Making Curriculum Decisions in K-8 Science: The Relationship between Teacher Dispositions and Curriculum Content

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ABSTRACT

This study examined teachers' dispositions toward and choices to teach ocean science using a survey design. A sample of 89 in-service K–8 teachers in the United States reported their (1) feelings of preparedness to teach about ocean literacy and (2) attitudes toward ocean science on three measures. Results of multiple linear regression showed that teachers' dispositions significantly predicted frequency of teaching ocean literacy. Findings indicated that teachers' curriculum decision-making likely reflects feelings of preparedness to teach and attitudes regarding particular topics. Implications for elementary science teacher preparation and professional development are discussed.
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INTRODUCTION

The National Research Council's Committee on Science Learning (2007) summarizes science as "both a body of knowledge that represents current understanding of natural systems and the process whereby that body of knowledge has been established and is being continually extended, refined, and revised" (p. 26). This definition is for the purpose of discussing the content of science education in kindergarten through eighth (K–8) grades in the United States. Children must learn to know, use, and interpret science understandings, generate evidence and explanations using the process of science, understand the nature of this process, and participate in the process and discourse inherent in this process (Committee on Science Learning, Kindergarten through Eighth Grade, 2007). Though few would argue with these summary statements, it is impossible to include, even in a simplified form, the entire body of knowledge and systems and processes of science in K–8 science. This lack of comprehensiveness is due to both the limited time allocated toward science in K–8 education and the enormous depth and breadth of science as a subject of study. Thus, choices must be made regarding which science content is learned, as well as how much time is allocated to particular topics of study. As explained by the National Committee on Science Education Standards and Assessment [National Research Council (NRC), 1996], "a curriculum is the way content is organized and presented," but the content of the curriculum "can be organized and presented with many different emphases and perspectives" (p. 2–3).

Decisions regarding the content of the enacted K–8 curriculum occur at a variety of levels in the United States, including national recommendations. For science education, the most influential national recommendations are the *Benchmarks for Science Literacy* from the American Association for the Advancement of Science (AAAS, 1993, 2009) and the *National Science Education Standards* from the NRC (1996). States, school districts, and localized administrations also make curricular and content decisions. Nonetheless, Porter (2002) named teachers as the "ultimate arbiters" of the content of instruction, deciding, among other things, the time allocated to subjects and the topics covered. Similarly, Remillard (2005) theorized that teachers co-construct the enacted curriculum, engaging in decisions about selecting and creating classroom activities, enacting these activities, responding to students as they interact with these activities, and organizing the content of the curriculum. Thus, "the *enacted curriculum* is more than what is captured in official policy documents or textbooks" (Remillard, 2005, p. 317).

It is understood that teachers' dispositions toward science and science teaching can affect their decision-making regarding science instruction, overall (Banilower *et al.*, 2006; Banilower *et al.*, 2007). This study is primarily concerned with teachers' decisions about the content within enacted science curriculum. Such decisions could occur within the context of broad, more generalized ideas or narrow, more specific concepts. For example, there is the scale of a subject (e.g., teach science or English language arts), a discipline (e.g., focus on Earth system science or biology), a subtopic within a discipline (e.g., physical oceanography or geology), or a specific concept or set of concepts that could be the base of activity (e.g., causes of ocean surface currents or formation of sedimentary rock).

The present study focuses on a relatively fine scale of science content, ocean literacy. Ocean literacy is defined as a set of essential principles (OLEPs: Ocean Literacy Essential Principles) about the "functioning of the ocean" (Ocean Literacy, 2006) that includes elements of both the body of knowledge of science and the systems and processes that are responsible for that body of knowledge. Thus, the OLEPs are a useful tool for summarizing and defining ocean literacy as a construct for the current study. While ocean literacy is not overly emphasized in U.S. state standards in an explicit manner (Hoffman and Barstow, 2007; Schoedinger *et al.*, 2006), the study of ocean literacy is aligned with most of the National Science Education Standards (Ocean literacy, 2006; Schoedinger *et al.*, 2006). Thus, ocean literacy is an example of a set of topics that a teacher could choose to emphasize within the constraints of most mandated curricula.

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Decisions about the content of science curricula are poignant because time for science instruction is extremely limited in U.S. K–8 education. Science lessons are generally brief. For example, Weiss (1997) and Weiss *et al*. (2001) found that U.S. elementary teachers in self-contained classrooms spent fewer than 30 min/day on science. Similarly, a survey of U.S. K–8 teachers showed that, on average, science instruction was allocated 98 min/week, with self-contained classrooms spending less than 20 min/day (Banilower *et al*., 2007). Moreover, from 2001 to 2007, 28% of school districts reduced elementary science instructional time by an average of 75 min/week (McMurrer, 2008). In 1990, only about half of U.S. elementary children received science instruction every day (Sivertsen, 1993). Though in the 1998 U.S. National Assessment of Educational Progress, fourth and eighth grade children in most states reported receiving science instruction every day (O'Sullivan *et al*., 1998), a recent survey found that almost 29% of elementary teachers teach science twice a week or less, and elementary teachers overall are only 35% likely to teach science every day (Bayer Corp., 2004). These variations should be interpreted within the context of the federal No Child Left Behind Act [Elementary and Secondary Education Act (ESEA) of 2001, 2001], which became effective in 2002. Prior to 2007–2008, this law focused on assessing mathematics and English language arts, linking assessment scores to distribution of resources. Some educational researchers hypothesized that a focus on these tested subjects limited students' exposure to other subjects, including science (e.g., Rentner *et al*., 2006).

THEORETICAL BACKGROUND

Teachers make decisions about both what they teach and how they teach it (Porter, 2002). This study focuses on the former, that is, choices regarding the science content of K–8 science lessons, as opposed to pedagogy. Specifically, this study is concerned with dispositional factors that affect teachers' choices regarding whether to include ocean literacy within the enacted curriculum. Two aspects of teachers' dispositions are likely to affect teachers' choices to instruct about ocean literacy—perceived self-efficacy and attitude toward this set of topics.

According to Bandura's self-efficacy theory (1977, 1986), people tend to take on activities they judge themselves capable of handling. The current study focuses on teachers' choices to engage children in the study of ocean literacy within science as a subject. This study focuses on one aspect of Bandura's (1977, 1986) self-efficacy construct, perceived self-efficacy. Bandura (1986) defined perceived self-efficacy as "people's judgments of their capabilities to organize and execute sources of action required to attain designated types of performances" (p. 391).

Perceived self-efficacy has been linked to teachers' decisions to teach science. Desouza *et al*. (2004) found that elementary teachers in urban India showed a relationship between minutes of teaching science and science self-efficacy, as measured by Riggs and Enochs' (1990), perceived self-efficacy construct and Science Teaching Efficacy Belief Instrument for in-service teachers (STEBI-A). Similarly, Banilower *et al*. (2007) showed that an aspect of perceived self-efficacy, that is, feelings of preparedness to teach science, was significantly correlated with frequency that teachers taught science in the K–8 classroom. [Banilower *et al*. (2007) interpret their data as saying that teachers' content knowledge affected their decision making process. However, the actual LSC survey question asked teachers about their "preparedness to teach" certain topics in science. The survey did not assess teachers' content knowledge.] These studies focused on science as a subject rather than particular disciplines and topics.

However, results of qualitative studies have indicated that perceived science teaching efficacy and its potential effects on teachers' decisions may work at a finer topical scale than science as a subject. Fetters *et al*. (2002) reported that experienced teachers' content choices were based on their dispositions toward the content, including uncertainty and level of confidence, with confidence often based on knowledge of content. Teachers' uncertainty about science teaching has been linked to knowledge of how to effectively use curriculum materials (Fetters *et al*., 2002). Together, these findings suggest a relationship between perceived self-efficacy in teaching and pedagogical content knowledge (PCK) (Shulman, 1987). PCK constructs generally include two elements: (1) an understanding of specific difficulties that learners experience with specific content and (2) an understanding of instructional strategies that work to facilitate understanding of that content (van Driel *et al*., 2001; van Driel *et al*., 1998), and PCK is closely related to content knowledge, though it extends beyond simple content knowledge (van Driel *et al*., 1998). Since PCK is derived from practical classroom experience (van Driel *et al*., 2001), it cannot be divorced from the specific content contextualizing that experience. The link between perceived self-efficacy to teach science and PCK (van Driel *et al*., 2001) creates a rationale for studying the relationship between perceived self-efficacy and choice regarding science content at a fine scale.

The STEBI-A self-efficacy questionnaire (Riggs and Enochs, 1990), as well as the instrument used by Banilower *et al*. (2007), focus on science as a subject rather than particular portions of science content. Little quantitative research exists relating teachers' perceived self-efficacy regarding particular science topics and their frequency of teaching this content. However, So (1997) described a teacher in Hong Kong who based choices of content on previous knowledge of the topic, peers' suggestions, and prior training. Though not explicitly studying perceived self-efficacy, So (1997), like Banilower *et al*. (2007), focused on the preparedness of teachers, as aspect of feelings of efficacy.

A second important aspect of dispositions is attitude toward particular topics and content areas in science. For the purposes of this study, the operational definition of attitude toward science is "the feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves" (Osborne *et al*., 2003, p. 1053). The present study is couched within Gogolin and Swartz's (1992) tradition, modifying their Attitude toward Science Inventory to refer to ocean science instead of science as a subject, and examines how teachers' attitudes toward ocean science correlate with their choices to teach (or not to teach) ocean literacy. This potential connection has been studied minimally, an exception being McCutcheon's (1980) report that, for the relatively few teachers who developed science unit

TABLE 1: Age and teaching experience.

Teaching experience (yr)	Age							
	20–29		30–39		40–49		50+	
	n	%	*n*	%	*n*	%	*n*	%
0–5	5	5.6	3.0	3.4	1	1.1		
6–10	1	1.1	8.0	9.0	8	9		
11–15			13	14.6	6	6.7	4	4.5
16–20			1	1.1	3	3.4	4	4.5
21–25					3	3.4	5	5.6
26+					1	1.1	22	24.7

plans, their choice of content was partially based on teachers' interests, an aspect of attitude.

RESEARCH QUESTIONS

The primary question of this study was whether teachers' feelings of preparedness to teach ocean literacy and their attitude toward ocean science predicted the frequency at which they teach ocean literacy. No established instruments exist for investigating these specific questions in a quantitative manner. Thus, a second aim of this study was to construct the necessary instruments to investigate the effect of these dispositions on the frequency of teaching construct ocean literacy within K–8 education.

METHOD

Participants

A sample of 89 in-service K–8 teachers in the United States participated in this study; 85.4% ($n = 76$) participants responded to all the questionnaire items. The majority ($n = 71$, 79.8%) were white women; 5.6% ($n = 5$) were minority women (African American or black, Hispanic or Latino, and Native American). All of the men ($n = 8$) who reported race were white. Most (87.6%) participants had more than 5 yr of teaching experience and were more than 30 yr old (Table 1).

Almost all of the teachers reported teaching reading and mathematics 4–5 days/week (Table 2). The frequency of science and social studies teaching was more variable (Table 2), though many (46.1%) teachers reported teaching science 4–5 days/week and many (39.3%) reported teaching social studies 4–5 days/week.

Participants reported their proximity to the ocean on a 5-point scale ranging from very near (e.g., coastal town) to very far (e.g., more than a weekend trip; see Table 3). Approximately 13.5% of participants were very near

TABLE 3: Geographic proximity to ocean.

Proximity to ocean	Operational definition	*n*	%
Very near	Coastal town	7	7.9
Near	Short drive	5	5.6
Neither near nor far	Day trip	17	19.1
Far	Weekend trip	17	19.1
Very far	More than a weekend trip	42	47.2
No response		1	1.1

(a coastal town) or near (within a short drive) to saltwater, while 38.2% were neither near, nor far (e.g., day trip) or far (e.g., weekend trip from the ocean. Many (51.7%) lived very far (e.g., more than a weekend trip) from the ocean.

Procedures

States sampled included ocean coastal states (Connecticut, Oregon, Georgia), Great Lakes coastal states (Illinois, Michigan, Indiana, Pennsylvania), and landlocked states (Nevada, South Dakota, Kentucky). A stratified random process was used to solicit participation, using information available publically from the U.S. Dept. of Education Institute of Education Sciences Common Core of Data (http://nces.ed.gov/ccd/). Within a given state, a county was chosen randomly; then, within a county, a school was chosen randomly. Only schools that listed teachers' names on a public web page were considered. Within a school, the sex of a teacher was randomly selected. Then, a grade number with a teacher of that sex was randomly selected, and one teacher was invited to participate. The process was reiterated for each invitation. Invitations were sent in May and November 2008, and January 2009, which resulted in a sample that was not evenly distributed across a spectrum of geography. Therefore, another set of invitations was sent in February 2009. For this invitation list, counties with ocean and Great Lakes coastlines were preferentially oversampled, and teachers within those counties were randomly chosen, using the method described above. Participation was solicited by sending an invitation letter and questionnaire to K–8 teachers at their professional address, followed by a reminder postcard. Participants returned all questionnaires via U.S. mail.

The first survey invitation was mailed to 500 teachers with an 8.2% response rate. The second invitation was sent to 300 teachers with an 8.3% response rate. The third survey was sent to 100 teachers with a 15% response rate. The last survey was sent to 100 teachers with a 7% response rate.

TABLE 2: Frequency of teaching individual subjects.

Subject	No. days (in last five school days)												No. response	
	0		1		2		3		4		5			
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Reading/language arts	1	1.1			2	2.5	3	3.4	2	2.2	73	82.0	8	9.0
Mathematics	5	5.6	2	2.2	1	1.1	4	4.5	2	2.2	67	75.3	8	9.0
Social studies	7	7.9	8	9.0	20	22.5	11	12.4	12	13.5	23	25.8	8	9.0
Science	0	9	5	5.6	16	18.0	12	13.5	11	12.4	30	33.7	6	6.7

Measures

Preparedness to Teach Ocean Literacy:

A scale to measure teachers' feelings of preparedness to teach ocean literacy was developed. Teachers responded to the question "Within science, many teachers feel better prepared to teach some topics than others. How well prepared do you feel to teach each of the following topics at the grade levels you teach, whether or not they are currently included in your curriculum?" Teachers responded as "not adequately prepared," "somewhat prepared," "fairly well prepared," or "very well prepared." The wording of this question followed that used by the *LSC* (*Grades K–8*) *2006 Teacher Questionnaire* (Question 10, Horizon Research Inc., 2000), which has established validity (Banilower *et al.*, 2007; Flora and Panter, 1999), and the topics included the OLEPs defined by the Ocean Literacy Network (Ocean literacy, 2006; see Table 4). For the present study, this scale was reviewed by the same panel that reviewed the Attitude toward Ocean Science Scale (below) and was pilot tested with the same group of in-service teachers. Principle components analysis of the current study group revealed one principle component, and all items showed high factor loadings (see Table 4). Teachers' feelings of preparedness to teach ocean literacy were measured as a composite score, calculated as the sum of scores on seven questionnaire items. Internal reliability was high (Cronbach's alpha $= 0.94$, $n = 85$). On the Preparedness to Teach Ocean Literacy Scale, a response of "somewhat prepared" was scored 2. Thus, a score above 13 indicated that, averaged over the scale, the teacher felt at least somewhat prepared to teach ocean literacy.

Attitude toward Ocean Science:

Attitude toward ocean science was measured as a composite, calculated as the sum of scores on nine questionnaire items, five positive and four negative. Negative items were reverse coded for analyses. Teachers responded using one of five Likert intervals ranging from "strongly disagree" to "strongly agree." The questionnaire items were modified from the Attitude toward Science Inventory (ATSI: Gogolin and Swartz, 1992; Young, 1998). The word "science" in the ATSI was changed to "ocean science." Only items relating to the original ATSI subscales of "value of science in society" and "enjoyment of science" were used (Gogolin and Swartz, 1992). Items not valid for in-service teachers were removed, as the original ATSI was developed for undergraduate students; this left 18 items in 9 positive–negative couplets. This version was completed and reviewed by four elementary teachers and three science education specialists and was also pilot tested with a group of elementary teachers in the state of Michigan ($n = 15$). Minor changes in wording were made due to questions regarding validity. The reviewers were also concerned with the length of the scale, so the number of items was reduced to 10, 5 negative and 5 positive items. After the scale was administered to the teachers in this current study, analysis of item correlations showed that one negative item was not sufficiently correlated, and removing this item significantly improved Cronbach's alpha. Removing this item resulted in a 9-item scale, as shown in the Online Supplement. This scale showed good internal reliability (Cronbach's alpha $= 0.78$, $n = 86$). On the Attitude toward Ocean Science scale, a neutral response ("neither agree nor disagree") was scored 3. Higher scores indicated more positive attitudes, and a score above 27 indicated a positive attitude, averaged over the scale.

Ocean Literacy Teaching Frequency:

A scale to measure how frequently teachers included ocean literacy in their K–8 instruction was developed. Teachers responded to the question "About how often do you teach about each of the following topics in this class?" with one of five responses ranging from "never" to "all or almost all lessons." The wording of the responses followed that used by the *LSC* (*Grades K–8*) *2006 Teacher Questionnaire* (Question 21, Horizon Research Inc., 2000). The question referred to teachers' "Science, Earth Science, Geography, and Social Studies teaching," and if teachers taught multiple sections or classes, they were directed to answer for the first class of the week in which they taught these subjects. The topics listed were the OLEPs, as defined by the Ocean Literacy Network (Ocean literacy, 2006; see Table 4). Validity of this Ocean Literacy Teaching Frequency Scale was determined similarly to the Preparedness to Teach Ocean Literacy Scale (see Table 4). Teachers' frequency of ocean literacy instruction was measured as a composite score, calculated as the sum of scores on seven questionnaire items. Internal reliability was strong

TABLE 4: Factor loadings.

Scale	Preparedness to teach ocean literacy	Ocean literacy teaching frequency
Ocean literacy fundamental principle		
The Earth has one big ocean with many features.	0.781	0.730
The ocean and life in the ocean shape the features of the Earth.	0.849	0.824
The ocean is a major influence on weather and climate.	0.893	0.784
The ocean makes Earth habitable.	0.916	0.854
The ocean supports a great diversity of life and ecosystems.	0.868	0.778
The ocean and humans are inextricably interconnected.	0.915	0.867
The ocean is largely unexplored.	0.788	0.651

TABLE 5: Summary of data.

Scale	Possible range	n	Range	Mean	Median
Preparedness to teach ocean literacy	7–28	84	7–28	18.3	18.5
Attitude toward ocean science	9–45	86	25–45	33.6	33
Frequency of teaching ocean literacy	7–28	81	7–28	15.7	15.0

(Cronbach's alpha = 0.95, $n = 80$). On the Ocean Literacy Teaching Frequency scale, scores above indicated that teachers included an ocean literacy principle in their enacted curriculum. Thus, scores above 7 indicated that teachers taught about at least one ocean literacy principle, at least rarely.

Findings

Preparedness to Teach Ocean Literacy:

Teachers' median composite score was 18.5 (see Table 5); most of the teachers felt somewhat prepared to teach the ocean literacy principles. Few (17%, $n = 14$) teachers scored below 14 on the scale, indicating that they felt "not adequately prepared" to teach ocean literacy. Only one teacher reported feeling "not adequately prepared" to teach all seven ocean literacy principles, corresponding to a minimum composite score of 7. Five teachers (6%) reported feeling "very well prepared" to teach all seven principles.

Attitude toward Ocean Science:

On the Attitude toward Ocean Science scale, the median composite score was 33 (see Table 5), indicating that most of the teachers had fairly positive attitudes toward ocean science. Four (5%) teachers reported negative attitudes, that is, composite scores below 27. None of the teachers' scores were below 25 (see Table 5).

Ocean Literacy Teaching Frequency:

Some teachers ($n = 6$, 7%) reported never teaching about ocean literacy. More commonly, teachers reported teaching "rarely" or "sometimes" about several of the ocean literacy principles, leading to a median composite score of 15.7 (see Table 5). The teacher who reported teaching about ocean literacy most frequently reported teaching each of the seven principles "often" (e.g., once or twice a week). There were no teachers who reported teaching about each of the ocean literacy principles in "all or almost all lessons."

Relationship among Variables:

This study investigated whether teachers' feelings of preparedness to teach ocean literacy and their attitudes toward ocean science would predict the frequency at which they taught about ocean literacy in their K–8 classrooms. Teachers' feelings of preparedness to teach ocean literacy was significantly correlated with the frequency of teaching ocean literacy, and teachers' attitudes toward ocean science showed a marginally significant correlation with this frequency (see Table 6).

TABLE 6: Pearson correlation results.

	Statistic	Preparedness to teach ocean literacy	Attitude toward ocean science
Frequency of teaching ocean literacy[1]	n	79	80
	r	0.35	0.23
	p	0.001[2]	0.041[2]
Preparedness to teach ocean literacy[1]	n		83
	r		0.30
	p		0.006[2]

[1]Composite scores were square-root transformed.
[2]Statistical significance at the $p < 0.05$ level.

All three composite scores were square-root transformed to improve normality and homoscedasticity. The multiple linear regression model predicted the frequency of teaching ocean literacy composite score based on the preparedness to teach ocean literacy composite score and the attitude toward ocean science composite score (see Table 7). This model was significant, $F(2, 75, 77) = 7.003$, $p = 0.002$, and explained 15.7% of the variance in the frequency of teaching ocean literacy. Preparedness to teach ocean literacy was a significant predictor of the frequency of teaching ocean literacy, $p = 0.008$ (see Table 7), and attitude toward ocean science was a marginally significant predictor, $p = 0.092$ (see Table 7).

DISCUSSION

This study investigated ocean literacy, a relatively narrow topic area, as opposed to a broader scale subject, such as science. A practical rationale exists for studying science as a subject at the K–8 level: K–8 curricula typically do not divide science into subdisciplines (Earth system science, physics, biology, chemistry). K–8 teachers could potentially teach any grade-appropriate topic in science. Consequently, focusing on a narrow topical area could cause a researcher to miss the area covered in the particular grade level of a given school. However, Bandura's (1986) social cognitive theory indicates that self-efficacy is specific to context, suggesting a theoretical reason to place studies of self-efficacy regarding teaching content within a relatively narrow topical context. A topical focus such as the OLEPs avoids the idiosyncrasies of individual curricula, because the OLEPs can be the context of a wide variety of conceptual investigations. The findings of this study suggest that

TABLE 7: Regression model terms and statistics.[1]

Term	B	SEM	t	p
Constant	0.49	1.16	.42	0.675
Preparedness to teach ocean literacy[2]	0.33	0.12	2.72	0.008[3]
Attitude toward ocean science[2]	0.35	0.21	1.71	0.092

[1]Dependent variable is the frequency of teaching ocean literacy composite score.
[2]Composite scores were square-root transformed.
[3]Indicates statistical significance at the $p < 0.05$ level.

it is possible to quantitatively study teachers' feelings of preparedness to teach content (a component of perceived self-efficacy) and teachers' decisions regarding the content of curriculum within a topic-specific focus, such as the OLEPs.

Feelings of preparedness to teach ocean literacy predicted the frequency of teaching about ocean literacy, which is consistent with studies within the broader contexts of the science curriculum and the entire K–8 curriculum. For example, quantitative investigations showed teachers' feelings of preparedness to teach science (Banilower *et al*., 2007) and self-efficacy regarding science teaching (Desouza *et al*., 2004; Riggs and Enochs, 1990; Tschannen-Moran and Hoy, 2001) were correlated with amounts of science teaching. More generally, science teaching efficacy (Haney *et al*., 2002) and general teaching efficacy (Gibson and Dembo, 1984; Haney *et al*., 2002) can predict teachers' choices of types of classroom activities. Thus, previous work and this current study concur that elements of perceived self-efficacy and, more broadly, self-efficacy, can be predictive of teachers' behaviors. (For a review of teacher efficacy and the history of the teaching efficacy construct see Tschannen-Moran *et al*., 1998.)

The theoretical underpinnings of this study, Bandura's social cognitive theory (1977, 1986), assume that perceived self-efficacy causes people to avoid or seek out particular experiences. However, in the case of teaching particular topics, this causal relationship may not be linear. Perceived self-efficacy is engendered and reinforced by experience (Bandura, 1986). Science teachers tend to teach topics they are confident in, gaining more confidence as they teach content (Appleton, 2006; Wallace and Louden, 1992), and thus, increasing their efficacy. Though the current study indicates that there is a significant, positive relationship between feelings of preparedness and frequency of teaching ocean literacy, the relationship may be reciprocal in nature.

Teachers' attitude toward ocean science also predicted their frequency of teaching ocean literacy. Attitude is a separate construct from perceived self-efficacy (Ramey-Gassert *et al*., 1996; Settlage, 2000). Therefore, it is conceivable that teachers may have a positive attitude toward an area of science and, yet, realize that they do not have the PCK to include this particular aspect of science in the curriculum. Despite being different constructs, teachers' attitudes toward science and science teaching efficacy may correlate (Ramey-Gassert *et al*., 1996), as they may originate in experiences with science education (Palmer, 2001; Ramey-Gassert *et al*., 1996; Young, 1998). Indeed, the current data showed that attitude toward ocean science and feelings of preparedness to teach ocean literacy were correlated.

This study's prediction that attitude would influence teachers' choice of content was based on reasoning similar to Mager's (1968) notion that "people who are strongly disposed toward a subject talk a great deal about it, encourage others to participate in it, read about it, buy books about it, attend lectures about it…. Students strongly disposed toward a subject sign up for more courses about it, say favorable things about it, and spend their study time studying it" (p. 25). Elementary teachers tend to lack preparation in science content (Rice and Roychoudhury, 2003; Sherman and MacDonald, 2007), whether considering broad science idea, such as the nature of science (Abd-El-Khalick and Akerson, 2004) or more specific topics (Davis *et al*., 2006; Wallace and Louden, 1992). Similarly, Tosun (2000) found that preservice teachers had little undergraduate science instruction, a finding consistent with Tilgner (1990). Thus, to teach science content, these teachers must put effort into gaining content knowledge. A natural extension of Mager's (1968) reasoning is that teachers who are positively inclined toward ocean literacy would tend to learn about it and thus include it in their enacted curriculum when possible. The results of the current study are consistent with this reasoning.

FUTURE RESEARCH AND IMPLICATIONS

Ocean literacy is one example of a curricular context that is aligned with mandated curriculum but is somewhat at the discretion of classroom teachers. Other examples of such curricular contexts exist in Earth System Science, such as the North American Laurentian Great Lakes, the Hudson River, and global climate change. However, ocean literacy offers an advantage to educational researchers and curriculum developers, in that it is defined in a validated construct, the OLEPs. Moreover, ocean literacy is an example of a curricular context that national bodies, including the National Marine Educators Association, the Ocean Literacy Network, and the National Oceanographic and Atmospheric Administration, are actively promoting as part of science curricula.

For those interested in environmental and ocean education, this study showed that the OLEPs are a useful construct for developing tools to study teachers' attitudes about and inclusion of content within the K–8 classroom. From a broader standpoint, this study shows the utility of defining essential principles for focused topic areas that can easily translate into valid and reliable research instruments, particularly for use by groups and organizations promoting particular topical foci in science education.

When developing such research instruments, it is important to consider the appropriate scale of the content studied, such as decisions regarding whether to develop a construct focusing on concepts, principles, or even entire subject areas. The OLEPs are comparatively broad in relation to the related Ocean Literacy Fundamental Concepts (Ocean Literacy, 2006). For instance, an OLEP used in this study is "The Earth has one big ocean with many features" (see Table 4). Under this OLEP is the concept that "Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), the Sun, and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation" (Ocean Literacy, 2006, p. 5). It may be argued that concepts are more appropriate for studying K–8 teachers' decisions than principles. In support of a more conceptual focus of research, Appleton and Kindt (2002) and Appleton (2006) found that new teachers' decisions were focused on activities, as opposed to larger scale curricular decisions. This activity-based focus may suggest that the amount of science content found in an activity, that is, a concept, maybe the ideal level of breadth for studying K–8 teachers' feelings of preparedness to teach a topic. Further research might consider each Essential Principle separately and construct scales measuring teachers' feelings of preparedness to teach the concepts within these principles. It would be worthwhile to see if the concepts underlying each principle define a single construct, or if teachers' feelings of preparedness varied distinctly among the concepts underlying individual principles. However, because teachers have varying interactions with mandated curricula and because K–8 curricula vary in the sequence of concepts, this type of inquiry may lend itself to qualitative or mixed methods, as opposed to survey methods.

Though the population represented by this sample was not unusual for K–8 teachers in the United States, reliability is never universally established, but, rather, is subject to re-evaluation when applied to differing populations. In particular, the current findings should be interpreted with caution due to possible nonresponse bias (Dillman, 1991), considering teachers who live very near coastlines, male teachers, and minority teachers were not well represented in this study's sample. Future studies need to confirm the validity and reliability of these scales for the populations under-represented in this study.

This study also provides recommendations regarding the inclusion of more traditional Earth System Science topics within the K–8 curriculum. For topic areas for which principles and concepts have been established at both state and national levels, it would be fruitful to investigate if these established constructs can translate into useful research instruments for measuring teachers' attitudes, self-efficacy, and knowledge. Currently, the content of science education is the subject of national efforts (NRC, 1996; AAAS, 1993, 2009) and is under ongoing discussion focusing on views of the entire curriculum (Commission on Mathematics and Science Education, 2009; Feinstein, 2009). However, teachers are, ultimately, the arbiters (Porter, 2002) deciding which portions of the curriculum receive emphasis and inclusion. Unlike policy makers, teachers may be more focused on science content at the scale of specific activities or concepts. Thus, studying teachers' decisions about the curriculum within a topic-specific focus makes sense from the perspective of teachers' everyday decision making. This study demonstrates that it is possible to consider teachers' decisions within such a topic-specific focus, rather than at the broad levels of science as a subject or the various disciplines of science.

Beyond the possibilities of research, the findings from this study suggest an opportunity for teacher education and in-service professional development. In teaching science, many teachers decide on the topical emphases of their science instruction. If teachers feel more prepared to teach some aspects of science than others or have a more positive attitude regarding some topics than others, it is likely the enacted curriculum will overemphasize some topics and underemphasize others. This suggests a need for professional development that focuses on topics about which teachers feel relatively unprepared to teach. Also, teacher education programs should pay particular attention to preservice teachers' content knowledge and pedagogical content knowledge of specific elementary science topics. This could entail including particular topics in science methods courses. Teacher educators could develop courses that deal with all aspects of elementary science and mandate that preservice teachers participate in these courses or encourage prospective teachers to include such courses in their preservice curriculum.

Similarly, focusing on topics about which teachers have poor attitudes, and pointedly working to help future and in-service teachers to change their attitudes, may help teachers choose to better emphasize those topics within their curriculum. Moreover, as Mager (1968) suggests, the natural inclination is to learn more about topics that one likes. In many cases, preservice and in-service teachers have autonomy in their choice of which science topics to study. Teacher educators and professional developers may do well to help teachers become aware of their dispositions toward topic areas and offer support to teachers who preferentially choose topics of study about which they may have relatively low feelings of efficacy or negative attitudes.

This study shows that the inclusion of ocean literacy within the enacted curriculum is correlated with teachers' dispositions toward ocean literacy. The current findings are couched within a topical area that is, in most states, not an explicitly mandated portion of the curriculum (Hoffman and Barstow, 2007; Schoedinger *et al*., 2006). An interesting and important avenue for future research may be to determine if the findings in this study extend to Earth System Science topics explicitly mandated by state or local powers. If so, then policy makers and administrators may find that mandating a topic for inclusion in the enacted curriculum is more effective if this action is concurrent with active professional development activities that address teachers' attitudes toward this topic.

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