

## **Preparing scientifically literate citizens: pre-service teacher candidates' use of normative and logical thinking for critically examining news-media**

Eva Erdosne Toth  
West Virginia University, USA

Meadow S. Graham  
West Virginia University, USA

### **Abstract**

Scientifically literate citizens are able to evaluate news reports on everyday problems with a critical stance to information, which means using both value and norm-based as well as evidence and logic based thinking. Developing a critical stance towards information in the news media, requires familiarity with a complex set of interdisciplinary skills, currently examined by standards in separate content domains. Therefore, our current schooling is limited in preparing future citizens for the combination of multiple skills and both value-based and logic-focused thinking processes. Using an exploratory, descriptive design, this study documented 14 pre-service elementary teacher candidates' critical examination of news media reports as they developed arguments about the use products from Science, Technology Engineering and Mathematics (STEM) discoveries in response to dire human need. The results indicated candidates' difficulties in combining logic focused thinking and the use of factual, "hard" evidence with personal perspectives based on personal values and norms. As a result their integration of evidence to develop well-supported arguments for civic action was limited. The findings suggest the need for additional studies on the evidence-interpretation processes of pre-service teacher candidates. By better understanding the argument and reasoning processes of teacher candidates, we can improve the preparation of our citizens for evidence-based civic action based on news-media reports.

**Keywords:** Scientific literacy, evidence-based arguments, media literacy, teacher preparation, socioscientific issues (SSIs), argumentation

Please direct all correspondence to: Dr. Eva Erdosne Toth, Assistant Professor of Science Education, College of Education and Human Services, West Virginia University, Morgantown, WV. 26505. Mail: [eva.toth@mail.wvu.edu](mailto:eva.toth@mail.wvu.edu) and [etoth6117@gmail.com](mailto:etoth6117@gmail.com)

### **Introduction**

Scientifically literate citizens are able to evaluate news reports and formulate evidence-based responses to everyday problems (AAAS, 2011; NRC, 2012). Competency requires interdisciplinary skills, currently taught under a variety of subjects. Relevant skills include being able to (a) examine evidence from varied sources as stated in social studies and English Language standards (CCSSO, 2010), (b) consider contrasting perspectives as stated in science

standards (NCSS, 2013) and (c) collect and evaluate data about discoveries and innovations as stated in science standards (NGSS, 2013; NRC, 2012). Our current schooling is limited in preparing citizens to construct these interdisciplinary skills for application in real-life settings (Fensham, 2002; Klosterman, Sadler & Brown, 2012; NSB 2014; Oulton, Day, Dillon, & Grace, 2004). This lack of preparation is especially critical in the context of discoveries in Science Technology Engineering and Mathematics (STEM) (Feinstein, 2011). Citizens often look at STEM innovation with suspicion and with distrust about the abilities of business and industry leaders who manage discoveries for public benefit (Cobb & Macaubrey, 2004, NSF, 2000). Therefore, preparing teachers to educate well-informed future citizens is critical. However, policies provide little support (Bybee, 2013) and current instructional practices are limited in supporting the development of interdisciplinary competencies that teachers require (Hobbs, 2004, 2010).

Recognizing the need for improved teacher preparation, three university professors with expertise in science, literacy / reading and social studies, contributed to the development to the instructional approach for pre-service teacher candidates. To evaluate the effectiveness of this approach the study focused on teacher candidates' examination of evidence from multiple sources in the context of a natural disaster. The study documented teacher candidates' (a) ways of recognizing and interpreting varied perspectives on responding to dire human need, and (b) their approaches to examining evidence from multiple sources of information by developing a logical argument for civic action. The study was grounded in the prior literature on using everyday media for evidence-based decisions and on developing skills of argumentation about socio-scientific issues (SSIs).

### **Review of Literature**

#### **Key ideas of prior research on learning from everyday media**

The analysis of everyday media requires skills that are contradictory to the way scientific investigation is represented in textbooks (Feinstein, 2011; Kolsto, 2001a). Textbooks convey knowledge in its final, commonly accepted form (Binns & Bell, 2015, Zimmerman, Bisanz, Bisanz, Klein, & Klein, 2001). However, emerging evidence in everyday news draws readers' attention to the ways commonly accepted knowledge develops, influenced by values, norms and conflicts of interest (Anmarkrud, Braten & Stromso, 2014; Kolsto, 2001b; Korpan, Bisanz, Bisanz & Henderson, 1997). Learning from everyday media requires the examination of evidence that may be value-laden (Albe, 2008; Gardner & Jones, 2011, Hammer, 2000) and subsequent civic action rests on these personal values and norms (Aikenhead, 1985, Driver, Asoko, Leach, Scott, & Mortimer, 1994). In the context of novel STEM discoveries that provide products for everyday use, such value-laden decisions are especially important since evidence is only emerging and the long-term effects are under study (Chinn, Buckland, & Samarapungavan, 2011; Kolsto, 2001a & 2001b; Sinatra, Kienhues, & Hofer, 2014; Zeidler, Walker, Ackett, & Simmons, 2002).

Examining a variety of perspectives on information from news media can assist learners in developing a critical stance for knowledge construction (Goldman, 2004; Wiley et al., 2009). The Electronic Journal of Science Education has been pioneering in conveying the results of interdisciplinary efforts that help learners develop a critical stance using multidisciplinary skills for knowledge construction (Cook & Dinkins, 2015). Similar to our approach Cook and Dinkins' team included a science educator and a literacy educator. We also added the advice of a social

studies professor. Cook and Dinkins provided a thorough review on components of disciplinary literacy to advocate for the pedagogical use of popular fiction. Complementary to their work, our approach focuses on evidence-based decisions in real-life contexts by evaluating everyday news.

### **Key ideas of research on decision-making in complex social settings**

The importance of examining social decision-making with focus on psychological processes is documented by the fact that two psychologists were awarded recent Nobel Prizes for their related work (Simon, 1959, Kahneman, 2011). In specific, Kahneman (2011) describes two complimentary systems of thinking during decision-making. One system works automatically and very fast, based on intuition, and the quick association of new information with prior experience. The other system is slow, and requires significant effort for the detailed, logical examination of complex interactions during knowledge development (Kahneman, 2011; Tversky & Kahneman, 1981). Upon closer review, prior research on decision-making in science education reflects this duality of thinking processes. One recent pedagogical approach to science education emphasises the need for logic, the other approach focuses on the importance of normative, value-laden thinking.

For example, approaching the development of informed citizenry from the perspective of conventional logic yields learning environments that target argumentation skills. Argumentation requires students to examine claims against multiple pieces of evidence, supported by backings and warrants, with limitations and qualifiers disclosed (Toulmin, 1958; Walton, Reed & Macagno 2008). The ultimate aim of this approach is to remove bias and subjectivity from decision-making (Albe, 2008; Bell, 2000; Erduran, Simon, & Osborne, 2004; Kelly & Takao, 2002; Sampson, Grooms, & Walker, 2011; Toth, Suthers & Lesgold, 2002; Walker & Sampson, 2013).

Parallel to this logic-focused perspective there is growing emphasis on a more inclusive conceptualization of critical thought about everyday events (Yore, et. al, 2004). This perspective stems from seminal studies on the historical inter-relationship between Science Technology and Society (STS) (Driver, Asoko, Leach, Scott, & Mortimer, 1994, Driver, Leach, Millar & Scott, 1996; Duschl, 2008). It draws attention to the importance of personal world-views in knowledge construction (Bybee, & NSTA, 1985; Yager, 1996). A recent extension of this perspective is the examination of morally challenging, ethical issues with social relevance or socioscientific issues (SSIs). SSIs demand that learners combine their existing knowledge with social norms, morals and personal worldviews as they form decisions for civic action (Ryder & Banner, 2011; Sadler, 2004; Zeidler, Sadler, Simmons & Howes, 2005). From this perspective, formal logic is only one component of decision-making and learners' reasoning can be emotive and intuitive in addition to rational (Sadler & Zeidler, 2005). Emotional reasoning employs empathy and concern for others and intuitive reasoning extends logical decisions with focus on gut-level feelings, values and norms (Sadler & Zeidler, 2005). This brief review of literature indicates that science educators have considered the two systems of decision-making, studied by psychologists. However, the combination of the two processes of thinking towards one multi-faceted, instructional approach requires further research.

The instructional method in this study combined both the logic-focused and norm-focused perspectives to develop a multi-faced approach to help teacher candidates formulate a

critical stance about news-media reports. It used an SSI to provide the context of immediate and dire human need that elicits thinking about the ethical, moral and personal aspects of knowing. Combined with this norm-focused approach the study also used the logical conventions of argumentation to support students' examination of available evidence. Therefore, the instructional approach provided an opportunity for students to both (a) interpret conflicting, often value and norm-based perspectives and (b) integrate a variety of emerging evidence from news media for a logic-based argument for a decision. In this context, the following questions guided the study:

- (1) *In what ways do teacher candidates interpret conflicting perspectives from news media?*
- (2) *In what ways do teacher candidates integrate information from news media to formulate their own position?*

## Methods

### Research Design

The study used an exploratory design (Creswell, 2013) to describe candidates' interaction with news media in a natural setting, in teacher candidates' regular university classroom. The design and data interpretation processes were exploratory as they aimed to unearth some of the complexities inherent in using both fast and associative (experienced based) and slow, effortful (logic-based) thinking processes in interpreting news media reports about an emotionally-charged, current event.

### Context and Participants.

The research took place at a land-grant research university in the United States. The study lasted two weeks with one, three-hour-long, face-to-face session each week. The participants were 14 female, pre-service, elementary teacher candidates. They were 20-23 years old and were residents of states around the Appalachian Mountains. Therefore, the prior educational experiences of these students exposed them to issues of geographical isolation, lack of resources and rural poverty. The participants took this required course on reading, with focus on media literacy as their third required literacy course. Candidates were assigned to the class based on university requirements, therefore, a random assignment was not possible, and the study design used a convenience sample of participants. Before this course, all candidates completed a course on instructional design and had an introduction to the theories of learning with attention to evidence-based teaching strategies. Candidates with science interest enrolled in their science-methods course concurrent to the study but the science content preparation of the participants was limited. With minor variation depending on individual schedules, candidates already had over 100 hours of field experience in various capacities: as classroom observer, tutor or teacher. All students in the class participated in the same activities.

### Activities by Participants.

With an aim to help candidates' develop competencies in critically examining news about the applications of STEM discoveries, the instruction used the Toulminian model of argumentation for the logical examination of information. In addition, the instruction also elicited feelings, morals and attitudes to develop arguments for a decision by using a socially complex issue: the application of novel technology products for recovery after a natural disaster.

The activities took place in four phases: introduction to the guiding question regarding the SSI, examination of background information, collaborative work-group session one and jigsaw followed by collaborative session two.

**Phase one.** Candidates viewed a video footage of the moments immediately after a natural disaster (an earthquake) affecting a developing nation. They examined photographs taken by a medical response team on the scene. Participants received a guiding question to focus their thinking about the recovery efforts and the use of novel technologies (Krajcik et al., 1998). It asked, “In what ways can we use products of scientific and technological innovation for recovery efforts after a natural disaster?”

**Phase two.** Candidates examined recent consumer products from discoveries by nanotechnology such as those used for water purification, health monitoring, laundering and cleaning. For example, they read articles on nano-scale materials and potential toxicity (Berger, 2007, Health Risks 2008; Hillie & Hlophe, 2007; Lehman 2009; Water pollution 2007) and examined a statement on the risks and benefits (PHRA, 2008). They also read information about the use of new products of information technology. In this context, it was likely that participants will not have significant prior knowledge about novel technologies such as nanotechnology. Therefore, the method provided an opportunity for candidates to move away from examining innovation in familiar contexts and allowed them to develop perspectives for civic action under at least some amount of uncertainty and emotional stress to respond to human suffering.

**Phase three.** Students worked in four small groups of three to four and read a series of news articles that were not the same across the groups. The articles included voices from the scientists / innovators, local and world government, and the people afflicted by the disaster (Table 1). Groups used a worksheet (the stakeholder-worksheet) to record their interpretations of conflicting interests for recovery.

Table 1. Publication sources, issues of concern and perspectives candidates examined to develop their views on conflicting interests for recovery. Candidates used information from these sources to complete their Stakeholder Worksheets, that provided data to answer the first research question on students’ interpretation of conflicting perspectives.

Source	Issue of Concern	Perspective(s)
Davidson 2010	Post-earthquake development	Haitian entrepreneurs, consumers, aid workers
CBS News 2010	Intimate earthquake experiences	Personal footage by Haitians
Berger, 2007	Technology, ethics, economics	Scientific perspective
Maynard, 2006	Nanotechnology products	Scientific perspective
Hillie 2007	Technology, environment, ethics	Scientific perspective
Lehman 2009	Technology, construction, ethics	Scientific perspective

Romero 2010	social, environmental impacts, politics, economy, aid	Haitian people, Haitian government
Lacey 2010a	Medical response, social, environmental impacts, politics	World & Haitian government Haitian people, aid workers
Thompson 2010a	politics, social impacts	Haitian people, government
Lacey 2010b	politics, social impacts, economy	World & Haitian government Haitian people, aid workers
Thompson 2010b	Social impacts, politics, economy	World & Haitian government Haitian people, aid workers

---

**Phase four.** Using the jigsaw method (Aronson & Patnoe, 1997), we assigned students to new groups so that the results of the previous discussions were distributed among the new groups. As before, three to four students worked in four small groups. The instructor introduced the Toulminian model (1958) and the logical convention for argumentation: claim, evidence, backing, and warrant as used by prior studies (Bell, 2000; Erduran et al., 2004; Osborne, Erduran, & Simon, 2004; Sampson et al., 2011). However, in addition to simply providing definitions, the instructor required students to develop a visual representation of their arguments (Toth et. al, 2002). Using a new worksheet (the argument-worksheet), participants recorded each argument element into unique shapes. For example, they recorded claims in a rectangle shape and evidence into a circle shape. Triangle shapes contained backings, rhombuses recorded warrants, pentagons referred to limitations and qualifiers took the form of a star shape. Students learned to indicate logical connections among these boxes with lines to create an argument map. Groups presented their argument maps for whole-class discussion.

### **Data Sources, Coding and Analysis**

Since qualitative data coding has an element of analysis (Denzin & Lincoln, 2005), this manuscript presents data sources, coding methods and analyses of coded data together, organized by the research questions. The study used two instruments: the stakeholder worksheet and the argument worksheet.

**The stakeholder worksheet.** This instrument was completed based on discussion by groups of students when they encountered the news about recovery after a natural disaster that was current in the media at the time of instruction. The video cases and readings related to this worksheet are listed in Table 1 with full citation in the references section. This worksheet included short, open-ended text statements on the motivations and interests of various stakeholders in recovery efforts. The coding and analysis of data from this instrument included the examination of students' ability to recognize different perspectives for recovery. The analysis used the following steps.

First, in order to respond to the first research question, the coding focused on the types of stakeholders students recognized (businesses, governments, reporters etc.). Next, the coding examined students' statements on the motivations and interests of these stakeholders. A research

assistant completed the preliminary coding of these short statements by assigning them to meaning-based themes. These themes associated different stakeholders with patterns of reasoning, as these emerged from students' statements on the worksheet. Subsequently the first author and the student-coder jointly negotiated the theme categories. This coding discussion lasted until the coders reached 100 % inter-rater agreement on the theme categories and the meaning of student statements in each theme category. The second author, a literacy professor who taught the class, reviewed the coding choices and themes, and established the validity of these in relation to the classroom instruction. Finally, each reasoning statement was re-examined by the first and second authors as they tabulated these into rational, emotional and intuitive rationales using prior work by Sadler and Zeidler (2005). *Rational* statements were those that used logic to explain processes and conclusions. Responses that were coded as *intuitive* focused on gut-level reactions and world-views. Responses that projected a care-based perspective and a focus on justice and morality were coded as *emotional*. Again, the two coders reached 100% agreement on this categorization of reasoning statements. The analysis of these coded data from the stakeholder-worksheets allowed us on students' interpretation of multiple perspectives and conflicting stakeholder intentions and helped us answer the first research question.

**The argument worksheet.** The argument worksheet allowed students to combine their learning in the previous groups to develop their own argument about the use of novel technologies to aid recovery. Candidates recorded the information from news articles and videos into the categories of claim, evidence, and warrants for evidence, with limitations and qualifiers. They used unique shapes to illustrate each category of argument development. The coding of these records took the following steps. The coding and analysis established candidates' successes of using argument conventions in the functional sense (to correctly use the Toulminian argument elements much like element of a specific language) and in the derived sense (to develop a well-supported position, the meaning of combined elements) (Norris & Phillips, 2003).

To examine these data, first, the two coders (the first and second authors) coded the use of argument maps in the functional sense by examining the argument elements students recorded (claims, evidence, backing etc...) as well as the logical connections between these elements (Toth et. al, 2002; Kelly & Takao, 2002). The next assessment of the arguments from the derived sense considered the meaning of the information students recorded (Sandoval, & Millwood, 2005). This coding established whether statements indicated as claims were indeed claims and evidence was indeed evidence (and so on). During this time, researchers also assessed the overall meaning of each argument by "reading" the map from claim to backing and qualifiers. As before, two coders negotiated structural and meaning-based analysis of argument maps until they reached 100% agreement. The analysis of the coded data from the argument worksheet allowed us to respond to the second research question on students' ability to combine evidence from multiple sources to develop a position for action.

## Results

The results of the two analyses are presented separately, organized by the guiding research questions on candidates' (a) interpretation of varied perspectives and on their (b) integration of evidence from multiple sources.

### Results on candidates' interpretation of conflicting perspectives

The analysis of teacher candidates' records on the stakeholders and their varied interests indicated that candidates examined information with a critical stance by identifying several stakeholders and indicating their various, often conflicting, interests in the processes of recovery. These included the people suffering after the disaster, the perspectives of businesses opened to meet needs, governments (both US and local), and those directly involved in recovery assistance and reporting (medical staff and journalists). Teacher candidates also considered themselves as one of the stakeholders. That is, candidates were able to consider a variety of stakeholders and their perspectives on recovery efforts.

The analysis found an equal distribution of the 73 statements made by candidates, indicating rational (logic focused), intuitive (gut reaction focused) and emotional (feeling and morality focused) interpretation of stakeholder motivations and interests. Rational statements included observations for the immediate need of suffering humans such as [survivors] "need housing... need to fix the buildings"; "water purification", "medicines, medical devices, mobile phones, batteries", "[they need] technology to build business". These rational statements also cited evidence from readings referring to issues of financial assistance for recovery saying that "[other countries] not wanting to give money directly to the government", "UN/US thinks their rules of donating are useful and necessary".

Intuitive statements indicated candidates' gut-level reaction to human condition "People live without electricity... living in tents for years", "[people appear] optimistic, treat events as opportunity", "[appear] amazed at recovery efforts [of some residents]", "won't let [disaster] defeat them". Other gut-level reactions focused on "Americans want to take control" but also voiced concern "How can we help everybody?" Emotive statements used voices of empathy and sympathy. Example statements in this category were [This] "makes my stomach hurt", "I wish there was something I could do". Teacher candidates also reflected on social well-being in economically advanced countries with statements such as "we take so much for granted", "[we should be] grateful for what we have [in the US]" and also noted pride in the ability to help "Americans are being helpful". Some emotional statements focused on the morality of using new technologies not fully tested "could there be any negative effects?"

Surprisingly, the distribution of rational, emotional and intuitive interpretations of motivations was not equal among stakeholders. For example, candidates described the motivations of the affected residents with a combination of emotional, rational and intuitive statements but when they described the motivations of governments (local and US combined), they rarely focused on emotion (Figure 1). In addition, candidates described the interests of scientists, medics and journalists with primarily rational statements, whereas emotional and intuitive statements were frequent in the description of candidates' own perspectives on recovery (Figure 1). A peculiar finding was that teacher candidates used rational statements frequently when they described the motivations of local governments in the affected country. However, they described the motivation of the US government with mainly intuitive statements that indicated an overall worldview rather than evidence collected from news reports. Next, the analysis examined how candidates used their experience in interpreting varied interests to formulate their own argument for using novel technology tools for recovery efforts.



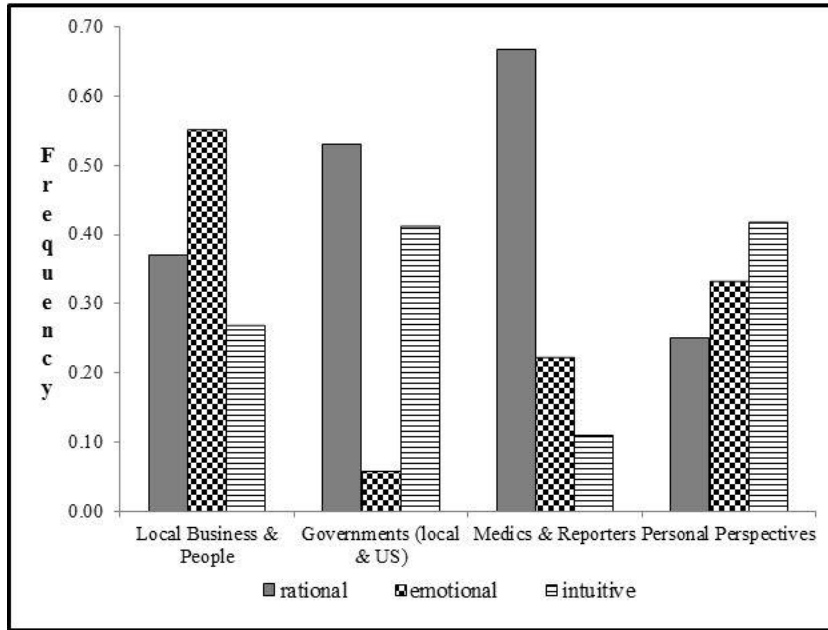


Figure 1. The frequency of teacher candidates' rational, emotional and intuitive reasoning about the motivations of different stakeholders.

**Results on candidates' integration of information from news media**

The analysis of candidates' argument maps in the functional sense considered the use of Toulminian argument elements as a convention of a language. The results indicated that candidates used all argument elements (claim, evidence, backing, etc.) but their attempt to form connections between the elements had limited success. Instead of using several pieces of evidence connected to a claim, candidates tended focus on one claim, connected to one piece of evidence, one backing, and so on. Furthermore, this one-to-one connection of argument elements was either top down or circular in structure (Figure 2). One group did not mark the connections between these argument elements at all. Only one of the four maps illustrated a deep examination of claims with multiple evidence and multiple backings (Figure 2).

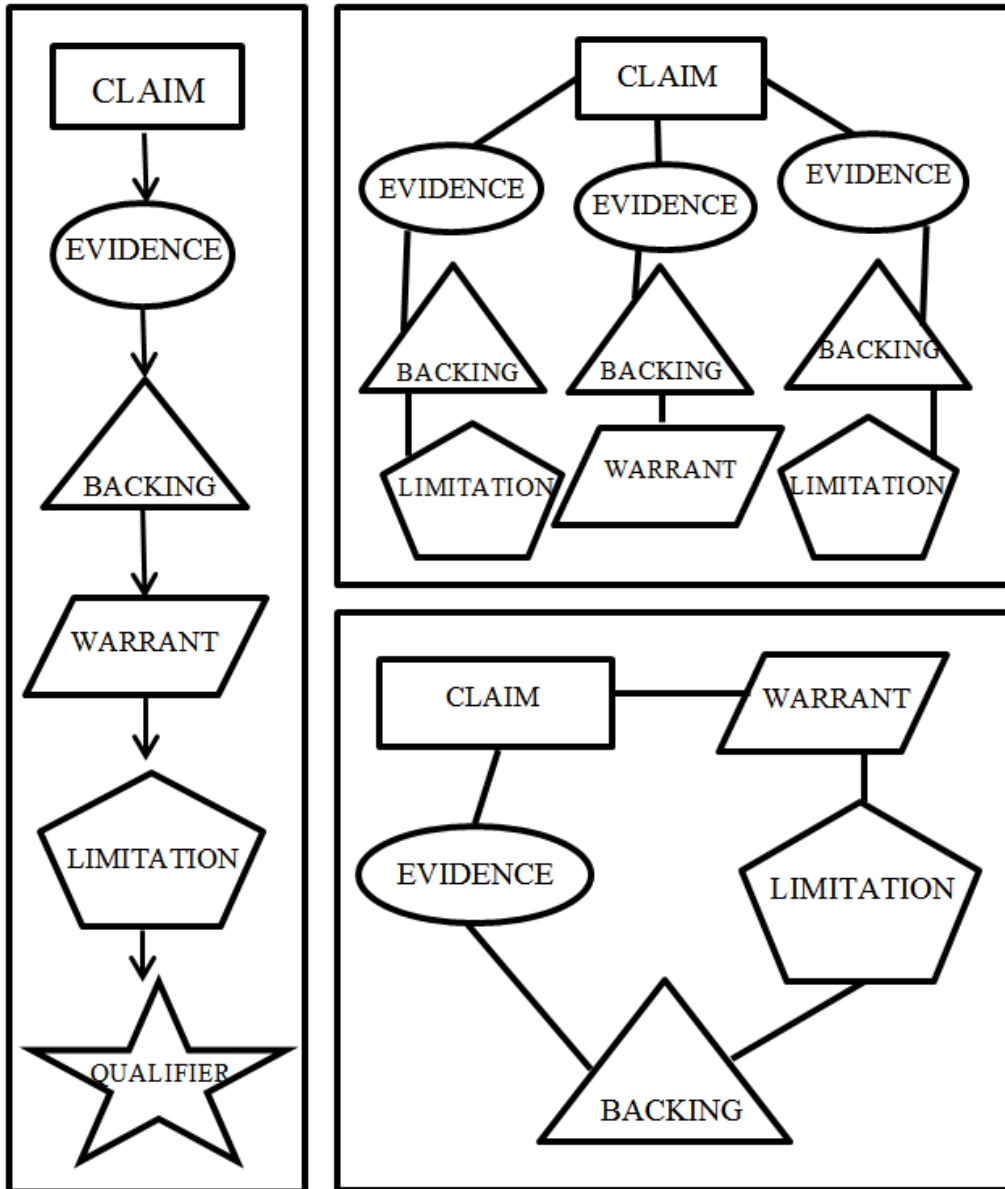


Figure 2. Three example argument maps developed by teacher candidates.

The derived, meaning-based analysis of candidates' argument maps found that two argument maps reflected a utilitarian / practical perspective using claims such as “technology can be used to construct buildings and keep documentation” and “technology will help jumpstart the economy”. The third argument focused on solving problems with the efficient distribution of financial aid and suggested “[It will work to] give certain amount of money [with spending monitored] over a certain period of time”. Yet another group focused their argument on the risks of using novel technologies for recovery with the claim “Nanotechnology [use for recovery is] worth the risk”. The next, meaning-based analysis of argument maps considered candidates' use of evidence to evaluate these claims.

The results indicated that candidates correctly used factual evidence such as research data on nanotechnology products being “cheaper, lighter, greener” than conventional technologies, and that “technology is already part of life” during recovery and “groups are getting together to plan with technology tools”. Candidates also correctly used historical evidence from their readings and mentioned prior issues with the distribution of humanitarian aid in the affected region. However, in a few instances, candidates did not detail any factual or historical evidence but simply referred to the source of information. They recorded “videos”, “pictures” or “readings” in evidence shapes and did not elaborate on the specific meaning of evidence in these sources. The analysis of the “backings” category showed similar patterns of evidence use. Teacher candidates often defrayed from stating specific evidence and referred to the source of the evidence instead by recording “New York Times”, “Stanford University Press”. Candidates’ warrant statements also indicated a mix of factual explanations and simple references to the source of information. Similarly, qualifiers stated, “We are fairly sure” rather than providing an account of facts, evidence or prior knowledge and norms as grounding for developing certainty.

## **Discussion**

A persistent challenge of teacher education is to assist learners in formulating evidence-based responses with a critical sense towards information (AAAS, 2011; Goldman, 2004; Wiley et al., 2009). In this study, we used an instructional method that allowed pre-service teacher education candidates to understand and use different ways of knowing the world – by using both fast, associative, norm-based and slow, effortful logic based thinking (Kahneman, 2011, Tversky & Kahneman, 1981). The study documents the successes and tribulations of developing this integrated approach. It examined two components of developing a critical stance towards information: candidates’ interpretation of varied perspectives in news media report about an SSI and their use of evidence to develop a position for action.

### **Discussion of candidates’ interpretation of varied perspectives from news media**

Teacher candidates recognized that different stakeholders in the recovery had multiple, often conflicting, interests. The use of fast, associative, norm-based thinking was evident when candidates did not separate themselves from the events as “objective observers” but considered themselves as stakeholders. Furthermore, when describing the motivations of stakeholders, candidates combined logical, intuitive and rational statements. In addition to the evidence they read in news reports, candidates had a strong, personal stance for providing immediate assistance in response to dire human need. This personal moral perspective may have elicited a critical view of other stakeholders, particularly those who may obstruct the opportunity for immediate assistance for recovery (Figure 1). Associative, norm-based thinking was also apparent in the way candidates’ integrated evidence from news media to develop their argument for a particular civic action.

### **Discussion of candidates’ integration of evidence from news media**

Two analyses indicated candidates’ ways of integrating evidence to their arguments: the function-focused analysis that examined whether the different argument elements (claim, evidence, backing etc.) were correctly used, and the meaning-based analysis that focused on the network of logical connections between elements. In the functional sense, the result that candidates used all argument elements shows that candidates made an effort to consider all

elements of logical argumentation. However, the depth of this examination was insufficient. Figure 2 indicates the presence of the limited examination of evidence and even circular argumentation practices. These results indicate that teacher candidates require additional experiences during their education to more effectively use the effortful process of logical argumentation towards the critical examination of news media in everyday settings.

The meaning-based analysis of argument maps also indicated candidates' difficulties with the logical examination of complex information from news media. In particular, the lack of well-expressed evidence was persistent. Candidates' continued reference to the source of information instead of personally interpreting the meaning of information indicates that they aimed to gain credibility for their thinking based on the perceived expertise of media sources. Similarly, their argument vouched that despite its potential risks the use of novel technology, such as nanotechnology, would be "worth it" in the setting of dire human need, but there was no elaboration with specific evidence to provide backing and warrants to this position. It appears from these results that candidates remained insecure in their abilities to form a decision by examining and interpreting evidence and referred to the credibility of the source instead. In essence, their integration of norm-based associative thinking and evidence-based, logical thinking was incomplete.

However, the brief, classroom learning did provide an experience for candidates that different from their prior learning from textbooks. In contrast to textbooks that rarely require the investigation of knowledge development processes and tend to communicate crystallized, final form information (Feinstein, 2011; Zimmerman et al., 2001) this combined instructional method did support the use of a variety of thinking processes, as evidenced by the results. Nevertheless, the results also suggest the need for the continued refinement of pedagogies to support teacher candidates in formulating scientifically literate, critical perspectives for civic action.

### **Limitations**

This study has considerable limitations that are partly due to the exploratory, descriptive nature of the research-design (Creswell, 2013). The classroom context required the use of a quasi-experimental design. The random selection of participants into different treatments was not possible. The small participant number also limited the opportunity to use controlled designs. However, the description of the nascent thinking processes of pre-service teacher candidates as they faced complex decisions to resolve human suffering is valuable for the development of continued interdisciplinary instructional approaches. Another limitation of the work is that student worksheets were completed by individual students based on group discussion. In this pilot study, these groups changed over time in a jigsaw-style that made it difficult to ascertain individual students' value and reasoning trajectories over time. Therefore, the data reflect thinking processes by a group recorded by individual students.

### **Conclusion and Future Research**

Despite its limitations, this study provides evidence for the development of pedagogies that address the persistent need for scientifically literate citizens who are able to make decisions based on evidence in news media (Hobbs, 2004, 2005). Amounting research indicate that the

final-form knowledge communicated in textbooks is not effective for this purpose (Feinstein, 2011, Zimmerman et al, 2001). Given the success of the argument-development instructional approach (Erduran et al. 2004; Sampson et al., 2011), and the benefit of using value-based perspectives for SSIs (Driver et al., 1994, 1996, Duschl, 2008, Sadler & Zeidler, 2005), the development of a combined, approach seems warranted. With the use of an interdisciplinary approach in this study, we were able to uncover specific difficulties teacher candidates' interpretation and application of news media reports. Continued studies could support the refinement of this combined approach by examining additional obstacles for the use of functional language elements, including the categories of argumentation as well as students' difficulties in formulating meaning by considering both, normative and logic focused thinking processes. The future refinement of this approach may have the added benefit of contributing to the existing tensions between the communities of science, social studies and literacy education (Yore & Treagust, 2006). Continued research, in experimentally controlled settings should probe these findings with a larger sample and collect information on individual reasoning paths.

**Acknowledgements:** The research was supported by the NSF – EPSCOR funded, WVnano, a state wide nanotechnology initiative housed at West Virginia University; NSF-0554328, Paul Hill, PI. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

The authors thank Brittany Witherspoon for her valuable data coding assistance and for Danielle Erdos-Kramer for the editing of the manuscript. Conversations with Social Studies professor Dr. Mary E. Haas contributed to the development to of the instructional approach. Two anonymous reviewers and editor, Dr. Molly Weinburgh provided valuable suggestions to bring this manuscript to fruition.

## References

- American Association for the Advancement of Science [AAAS]. (2011). *Vision and Change: A Call to Action, Final Report*. Washington, DC. : AAAS. Retrieved from <http://visionandchange.org/files/2011/03/Revised-Vision-and-Change-Final-Report.pdf>
- Aikenhead, G. S. (1985). Collective decision making in the social context of science. *Science Education*, 69(4), 453-475.
- Albe, V. (2008). Students' positions and considerations of scientific evidence about a controversial socioscientific issue. *Science & Education*, 17(8-9), 805-827.
- Anmarkrud, Ø., Bråten, I. & Stromso, H. I. (2014). Multiple-documents literacy: Strategic processing, source awareness, and argumentation when reading multiple conflicting documents. *Learning and Individual Differences*, 30, 64-76.
- Aronson, E., & Patnoe, S. (1997). *The jigsaw classroom: Building cooperation in the classroom*. Beverly Hills, CA.: Sage.
- Bell, P. (2000). Scientific arguments as learning artefacts: Designing for learning from the web with KIE. *International Journal of Science Education*, 22(8), 797-817.
- Berger, M. (2007). Water, nanotechnology's promises and economic reality. *Nanowerk*. Retrieved from <http://www.nanowerk.com>
- Binns, I. C.; Bell, R. L. (2015). Representations of Scientific Methodology in Secondary Science Textbooks. *Science & Education*, 24(7), 913-936.

- Bybee, R. W. (2013). *Translating the NGSS for classroom instruction*. Arlington, VA: NSTA Press.
- Bybee, R. W., & National Science Teachers Association [NSTA], (Eds.) (1985). *Science Technology Society: Yearbook of the National Science Teachers Association*. Washington D.C. : NSTA.
- CBSNewsOnline (2010, January 12). Haiti earthquake aftermath. *CBS News RAW*. Retrieved from <http://www.youtube.com>
- Chinn, C. A., Buckland, L. A. & Samarapungavan, A. L. A. (2011). Expanding the dimensions of epistemic cognition: Arguments from philosophy and psychology. *Educational Psychologist*, 46(3), 141-167.
- Cobb, M. D. & Macoubrie, J. (2004). Public perceptions about nanotechnology: Risks, benefits and trust, *Journal of Nanoparticle Research*, 6, 395-405.
- Council of Chief State School Officers [CCSSO], (2010). *Common Core State Standards*. Washington, D.C.: National Governors Association.
- Cook, K. L., & Dinkins, E. G. (2015). Building Disciplinary Literacy through Popular Fiction. *Electronic Journal of Science Education*, 19(3) 1-24.
- Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Beverly Hills, CA. : Sage.
- Davidson, A. (2010, March 26). A tent-city economy grows in Haiti. *National Public Radio*. Retrieved from <http://www.npr.org>
- Denzin N. K., & Lincoln, Y. S. (2005). *Handbook of qualitative research (2<sup>nd</sup> Ed)*. Thousand Oaks, CA. : Sage.
- Driver, R., Asoko, H., Leach, J., Scott, P., & Mortimer, E. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher*, 23(7), 5-12.
- Driver, R., Leach, J., Millar, R., & Scott, P. (1996). *Young people's images of science*. Bristol, UK. : Open University Press..
- Duschl, R. (2008). Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of Research in Education*, 32(1), 268-291.
- Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's argument pattern for studying science discourse. *Science Education*, 88(6), 915-933.
- Fensham, P. J. (2002). Time to change drivers for scientific literacy. *Canadian Journal of Math, Science & Technology Education*, 2(1), 9-24.
- Feinstein, N. (2011). Salvaging science literacy. *Science Education*, 95(1), 168-185.
- Gardner, G. E., & Jones, M. G. (2011). Science instructors' perceptions of the risks of biotechnology: Implications for science education. *Research in Science Education*, 4(5), 711-738.
- Goldman, S. R. (2004). Cognitive aspects of constructing meaning through and across multiple texts. In *Uses of intertextuality in classroom and educational research* (Shuart-Faris, N. & Bloome, D. (Eds), 317-351. Greenwich CT. : Information Age Publishing.
- Hammer, D. (2000). Student resources for learning introductory physics. *American Journal of Physics*, 68(S1), S52-S59.

- Health and Environmental Alliance [HEA], (2008). Nanotechnology and health risks. Retrieved from [http://www.env-health.org/IMG/pdf/17\\_NANOTECHNOLOGY\\_AND\\_HEALTH\\_RISKS.pdf](http://www.env-health.org/IMG/pdf/17_NANOTECHNOLOGY_AND_HEALTH_RISKS.pdf)
- Hillie, T. & Hlophe, M. (2007). Nanotechnology and the challenge of clean water. *Nature Nanotechnology* 2, 663-664. doi:10.1038/nnano.2007.350.
- Hobbs, R. (2004). A review of school-based initiatives in media literacy education. *American Behavioral Scientist*, 48(1), 42-59.
- Hobbs, R. (2005). Media Literacy and the K-12 Content Areas. *Yearbook of the National Society for the Study of Education*, 104(1), 74-99.
- Hobbs, R. (2010). Digital and media literacy: A plan of action. Washington, DC. : *The Aspen Institute*.
- Kahneman, D. (2011). *Thinking, fast and slow*. New York, NY. : Farrar, Straus, and Giroux..
- Kelly, G. J., & Takao, A. (2002). Epistemic levels in argument: An analysis of university oceanography students' use of evidence in writing. *Science Education*, 86(3), 314-342.
- Klosterman, M. L., Sadler, T. D. & Brown, J. (2012). Science teachers' use of mass media to address socio-scientific and sustainability issues. *Research in Science Education*, 42(1), 51-74.
- Kolstø, S. D. (2001a). Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial socioscientific issues. *Science Education*, 85(3), 291-310.
- Kolsto, S. D. (2001b). To trust or not to trust,...'-pupils' ways of judging information encountered in a socio-scientific issue. *International Journal of Science Education*, 23(9), 877-901.
- Korpan, C. A., Bisanz, G. L., Bisanz, J., & Henderson, J. M. (1997). Assessing literacy in science: Evaluation of scientific news briefs. *Science Education*, 81(5), 515-532.
- Krajcik, J., Blumenfeld, P. C., Marx, R. W., Bass, K. M., Fredricks, J. & Soloway, E. (1998). Inquiry in project-based science classrooms: Initial attempts by middle school students. *Journal of the Learning Sciences*, 7(3-4), 313-350.
- Lacey, M. (2010, January 15). Patience wears thin as desperation grows. *The New York Times*. Retrieved from <http://www.nytimes.com>
- Lacey, M. & Thompson, G. (2010, January 25). Agreement on effort to help Haiti rebuild. *The New York Times*. Retrieved from <http://www.nytimes.com>
- Lehman, M. L. (2009, February 6). Nanotechnology and new materials for architecture. Retrieved from <http://sensingarchitecture.com/523/nanotechnology-and-new-materials-for-architecture/>
- Maynard, A., Michelson, E. (2006). The nanotechnology consumer product inventory. Retrieved from [http://www.nanotechproject.org/process/files/2753/consumer\\_product\\_inventory\\_analysis\\_handout.pdf](http://www.nanotechproject.org/process/files/2753/consumer_product_inventory_analysis_handout.pdf)
- National Council for the Social Studies [NCSS], (2013). The College, Career, and Civic Life (C3) Framework for Social studies State Standards: Guide for Enhancing the Rigor of K-12 Civics, Economics, Geography, and History. Washington, DC. : NCSS.
- National Research Council [NRC], (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC. : National Academies Press.
- National Science Board,(2014). *Science and Engineering Indicators 2014*. Arlington VA: National Science Foundation (NSB 14-01).

- National Science Foundation [NSF], (2000). *Science and Engineering Indicators 2000*. National Center for Science and Engineering Statistics. Washington, DC. National Science Foundation.
- NGSS Lead States (2013). *Next Generation Science Standards: For States, By States*. Washington DC. : National Academies Press.
- Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, 87(2), 224-240.
- Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research on Science Teaching*, 41, 994-1020.
- Oulton, C., Day, V., Dillon, J. & Grace, M. (2004). Controversial issues-teachers' attitudes and practices in the context of citizenship education. *Oxford Review of Education*, 30(4), 489-507.
- Romero, S. & Lacey, M. (2010, January 12). Fierce quake devastates Haitian capital. *The New York Times*. Retrieved from <http://www.nytimes.com>
- Ryder, J., & Banner, I. (2011). Multiple aims in the development of a major reform of the national curriculum for science in England. *International Journal of Science Education*, 33(5), 709-725.
- Sadler, T. D. (2004). Moral sensitivity and its contribution to the resolution of socio-scientific issues. *Journal of Moral Education*, 33(3), 339-358.
- Sadler, T. D., & Zeidler, D. L. (2005). Patterns of informal reasoning in the context of socioscientific decision-making. *Journal of Research in Science Teaching*, 42(1), 112-138.
- Sampson, V., Grooms, J. & Walker, J. P. (2011). Argument-Driven Inquiry as a way to help students learn how to participate in scientific argumentation and craft written arguments: An exploratory study. *Science Education*, 95(2), 217-257.
- Sandoval, W. A., & Millwood, K. A. (2005). The quality of students' use of evidence in written scientific explanations. *Cognition and Instruction*, 23(1), 23-55.
- Simon, H. A. (1959). Theories of decision-making in economics and behavioural science. *The American Economic Review*, 253-283.
- Sinatra, G. M., Kienhues, D. & Hofer, B. K. (2014). Addressing challenges to public understanding of science: Epistemic cognition, motivated reasoning, and conceptual change. *Educational Psychologist*, 49(2), 123-138.
- Thompson, G. & Cave, D. (2010, January 17). Officials strain to distribute aid to Haiti as violence rises. *The New York Times*. Retrieved from <http://www.nytimes.com>
- Thompson, G. & Lacey, M. (2010, February 1). In quake's wake, Haiti faces leadership void. *The New York Times*. Retrieved from <http://www.nytimes.com>
- Toth, E. E., Suthers, D. D., and Lesgold, A. (2002). Mapping to know: The effects of representational guidance and reflective assessment on scientific inquiry skills. *Science Education*, 86:264-286.
- Toulmin, S. E. (1958). *The Uses of Argument*. Cambridge University Press: Cambridge.
- Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, 211(4481), 453-458.
- Walker, J. P., & Sampson, V. (2013). Learning to Argue and Arguing to Learn: Argument-Driven Inquiry as a Way to Help Undergraduate Chemistry Students Learn How to Construct Arguments and Engage in Argumentation During a Laboratory Course. *Journal of Research in Science Teaching*, 50(5), 561-596.



- Walton, D. N., Reed, C., & Macagno, F (2008). *Argumentation schemes*. New York, NY. : Cambridge University Press.
- Water pollution and nanotechnology. (2007). *UnderstandingNano.com*. Retrieved from <http://www.understandingnano.com/water.html>.
- Wiley, J., Goldman S. R., Graesser, A. C., Sanchez, C. A., Ash, I. K. & Hemmerich, J. A. (2009). Source evaluation, comprehension, and learning in Internet science inquiry tasks. *American Educational Research Journal*, 46(4), 1060-1106.
- Yager, R. E. (1996). History of Science/Technology/Society as a reform in the United States. In Yager, R. E. (Ed). *Science/Technology/Society as a reform in Science Education*. Albany, N.Y : State University of New York Press.
- Yore, L. D., Hand, B., Goldman, S. R., Hildebrand, G. M., Osborne, J. F., Treagust, D. F & Wallace, C. S. (2004). New directions in language and science education research. *Reading Research Quarterly*, 347-352.
- Yore, L. D., & Treagust, D. F. (2006). Current realities and future possibilities: Language and science literacy—empowering research and informing instruction. *International Journal of Science Education*, 28(2-3), 291-314.
- Zeidler, D. L., Sadler, T. D, Simmons, M. L. & Howes, E. V. (2005). Beyond STS: A research-based framework for socioscientific issues education. *Science Education*, 89(3), 357-377.
- Zeidler, D. L., Walker, K. A., Ackett, W. A., & Simmons, M. L. (2002). Tangled up in views: Beliefs in the nature of science and responses to socioscientific dilemmas. *Science Education*, 86(3), 343-367.
- Zimmerman, C., Bisanz, G. L., Bisanz, J., Klein, J. S. & Klein, P. (2001). Science at the supermarket: A comparison of what appears in the popular press, experts' advice to readers, and what students want to know. *Public Understanding of Science*, 10(1), 37-58.