Innovations

Using 3MT Storytelling Approaches to Improve Science Communication

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Abstract

Traditional academic communication practices tend to be jargon-heavy jargon and lack public relatability. Thus, it is paramount that scientists learn to develop effective communication skills. The Three Minute Thesis (3MT) competition is one avenue to refine and build science communications skills. Using one static slide as a visual supplement, competitors have three minutes to explain their research goals and relevance through easily comprehended vernacular. Using an observation protocol including three criteria: presentation framing, verbal, and non-verbal communication, we identified characteristics of prior successful 3MT presentations. We also tested the identified characteristics by observing 15 local 3MT presentations and found that all successful presentations contained similar communication patterns. For example, we found that using storytelling frames resulted in the most compelling and successful presentations. Our study offers implications on how these identified characteristics can be used to help budding scientists build critical communication skills for sharing their research with non-scientists. Scientists can apply our outcomes to build effective presentations and successfully deliver science messages helping create a more informed public.

Key Words: Science Communication, Storytelling, Generalist Audience, Three-Minute Thesis

Introduction

With the influx of anti-science rhetoric, now more than ever, scientists need to develop their communication skills to provide the public with information in a comprehensive form they can understand and use (Jucan & Jucan, 2014). Unfortunately, traditional academic practices and the inherent complexity of academic disciplines have painted a picture of science that is isolated from everyday experiences, and the jargon-heavy language typical of academics has enforced the need for 'translators' to act as an intermediary between science and society (Avraamidou & Osborne, 2009). By borrowing skills from interpretive practices, scientists can be effective science communicators, even through messages as short as three minutes.

It is paramount for junior researchers to be able to develop effective communication skills throughout higher education as we fight to improve scientific literacy (Baram-Tsabari & Osborne, 2015). The Three Minute Thesis (3MT) competition serves as a platform for graduate students to refine their presentation and research communication skills while practicing explaining their research goals and relevance in a vernacular that caters to a broad but intelligent audience. During the 3MT, graduate students explain their thesis research within three minutes using only one static PowerPoint slide as a visual aid (University of Queensland, n.d.). Although graduate students deliver these presentations across all academic disciplines, and some presentations may lack professional

polish, the 3MT has important educational value for how to approach communicating advanced research with non-specialist audiences (Hu & Liu, 2018). The 3MT allows for the cultivation of research-based technical skills that will supplement future endeavors in both academia and industrial projects. This is also a step in learning how to interpret a researcher's work for non-scientific persons.

While the 3MT began in 2008 at the University of Queensland with 160 postgraduate research students competing (University of Queensland, n.d.), today, the competition has been adopted in 85 countries outside of Australia, with over 900 competitions hosted annually. The 3MT competition provides an exciting competitive environment for students to practice and develop verbal science communication skills used in academia, popular media, community presentations, healthcare consumer, and funding bodies (Davidson & Ferguson, 2014). This academic genre allows graduate students to hone their interpretive communication skills with non-experts, foster presentational competence, and prepare to defend their research (Mezek & Swales, 2016). But like any skill set, understanding key elements and maintaining continued practice is essential for mastery.

The 3MT format may serve as a tool for those not only wishing to further their career but also their science communication skills. Still, amongst the litany of research articles on scientific communication and its place in academia, few have investigated the role of the 3MT (e.g., Carter-Thomas & Rowley-Jolivet, 2020; Hu & Liu, 2018; Hyland & Zou, 2021; Yang, 2020). In an effort to aid researchers across all science disciplines in increasing their communication efficacy, our study 1) examined what has made prior 3MT presentations successful, 2) created a set of critical communication characteristics based on successful 3MT presentations, and 3) tested identified parameters for communication effectiveness.

Literature Review

Unlike other interpretive communication outlets, the 3MT imposes a strict time restriction of three minutes and requires appropriate messaging for a non-specialized audience (Hu & Liu, 2018). A prior inquiry into 3MT presentations showed that successful presenters tended to use similar stable approaches across the board, regardless of discipline (Carter-Thomas & Rowley-Jolivet, 2020). In contrast, Hyland and Zou (2021) found that while the overall presentation structure may look similar due to the limited time structure and the anticipated audience, presenters used different approach stances depending on if they were communicating hard or soft science. They found that successful presenters of hard sciences tended to use hedges (acknowledgment of variability in the observation of results) and boosters (confidence and commitment) whereas successful presenters of soft sciences tended to focus more on self-assertion (Hyland & Zou, 2021). Further research has indicated that successful 3MT presenters communicate their research using a first-person, present tense, authoritative voice when engaging with their audience (Hu & Liu, 2018; Yang, 2020). These prior investigations did not consider the impact of nonverbal communication such as presenter blocking, eye contact, posture, facial expression, hand placement, types of visuals used, or size of visual content in their analysis of successful 3MT presentations. Additionally, these prior investigations did not review the role of the visual support provided by the single slide that presenters are allowed to use during the 3MT. Visual communication can help convey complex scientific ideas when represented in an accessible format (Daniel, 2018). However, scientists are not typically trained in visual communication. Thus, experts and novice scientists may both struggle to produce appropriate representations of their scientific data (Daniel, 2018; Hullman & Bach, 2018; O'Donovan et al., 2015).

Science Communication and Academia

A scientist's reputation and the impact of their research rely heavily on their ability to effectively communicate their findings (Becher & Trowler, 2001). Thus, there is a growing consensus that strong verbal communication skills are a vital asset for both early-career and established scholars (Shaikh-Lesko, 2014). While much scientific research is communicated via written manuscripts, oral presentations and interpretive messaging are becoming increasingly popular (Hyland, 2006; Lee, 2016). Still, traditional academic training in higher education does not typically prepare student scientists as effective science communicators for non-specialist audiences (Jucan & Jucan, 2014). It is more common for scientists to learn how to communicate research to peers and focus on explaining hypotheses, executed methods, data analysis, and technical results (Baron, 2010; Baram-Tsabari & Sharon, 2014). Although many scientists engage in science communication voluntarily, other scientists believe that sharing the implications of their research outside of their professional circles carries risk and could damage their credibility (Allen, 2018; Poliakoff & Webb, 2007). This belief is likely due to the potential for highlighting their own bias, overstating claims, or making imprecise statements (Allen, 2018). Specifically, there is a need for scientists to learn how to present research to non-specialists in an engaging manner (Green et al., 2018; Zimmer 2018). Despite notable new directions, many communication efforts continue to be based on ad-hoc, intuition-driven approaches, paying little attention to several decades of interdisciplinary research on what makes for effective public engagement. (Nisbet & Scheufele, 2009).

In teaching the content of science curriculum and the values that often go with it, we sometimes unwittingly, perpetuate a certain harmful mystique of science. That mystique tends to make science seem dogmatic, authoritarian, impersonal, and even inhuman to many students (Dupree & Fiske, 2014; Jucan & Jucan, 2014). Science can also be portrayed as being much more difficult than it is, turning scientists into geniuses with whom students cannot identify and increasing the potential for alienating students from science (Lemke, 1990). Poor communication is contextually characterized by the action of withholding scientific knowledge, thus making it unavailable (Fischhoff, 2013). Poor communication or a lack thereof contributes to lasting damage between scientists and the public by eroding trust and creating a disconnect. As a result, the general populace sees scientists as insensitive to their needs, while scientists see civilians as incapable of grasping fundamental knowledge (Fischhoff, 2013).

Science Communication Efficacy A Growing Area of Study

Science communication interest has drastically increased over the past several years. For example, a network of informal educators (e.g., park rangers, zoo and museum docents) promotes effective scientific communication through interpretive programs for millions of public visitors each year (Allen, 2018). These interpreters propagate scientific stories where they are most meaningfully told, in the places where members of the public are open to learning (Allen, 2018). Still, there is a need for scientists who are subject matter experts to learn how to communicate with or collaborate with communication experts to develop an accurate and compelling narrative (Fischhoff, 2013). Science educators and organizations have even explicitly identified communication skills as a requisite competency for scientific literacy in the twenty-first century (Chung et al., 2016). Efforts to increase scientist engagement in dialogue and participatory forms of communication are most likely the cause of this real and lasting behavioral change (Monroe et al., 2008)

Effective science communication informs people about the benefits, risks, viability of future outcomes, and other costs of their decisions, allowing the recipient audience to make more informed decisions (Fischoff, 2013). As the rhetoric of outrage surrounding

controversies over science and policy increases, there is an urgent need for credible, trusted voices that frame science issues in ways that resonate with a diverse public (Allen, 2018). However, even the most effective communication cannot guarantee that people will agree about what those choices should entail regarding decision-making (Fischoff, 2013; Lackey, 2007).

Storytelling and narrative

Scientific pursuits are integral to critical thinking and growth within the scientific community. Science is used to identify problems, understand their extent, systematically seek solutions, and help shape many aspects of our societies (Green et al., 2018). Researchers are privy to witnessing discoveries and changes that most people will never be able to experience (Green et al., 2018). As such, scientists must learn how to share their research in engaging ways through effective communication strategies such as storytelling (Green et al., 2018). Storytelling, in its essence, takes one of three approaches:

- **Shape 1: Discovery -**Discovery is at the very essence of science and good stories. As scientists, our methods revolve around asking questions and discovering answers.
- **Shape 2: Rescue** - Science in service to society operates on the core tenet that the research outcomes should be solutions to significant challenges that we face as individuals, communities, nations, and as a global community.
- **Shape 3: Mystery -** Often, phenomena occur that we cannot readily explain, and there is much at stake–often for society– by not understanding how, why, and what has transpired. Part of what drives science is the desire to solve mysteries and uncover a new understanding of the world, leaving us at a story high (Green et al., 2018).

Human beings know story structure implicitly (Bruner, 2003), making storytelling a type of universal language that connects our communities together. Using stories helps audiences remember communicated themes as they evoke the need for resolution (Orgborn et al., 1996). Stories act as a vehicle through which experiences and events are communicated across audiences. Stories even have the potential to influence people's understanding and beliefs, as well as promote societal and cultural change (Schank & Berman, 2002; Brock et al., 2002). Additionally, the use of story-telling should be integral in both science and environmental education as using narrative strategies may be more appropriate for representing science than expository textual practices (Avraamidou & Osborne, 2009; Gough, 1993). Such an idea is not a large stretch when considering that current 3MT presentations have been found to use a higher rate of positional stances compared to science shared through written communication (Hyland & Zou, 2021).

Framework

Our study was guided by the idea that 3MT presentations provide a way of sharing research through a storytelling or narrative lens. As these presentations are intended for wide generalist audiences representing diverse backgrounds in content knowledge, it is critical that speakers use accessible language to tell their research story (Sugimoto & Thelwall, 2013). The use of professional scientific jargon can create a cognitive gap causing what is being presented by a speaker to not be accurately understood by listeners (e.g., Otoshi & Heffermen, 2008; Rakedzon et al, 2017; Willoughby et al., 2020). Presenters are encouraged to offer an academic narrative that helps to demystify scientific concepts and promote the outcomes of their projects (Jiang & Qui, 2022; Qui & Jiang, 2021). Furthermore, 3MT presentations are intended to be shared in a manner that does not require a high degree of subject-matter knowledge on the part of listeners (Qui & Jiang, 2021). As such, one aspect of 3MT presentations we looked at included verbal characteristics of each talk such as the use of jargon: whether the presenter used ample professional jargon, took time to define included jargon for the audience, or found ways to communicate their science without the need

for professional jargon.

Effective 3MT presentations must be structured in a way that captures and holds the interest of a typically non-scientific audience (Qui & Jiang, 2021; Taylor & Toews, 1999). One way a speaker can connect to an audience is by supplementing traditional academic thinking with emotionally connected storytelling (Copeman, 2015). Another way speakers can appeal to an audience is through persuasive interactions and the use of discursive strategies construing immediacy, affectivity, shared goals, and social support (Carter-Thomas & Rowley-Jolivet, 2020). Given the importance of using a communication structure that engages the audience, we looked at how successful speakers framed their 3MT presentations. This element included considerations of how presenters crafted their research narrative in terms of who was presented as the story protagonist, the shape (Green et al., 2018), the context of a story created to facilitate emotional appeal and intellectual impact (Copeman, 2015), and how the presenter framed their overall pitch. The pitch aspect cannot be overlooked, as academic interactions are widely acknowledged to be persuasive. Academics do not just report neutral facts, but instead take a novel point of view when discussing their findings as they anticipate and attempt to react to the views of their intended audience (Deroey, 2015; Hyland, 2001; Hyland, 2004).

Effective presentations require developing both verbal and non-verbal elements to support a performance presence that connects with an audience (Copeman, 2015; Otoshi & Heffemen, 2008). For example, elements such as the clarity of speech and voice quality (e.g., audible volume, a steady pace, organized structure, confidence of the speaker), the correctness of language (e.g., proper pronunciation, correct use of grammar), and how presenters interact with the audience (e.g., use of eye-contact, expressive body language, use of presentation space, visual enhancements) can increase communication effectiveness (Copeman, 2015; Otoshi & Heffemen, 2008). As such, in addition to presentation framing and verbal characteristics, we also took into consideration the non-verbal characteristics of each observed 3MT presentation.

Research questions

The purpose of our project was to investigate communication characteristics of successful 3MT presentations and test those parameters by observing a local university 3MT competition based on how student presenters used those characteristics. The aim of which is to help researchers in all science disciplines increase their communication skills and efficacy for interacting with generalist audiences. Specifically, we focused on the following research questions:

1. What combination of communication elements leads to effective parameters for presenting research to generalist audiences during a 3MT presentation?
2. To what extent do applied communication elements lead to predictably effective presentations?

Methods

Participants

We used a qualitative approach to explore the presentation structure and communication approach for 60 first and second place 3MT presentations over six years from five official 3MT competitions across the globe. Of these observed presentations, 70% focused on science, engineering, or medical topics, while 30% focused on other topics such as applied arts, social sciences, or education. Then we tested the extent to which the identified communication parameters from these prior winners were followed by 15 presenters competing at a local 3MT competition and their resulting success. We then developed implications for scientists to consider when building effective talks for generalist audiences.

Data Sources

We created a communication element protocol to collect observation data from 3MT presentations. This protocol included 19

communication criteria drawn from our framework and organized into three categories: presentation framing, verbal communication, and non-verbal communication.

Presentation Framing.

The presentation framing category of our observation protocol focused on the presentation structure itself and included seven communication criteria: the main character, type of hook, presentation of the problem, resolution, shape of the story, approach, and consistency between approach and resolution. For the main character criterion, we recorded who was presented as the primary focus of the talk. We identified the main character as the audience or as someone else including the presenter themselves. For example, we identified the audience as the main character when the presenter referenced statements such as, “Consider this, you have stumbled upon an…” or, “Let’s say that you decided to explore…” Whereas, we identified the main character as someone else or the presenter when the speaker referenced a hypothetical person doing the research or used first-person voice to share their own role in the story. We described the opening sentence or phrase that the narrator used as the type of hook. We coded the type of hook used as either using a statistic, sharing an opening story or anecdote, making a factual statement, posing a rhetorical question to the audience, describing an analogy, or not using a hook and instead proceeding directly into the body of the presentation. We also coded presentations according to if the presenter posed a problem that they were addressing or not and if that problem was resolved, not resolved, or if their work was in the process of finding a potential resolution by the end of the presentation. We used our guiding framework (Green et al., 2018) to identify the shape of the stories presented. Presentations shaped as Discovery stories involved the presenter taking the audience on a journey of ups and downs ending with a problem solved or definitive actions being taken and the story ending on a positive note. Rescue stories involved the presenter starting out on a high note, such as an exciting event, but then having the story take a negative turn, such as a discouraging event or disaster before ending the story on another positive note or resolution. In Mystery stories, the presenter began with a problem presented but not solved. However, in mysteries, the speaker also mentions a positive direction for the future when wrapping up the presentation. We focused on if the presentations used any of these defined story shapes versus presentations with no defined shape, wherein the presentation did not fit into the three prior defined classifications. For the approach criteria, we coded presentations on if they took a storytelling or cheerleading strategy or a reporting or marketing pitch strategy. With storytelling, the presenter used a narrative to share their thesis results. As a cheerleader, the presenter used positive vocabulary to get the audience on board with the project. For example, using this strategy a presenter may use language such as, "We can do this," or, "Let's go, team!" With the marketing pitch strategy, the presenter made it a goal to get the audience interested in a tool or object used in their daily lives. With the reporting strategy, the presenter was more likely to use unbiased facts with no clear storyline (e.g., an engaging lecture). For the consistency criterion, we looked at if the presenter’s approaches and resolutions were consistent with literature expectations. For example, we expected that presentations using the cheerleading and marketing pitches included resolved problems while reporting strategies offered resolved problems or potential resolutions in process, and we expected stories to be about potential resolutions in process. We recorded these interactions as either consistent with expectations based on prior published communication theory (Green et al., 2018), partial to what would be expected (i.e., when a story offered a fully resolved problem), or not consistent.

Verbal Communication.

The verbal communication element of our observation protocol focused on the qualities of oral delivery of the 3MT and included five

criteria: cadence, tone, volume, use of jargon, and verbal emphasis. For the cadence criterion, we coded the pace at which the presenter used as slow, naturally rhythmic, or fast. We coded the presenters' tone as fluctuating, normal, or monotonous. We coded the volume criterion based on the level of projection the presenter used as clearly audible or too quiet. The jargon criterion encompassed the amount of subject-specific language the presenter used during the 3MT and the care given to defining the jargon used. We recorded if presenters avoided jargon or explicitly explained the technical jargon included in the presentation versus presenters who used jargon without providing explanations for the terms. The final criterion in this category, verbal emphasis, focused on the different ways the narrator chose to add emphasis to their story be it through purposeful pauses or explicit emphasis on targeted words, conversational narration, or no noticeable emphasis.

Non-Verbal Communication.

The non-verbal communication element of our observation protocol focused on describing the physical actions of the presenter as well as the visual composition of the presentation slides. This category included seven criteria: presenter blocking, eye contact, posture, facial expression, hand placement, types of visuals used, and the size of supplemental visual content. We coded presenter blocking, or how the stage was used by the presenter, based on if the presenter gave their entire presentation from a single location, or if they made purposeful or constant movement across the stage. We coded the eye contact criterion on whether the presenter focused on a single, outward point or if they made eye contact with multiple audience members. We coded presenter posture on whether they carried themselves in a normal or relaxed stance or if they were more rigid or slumped in stature. Presenters varied in their facial expressions with some maintaining a similar expression throughout the 3MT, while others included explicitly animated facial expressions in order to emphasize points made. The hand pavement criterion described where the speaker placed their hands when not gesturing. We coded presenters that held both of their hands in front, similar to a basketball stance as normal versus other resting hand positions, including if presenters clasped their hands in front or behind them, used one hand to move while the other stayed still, or kept their hands at their sides of the body and not moving. We also coded the type of visuals on the single slide used to support the presentation as either a picture, collage (i.e., multiple visual types used in combination), diagram, graph, text, or no visual used. Then we coded the size of the visual content as being legible and easy to see or too small/missing.

Analysis

We used a deductive approach to code the 60 prior winning 3MT presentations for which characteristics they used according to the described criteria included in the observational protocol. We then compared implemented criteria across the winning presentations in search of communication patterns. Then, we reviewed observations of presentations from a local 3MT competition to map emergent patterns and explore to determine how accurately we could predict the winners in a local 3MT competition as evidence of successful communication.

To complete this predictive investigation, we first observed and analyzed the 15 local 3MT presentations in the same manner as the prior winners coding the communication criteria in the same manner described prior. We then compared our tested outcomes from the current 3MT competition results to our prior expected means to determine the accuracy of the predictive power for both the preliminary and final competition rounds. To test successfulness of these local presentations, we compared individual communication patterns across each category to the established presentation patterns recorded from prior winners. We record participants with communication patterns that most overlapped the prior presentation profile patterns and were mostly like to be judged highest in the competition,

therefore we predicted them as being the mostsuccessful communication strategies. If participants majorly deviated in which communication criteria they used in comparison to prior winners (e.g., major pauses in presentation, lack of observable structure), we eliminated them from consideration as predicted round winners. Then, in order to determine the likely winners across each round of the local 3MT competition, we ranked qualified participants based on which presentation profile most overlapped established representative profiles from prior winners in each category: we weighted ranking on Presentation Frame mean as the strongest category, followed by Non-Verbal Communication, then Verbal. We predicted competition success by averaging the rank scores across categories to determine the overall rank scores for each participant. In the event of a tied rank, the participants received the same rank score, and we skipped places until reaching the next rank score (i.e., if there was a 2nd place tie, we ranked participants, 1st, 2nd, 2nd, and 4th). Given the nature of the local 3MT competition, in the event that more competitors were eliminated than preliminary awards available (four winners from each preliminary round moved on to the final competition for a total of 12 finalists), we included previously disqualified competitors until we were able to make predictions about the rank the top four speakers in each preliminary round. We systematically requalified presenters by selecting individuals that qualified in at least two categories and matched at least partial profile patterns with prior winners. We only predicted the ranking of the top two speakers in the final round of the competition as there were only two final awards presented, first and runner-up. We did not attempt to test models of prediction for the 3MT people's choice award winners as this award was largely decided based on which participant drew the most attendance for support and votes rather than on communication composition and skill. Thus, the people's choice award is not dependent upon the identified communication criteria and cannot be predicted using our model.

Results

Using our observation protocol, we found that prior winning talks (n=60) were similar in composition across three criteria of presentation framing, all five criteria affiliated with verbal communication, and four criteria of non-verbal communication.

Similarities Across Successful Presentations

We found that all presentations (100%) introduced their thesis as a problem that needed to be solved and most presenters (96.7%) offered a complete or partial resolution to the presented problem. All (100%) of the winning presenters used a storytelling frame although the nature of the story slightly varied (Mystery 71.7%, Discovery 20%, and Rescue 8.3%).

We found that winning speakers were consistent across all five criteria observed within verbal presentation skills. The speakers talked with a rhythmic cadence (91.7%), maintained a loud enough volume projection for all audience members to easily hear (98.3%), used verbal fluctuations in their speaking tone (100%), and included purposeful verbal emphasis (85%) to draw home main talking points. Furthermore, we found that the successful presentations used limited to no professional jargon usage or limited jargon was well explained when included (90%)

We found that all (100%) successful presenters maintained eye contact with the audience as they talked and most (95%) maintained a natural and relaxed posture during the talk. We also found that the majority (75%) of successful presenters kept their hands placed in front of their bodies in an open position while talking. The remaining speakers tended to keep their hands clasped (21,7%) or to their sides (3.3%) during the presentation. Successful presenters also were consistent in including easily legible text size or providing no text on their supplemental slides (96.7%). In all cases of successful 3MT presentations, the presenters explicitly addressed the images presented on their slides as part of their talk.

Differences Among Successful Presenters

The main differences among prior 3MT presentation winners were recorded primarily within the remaining seven criteria (four criteria connected to presentation framing, and three criteria connected to non-verbal communication). For example, while all but five (8.3%) winning presenters used a type of hook, we found variation in the nature of the hooks used. Of the successful presenters, 26.7% began their talk with a personal story or an anecdote; 21.7% used a call to action; 21.7% asked a question of the audience; 18.3% provided a relevant statistic; and 3.3% shared an analogy connected to their topic. And, while we found that all winning presenters used a storytelling approach to frame their talk, speakers varied in their selected storytelling approach. While all winning presenters framed their talk as a story, 40% acted as reporters, 35% gave a generic story narrative, 23.3% used a marketing pitch approach, and 1.7% acted as a cheerleader. Likewise, we also found that every presentation used a person as the main subject of the story presented, but differentiated in whom they chose to serve as the main character of the presentation with 36.6% putting the audience or "you" and the focal person, 31.7% placed themselves as the focal person, and 31.7% created a fictional entity to tell their story about. We found larger differences when comparing how the presentation shapes used matched the approach and resolutions offered during the presentations. We anticipated that the successful talks would offer consistency to the expected outcomes, but instead, we found that only 61.7% of the winning presentations were consistent in the structuring of their selected storytelling framework with the expected shape and resolution. We found that 13.3% of presenters structured their talk in a way that offered a partial match and 25% of presenters were not consistent across their storytelling structure. This particular finding led us to believe that many of the presenters may be skilled storytellers for these competitions but have not developed sophisticated communication techniques aligned with research-support practices.

The variability across presentations also helped define each talk in a personalized manner. For example, presenters varied in their use of visualizations (pictures 48.3%, collages 30%, diagrams 15%, graphs 3.3%, text only 1.7%, or nothing 1.7%) to best showcase their research. These visualizations ranged from cute cartoons to detailed representations of their data, with the slide often matching the personality and story choice of the presenter.

Likewise, successful presenters used blocking and facial expression in different manners, but in ways that emphasized the intended message and enhanced the story they presented. The winning speakers tended to stay in one place on the stage or move at most to one new position during their presentation (75%). However, some (18.3%) used purposeful blocking to drive home talking points, and others (6.7%) constantly moved around the stage. Also, 63.3% of the presenters were very facially expressive or animated during their presentation, while 30% of speakers could be described as maintaining a normal facial expression and 4.7% held a flat expression throughout the talk.

Testing Our Criteria Model

Using our described observational protocol, we were able to successfully predict nine of the 12 preliminary participants who advanced to the final competition as well as both of the final 3MT winners (Table 1). More interestingly, we were able to successfully predict the accurate rank of the three preliminary finalists and both final competition winners. We found that the 3MT presenters who purposefully developed their presentation's story shape in accordance with their intended message, combined with an appropriate approach, advanced further in the competition. While framing science messages through a storytelling lens was the most compelling similarity across successful 3MT presentations, we found that no single criterion outweighed any others in terms of importance. Still, the combined use of best communication

Table 1. Predictions on presenter advancements through 3MT competition.

Participant	Predicted Rank	Official Rank	
Preliminary Competition			
Group A			
Qualified Presenter 1	4	1	*
Qualified Presenter 2	3	3	*
Qualified Presenter 3	1	PC	
Qualified Presenter 4	1	2	*
Qualified Presenter 5	NR	NR	*
Group B			
Qualified Presenter 1	4	3	*
Qualified Presenter 2	3	NR	
Qualified Presenter 3	2	2	*
Qualified Presenter 4	1	1	*
Group C			
Qualified Presenter 1	2	2	*
Qualified Presenter 2	4	1	*
Qualified Presenter 3	2	3	*
Qualified Presenter 4	1	NR	
Final Competition			
Qualified Presenter 1	1	1	*
Qualified Presenter 2	2	2	*
Qualified Presenter 3	NR	NR	*
Qualified Presenter 4	NR	NR	*

**Successful prediction based on weighted observational protocol. (NR = No Rank, PC = People's Choice Winner)*

practices is what resulted in the highest-ranking presentations by competition judges.

Our model does not recommend a single communication style or stance combination that is unilaterally appropriate for sharing science stories with a generalized audience. Rather, our data suggest that potential presenters can follow our general communication model guidelines to develop a successful presentation. We noted that most successful 3MT presentations began with a strong, related hook, used a lead-in in which the speaker introduced themselves and their research problem, and included three main speaking points with evidence that supported their primary take-home point. Furthermore, successful while 3MT presenters showed some variability in jargon usage, none of the observed 3MT winners gave jargon-dense talks.

Implications for Practice

Exploring ways to reach community members that may view science with skepticism is an important step toward increasing scientific literacy in the community, and events like the 3MT provide one such avenue researchers can use to communicate scientific information (Allen, 2018; Schmitt, 2008). Additionally, building a scientifically literate populace is essential for taking steps toward passing science-based policies and making publicly supported positive environmental impacts. To build this populace we need audiences to understand the messages we convey. Prior research (Schmit, 2008) claims that audiences need to understand at least 98% of the words used in order to fully comprehend a message. This notion is consistent with the notion that

presenters should use accessible language to tell their research story (Sugimoto & Thelwall, 2013) and the approach of successful 3MT presenters during our investigation. We can further aid science communicators by teaching them how to avoid jargon-heavy language typically associated with science presentations by providing them with tools like the De-Jargonizer to identify potentially problematic terms to avoid in order to improve language comprehension of intended messages (Avraamidou & Osborne, 2009; Rakedzon et al., 2017). Furthermore, scientific storytelling can encourage non-scientists to be more open to learning (Allen, 2018; Fischhoff, 2013) and possibly help reduce skepticism by building transparency, improving trust, and reducing the potential mystique around research that can alienate the discipline from non-scientists. Storytelling can increase accessibility to sometimes inapproachable and complex science topics (Fischhoff, 2013) through the personalization of science messaging, allowing scientists to be viewed as more human to their audience. By selecting a purposeful narrative to shape a scientific message (discovery, rescue, or mystery) (Green et al., 2018), successful 3MT presenters were able to share their research in an engaging and effective way. And even within the short three-minute time limit, taking a moment to explain the link between the provided visual and the presented verbal message can support audiences' attention to the intended message and illustrates best practices for building representational competence (Daniel, 2018; Qiao & Hullman, 2018). Reconsidering science communication as a form of storytelling with visual aids can help audiences connect with scientists as characters and increase buy-in to the presented problem as a theme that needs a resolution (Avraamidou & Osborne, 2009; Gough, 1993; Orgborn et al., 1996).

Overall, effective science communication serves to help create an informed audience that can understand and apply scientific ideas as they make informed decisions within their community (Fischoff, 2013). The 3MT is one option we can support to help early career scientists build their essential communication skills and become trusted voices listened to by generalist audiences.

Acknowledgments

We wish to thank the Daniel Biology Education Research Lab, particularly Lyric Pullman and Ryan Spencer, for support with data collection and for providing a critical eye for us to consider our project outcomes. This study was conducted following approved IRB procedures (#6322).

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