FRAME WORKS INSTITUTE

Missing Matter:

Holes in the Media Narrative about Informal and Formal STEM Learning

A FRAMEWORKS RESEARCH REPORT

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Introduction

The media analysis presented here was conducted by the FrameWorks Institute with funding from the Noyce Foundation. This report represents a critical component of a larger effort to inform communications strategies designed to increase public support for policies and programs that improve Science, Technology, Engineering and Mathematics (STEM) learning with empirically-tested power. Moreover, we are concerned with support for STEM in formal as well as informal, out-of-school, contexts. Here we analyze the issue frames — or patterned cues in messages that structure specific definitions, causal interpretations and solutions to social problems[1] — that are embedded in media stories about STEM learning.

Communicators pay attention to media coverage because it plays a powerful role in shaping and reinforcing how the public understands issues related to STEM, including the importance of informal STEM learning experiences, the identification of the best pedagogical practices for STEM teaching, and the efficacy of initiatives designed to improve educational outcomes in STEM-related subjects. The media are also fed and reinforced *by* dominant public understandings of STEM-related issues.[2] This report empirically examines this cycle of influence by documenting the frames that are pervasive in the media's coverage of STEM issues, exploring the degree to which these media frames correspond to the messages that STEM experts and advocates want to disseminate and, finally, examining the likely impacts of these media frames on public understanding of STEM-related issues.[3]

We begin with the knowledge that experts believe needs to be imparted if Americans are to grasp the importance of STEM and related issues. STEM learning experts agree that improving STEM learning for all U.S. students is vital to future economic development, and that achieving this goal requires systemic and structural change. Experts assert that high-quality, universal STEM education is critical to a vibrant democracy, noting that deep engagement with pressing contemporary social problems, such as climate change and food systems policy, requires STEM skills and literacy. Experts also maintain that individual success in fields like engineering, math or computer sciences is not simply the result of extremely talented students, but that these successes are dependent upon educational contexts and pedagogical approaches that support and enable effective STEM learning. These contexts include students' access to rich and engaging informal learning opportunities that extend, and complement, the learning that takes place in formal classrooms. At the same time, STEM experts attribute many American students' lack of proficiency in STEM-related subjects to contextual elements. For example, experts explain that the U.S. education system is facing a shortage of teachers who are adequately trained in

the STEM fields, and who have access to institutional support to master the most effective methods of teaching STEM. To this end, experts offer solutions that are designed to change the contexts in which the STEM fields are taught. These include providing students with multiple opportunities and high-quality contexts in which to develop and hone STEM-related skills.

News media are a key source of the public's information on most social issues, and identifying patterns in media coverage about informal STEM learning is critical in understanding why gaps exist between public and expert accounts, and how the introduction of new stories about informal STEM learning can be used to bridge these gaps. This report documents considerable distance between this set of expert messages and the stories circulating in the public sphere through the mass media. In the conclusion of this report, we identify reframing strategies that can be used to create new stories that will expand public understanding of informal STEM learning, and increase support for the policies and programs advocated by experts.

Executive Summary

Media coverage of STEM issues lacks a coherent and complete narrative. In general, the media consistently fail to explain: (1) why the public should be concerned about improving STEM learning, (2) the nature and source of the problems affecting STEM learning, and (3) how to address these problems and improve outcomes.

Media stories employ an episodic storytelling style that highlights individualized instances of STEM teaching or learning. The media are more likely to focus on individual successes or failures in acquiring proficiency in STEM skills or teaching STEM-related subjects than systemic problems with STEM education in the United States. People are more likely to come across episodic stories about an individual teacher's failures in developing quality STEM curricula rather than thematic stories about the lack of availability of training and ongoing professional development programs for STEM teachers.[4]

Informal and formal learning contexts are represented as wholly separate domains, with positive and negative valences attached respectively. The media represent informal STEM settings as sites of innovation in STEM pedagogical practices. However, this representation is constructed through a constant comparison with the portrayal of formal contexts — particularly, traditional public education — as dismal failures in STEM learning. As a result, informal STEM learning becomes a "work around" for the traditional system, and the *primary* and *discrete* solution to improving education in STEM subject areas. A more integrated relationship between STEM learning in formal and informal contexts is absent from the media's coverage.

Media coverage assigns responsibility for outcomes to individuals and individual attributes. The absence of a consistent narrative about STEM invites the public to "fill in" understanding with available cultural models that attribute the success or failure in STEM skills to the intrinsic qualities of students and teachers, such as their dedication, discipline and drive.[5] The frequent use of portraits of individual students and teachers cues these same unproductive models. The effects of these patterns in the media are perhaps most damaging when the public reasons about gender, race and income disparities in STEM educational outcomes. Working from individualist models, solutions to these issues are seen as squarely in the private domain, and the role of public programs and policy initiatives fades from consideration.

***Pollination Points, Charging Stations* and *Remodeling* Explanatory Metaphors hold the potential to better align media stories and expert messages, and broaden public discussion around STEM learning.** Media content analyses afford the advantage of identifying "slots" in the existing narrative that lend themselves to framing elements. In this case, FrameWorks has developed several metaphors that can assist STEM communicators to address these conceptual challenges as they position stories in the media.[6] *Pollination Points* establishes a more productive, interactive and mutually-reinforcing understanding of the relationship between formal and informal learning contexts. *Charging Stations* provides a concrete and contextual way of thinking about disparities among populations of students. Finally, *Remodeling* provides members of the public with a way to think about the reality and process of meaningful education reform. FrameWorks recommends that communicators employ these metaphors to expand the existing media narratives now in use about STEM learning.

Methods

The analysis presented here was guided by the following three research questions:

1. *What are the dominant media narratives of STEM learning in general, and of STEM learning in informal or out-of-school contexts in particular?*

2. *How do media narratives compare to expert understandings of these issues?*

3. *How do media narratives shape public understandings of STEM learning and related issues?*

In order to address these questions, we draw on the following analyses:

Media Analysis

A recent Pew Center study suggests that the majority of Americans receive their daily news from a combination of newspapers (both print and online) and broadcast news sources.[7] Working from this finding, the sample in the current study includes stories taken from national newspapers and television broadcasts, as well as news blogs. Using LexisNexis, Factiva and Google News databases, specific news sources were selected based on circulation/viewership statistics as well as their ability to represent geographical and political diversity. The sample consisted of the following sources: *Austin American-Statesman*, *Chicago Daily Herald*, *The Denver Post*, *Los Angeles Times*, *San Jose Mercury News*, *Minneapolis StarTribune*, *New York Post*, *The New York Times*, *The Washington Post*, *USA Today*, CNN.com, Politico.com, ABC News, CBS News, CNN News, Fox News Network and MSNBC.

We used the following search terms to assemble a sample of stories from these sources:

- "Science, Technology, Engineering and Mathematics" or
- "STEM" or "science learning" or
- "science education" or
- "teaching science" or
- "science teaching" or
- "science" and "informal learning" or
- "science" and "after school programs" or

- "science" and "after school learning" or
- "science" and "out of school learning" or
- "science" and "out of school time"

This strategy was designed to capture articles that explicitly mention the term "Science, Technology, Engineering and Math," as well as articles that cover issues related to STEM education but that do not use the "STEM" acronym, and articles that cover STEM learning in informal contexts. We searched all sources using this string of search terms from May 1, 2012, through May 1, 2013. This search resulted in the identification of 1,788 stories. We assigned each of these stories a unique number and randomly selected a sample of 500 stories from this larger set. We then eliminated stories that were not pertinent to the current analysis (for example, announcements of science fairs in community calendars), yielding a final sample of 283 stories that were coded and analyzed.

Each document was coded using a coding scheme designed to track all the narrative components present in organizational materials. These components include elements such as values statement, absence or presence of a causal story, solutions statement, and responsible actor, among other codes. Each narrative component comprises a distinct category that contains a number of possible codes. Together, these narrative components map the stories that media organizations are telling about STEM-related issues (see Appendix A).

After coding the full sample of 283 stories, we analyzed the frequency of codes in each category, as well as the relationships between selected codes. The purpose of this portion of the analysis was to chart the frequency of specific narrative components and frames and to examine the co-occurrence of narrative elements, thereby documenting dominant narratives that run through media coverage of STEM-related issues.

Following this quantitative analysis, we qualitatively examined 100 randomly selected stories in order to contextualize our quantitative findings. The qualitative analysis provided greater description and context for quantitative results by identifying common ways in which the media articulate specific narrative components.

Expert Interviews

As part of the larger communications project on informal STEM learning, FrameWorks researchers interviewed experts and practitioners from the STEM field in order to identify and distill the key concepts, ideas and points that emerge from their work.[8] Results from

the analysis of these expert interviews were then compared to the media narratives identified in the present study. This process allowed us to understand the similarities and differences between expert messages and the stories that are presented in the media — or in what ways current media narratives converge or diverge from the stories that experts wish to tell.

Cognitive Analysis

In the final stage of analysis, we compared findings from the media analysis to the cultural models[9] — or shared, patterned and implicit understandings and assumptions — that Americans use to think about STEM learning issues. These cultural models were identified in a previous phase of the project through one-on-one, semi-structured interviews in multiple U.S. locations.[10]

This comparative analysis identifies:

- How media narratives *cue and strengthen* existing cultural models.
- How these narratives *conflict with or challenge* existing cultural models.
- How stories *fail to address* key aspects of STEM learning issues, causing members of the public to "fill in the blanks" with dominant cultural models.

We conclude with strategic recommendations that STEM learning professionals, experts and advocates can use to more effectively communicate about their issues.

Findings

The following section presents the results from the media analysis. Key findings include the incomplete narrative structure of the media's coverage of STEM issues; the over-reliance on individual, episodic stories; and the separation of formal and informal learning contexts, leading to a devaluation of the public education system as a site of STEM learning.

STEM Media Coverage and Narrative Form: An Incomplete Story

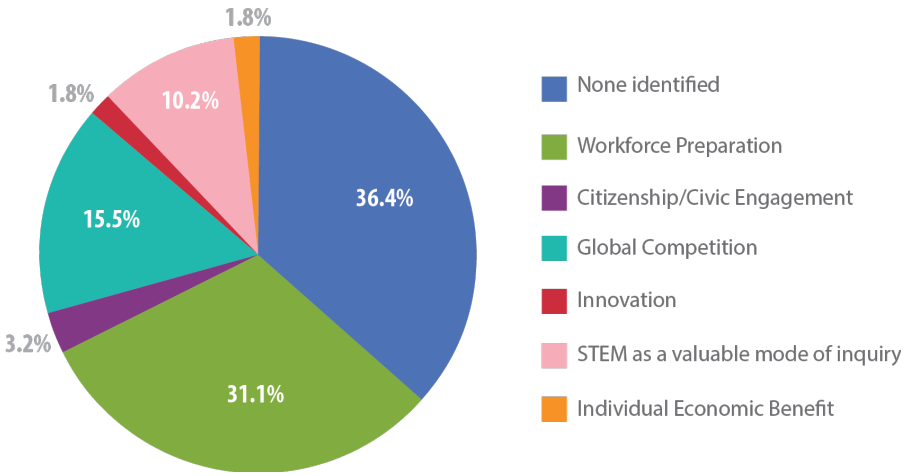
According to the articles in this sample, the major problem associated with STEM education is that the United States is facing a shortage of qualified workers to enter careers that require proficiency in the STEM fields (see Figure 6). Not surprisingly, then, media stories analyzed here were overwhelmingly supportive of STEM learning initiatives. Only six stories were critical of STEM learning initiatives — and even these six were not necessarily critical of STEM initiatives per se, but were concerned about their potential to divert resources from strong training in the humanities.

Despite the discussion of a common problem and a positive stance on the value of STEM education, the media narrative about STEM education was notably incomplete and, in many ways, dramatically different from the messages that experts wish to convey. Several key questions about STEM learning were not consistently addressed. These questions include: Why is it important for all students to receive quality STEM education? Why are students not receiving the most up-to-date training in STEM? How can STEM learning be improved?

Figure 1:

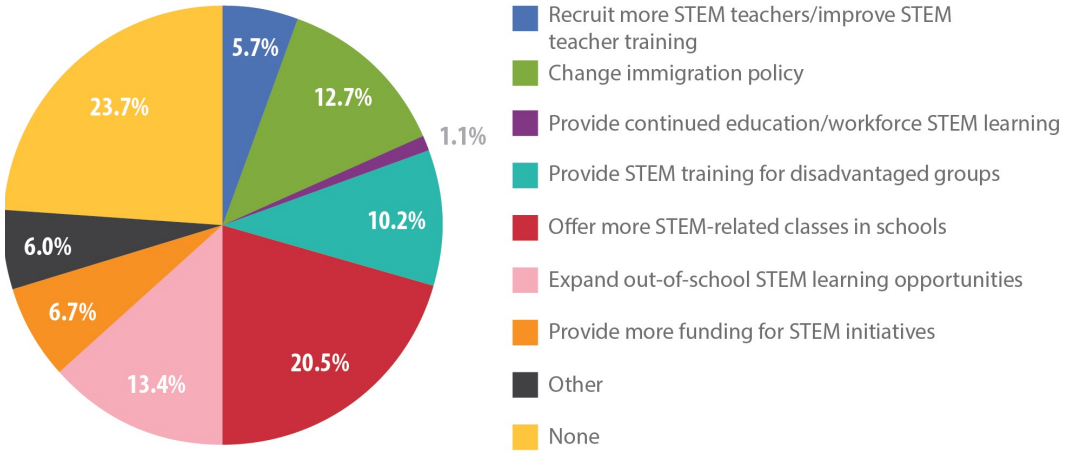
Value Statements

(n=283)



For example, over one third of the stories in the sample contained no value statement or rationale for reforming current STEM education (see Figure 1).

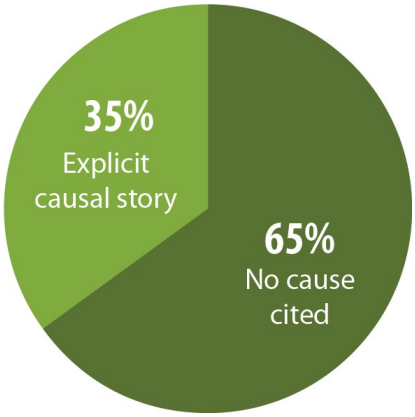
Figure 2:
Solution
(n=283)



Almost a quarter of the stories contained no solution or direct statement as to how problems associated with STEM might be addressed (see Figure 2).

Finally, nearly two-thirds of the sample contained no causal sequence, meaning that, while stories presented a topic or a problem, they provided no information as to how or why this problem came about (see Figure 3).

Figure 3:
Presence of Causal Story
(n=283)



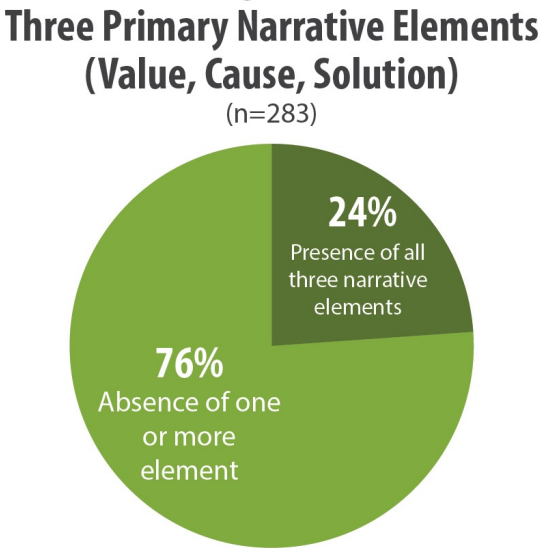
Even more significantly, less than a quarter of the sample contained all three narrative elements in a single article (see Figure 4), meaning that a vast majority of articles did not contain a complete story about STEM education in the United States. Communications that adhere to a culturally familiar narrative form, in which diagnostic claims about social problems are logically linked to values and solution claims, have shown to be more effective in mobilizing collective action.[11] Values, because of their ability to motivate people's engagement with an issue and provide a goal around which to structure their beliefs, are a particularly important component of the framed content of narratives.[12]

The following is an example of an article that fails to provide a complete narrative about the state of STEM education in the United States:

> *Many of Obama's education goals have been voiced before. In 2010, the President's Council of Advisors on Science and Technology called for a national effort to recruit and retain teachers in science, technology, engineering and math, noting that out of about 477,000 math and science teachers from kindergarten through high school, about 25,000 leave teaching each year.*[13]

This excerpt leaves several critical questions unanswered. *Why* are STEM teachers leaving the profession at this rate? *How* does teacher turnover negatively impact educational outcomes? What are the *specific policies and programs* that work to improve teacher retention in the STEM fields? This article simply provides an alarming, but decontextualized, statistic, instead of addressing these questions and thereby providing a complete story and coherent *explanation* of the problems associated with STEM education in the United States. Such tendencies were typical of a large portion of the media stories examined in this analysis.

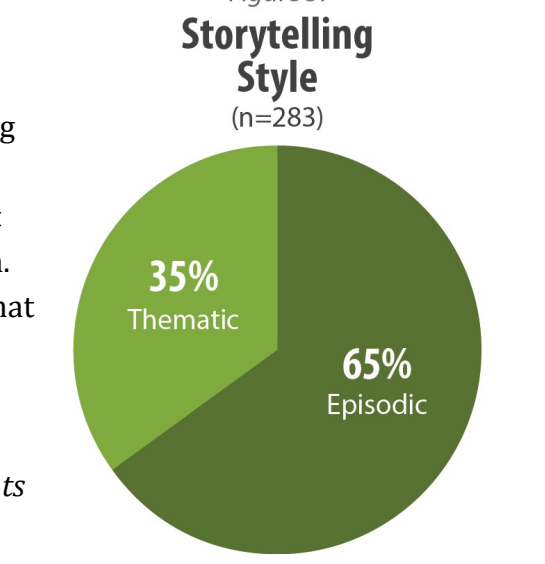
Figure 4:



STEM Media Coverage and Storytelling Style: Highly Episodic

The fact that STEM coverage in the media lacks a strong narrative explanation for why STEM learning is important, why reform is necessary or how such reforms might be implemented does not mean that the media do not tell stories about STEM education. In fact, there is a *very* dominant storytelling style that journalists employ in media stories about STEM. Sixty-five percent of the documents in the sample followed an episodic storytelling style — stories about the *successes and failures of individual students and teachers*. That is, they focused narrowly on

Figure 5:



individual triumphs or failures rather than on "widening the lens" to include the systemic or structural causes or solutions to social problems.[14] In focusing on individual achievements of individual students and teachers, these stories exclude discussion of major structural or systemic trends in STEM education.

These types of stories are referred to in the framing literature as *episodic stories*, and their power to perpetuate a narrow and decontextualized vision of an issue has been well documented.[15] The perspective facilitated by these episodic stories is at odds with the contextually-based understanding of STEM issues advocated by experts.

Media coverage was populated with inspiring examples of charismatic teachers who have developed innovative STEM curricula, and who have been successful in "inspiring" student interest in STEM fields. For example, the following article describes how a university professor was able to get his undergraduates interested in, and excited about, the mathematics of complex linear systems:

> *Blame the fame on tiny Butler University. Chartier's math class recognized that fifth-seeded Butler was destined for the Final Four in 2010. That turned a lot of heads and convinced Chartier that their modeling was better than the collective intuition of sports experts. That was the second year Chartier started making bracketology — the art and science of picking winners among 68 teams in a single-elimination tournament — part of his syllabus. That's right: Take Chartier's course and you'll get college credit for studying college hoops.*[16]

Stories like the one excerpted above provide incredibly rich and engaging examples of innovative and hands-on STEM teaching. In so doing, however, they reduce the implementation of innovative pedagogical practices in the STEM fields to the extraordinary effort of *individual* teachers. What is absent from these accounts is the training and ongoing institutional support that allows STEM teachers to successfully implement such engaging and effective lesson plans. While this coverage provides the audience with an example of successful STEM teaching, it offers no information about how or why teachers are able to develop these skills, and how such approaches might be incorporated more broadly into pedagogical standards for STEM teaching.

Flipping the coin, the media's coverage of *problems* associated with STEM education in the United States was similarly episodic, and focused primarily on the deficiencies of individual teachers. The following is an example of this trend in coverage:

> *Several students at the Thomas Jefferson High School for Science and Technology in Fairfax County noticed their linear algebra teacher was struggling this semester. They said he made mistakes, erased his work without explanation and seemed confused. Then it got worse. He quit in mid-March. The administration had to scramble. Retired math chairman Jerry Berry, with no experience teaching linear algebra, kept an eye on student progress while a George Mason University graduate student provided the instruction. The graduate student's wife had a baby. Another graduate student replaced him. A substitute teacher without much linear algebra experience replaced Berry as supervising teacher, telling students he would do his best.*[17]

Students' STEM learning outcomes were similarly characterized in highly episodic terms. Stories ranged from profiles of genius students to portraits of students who struggle to reach even basic proficiency in STEM-related fields. For example, the story excerpted below chronicles a young woman's achievements in the STEM fields. The article homes in on how some girls are trying to "break the mold":

> *She is one example of female high school students trying to break the mold and succeed in the areas of science, technology, engineering and math, collectively known as STEM, which historically have been dominated by males.*[18]

These kinds of hero-or-victim episodic stories have a similar impact as those that profile individual teaching successes and failures — successes in STEM subjects are viewed as more a matter of personal aptitude than of education policy. While positive stories about STEM learning are uplifting, they leave little space for discussion of the importance of the way in which STEM subjects are taught and teachers are supported. Even more generally, they fail to explain the importance of *universal* STEM education and the value of quality STEM curricula for *all* children. For example, the article below covers the perspective of a teacher who questioned higher standards in STEM training for all:

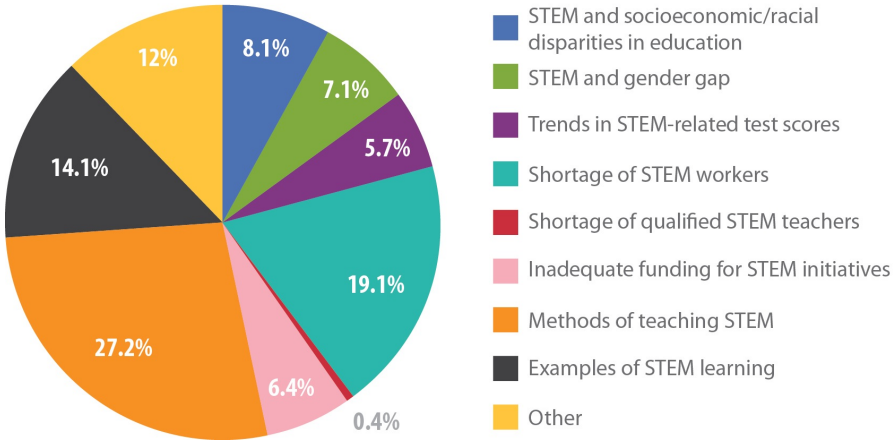
> *Shapiro applauded raising standards for college-bound students, but to him the state seemed to be ignoring students who had dreams that did not include college or global industries. What of those who looked forward to staying close to home in jobs such as carpentry or cosmetology that couldn't be exported to Bangalore?*[19]

In this particular article, the goals of STEM education are narrowly defined in terms of individual career gain; other, more collective, economic benefits, and certainly non-

Figure 6:

Plot

(n=283)



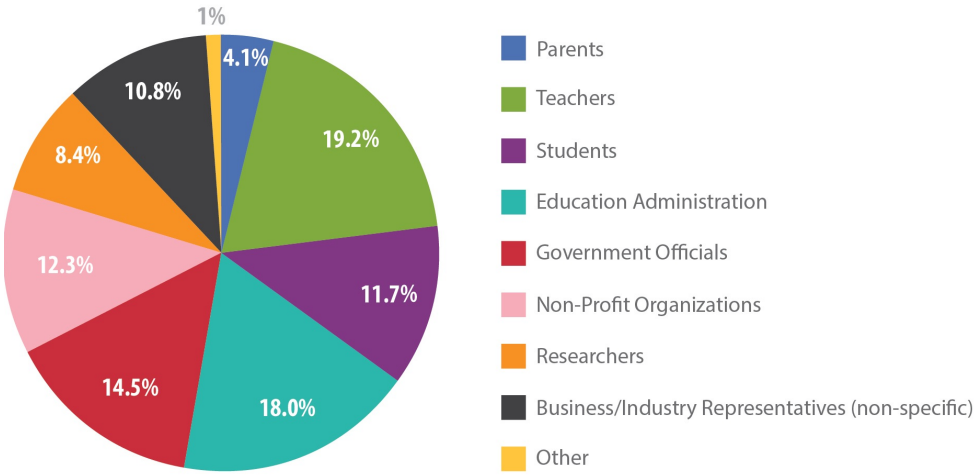
economic advantages of STEM learning and skills, are left out. But, perhaps more problematic, the teacher is questioning advanced STEM classes for all students, even those who may end up in professions like carpentry or cosmetology.

Perhaps the most unproductive aspect of this episodic coverage is that it excludes systemic accounts of problems facing STEM education in the United States, or consideration of the social contexts in which academic success or failure takes place. Indeed, stories that documented racial, socio-economic and gender disparities in STEM education together constituted only 15 percent of the sample (see Figure 6). As further evidence of the trends towards episodic coverage of STEM education, consider the finding that researchers — who arguably are best positioned to discuss systemic and structural trends in a given field — were the most infrequent messengers cited among articles in the sample (see Figure 7).

Figure 7:

Messengers

(n=489)



Formal and Informal STEM Learning: Worlds Apart

Articles that covered STEM education in informal contexts constituted a third of the sample (see Figure 8). The framing patterns in the subsample of stories that dealt with STEM in out-of-school contexts was similar to that observed in the overall sample. The personal attributes of teachers and the success or failure of individual students, along with the unexplained shortage of qualified workers in the STEM fields, constituted the primary focus of these stories (see Table 1). While the most-cited solution to problems discussed was to increase *the number* of out-of-school STEM learning programs (32 percent), a substantial proportion of these stories offered no solution to problems discussed (28 percent). It is important to note that these articles focused on increasing the quality of STEM programs, but had very little information as to how readers might assess programmatic quality. Furthermore, an even higher percentage of out-of-school STEM articles were episodic in nature than in the sample overall (77 percent versus 64 percent). For example, the following article describes a specific (and very exclusive) science program offered at a school in Minnesota. It offers very limited information as to how this program might be employed to improve STEM education across the United States.

> *Minnehaha Academy students are about to get some real-world experience that's literally out of this world. Watching paint dry is anything but a mundane task for a group of Minnehaha Academy high school students who are going above and beyond to take the expression literally. The select group has the rare opportunity to test a science experiment in outer space this year — one of only eight school groups nationwide and the only one in the Midwest. They've chosen a simple test for their complex project: watching paint polymers dry in space.*[20]

Figure 8:

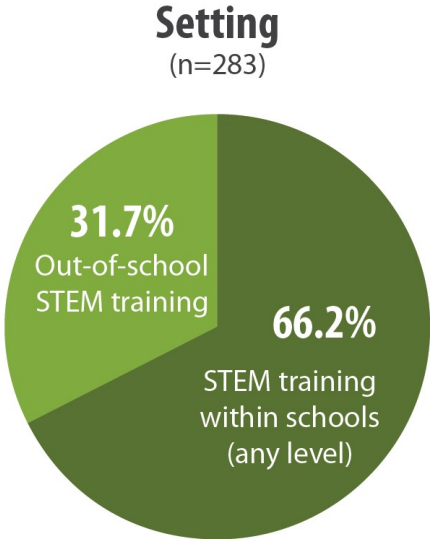


Figure 9:

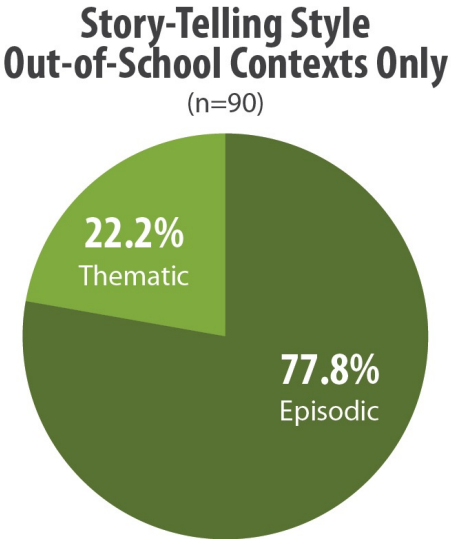
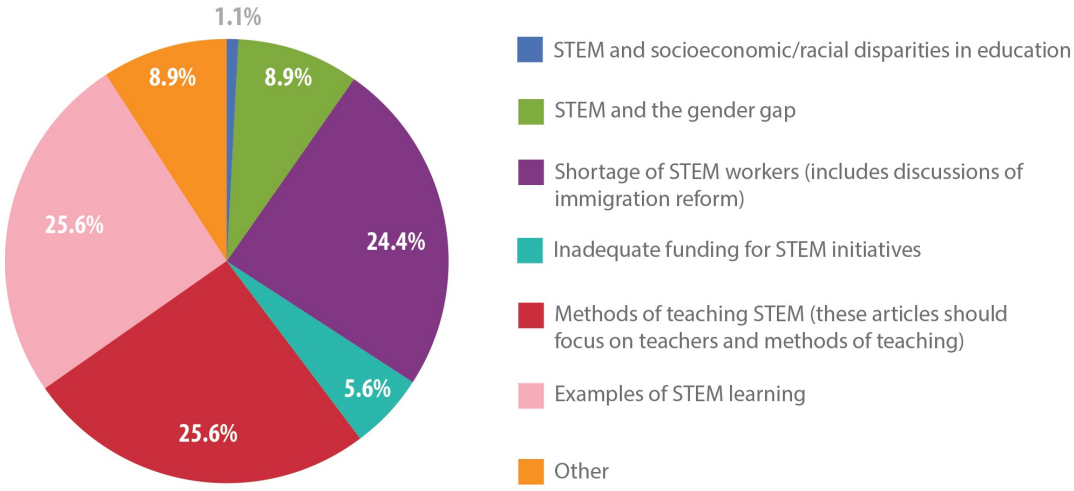


Figure 10:

Plot Out-of-School Only

(n=90)

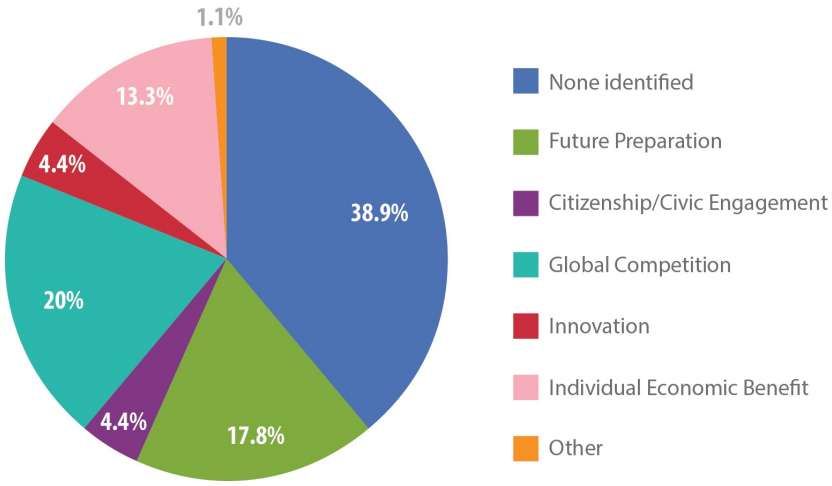


Examining the co-occurrence of narrative elements across the sample yields additional insights into media portrayals of informal STEM learning. Across the sample (i.e., not just those covering informal STEM learning), discussions of STEM teaching were frequently associated with the recommendation of *more out-of-school* learning opportunities (see Table 1). Put another way, media stories portray increasing the availability of out-of-school learning contexts as the way of addressing issues associated with STEM teaching. This linkage — between issues with STEM teaching and more out-of-school STEM learning as the solution — is an important indication of the value that the media place on informal contexts of STEM learning. However, a closer examination of the way in which the media frame the solution of more informal STEM opportunities provides cause for concern. The media's positive focus on *out-of-school* STEM learning consistently comes at the expense of the public education system and its ability to facilitate STEM learning. The following article, for example, highlights informal science learning opportunities while implicitly dismissing the science education that occurs within public schools.

Figure 11:

Value Out-of-School Only

(n=90)



In an area known for its technologically savvy citizens and beautiful landscapes, there are children who have never used a microscope or set foot in a forest. As Santa Clara County schools spend less time teaching science — about an hour a week — and children become more fascinated with their smartphones than with nature, this has become more common. But a group of people on 35 acres of land in the hills of Saratoga have been working to enhance the science curriculum in schools for the past 60 years. And now they have a new tool. Walden West recently unveiled the new Abby Sobrato Science and Sustainability Center. Apart from being "a dream come true" to those involved with Walden West, the center gives students from throughout the county an opportunity for hands-on, science-based learning that they otherwise wouldn't receive.[21]

These data indicate that informal STEM education is largely discussed in media stories as a valuable way to compensate for the deficiencies of a failing public system, but not as an integrated component of the traditional education system. Informal sites are outside of, and apart from, the traditional education system, and are therefore represented as effective domains in which to enact change. In this mode, they "pick up the slack" for a failing education system, rather than bolster and complement that system to provide quality STEM learning for all children. This story departs substantially from the expert view of formal and informal STEM learning opportunities as complementary, coordinated and bi-directional — as component parts of a broader learning "ecology."

Solution * Plot Cross-Tabulation

Solution	Resp. Actor									
	STEM and socioeconomic/racial disparities in education	STEM and the gender gap	Trends in STEM-related test scores	Shortage of STEM workers	Shortage of qualified STEM teachers	Inadequate funding for STEM initiatives	Methods of teaching STEM	Examples of STEM learning	Other	**Total**
Recruit more STEM teachers and/or improve STEM teacher training	1	0	2	1	0	0	10	1	1	**16**
Change immigration policy	0	0	0	35	0	0	0	0	1	**36**
Provide continued education/workforce STEM learning	0	0	0	2	0	0	0	0	1	**3**
Provide STEM training for disadvantaged groups	11	12	1	1	0	0	0	1	3	**29**
Offer more STEM-related classes in schools	2	0	6	5	1	2	25	5	12	**58**
Expand out-of-school STEM learning opportunities	1	5	0	1	0	1	**16**	14	0	**38**
Provide more funding for STEM initiatives	1	1	0	2	0	10	2	1	2	**19**
Other	1	1	1	2	0	0	6	0	6	**17**
None	6	1	6	5	0	5	18	18	8	**67**
Total	23	20	16	54	1	18	77	40	34	**283**

Collective Economic Benefits: Aligned With Expert Views

In addition to the problematic media frames discussed above, there were several positive trends that emerged from this analysis. These are areas where the media's story is in line with components of the expert account of STEM learning and productive framing of the issue. Almost 20 percent of articles in the sample focused on the shortage of STEM workers in the United States, and the value most frequently recruited in support of STEM education was *Workforce Preparation* for collective benefit (see Figure 1). In contrast, only 5 percent of articles cited the value of individual financial gain. The following quote exemplifies the use of the value of *Workforce Preparation* in outlining the importance of providing high-quality out-of-school learning opportunities for students.

> *The seventh-graders at Forest Oak Middle School viewed Frontiers in Science and Medicine Day, which took place at the Universities at Shady Grove in Rockville, as an exciting learning experience outside the classroom. The adults who made it happen see it as much more. The event — hosted each year by either USG, a campus community — or Johns Hopkins University, is about building a workforce and making sure children don't think that people who work in the biosciences are "crazy scientists."*[22]

The above quote illustrates that the media are generally more focused on how STEM training can impact the economy as a whole, rather than on the individual financial success of a few extraordinary individuals. This type of value framing better aligns with experts' calls for high-quality and *universal* STEM training, and has been shown in previous FrameWorks experimental research to lead to increases in support for progressive education policies. It also contrasts markedly with trends in media coverage that FrameWorks has observed on education reform issues more generally; STEM issues appear to enjoy an advantage in this respect.

Cognitive Impacts

Based on FrameWorks' analysis of the cultural models that people employ to think about STEM learning,[23] we conclude that exposure to the media frames described above is likely to have the following effects on public thinking:

The public will fill in the media narrative with unproductive cultural models. The media lack a narrative that clearly and consistently defines the problems associated with STEM learning in the United States, explains why such problems are occurring, describes why addressing such problems is important, and lays out concrete ways in which those problems can be addressed. In the absence of these explanations, the public is left to answer these questions for themselves. The public will likely "fill in" the missing elements of this narrative with unproductive cultural models that impede support for policies designed to improve STEM education. For example, the public will fill in stories that lack a clear causal story about problems with STEM education with the assumption that success in these subjects is determined by individual aptitude. These assumptions render policies designed to improve the quality of educational environments — including informal settings — difficult to understand and support.[24]

Episodic coverage of student learning works against proposals to improve *universal* STEM training. Media stories that focus on the success and failure of individual students will impede public support for quality and universal STEM training. When the public is presented with a consistent stream of articles that cover extremely talented students, they are likely to ignore messages about the importance of quality STEM training for *all* students, or of the role of contextual factors in shaping STEM learning outcomes. As mentioned above, these stories will further entrench models that equate academic success in STEM learning to individual talent and aptitude.

Episodic coverage of ingenious or inept STEM teachers discounts the role of STEM teacher training and ongoing professional development. Episodic coverage of STEM teaching focuses the reader on the abilities of individual teachers. When the coverage is positive, the stories describe individual teachers' drive and creativity, and when journalists turn a critical gaze, they zoom in on their lack of motivation and caring. In either case, teacher effectiveness is wholly attributed to interpersonal characteristics. In contrast, experts focus on a system that does not provide teachers with the tools they need to master the most effective practices for teaching STEM. When the media train their attention on individual teachers, it excludes policies designed to improve teacher training or yield higher

rates of teacher retention. This makes it difficult for the public to appreciate the role of systemic and structural factors in shaping STEM educational outcomes in the United States.

Informal STEM learning is measured against the public school system, which dampens public support for reform in all contexts. In the media, out-of-school STEM learning is represented as a world apart from the public education system. While the valence attached to informal contexts is positive, these discussions are positioned in contrast to a public education system that is mired in problems and dysfunction.[25] It is apparent that this comparison has negative implications for formal STEM contexts. However, even though the coverage is positive, there are also potentially negative impacts on how the public thinks about informal STEM learning. First, the public may not consider what takes place in these contexts to be "real" learning, because it is divorced from traditional school learning. This may result in a lack of support for informal sites on those grounds (and almost certainly the use of public funds to support these contexts).[26] Second, the separation of informal and formal learning contexts impedes public understanding of the mutually reinforcing relationship between STEM learning in each of these settings — a centerpiece of the expert account. Finally, situating informal STEM learning as a way to "get around" or "make up for" a failing public school system further entrenches pessimism about the possibility of education reform.[27] This pessimism, and its grounding in a foundational American cultural model of *Fatalism*, is easily transferred to *all* proposals for reform, including those that address informal contexts.

Emphasis on quantity will dissuade public thinking about quality programming in STEM education. Experts point to several factors that constitute quality STEM programs in both formal and informal contexts, including the presence of highly qualified teachers and emphasis on hands-on and experiential learning, to name a few. While journalists argue for more STEM training for students, they do not provide systemic information that will allow the public to distinguish effective STEM programs. This coverage may garner public support for the implementation of new programs, but with little consideration of the quality of those programs.

Scant media discussion of disparities in STEM learning invites the public to fall back on dominant cultural models. Addressing the shortage of women and people of color in careers in the STEM fields is high on the agenda of those advocating for improving STEM education.[28] The prioritization of this issue is not well reflected in the media. Moreover, the stories that cover STEM and underrepresented groups are heavily episodic and focus on individuals who were able to "break the mold" and defy stereotypes to succeed. They become the exception that proves the rule that anyone can succeed with enough discipline

and drive.[29] The reliance on episodic storytelling, in combination with the narrative holes described above, will likely cue the public's dominant assumption that disparities in educational outcomes are largely a matter of individual (or group) willpower, character and strength.[30] Thinking from this model, the public becomes blind to the role of the systemic *causes* of disparities in STEM outcomes, and finds systemic *solutions* to disparities hard to think.

Emphasis on *Workforce Preparation* reminds the public of the collective benefit of high-quality and universal STEM training. The most promising aspect of the media's coverage of STEM education is its discussions of the collective economic benefits of STEM education, rather than individual financial gain. The existence of this value in the media's coverage of STEM issues is an opportunity that communicators can use to create a more contextual and collective story of STEM learning in both formal and informal learning contexts by building on an existing strand in the current media narrative.

Conclusion and Recommendations

The coverage of STEM education presents opportunities for communicators attempting to advance public support for these issues:

- First, STEM learning in informal contexts does not receive a significant amount of attention in the media, indicating that there is "space" for communicators to introduce stories about informal contexts into the media. The ways in which STEM learning can be successfully implemented in informal contexts is a "new" angle to a broader public discourse on STEM education that may be of interest to journalists and their editors. Importantly, there is an opportunity to link informal and formal settings in stories that overcome the "worlds apart" theme, and to support more synergistic depictions.

- Second, initiatives to expand and improve STEM training in the United States receive overwhelmingly positive coverage; communicators, therefore, do not have to fight against negative media portrayals of STEM education initiatives. Instead, they can build upon existing positive coverage with stories that build out the "missing pieces" of the narrative structure — for example, by linking problems to solutions.

- Lastly, media coverage highlights the collective economic benefits that will accrue from improving STEM instruction, which broadens the discourse beyond just individual financial gain. This is a major opportunity for communicators to use an existing value to build a more productive and contextual story of STEM learning. Here there is no reframing necessary, but a more concerted effort to systematically link stories to this media narrative already in use.

However, this analysis also highlights problematic aspects of the stories the media tell about STEM education in the United States. First, experts and advocates will be under pressure to continue to provide stories about individual successes and failures in STEM learning and teaching. This is a pressure communicators should resist. Second, experts' and advocates' stories about the innovation and effectiveness of STEM pedagogical practices used in informal contexts risk being "hijacked" to highlight deficiencies in the public education system in teaching STEM-related subjects. As explored in this analysis, this tendency will dampen support for policies aimed at improving STEM instruction and ensuring that all students have access to high-quality STEM educational opportunities. We

recommend that communicators employ the following strategies to avoid reinforcing these problematic tendencies in coverage:

Tell stories about systems. In interactions with the media, communicators should seek to create a narrative that defines STEM learning, explains why this kind of training is important, explains the current challenges facing this kind of instruction in the United States, and describes the kinds of policies and programs that can effectively address these challenges. These stories should avoid individualizing or episodic portrayals of STEM learning and teaching. For example, instead of highlighting an individual girl's success in STEM disciplines, communicators might describe systemic obstacles to girls' access to training and how informal learning sites are especially helpful for reducing gender disparities in STEM-related occupations.

Use the *Charging Stations* Explanatory Metaphor to explain disparities in outcomes in STEM subjects. FrameWorks developed the *Charging Station* metaphor to bring systemic and structural causes of disparities in educational outcomes into focus. The metaphor effectively inoculates against the tendency in the public to attribute disparities to individual characteristics and traits. This will be an important communications tool for communicators who are working to build support for programs that address such disparities, because when the public can grasp the systemic causes of racial, class or gender disparities, they are more likely to support policy-level solutions.

Use the *Pollination Points* Explanatory Metaphor to model the relationship between formal and informal learning contexts. Communicators should take advantage of opportunities to teach the public *how* informal learning contexts constitute an important part of the learning "ecology" in which students are embedded. The *Pollination Points* metaphor was developed by FrameWorks to expand public understanding of where learning takes place, and is particularly helpful in this regard. It provides the public with a concrete way of understanding the idea that informal sites are important *learning* contexts, rather than simply a distraction or "time off" for students. The metaphor also sets up a productive way of thinking about the relationship between formal and informal learning contexts by positioning informal learning opportunities as sites that enhance and complement learning in formal contexts, rather than "pick up the slack" for failing schools.

APPENDIX: THEORETICAL BACKGROUND: Theories of Framing and Narrative in Mass Media

This analysis draws on theories of framing and narrative. *Framing* deals with the presentation and selection of perceptual cues that make stories meaningful, while *narrative* is concerned with the structure of frame elements. Taken together, these concepts can be employed to chart the types and relative frequency of media messages within media coverage, and to formulate hypotheses as to the effects of media messages on their audiences.

The literature on framing spans the social and cognitive sciences, including disciplines such as communications, political science, sociology and psychology. At FrameWorks, we define framing as "the selection of certain aspects of an issue in order to cue a specific response … the way an issue is framed explains who is responsible, and suggests potential solutions conveyed by images, stereotypes, messengers, and metaphors."[31] The conventional belief is that framing's effects on public opinion stem from the psychological process known as accessibility. That is, contextual cues in the frame activate, or prime, particular mental representations, which stay "on top of the mental bin" and become more accessible at the time of judgment.[32]

Over the last three decades, researchers in the social sciences have become increasingly interested in how narrative inquiry can be applied to studying various aspects of social life.[33] Like framing, there are rich and varied literatures on narrative, complete with controversies surrounding definitions and analytic approaches.[34] One useful definition of narrative holds:

> *Narrative stories in the human sciences should be defined provisionally as discourses with a clear sequential order that connect events in a meaningful way for a definite audience and thus offer insights about the world and/or people's experiences of it.*[35]

In order to distinguish narrative from other forms of discourse, and to separate one narrative from another, scholars have sought to define the components that constitute particular narratives. Labov and Waletsky described the following elements of narrative:

- An abstract (a summary of the what the narrative is about).

- The orientation or setting.
- The complicating action (what happened).
- The evaluation (the significance of the event).
- The resolution.
- The coda, which relates the narrative to the present.[36]

They developed their approach to narrative in the context of oral storytelling. However, it has been employed to examine a variety of narrative forms, including film, archival documents, rituals and, most important for our purposes, media texts.[37] For the purposes of studying socio-political issues in mass media, FrameWorks has simplified Labov and Waletsky's scheme to include orientation, cause and solution, on the assumption that media stories have a less complicated structure than the interpersonal narratives that their typology was developed to chart. Our scheme, in addition, builds off of humans' natural tendency to focus on causes and solutions — an impulse that is reinforced in media narratives.[38]

Scholars acknowledge that narrative makes information meaningful through recognizable, continually reiterated and culturally specific representational forms.[39] Furthermore, narratives have the power to channel certain forms of interpretation and prescribe the scope of possible social actions.[40] As narratives are retold, they are continuously resubstantiated and come to dominate public discourse. As dominant narratives, they have an extraordinary effect on how citizens understand the world around them.

The media are arguably the most powerful producers of socio-political narrative in the United States and, in many ways, control the kinds of narratives that we are accustomed to encountering.[41] Conventionally, schools of journalism consider news media a form of objective, impersonal and unbiased accounts of "what happened."[42] Analyzing news media as narrative, however, looks to the cultural processes by which meanings about social issues circulate and become part of the public's everyday and dominant understandings of those issues. Journalistic modes of storytelling can determine whether problems are interpreted as necessitating individual or societal-level action,[43] as well as articulate dominant social values and guidelines for appropriate behavior.[44]

About The FrameWorks Institute

The FrameWorks Institute is an independent nonprofit organization founded in 1999 to advance science-based communications research and practice. The Institute conducts original, multi-method research to identify the communications strategies that will advance public understanding of social problems and improve public support for remedial policies.

The Institute's work also includes teaching the nonprofit sector how to apply these science-based communications strategies in their work for social change. The Institute publishes its research and recommendations, as well as toolkits and other products for the nonprofit sector, at www.frameworksinstitute.org.

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