc.)	1	2	3	4	5	don't know
E. Demographer (Population expert)	1	2	3	4	5	don't know
F. Developer (Owner of a company who builds houses, offices, etc.)	1	2	3	4	5	don't know
G. Ecologist (someone who studies the distribution and population of living organisms)	1	2	3	4	5	don't know
H. Economist	1	2	3	4	5	don't know
I. Geographer (someone who studies the Earth's physical environment and human habitat)	1	2	3	4	5	don't know
J. Historian	1	2	3	4	5	don't know
K. Landscape architect (someone who plans and designs outdoor spaces such as parks and playgrounds)	1	2	3	4	5	don't know
L. Local government official	1	2	3	4	5	don't know
M. Local residents	1	2	3	4	5	don't know

OTHERS YOU WOULD CONSULT (if needed):	
O.	R.
P.	S.
Q.	T.

<u>Scenario Question C.</u> State by rank the four most important questions you would want answered and for each one, who (letter from Part B above) you would ask each question. (1 being the top question) You may use the same letter over.

<u>Question you would ask</u> <u>Letter</u> (who you would ask)

1.

2.

3.

4.

The following two questions are about your actual life and are unrelated to the scenario:

<u>Question D</u>. List any actions you have taken in the past month that can help contribute to sustainable land use. For each action, briefly explain how it can contribute and why you did it.

<u>Action</u> <u>Why you took action</u> <u>How it contributes to sustainability</u>

Or, if you did not take any actions, why didn't you?

<u>Question E</u>. If you wanted to contribute to more sustainable land use in your community in the future, what actions would you be able to take to help do so? For each action, briefly explain how it would contribute.

<u>Action</u> <u>How it contributes</u>

Appendix D: IRB exemption

University of Michigan
Behavioral Sciences Institutional Review Board (IRB) • 540 East Liberty Street, Suite 202, Ann Arbor, MI 48104-2210 • phone (734) 936-0933 • fax (734) 998-9171 • irbhsbs@umich.edu

To: Laura Kumler

From:

James Sayer

Cc:

Michaela Zint

Subject: Notice of Exemption for [HUM00009779]

SUBMISSION INFORMATION:
Title: Effects of a cross-subject environmental education curriculum on secondary student perception of decision-making complexity Full Study Title (if applicable): Study eResearch ID: HUM00009779

Date of this Notification from IRB: 3/21/2007 Date of IRB Exempt Determination: 1/12/2007 UM Federalwide Assurance: FWA00004969 expiring on 5/10/2009 OHRP IRB Registration Number(s): IRB00000246

IRB EXEMPTION STATUS:
The IRB Behavioral Sciences has reviewed the study referenced above and determined that, as currently described, it is exempt from ongoing IRB review, per the following federal exemption category:

> **EXEMPTION #1 of the 45 CFR 46.101.(b):**
> Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula or classroom management methods.

Note that the study is considered exempt as long as any changes to the use of human subjects (including their data) remain within the scope of the exemption category above. Any proposed changes that may exceed the scope of this category, or the approval conditions of any other non-IRB reviewing committees, must be submitted as an amendment through eResearch.

Although an exemption determination eliminates the need for ongoing IRB review and approval, you still have an obligation to understand and abide by generally accepted principles of responsible and ethical conduct of research. Examples of these principles can be found in the Belmont Report as well as in guidance from professional societies and scientific organizations.

SUBMITTING AMENDMENTS VIA eRESEARCH:
You can access the online forms for amendments in the eResearch workspace for this exempt study, referenced above.

ACCESSING EXEMPT STUDIES IN eRESEARCH:
Click the "Exempt and Not Regulated" tab in your eResearch home workspace to access this exempt study.

EXEMPT STUDY DOCUMENTS:
You must use any date-stamped versions of recruitment materials and informed consent documents available in the eResearch study workspace (referenced above). Date-stamped materials are available in the "Currently Approved Documents" section on the "Documents" tab.

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