The future of K-12 water education: The 2010 Mississippi framework and the proposed National Research Council framework for science education

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Previous researchers (Brzuszek et al 2009) investigated the role of non-governmental organizations (NGOs) in four northern Gulf Coast watersheds (Alabama, Florida, Louisiana, and Mississippi), and reported that the NGOs' focus varied by watershed. However, subsequent analysis of these northern Gulf States' educational standards revealed that the NGOs' focus was not being reflected in the respective state's water education requirements (Clary & Brzuszek 2009). Under the 2001 Mississippi Science Framework, 69% of the researchers' 13 identified water topics were included, but most of these were non-required objectives, or within elective courses that are not taught at all Mississippi schools. Only one topic, pollution, was required to be taught as a state competency (grade 4). While Louisiana fared better than other coastal states with 54% of the water content topics in K-12 education, several topics were still omitted. Clary and Brzuszek (2009) concluded that greater collaboration was needed between watersheds, their associated NGOs, and educators to implement water education in public schools through the required science content standards.

However, science education is not static: Both the 2010-11 adoption of Mississippi's 2010 Science Framework and the recently released 2010 National Research Council (NRC) draft of the conceptual Framework for Science Education indicate that new challenges and opportunities exist for water education. Our current research compared water education topics in the Mississippi 2010 Science Framework against the earlier 2001 Framework. While there is greater vertical alignment between grades K-8 in the 2010 Framework, many of the water topics are included as optional objectives and not as required competencies, resulting in increased water education possibilities with teacher flexibility. Content analysis of the preliminary public draft of the NRC science framework also revealed flexibility and water education potential: Although water education was not regularly mentioned in the document, the new NRC draft focuses upon "learning progression." Another notable change is the incorporation of Engineering and Technology as a fourth domain of science alongside the current domains (Life, Earth and Space, and Physical sciences).

Both Mississippi's vertical alignment and the NRC learning progressions are consistent with our best practices model (Clary & Brzuszek 2009). These documents also suggest a potential educational trend toward increased content reinforcement across grade levels and teacher flexibility. We suggest there may be increased opportunity for NGOs to develop water education programs at multiple grade levels that address these broader science standards, resulting in greater inclusion of water education within the local watershed.

Key words: Conservation, Ecology, Education, Water Quality

Introduction

Goldman Sachs referred to water as "the petroleum of the next century" and stated that water demand continues to escalate at unsustainable rates (Economist, 2008). Therefore, it is imperative that our future citizens are instructed in water education, watershed management, and sustainability. Water education includes fundamental concepts needed by all citizens for future water management and sustainable development.

This research continues the collaborative investigation between science educators and a professor of landscape architecture. Our original research determined the quality of water education in the Gulf Coast states of Mississippi, Louisiana, Alabama, and Florida (Clary & Brzuszek, 2009). Although this earlier research reported that several important concepts were missing from each state's mandated science education standards, we noted the potential for improved water education, and identified an optimal model for incorporation of water education in K-12 classrooms.

Fortunately, water education is not static: Recent science education developments include the adoption of Mississippi's 2010 Science Framework and the release of the 2010 National Research Council (NRC) draft of the conceptual Framework for Science Education (National Research Council, 2010). Our current research extends the earlier investigation, and compares the water education concepts in the 2010 Mississippi Science Framework against the 2001 state science curriculum utilized in the previous investigation. We employ content analysis (Neuendorf, 2002) to determine the potential for water education concepts within the new NRC draft framework, and further analyze how it, and Mississippi's 2010 Science Framework, align with the optimal model for water education (Clary & Brzuszek, 2009). Finally, we identify the new challenges and opportunities for effective water education programs.

Relevant Research: NGOs, Gulf Coast Watersheds, and Education

Brzuszek et al (2009) investigated the role of non-governmental organizations (NGOs) within four Gulf Coast watersheds (Louisiana, Mississippi, Alabama, Florida). Their analysis of survey responses from 22 NGOs (n = 5 NGOs/state except Mississippi, where n = 7) revealed different associations between each watershed and its associated NGOs. Florida's New River Watershed, for example, emphasized development review and education. In the Smart Benchmarking Tool, the Center for Watershed Protection (2006) recommended that NGOS partner with schools to build watershed education into the curriculum. However, none of the Gulf Coast NGOs developed partnerships within their regions' schools (Brzuszek et al, 2009).

Reports from effective water quality programs underscore the important role of NGOs in regional watershed programs (Wiley & Candy, 2003; Koehler, 2001). Outside the United States, NGOs assist in environmental education and sustainable development programs (Tilbury et al, 2008), and may be one of the best situated organizations that can counter destructive aspects of our modern society (Haigh, 2006). The NGOs' role has become increasingly important in developing countries (Nomura et al, 2003) and they are highly significant in regional resolution of environmental problems (Hirono, 2007).

The National Science Education Standards and Water Education in States' Science Curricula

In 1993, the American Association for the Advancement of Science (AAAS) published the Benchmarks for Science Literacy, which identified the science curriculum needed by all future Americans at the conclusion of grades 2, 5, 8, and 12. The National Science Education Standards (NSES) emerged from the Benchmarks for Science Literacy, as well as AAAS' Science for All Americans (1989), to provide a set of science content standards that guide the science education of K-12 students in US public schools (National Committee on Science Education Standards and Assessment, 1996). Organized under eight categories, the science content standards include three science discipline categories: Physical Science, Life Science, and Earth and Space Science.

While the NSES provide the guiding framework for K-12 science education, the No Child Left

Behind Act of 2001 (NCLB) required each US state to develop its own content standards. NCLB subsequently mandated that each state implement "challenging science content standards by 2005-06." Therefore, each US state has unique science content standards, constructed under the framework of the NSES. Each state is further accountable for its students achieving at the proficiency level.

A watershed education program is more likely to be incorporated and implemented within a public school classroom if it aligns with the state-mandated science content standards. When we first investigated the national framework for portals by which water education could be incorporated, we located opportunities at all grade level spans (K-4, 5-8, 9-12) and within five content categories (Unifying Concepts and Processes, Science as Inquiry, Life Science, Earth and Space Science, Science in Personal and Social Perspectives) for potential water education concept inclusion (Clary & Brzuszek, 2009). The best-fit category of the NSES for water education appeared to be Science in Personal and Social Perspectives, which offers several strands for environmental investigation. We were further encouraged by the reports of some watershed study programs that were successfully aligned with the NSES (Shepardson et al 2007).

Gulf Coast States and Water Education

Once we determined the NSES portals by which water education could be introduced in science classrooms, we turned our attention to the Gulf Coast states: We examined each Gulf Coast state's curriculum to determine whether water education could be incorporated in the classroom through the state's science education framework and the required science standards (Clary & Brzuszek, 2009). We identified and utilized basic, although not inclusive, water education concepts, including aquatic organisms, aquifers, coastal loss, flooding, groundwater, infiltration, pollution, quality of water, runoff, soil erosion, Surf Your Watershed (United States Environmental Protection Agency, 2009), urban development, total maximum daily loads (TMDLs), and state-specific water features. Initial investigations showed little inclusion of water-specific topics at grades K-3 beyond the hydrologic cycle, so our in-depth investigation focused primarily on grades 4-12.

Of the four Gulf Coast states we investigated, Louisiana ranked as the most adequate in water education with seven of the identified water concepts addressed in the state science curriculum. Four of these concepts (aquifers, groundwater, pollution, soil erosion) were addressed at multiple grade levels for an enforced and vertically-aligned curriculum. Florida's science curriculum ranked as second of the Gulf Coast states, with six of the water concepts incorporated within the curriculum. However, only two of these concepts (quality of water, soil erosion) were addressed at more than one grade level. Alabama's science curriculum only addressed four of our identified water concepts, and none of these was enforced at more than one grade level.

At first appearance, Mississippi's 2001 state science curriculum seemed impressive (Table 1). Nine of our identified water concepts were included in the curriculum, but it quickly became apparent that not all these concepts were required—and therefore not systematically incorporated—in all of Mississippi's classrooms. Many concepts were mentioned as objectives, which were suggested alternatives for a teacher, but were not required. Other concepts were addressed in courses that are not available at all schools within the state. When the optional objectives and elective courses were eliminated, we concluded that only one concept—pollution—was required to be taught at the fourth grade under Mississippi's 2001 science curriculum (Table 2). We found no evidence that any of the Gulf Coast watersheds and their associated NGOs had impacted their state's mandated science curriculum (Clary & Brzuszek, 2009).

Water Education Best Practices Model

Following the investigation of the inclusion of water education in Gulf Coast states' curricula, we investigated premier water education programs throughout the nation, and also analyzed the other 46 US states' curricula for water education inclusion. The Chesapeake Bay Program is recognized as an outstanding water education program that provides curriculum-based environmental education activities for the seven partnering states and the District of Columbia (Chesapeake Bay Program, 2009). Through this successful program, the watershed and its associated NGOs impact the school curriculum and water education of the future water stewards. Beyond the Chesapeake Bay partner states, the Illinois state science framework offered potential for effective water education. The Illinois State Performance Descriptors (Illinois State Board of Education, 2001) were not notable for the amount of water concepts that were incorporated, but for the manner in which the concepts were introduced into the classroom. Although Illinois incorporated only five of our identified water concepts, there was consistent overlap in the topics over several grade levels, leading to a reinforced, vertically-aligned curriculum.

The Water Education Best Practices model that emerged from our exploratory research incorporated the three C's of **Collaboration, Content,** and **Consistency** (Clary & Brzuszek, 2009). Chesapeake Bay Program's successful collaborative efforts should serve to guide other watersheds and their partnering NGOs in the development of water education activities and outreach that can provide meaningful learning experiences for K-12 classrooms. It is noteworthy that the Chesapeake Bay Program was successful in the incorporation of their water education program within the participating states' curricula.

While collaboration among a watershed, associated NGOs, and schools is important for water education, there still exists basic content that must be incorporated in the classroom for a comprehensive water education program. The original water concepts that we identified were not intended as a comprehensive list for water education; it was surprising to us that several states incorporated only a few of the concepts we identified. Water education must be broad-based, with several water concepts included in the classroom for an optimum education of our future water stewards.

Content can not be introduced at one grade level and then abandoned, however. In order for meaningful learning to occur, students not only need exposure to the content, but also the consistency of a vertically-aligned water education program. The Illinois model should guide the development of a water education program that is not only introduced, but reviewed and reinforced.

2010 Mississippi Science Framework

Science education is not static, and in 2010, the updated and retooled 2010 Mississippi Science Framework was adopted for Mississippi's public schools.

We investigated the 2010 Framework for the potential of water education inclusion in Mississippi's K-12 science classrooms using the original water concepts we identified. Both a science education researcher and an undergraduate pre-service science teacher (who also majors in geology) investigated the 2010 Framework. We immediately noted a difference between the 2010 framework and the 2001 curriculum: Whereas the 2001 curriculum was detailed with specific, mandated competencies and suggested objectives, the 2010 Framework organized science content under broad concepts, which allowed greater teacher flexibility. Therefore, our investigation of the 2010 Framework focused upon those competencies and strands which offered the potential for the inclusion of the water education concepts we identified. Table 3 is the result.

Because of the important organizational and style differences between the 2001 Mississippi state science curriculum and the 2010 Mississippi Science Framework, a direct comparison of the water education facilitated by each curriculum cannot be made. However, Table 4 organizes the potential for water education inclusion by topic under the 2001 and 2010 frameworks. While some water concepts are not precisely specified in the 2010 Framework, fewer mandated competencies and broader themes provide teachers with the flexibility to implement more water education concepts.

Not only can the water education concepts be incorporated at more than one grade level for greater consistency, but the 2010 Mississippi Science Framework also provides K-8 vertical alignment charts for the four strands it targets: Inquiry, Physical Science, Life Science, and Earth and Space Science. The charts detail the competencies, objectives, and sub-objectives with the corresponding Depth of Knowledge (DOK) at each grade level. (Based on the work of Norman Webb (1999), DOK levels specify the degree of complexity at which a concept is taught. DOK 1 (recall), DOK 2 (skill/concept), DOK3 (strategic thinking) and DOK 4 (extended thinking) are used within the 2010 Mississippi Science Framework.) Therefore, the 2010 Mississippi Science Framework impacts practicing teachers through broader themes and competencies, and the degree—and documentation—of the vertical alignment of the curriculum.

2010 NRC Draft of the Conceptual Framework for Science Education

In the summer of 2010, the National Research Council released its draft of the conceptual Framework for Science Education and solicited public feedback (National Research Council, 2010). While the Framework is the first step in the revision of the current NSES, the second step will develop internationally benchmarked standards from the Framework.

We investigated and analyzed the draft conceptual Framework for emerging themes and trends, using Neuendorf's (2002) content analysis guidelines. Three major themes emerged: 1) The draft NSES conceptual framework is organized under broader, organizing questions when compared to the older NSES; 2) The draft NSES conceptual framework elevates "Engineering and Technology" to a science discipline strand, on the same level as Life Science, Physical Science, and Earth and Space Science; and 3) The draft NSES conceptual framework promotes learning progressions and vertical alignment of activities. The draft NRC Framework further stresses that classroom time should be allocated for investigations and argumentations.

With respect to water education, one of the large framing questions for Earth Science content is ESS-3, "Why do we call Earth the water planet?" Through ESS-3, the NRC's draft Framework indicates that future US K-12 science education will stress the importance of water education. By framing an Earth Science core idea (e.g., Earth is often called the water planet, because of the abundance of liquid water on its surface and because water's unique combination of physical and chemical properties are essential to the dynamics of most of Earth's systems), the new NSES potentially offer more opportunities for sustained water education and inclusion of important interdisciplinary water concepts.

Alignment of the 2010 Mississippi Science Framework and the NRC Draft Conceptual Framework with the Best Practices Model

We analyzed the 2010 Mississippi Science Framework and the NRC draft conceptual framework against our water education best practices model that emerged from our previous research (Clary & Brzuszek, 2009). Whereas specific content standards and competencies are much reduced in both the 2010 Mississippi Framework and the draft NRC Framework, the broad organizing questions and strands of the documents provide portals through which the necessary water concepts for a comprehensive water education can be taught. Consistency, one of our recommended guidelines in the best practices model, is improved and highlighted in both frameworks through the vertical alignment and reinforcement of the curriculum. However, any collaboration between watersheds, NGOs, and public education remains to be determined. It is encouraging that the 2010 Mississippi Science Framework specifically mentions several NGOs as well as governmental facilities in its sub-objectives. Some of the organizations identified, such as the Engineer Research and Development Center of the Vicksburg District of the US Army Corps of Engineers, are particularly relevant to water education within the state.

Discussion and Concluding Remarks

When we presented an idealized model for water education that included collaboration and feedback between a watershed, NGOs, and public education in our previous research, we acknowledged that the model was far from being realized within the Gulf Coast states (Clary & Brzuszek, 2009). The important factors for a watershed may have been translated into the actions of its associated NGOs, but these factors were not being systematically implemented in public school systems.

With the new 2010 Mississippi Science Framework and the draft NRC conceptual Framework, we see an educational focus on consistency of scientific concepts across a curriculum, and an increased potential for water education through broader organizing themes and concepts. Both frameworks reflect a change from a multitude of stand-alone concepts that were not reinforced across grade levels. Notably, the Ocean Literacy Community (2010) concurred: They applauded the NRC's effort through the draft framework to "overcome the mile wide, inch deep syndrome by including a limited number of core ideas" (p. 1).

The recent implementation of the 2010 Mississippi Science Framework and the release of the draft NRC conceptual framework indicate that there is increased opportunity for water education within K-12 classrooms. These documents suggest that the future educational trend may be geared toward increased content reinforcement across grade levels, and increased teacher flexibility to include science content beyond a specific list of competencies and standards that are required to be taught. The 2010 Mississippi Science Framework stated that required competencies do not have to be taught in a given order, and that they may be combined and introduced throughout the school year. Teacher flexibility is emphasized.

We suggest that new opportunities exist for water education. With the vertically-aligned curricula (consistency), and the flexibility of the framework to allow teacher-determined sequence of activities and investigations (potential greater water content inclusion), a collaborative effort between local watersheds, their associated NGOs, environmental organizations, and interested educators may be possible within a state, leading to the development of water education programs at multiple grade levels that address the broader science standards. However, the increased opportunity for water education is also accompanied by new challenges: With greater content flexibility for teachers, the onus may be upon the watershed, NGOs, and interested environmentalists to develop quality materials that reflect the broad state competencies, incorporate inquiry-based learning, and that facilitate an easy incorporation of water education concepts into the classroom.

In order to accomplish this, water education concepts must be introduced at the proper level of complexity at the proper K-12 grade level, and subsequently reinforced in later years. Water education activities must align with the state science framework. Supplies for activities must be made available or easily procured by teachers at little or no cost. Authentic assessments should accompany the water education activities so that teachers can easily determine the effectiveness of an activity or program, and test the knowledge acquired by their students.

NGOs now have an opportunity to develop programs that address the broader required standards and competencies, which will potentially result in greater inclusion of water education on a local level. The development of high-quality water education instructional materials and collaborative efforts between NGOs and a state educational agency can potentially lead to state-wide inclusion of activities. If the draft NRC conceptual Framework is an indication of the future of water education, then the ESS-3 framing question points toward an educational environment that is conducive for a comprehensive program that can impact our future water stewards.

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References Cited

1. Alabama Department of Education. (2006). Curriculum Guide to the Alabama Course of Study: Science Grades K-12. URL: ftp://ftp.alsde.edu/documents/65/Curriculum%20Guide%20to%20the%20Alabama%20Course%20of%20Study%20SCIENCE.pdf
2. American Association for the Advancement of Science. (1989). Science for All Americans. Online version, URL: http://www.project2061.org/publications/sfaa/online/sfaatoc.htm .
3. American Association for the Advancement of Science (1993). Benchmarks for Science Literacy. Online version, URL: http://www.project2061.org/publications/bsl/online/index.php.
4. Brzuszek, R.F., Fulford, III, T. Roberts, H., & Schauwecker. T.J. (2009). Comparison of water quality program efforts for non-governmental organizations within northern Gulf of Mexico watersheds. Journal of Extension, 47(6).
5. Center for Watershed Protection (2006). The Smart Watershed Benchmarking Tool. URL: http://www.stormwaterpa.org/assets/media/resources/ELC_SWBT.pdf
6. Chesapeake Bay Program. (2009). Education and interpretation. URL: http://www.chesapeakebay.net/bayeducation.aspx?menuitem=14783
7. Clary, R.M., & Brzuszek, R.F. (2009). Gulf Coast watersheds and water education: Outreach alignment and best practices. Mississippi Water Resources Conference Proceedings. http://www.wrri.msstate.edu/index.asp
8. Economist. (2008, July 19). A soluble problem. URL: http://www.economist.com/node/11751887
9. Florida Department of Education. (2005). Next generation Sunshine State Standards. URL: http://www.floridastandards.org/Standards/FLStandardSearch.aspx
10. Haigh, M. (2006). Promoting environmental education for sustainable development: The value of links between higher education and the non-governmental organizations (NGOs). Journal of Geography in Higher Education, 30(2), 327-349.
11. Hirono, R. (2007). Japan's environmental cooperation with China during the last two decades. Asia-Pacific Review, 14(2), 1-16.
12. Illinois State Board of Education (2001). Illinois Learning Standards. URL: http://www.isbe.state.il.us/ils/
13. Koehler, C. (2001). Putting it back together: making ecosystem restoration work. San Francisco: Save San Francisco Bay Association. URL: http://www.crcl.org/images/NGOR_Putting_it_Back_Together.pdf.
14. Louisiana Department of Education. (2009). Standards, assessments, and accountability: Comprehensive Curriculum. URL: http://www.doe.state.la.us/lde/saa/2108.html.
15. Mississippi Department of Education (2001). Mississippi Science Curriculum 2001. URL: http://www.mde.k12.ms.us/acad/id/curriculum/Science/science_curr.htm
16. Mississippi Department of Education. (2010). 2010 Mississippi Science Framework. URL: http://www.mde.k12.ms.us/acad/id/curriculum/Science/Webpage%20links%207%2031%2008.htm
17. National Committee on Science Education Standards and Assessment. (1996). National Science Education Standards. National Academies Press. Online version, URL: http://www.nap.edu/openbook.php?record_id=4962&page=R1.
18. National Research Council. (2010). A Framework for Science Education, Preliminary Public Draft, Committee on Conceptual Framework for New Science Education Standards. 190 p.
19. Neuendorf, K. (2002). The Content Analysis Guidebook. Thousand Oaks, CA: Sage.
20. Nomura, K., Hendarti. L, and Abe, O. (2003). NGO environmental education centers in developing countries: Role, significance and keys to success, from a "change agent" perspective. International Review for Environmental Strategies, 4(2), 165-182.
21. Ocean Literacy Community. (2010, July 22). Comments on the draft NRC Science Framework for Science Education. National Marine Educators Association: Univeristy of California-Berkeley, 18 p.

22. Shepardson, D.P., Wee, B., Priddy, M., Schellenberger, L., and Harbor, J. (2007). What is a watershed? Implications of student conceptions for environmental science education and the National Science Education Standards. Science Education, 91(4), 554-578.
23. Tilbury, D., Goldstein, W., and Ryan, L. (2003). Towards environmental education for sustainable development: The contributions of NGOs in the Asia-Pacific region. International Review for Environmental Strategies, 4(1), 59-73.
24. United States Environmental Protection Agency (EPA). (2009). Surf your watershed. URL: http://cfpub.epa.gov/surf/locate/index.cfm.
25. Webb, Norman L. (1999). Alignment of Science and Mathematics Standards and Assessments in Four States. National Institute for Science Education, University of Wisconsin-Madison.
26. Wiley, H., and Canty, D. (2003). Regional environmental initiatives in the United States: A report to the Puget Sound Shared Strategy. URL: http://www.sharedsalmonstrategy.org/files/Final_regional%20initiatives.pdf

Table 1: Water Education Content in Mississippi's 2001 Science Curriculum. It appeared nine water education topics were introduced in Mississippi's 2001 state science curriculum (Mississippi Department of Education, 2001). However, items marked with superscript 1 are not required courses, and are not offered in every school system in the state. Objectives are marked with superscript 2. Objectives were suggested for a classroom, but were not required to be taught.

TOPIC	GRADE LEVEL	STANDARD
Aquatic Organisms	Aquatic Science[1]	Competency 2, 4
Coastal Loss	Aquatic Science[1], Environmental Science[1]	Competency 6b,7; Competency 3e
Flooding	Aquatic Science[1]	Competency 6b, 7
Pollution	4, Aquatic Science[1]	Competency 7b, Competency 6a, c
Quality	4	Suggested objective[2]
Run-off	Aquatic Science[1]	Suggested objective[2]
Soil Erosion	4, Aquatic Science[1]	Objective 5a[2], Competency 3
Surf Your Watershed	4, Aquatic Science[1], Spatial Information Science[1]	Objective[2] Competency [2]
Urban Development	Aquatic Science[1]	Competency 6d

Table 2: Required Water Education Content in Mississippi's 2001 Science Curriculum. After elective courses that are not available in all school districts were removed, as well as those suggested objectives that were not mandated to be taught, the only required water education topic in the state of Mississippi was pollution, at grade level 4.

TOPIC	GRADE LEVEL	STANDARD
Pollution	4	Competency 7b

Table 3: Water Education Content in Mississippi's 2010 Science Framework. The 2010 Science Framework offered greater potential for water education in Mississippi's public schools. Ten water education concepts can be introduced via the 2010 Mississippi Science Framework, and all ten concepts can be offered through K-8 portals within the state. The new 2010 Mississippi Science Framework exhibits greater vertical alignment of the curriculum for the potential of reinforced water education concepts across various grade levels. Items marked with superscript 1 are not required courses, and are not offered in every school system in the state. Parentheses indicate that only one of the investigators identified the grade or course portal as having potential for inclusion of the water education concept.

TOPIC	GRADE LEVEL	FRAMEWORK
Aquatic Organisms	7 Aquatic Science[1]	4d 3a-f, 4a-c
Coastal Loss	3, 5 Aquatic Science[1] Earth and Space[1]	4b 2e 4d, 5a
Conservation	K, 5 7 8 Environmental Science[1]	4d 4g 4d 3a
Flooding	3, 4, 5	3c
Groundwater	5 6 7	4a, 4g 4g 4a
Pollution	1, 2, 3, 4, 6 Aquatic Science[1]	4d 4a
Quality	(5), 6, Environmental Science[1]	4g 3a
Run-off	(5), 6	4g
Soil Erosion	3, 5, Aquatic Science[1] Earth and Space[1]	4b 2e 4d,e
Urban Development	4, 5 (7) Aquatic Science[1]	4d 4g 4a

Table 4: Comparison of 2001 and 2010 Mississippi Science Frameworks for Water Education Content. Although a direct comparison between the 2010 Mississippi Science Framework and the 2001 Mississippi state science curriculum is not possible, the potential for water education according to topic and grade level are listed for each of the frameworks. Items marked with superscript 1 are not required courses, and are not offered in every school system in the state. We interpret the 2010 Mississippi Science Framework as having more potential for water education, and an improvement from the 2001 science curriculum. Blue cells are those concepts that have improved potential in the K-8 classroom under the 2010 Mississippi Science Framework.

TOPIC	**2001 MS State Science Curriculum—Grade Level and/or Elective**	**2010 MS Science Framework—Grade Level and/or Elective**
Aquatic Organisms	Aquatic Science[1]	7, Aquatic Science[1]
Coastal Loss	Aquatic Science[1], Environmental Science[1]	3, 5,Aquatic Science[1], Earth and Space[1]
Conservation		K, 5, 7, 8, Environmental Science[1]
Flooding	Aquatic Science[1]	3, 4, 5
Groundwater		5, 6, 7
Pollution	4, Aquatic Science[1]	1, 2, 3, 4, 6, Aquatic Science[1]
Quality	4	(5), 6, Environmental Science[1]
Run-off	Aquatic Science[1]	(5), 6
Soil Erosion	4, Aquatic Science[1]	3, 5, Aquatic Science[1], Earth and Space[1]
Surf Your Watershed	4, Aquatic Science[1], Spatial Information Science[1]	
Urban Development	Aquatic Science[1]	4, 5, (7), Aquatic Science[1]