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Hazards education and academic standards in the Southeast United States

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A continued increase in US disaster losses suggests that there is still much to be learned about hazards. Hazards education, therefore, remains an important facet of preparedness. This paper investigates the science and social studies academic standards for 10 Southeast states to reveal the extent to which hazard topics are covered in grades K-12. The findings suggest that hazards are treated unevenly from one state to another, that geophysical events are overrepresented in the curriculum, and that little integration between science and social studies exists on the topic. One suggested remedy is to re-incorporate geography strongly within the state standards as an attempt to make both the physical and social aspects of hazards known to the student.

Keywords: academic standards; education; hazards; Southeast

An estimated $1 billion per week. That figure refers to the cost of the lives lost and public and private properties destroyed every year by natural and technological hazards in the United States (NSTC, 2005). The frequency of hazard events, however, has remained relatively constant (Cutter & Emrich, 2005; NRC, 1999; van der Vink et al., 1998). Human factors – the growing concentration of people, their wealth, and their migration to hazard prone areas – are the primary contributors to these increased losses (Cutter, Johnson, Finch, & Berry, 2007; Pielke et al., 2008).

What then is needed to stem these rising losses? Past responses have included structural and institutional solutions (e.g., flood-proofing or insurance, respectively), but clearly the rapid rise in losses requires a more aggressive approach. The *Grand Challenges for Disaster Reduction* report (NSTC, 2005) suggests six broad strategic challenges, one which directly involves education, i.e., promoting risk-wise behavior by raising public awareness. Before people can make protective decisions fitting their own situations, appropriate education about the character of threats and their interplay with human populations is necessary.

An obvious starting point for hazards education would be the K-12 classroom. Izadkhah and Hosseini (2005) conclude that one of the best ways of publicizing disaster awareness programs is to integrate them with children's education. Previous work in hazards education has primarily focused on the development of teaching materials and instructional strategies, but no systematic effort has been made to assess the status of hazards education currently required in American schools. One overview of hazard education in Australia found a tremendous variety in hazards curricula among states and territories (Kriewaldt et al.,

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2003). Some curricula were developed in the form of standards by the territory, in other places school-based curriculum was developed, and in just about all places the topics varied from one grade level to another. These findings suggest that hazards education in the United States may also be uneven in its presentation, undermining the desired goal of a population uniformly aware of the threats they face and how to stem losses from them.

The purpose of this paper is to explore what hazard concepts students are expected to understand, and subsequently what that understanding (or lack thereof) may mean for future hazard mitigation. This initial exploration is accomplished through a review of science and social studies academic standards for 10 Southeastern US states. For this assessment, the Southeast region comprises Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia.

A variety of natural hazards occur within the Southeast region, with meteorological events (e.g., hurricanes, tornadoes, floods) historically being the most prominent in terms of occurrence and loss (Cutter & Emrich, 2005; Thomas & Mitchell, 2001). Other events, including seismic activity, have also occurred. For example, the New Madrid seismic zone lies along the region's western periphery and a very damaging earthquake befell Charleston, South Carolina in 1886. Currently the Southeast is coming to terms with Hurricanes Wilma, Rita, and, of course, Katrina (see Figure 1). That so much damage continues to occur suggests that much is still to be learned about the disaster potential of the region.

A review of classroom learning expectations as they relate to hazards must begin presently with an examination of social studies and science standards state by state. Any

Figure 1. Hurricane Katrina damage, Biloxi, Mississippi (photo by author, 2005).

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topical, geographical, or disciplinary variations can be summarily uncovered and acceptable remedies may be suggested. Accordingly, there are three main research questions that form the basis of this inquiry. First, what hazard topics are present within state academic standards and does the presentation of a hazard topic (its context) vary between science and social studies standards? Second, does geographic variation exist among states and their hazards topics? Third, does curricular integration exist that suggests both the physical and social aspects of hazards are being taught?

Background and literature review

An understanding of three sets of literature is required for this inquiry. First, the standards movement in American education is reviewed for its initial promise and unfortunate narrowing of the curriculum. Second, hazards education for the *classroom* as well as *public* hazards education, is evaluated. The final set of literature establishes the goals of geography education, suggesting opportunities to mesh the best intentions of standards-based education with pressing content (e.g., hazards) material.

Academic standards

Nearly all 50 US states have adopted academic content standards for subjects such as reading and language arts, mathematics, science, and social studies. The standards vary considerably in their topics, sequencing, and specificity, ensuring tremendous variety in what a student is expected to learn from one state to another.

The standards movement can be traced to the 1980s and 1990s and was seen as a remedy for an ailing public education system (Lefkowits & Miller, 2006). Specified learning standards, benchmarks, and high-stakes testing were at the heart of a more intensive assessment system (Vogler & Virtue, 2007). Curriculum standards have many proponents as the standards provide teachers with a common sequence of instructional targets and specify which knowledge and skills students must demonstrate (Ogawa, Sandholtz, Martinez-Flores, & Scribner, 2003).

Best intentions aside, an unfortunate by-product of content frameworks can be a narrowing of the curricula that includes only items within the framework or those likely to appear on the test (Grant et al., 2002; Vogler, 2005). High-stakes and end-of-course testing focuses on the content standards. Teachers, students, and administrators are all held accountable to some degree upon the outcome. Success on the exam means straying little from the content standards. The implication for hazards education is clear. Hazards teaching in unlikely to make the cut if those topics are not included in the content standards. Should hazards concepts find their way into the content standards, a different yet related issue presents itself. Should hazards be discussed within the physical science standards in terms of their origin and properties, within the social science standards in terms of their consequences, or within both sets of standards?

Hazards education

K-12 hazards education begins with the premise that teaching about hazards might help us avoid their consequences. Their "explosive" nature can also provide a hook to excite students about events and activities at other places. Not surprisingly, a number of materials are available to assist instruction (e.g., National Geographic Society's *Forces of Nature* (NGS, 2008) and *JASON* (NGS, 2007) series), and other online resources also continue to appear

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(UNISDR, 2007a). As noted earlier, how, when, and if these materials are used depends largely upon the instructional objectives laid out on a state-by-state basis within their academic standards. Without explicit direction within the standards, hazards instruction is absent at worst and uneven from one school to another at best.

The hazards education literature has focused on two main areas: the creation of teaching materials and a review of which topics should be included. In addition to the referenced National Geographic materials, educators have demonstrated how to use hazards maps in the classroom (Cross, 1988) and how to teach geographic principles using tornadoes (Lewis, 2006), global change (Mitchell & Cutter, 1997), and hurricanes and tsunamis (Lintner, 2006), among others.

How students should be taught about hazards is a much more limited area of investigation, especially in the K-12 environment. Typically only higher education or professional training is given the spotlight (Mileti, 1999). Very early work in this area found that people are "not familiar enough with the K-12 curriculum to offer an opinion on the adequacy of hazard education" (Vitek & Berta, 1982, p. 228). Others looking into the place of hazards within K-12 curricula have found that students were not able to distinguish between natural and human-induced hazards and that students were confused about disasters that could be forecasted (Valussi, 1984). Lidstone (1996) has found the curricula to be biased toward physical geography and technocratic in its approach; rarely is vulnerability or human response touched upon (Lidstone, 1990).

Despite these shortcomings, there is hope that hazards instruction can be better integrated with the regular instruction core. One attempt has been made to integrate the physical and social aspects of hazards using a geographic information system for middle school-level instruction (Mitchell, Borden, & Schmidtlein, in press). Other efforts are underway internationally to promote more and better teaching about hazards by using schools as the centers of participatory risk reduction in their communities (Wisner, 2006). Still, standards alignment remains a recurrent issue in United States. An education program designed by the American Red Cross explains that "while the curriculum was aligned to national education standards, *the school district curriculum was defined at the state level*" [author emphasis] (UNISDR, 2007b). State-level specifications for curriculum standards make the integration of hazards education a challenge.

Although information and materials developed for public hazards education may find their way into a K-12 classroom, the intended audience differs. Using posters, pamphlets, public-service announcements, and community meetings, the primary goal is to reach *adults* – prospective home-buyers, elected officials, corporate officials, realtors, current homeowners, and so on – to spark behavior change. A variety of public hazards education programs have been reviewed from wildfires to earthquakes (Donovan, Champ, & Butry, 2007; Nathe, Gori, Greene, Lemersal, & Mileti, 1999; Tanaka, 2005); however, their focus remains outside the K-12 environment. The argument made here and elsewhere (Izadkhah & Hosseini, 2005) is that youth hazard education is carried forward throughout their lives, is likely shared with their families, and accordingly serves as a better starting point for hazards understanding and (hopefully) eventual behavior change. To be sure, one cannot be certain that improving conceptual learning about hazards will necessarily lead to enhanced action. Hazards researchers assume that education enhances preparedness, in turn leading to contained losses. This assumption may be incorrect and could use a larger, more systematic examination (Tierney, Lindell, & Perry, 2001). Nonetheless, most would agree that any subsequent action in the face of disaster is better when informed. Early education, therefore, appears sensible.

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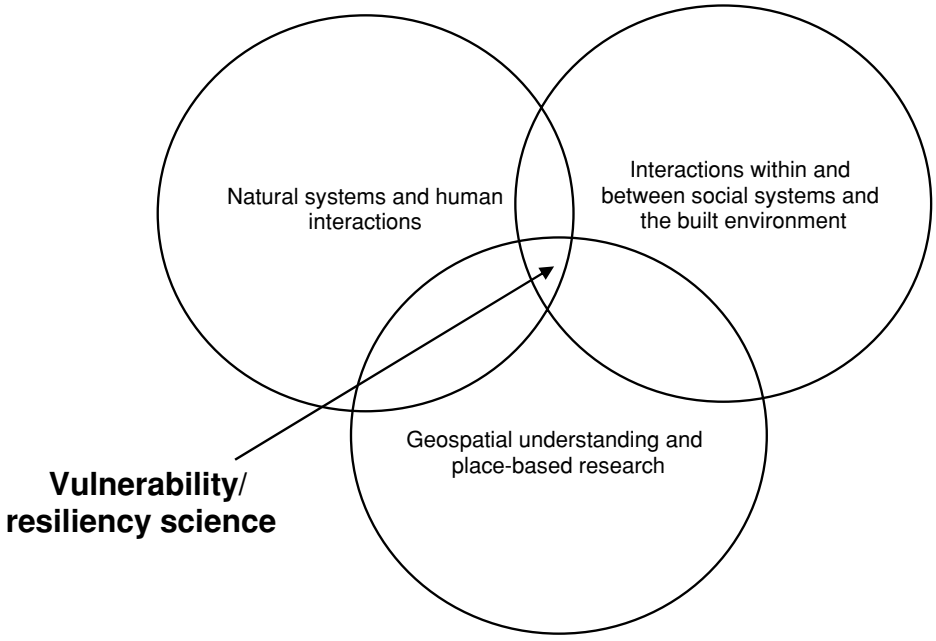

Figure 2. Intersection of hazards, humans, and place (Source: Mitchell & Cutter, 2006).

Geography education

Geography is the natural academic "home" for teaching about hazards with its dual concern for both the Earth's physical and social domains (Figure 2).

However, a number of disciplinary conventions and time constraints hinder comprehensive hazards education within geography education. Geography as a subject is typically allied with the social studies, as are history, economics, and civics. But geography is also a physical science, as Marran (1994) notes about the National Geography Standards (NCGE, 1994):

> Most social studies programs have presented geography exclusively as a cultural study. The Standards recognize that it is both a physical and human science and place considerable emphasis on physical geography so that students will have a better understanding of such phenomena as climate and weather, landforms, the processes responsible for the formation of Earth as well as *the natural hazards that so often disrupt human activity* [author emphasis].

Care must be taken here. As Lidstone (1996) observes, hazards are primarily taught from a physical perspective. What is missing is the integration of the human component with the physical science as called for in the national standards. State standards tend to separate the two, leading to a diminished geography, and by extension, hazards education. When geography is considered solely within the domain of social studies, hazard event's physical properties are likely absent. The reverse is true for human systems when hazards are taught within the realm of science. Teachers are also unprepared to handle the synthesis required. Most social studies and science teachers are not trained in geography, but rather in history and the natural sciences, respectively. Proper hazards education – arguably best done from a geographical perspective – demands that teachers must be prepared in both content areas and willing to work across disciplinary boundaries. A final concern is the

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place of geography within the curriculum. When geography is taught – a seemingly near constant battle in a time-precious school day[1] – it remains marginalized among the many disciplinary areas competing for attention.

Ideally, hazards education would include an analysis of the potentially threatening physical event and the community social structure. A number of factors other than the aforementioned place of geography in the curriculum also complicate this end goal. These include the time available, the teacher's own educational background, the age group of the students, and importantly, whether hazards instruction fits within a larger curriculum and testing environment.

This paper focuses on this final factor. As is now frequently stated within the larger education community regarding high-stakes and end-of-course testing, "what gets tested is what gets taught". The material to be tested is that which is articulated in state academic standards. If hazards are not explicitly detailed within the standards they will not be taught. A review of 10 Southeast state academics standards follows to explore what students are expected to learn about hazards.

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Methods

This assessment utilized a content analysis of the science and social studies academic standards for the 10 Southeastern states. All standards' documents can be found online with the respective state boards of education. The adoption of standards was for the purpose of developing curricula and also for consistent statewide assessment. For example, the South Carolina social studies standards "describe for each grade or high school core area the specific focus of student learning that are considered the most important for proficiency in the discipline at the particular level" (South Carolina SDE, 2005). The 10 states reviewed have standards as current as 2008 and as old as 1996 (see Table 1).

A typical standards document is comprised of a statement about its enabling legislation, its purpose, and a list of any documents (such as the National Geography Standards) that guided its development. A conceptual framework and position statements follow. In the case of the *Alabama Course of Study – Social Studies* (ADE, 2004), for example, a description of the disciplines of economics, geography, history, and political science precedes short discussions on instructional strategies, cultural awareness, and technology, among others. The remainder of the document focuses on the standards for each specific grade level.

Within content analysis one commonly used method to process content is to search for frequency of terms or recurring themes within the text (Baker, 1999). In this case

Table 1. Year of standards and number of hazard terms by state.

State	Science year	Science terms (#)	Social studies year	Social studies terms (#)
Alabama	2005	32	2004	44
Florida	1996	23	1996	2
Georgia	2004	17	2006	7
Kentucky	2006	71	2006	6
Mississippi	2001	22	2004	22
North Carolina	2004	15	2002	5
South Carolina	2005	30	2005	8
Tennessee	2003	14	2002	9
Virginia	2003	13	2001	0
West Virginia	2008	28	2008	10

Table 2. Key hazard terms.

Term	Term
Accident	Hurricane
Agricultural disasters	Landslide
Catastrophe	Natural disaster
Drought	Natural hazard
Earthquake	Nuclear disaster
Emergency	Police
Environmental disaster	Safety
Environmental hazard	Storm
Evacuation	Thunderstorm
Fire	Tornado
Firefighter	Tsunami
Flood	Typhoon
Forest fire	Volcano
Hazard	

common hazard terminology was identified. These terms largely consisted of events' names or phrases; general environmental information such as pollution (although this could be broadly interpreted as a chronic hazard) was excluded. Plurals or variants of terms were treated as the same thing (i.e., volcano, volcanoes, volcanic). These terms are shown in Table 2. Also important, as noted later, is the context in which the term is utilized. This could mean using hazards terminology to describe processes other than disaster, a frequent occurrence uncovered here. Hazard terms are also used to enliven language (e.g., drought = lack of; storm = strong disturbance) and must be considered accordingly.

Results

Presence of hazards topics and context

The science standards encompass a wide variety of higher-level courses such as biology, chemistry, and earth science. Lower-level science standards are identified by grade only. Two sample standards are given below:

> Alabama, Grade 3, 12: Identify conditions that result in specific weather phenomena, including *thunderstorms*, *tornadoes*, and *hurricanes*. (ADE, 2005)

> South Carolina, Grade 5, 3.1: Explain how natural processes (including weathering, erosion, deposition, *landslides*, *volcanic eruptions*, *earthquakes*, and *floods*) affect Earth's oceans and land in constructive and destructive ways. (SCSDE, 2005)

Note first that neither of these standards includes people. The instructional goal is to understand how these processes work, not what their impacts on human systems might be. Similarly, as demonstrated later in this paper, the social studies standards treat the disaster event as an entity whose physical properties are assumed as known.

A review of hazards-related terms in the science standards for the 10 Southeast states shows that the terms are overwhelmingly geophysical. Earthquake and volcano alone account for nearly 40% of the mentioned terms (see Table 3). Meteorological (hurricane, flood, tornado, and thunderstorm) and other threats, such as *wildfire*, were also noted. More general terms, such as *hazard*, *natural disaster*, *safety*, and *emergency*, appeared in smaller numbers. In total, there were 265 mentions of hazards-related terms within the science

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Table 3. Sample of hazard terms in science and social studies standards.

Science	Frequency (#)	Social studies	Frequency (#)
Earthquake	54	Earthquake	17
Volcano	49	Natural disaster	14
Fire	20	Hurricane	12
Tornado	18	Flood	11
Safety	17	Police, volcano, tornado	7

standards. These terms have been grouped into the general categories, i.e., geophysical threat, meteorological threat, other threat, and general terms (see Figure 3).

Hazards terms in the social studies standards are much less frequent with only 113 references. Lower-level standards are likewise grade specific and culminate in higher-level coursework in World Geography and Economics, among others. Sample standards include the following:

> Georgia, Grade 6, G3d: Explain the impact of natural disasters (i.e., hurricanes, earthquakes, floods) on Latin American and Caribbean countries. (GDE, 2006)

> Mississippi, High School World History 1750 – Present, 5b: Discuss the response of the American people to various world crises (e.g., apartheid, natural disasters, fall of communism, economic problems, human rights issues, etc.). (MDE, 2004)

Earthquake is again the most frequent hazard, but with only 17 total mentions. Overall, general terms, such as natural disaster, and meteorological terms comprise 74% of the total identified (Figure 4).

Geographic variation

A review of the standards individually by state reveals some unexpected results. Geophysical threats dominate science instruction in the Southeast overall (Figure 5). Leading the way in this regard is West Virginia, Tennessee, Alabama, and, surprisingly, Florida. While Florida does have geophysical issues of concern – think sinkholes – only volcanoes and earthquakes are identified. This topical coverage is reasonable for California or Wyoming, but perhaps excessive for the most southern portions of the Southeast region. There are two possible educational goals to note here: one is to broadly teach students about earth processes, the other is to inform students about the threats they are most likely to face. In the first instance,

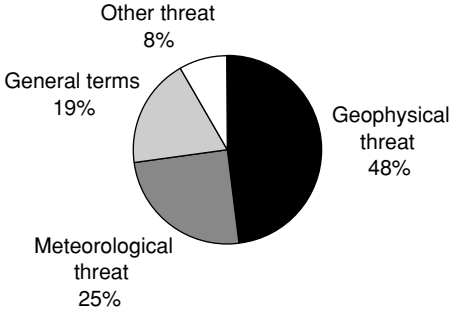

Figure 3. Hazard-related terms in Southeast science standards.

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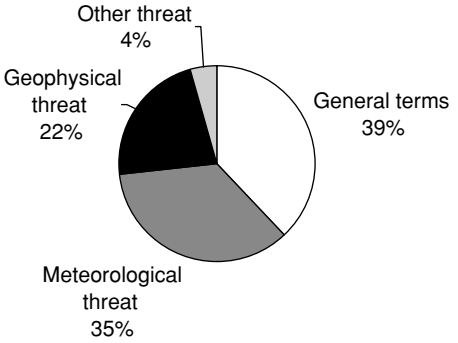

Figure 4. Hazard-related terms in Southeast social studies standards.

events like earthquakes and volcanoes are often utilized as part of a larger unifying theory, plate tectonics, to explain how the world "works." In this regard the standards succeed. Arguably the latter goal – to arm students with the knowledge of how to be prepared in their local environment – is less likely to be achieved under the current standards in use.

Geophysical threats largely disappear from the social studies standards, save for North Carolina and, again, Florida (Figure 6). Hazards are treated as generic events to discuss,

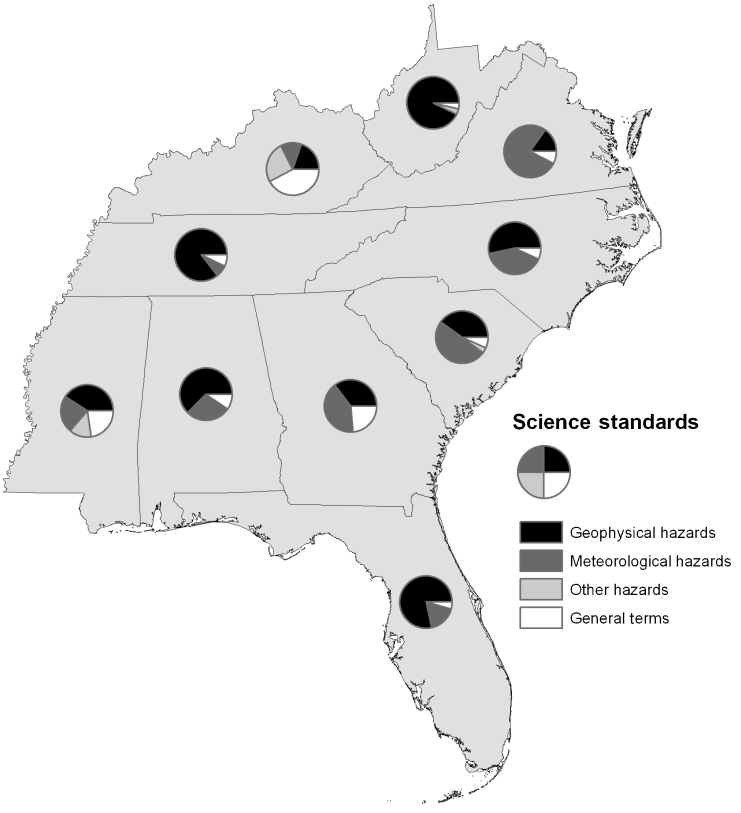

Figure 5. Southeast science standards hazard topic distribution.

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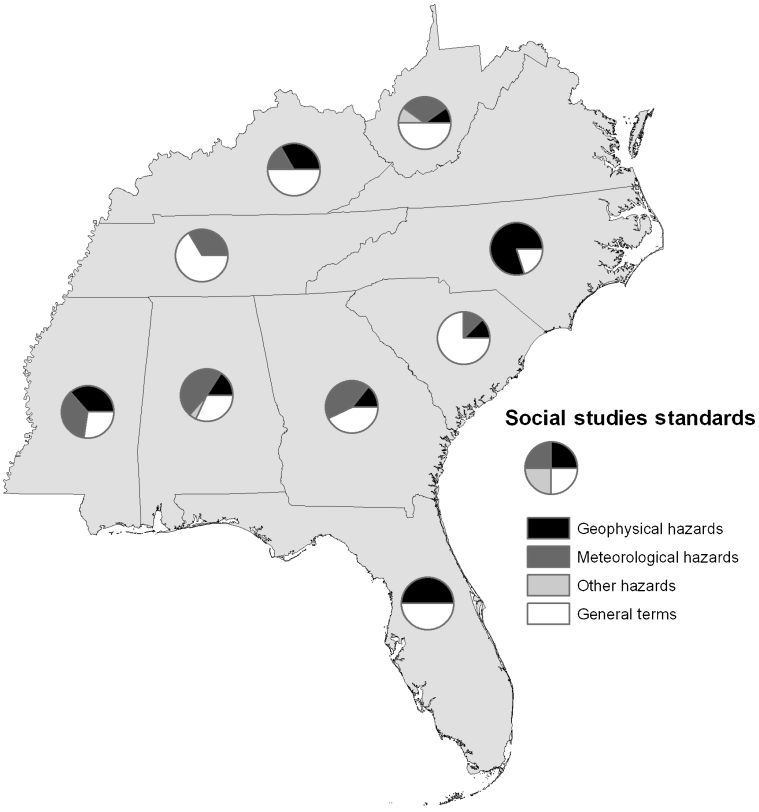

Figure 6. Southeast social studies standards hazard topic distribution.

mere natural disasters (see Mississippi standard above). It is left to the instructor to decide how to approach the threat, whatever that might be. Virginia perhaps best exemplifies this extreme. Not a single hazard term is found within the social studies standards. Their standards indicate generally that students shall understand how the environment affects humans and vice-versa, but it is up to the instructor to make the leap that teaching about hazards is appropriate in that instance. Surprisingly – given how they figure so prominently in the disaster history of the region – there is no mention of Hurricanes Camille, Hugo, or Andrew in any of the science or social studies standards.

Curricular integration

There is little to suggest in a reading of these academic standards that curricular integration exists between science and social studies. Therefore, the physical and social aspects of hazards, if discussed, are apt to be treated separately. An example from outside the region illustrates how links can be made with simple suggestions for the instructor. The Arizona state science standards dictate in Grade 6 (Concept 1, PO 2) that students should "describe how people plan for, and respond to, the following natural disasters: drought, flooding, tornadoes" (ASBE, 2005a). This same standard is re-referenced in the social studies standards, Grade 6, Strand 4, instructing the teacher to connect "hazards as science" and "hazards as social studies" through geography (ASBE, 2005b). If this overview of 20 sets of standards

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has made anything clear, it is that if we want hazards to be well taught then the standards must include a stronger emphasis on geography.

Discussion

Most previous research on hazards education has focused on the use of teaching materials and instructional strategies. Mitchell et al. (in press) conclude that increasing disaster losses suggest there is still much to teach and learn about hazards. Why we should teach about them is, therefore, fairly straightforward. How we should teach about hazards is an altogether different question those authors also attempt to answer. It should be clear, however, that questions other than "why" and "how" require answers too. This investigation demonstrated the need to question the current academic standards structure and how that influences the teaching of hazards in the first place.

Three questions were posed at the outset of this piece. Hazard topics are present within the science and social studies standards, but they tend to focus on geophysical events in the former and are much more general in the latter. Hazards instruction in the sciences that is excessively oriented toward geophysical events often stands in direct contrast to likely events on the ground for states such as Florida. Context here matters as the intent behind many of the standards is not to teach about hazards per se, but rather about these physical earth events as components of larger earth systems and happenings. Hazards instruction in the social studies tends to be vague – emphasizing the role of natural disasters and *catastrophic phenomena* on the formation of contemporary cultures (Mississippi) – or nonexistent (Virginia). This lack of specificity is not unique to the Southeast region. Vermont, for example, requires students (Standard 6.4 Historical connections, Grades 9–12) to "discover the challenges that continue to face Vermonters (e.g., rural to urban, natural disasters, local vs. state control, cultural diversity, and the Great Depression, World War I, and World War II)" (VDE, 2000). Plainly, there is little to connect natural disasters with these disparate topics. In any case, neither the science or social studies standards require a recognition of both the physical and social aspects of hazards.

Hazards education does exist, but it is scattershot, lacks integration, and varies considerably by grade level (Table 4) and location. Rarely are students asked to think specifically about threats within their own personal geographies. When places or specific events are mentioned, students are left with the impression that these are events that happen *there* and not *here*. Curiously, the Georgia standards (grade 6) only mention disaster in Latin America and the Chernobyl nuclear meltdown in the Ukraine. The only US disaster named is the Dust Bowl, further reinforcing a notion of events that happen far away or a long time ago.

These observations are based upon what is written in the standards; this does not mean that hazards instruction does not occur. Undoubtedly hazards instruction is happening and in some cases it is probably quite good. This review simply demonstrates that teachers are rarely asked explicitly to teach about hazards. Many teachers doing so may be driven by simple personal interest or a desire to use a current event, taking advantage of the "teachable moment" (Virtue, 2007). Unfortunately there is little congruity between the social studies and science standards to suggest an integrative approach. The Arizona example cited earlier is outside the norm.

The next step in this investigation would be to sample classrooms across the region to see what is actually being taught in the classroom with respect to hazards. This would provide the baseline for subsequent intercession. Given that academic standards are updated infrequently, a useful approach would be in-service teaching training. The purpose of the

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Table 4. Number of states with hazards content by grade.

Grade	Science standards number of states	Social studies standards number of states
K	2	5
1	2	3
2	3	5
3	6	3
4	4	1
5	7	1
6	7	4
7	5	3
8	4	1
9*	10	6
10*	10	6
11*	10	7
12*	10	7

*High school courses are often electives and not specific to a given grade level. A course with hazards content was counted for each possible grade level. This likely overestimates hazards education exposure at the high-school level.

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training would be twofold: (1) to identify knowledge gaps in this seasoned teacher corps and (2) demonstrate opportunities within the standards to use hazards as the instructional base. For example, Virginia is not explicit about hazards within the social studies standards. An instructor could however use hazards to teach World Geography Standard WG.2b, describing how humans influence the environment and vice versa. Cross-curricular instruction or team-teaching subjects could be similarly encouraged.

Unfortunately, if we expect hazards education to occur in the social studies, the current academic standards make it unlikely that geography will be the base discipline. Conversely, if hazards are taught in the sciences, the teacher's probable background will be in the natural and physical sciences, if they even have a science degree (BHEF, 2007). Given this unevenness of instruction, it is doubtful that Southeast students will have a comprehensive understanding of the threats they face. Their ability in the future to prepare accordingly is certainly suspect.

Hazards education is frequently distinguished as an important facet of mitigation and preparedness. Unfortunately, much of the research literature focuses on educating professionals, builders, real estate agents, and investors (Burby, 1998), not K-12 students who may actually take what they learn to correct past mistakes and avoid repeating them in the future. Our students should be versed in the physical workings of hazards and about the differing capacities people and communities have to deal with them. One can hope that as science and social studies standards undergo future revisions that efforts will be made to more effectively include hazards – and hopefully to do so through geography.

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Note

1. Yet another attempt to remedy the lack of geography instruction in the U.S. schools was the introduction of the Teaching Geography is Fundamental Act (HR 1228, S727) in the 110th Congress in 2007. The basic provisions are to improve and expand geographic literacy among K-12 students in the United States by improving professional development programs for K-12 teachers. The act provides funds for national-level projects and research and for collaborations between institutions of higher education and Geographic Alliances, nonprofit educational organizations, and state or local educational agencies.

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