Analyzing Engineering Design Stories – Predicting Engagement in Inventive Action

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Abstract – **In this experiment we intend to discover characteristics of stories that make them effective and utilize the findings to teach engineers and designers effective storytelling to create inventive action. A diverse team of undergraduate and graduate students, and faculty across university departments formed and re formed methods for a preliminary investigation.** One central research question organized the study: How do ineffective stories predict disengagement? A paper and pencil test and a projective cue method are utilized to uncover preliminary findings. Results from four audiences in one experiment show a high engagement for an effective delivery and some surprises concerning engagement regardless of delivery. The experiment also reveals that participants imagining what would happen next in the ineffective story included a surprising amount of communication cue suggestions for the ineffective story. And, achievement motives were clearly stated across all stories. Results provide us with promising evidence to suggest that we are able to connect audience engagement with the level of effectiveness of a story. Finally, we discuss implications for further work and applications of the findings in engineering and design education.**

Index Terms – Storytelling, Engineering Design, Source and Narrative characteristics, Inventive Action

INTRODUCTION

Our diverse team began a conversation about designing a research study on telling organizational stories—a Ph.D. mechanical engineering student, a co-term cognitive science student, a golf scholar athlete, a football scholar athlete, and professors across departments of engineering design and communication. We began talking about what makes an effective story. We then talked about the communication cues that engage people. We continued to discuss the engineer or designer as an entrepreneurial leader context and the impact of stories and storytelling on not only communicating a compelling message but also facilitating progress forward on a project. Multiple meetings later, after extensive attention to the definition of variables, and intrigued by the learning possibilities of studying the opposite, we decided to flip our question around and examine the elements in an ineffective story that predicts disengagement. We draw upon previous work [1] and explore the cues in entrepreneurial leader stories and the existing literature [2, 3, 4] on the universal cues in organizational stories and disengagement.

"What drives your desire and vision for your project?" Ask this question at any stage of a project and you will not receive a clear outline describing the steps to making your vision a reality. Instead, you will hear a *story*. Stories are used as the primary mode of engagement. There are some obvious similarities across stories. Specifically, designers and engineers (D/Es) talk about: attempts to thrive from the beginning stages of an idea; the joy and frustration of iterating on prototype after prototype; their successes and failures of getting people to commit to their goals; and the drifting and re-setting from one idea to another—all with the hope of creating a compelling artifact.

A few of these stories are strikingly clear and compelling, making one feel that they are working alongside the D/E, immediately grasping and committing to the vision and mission of the project. Unfortunately, the vast majority of the stories are opaque and disengaging: the listener cannot understand or identify with what is going on. This failure in storytelling doesn't just impede those trying to understand what happened. Instead, at every stage of creation, it is clear that the communication problems created by the inability to present effective narratives create barriers to enlisting others to understand and realize the D/E's goals.

In this study, we plan to find the things about a story that produce connections, which will in turn predict engagement. We examine whether one can influence audience respondents' feelings of disengagement merely by manipulating an entrepreneurial leader's way of delivering the story, including a theme of design discovery, and the storyteller's perceived need to communicate a good message.

We then intend to discover the characteristics of stories that make them effective and utilize the results to train D/Es in effective storytelling to create inventive action, i.e., to move forward in their work and make real progress.

Research Questions

RQ1a: Will there be a correlation between the effectiveness of the story and the engagement of the audience?

RQ1b: Can we identify and incorporate the necessary elements to make a story of discovery more effective?

RQ2: How do we combine these findings with theories of storytelling to help engineers/designers to progress and realize inventive action?

When a D/E is telling a story, he or she may have an excellent story to tell and all of the verbal skills to tell that story well, but that does not ensure that the D/E will effectively share his or her vision with the intended audience. What causes the disconnection between the capable D/E and the audience? One of the unique aspects of telling a story is that *what* is said does not determine the strength of engagement between the D/E and the audience. *How* that information is presented in the story will predict the effectiveness of the D/E to share his or her vision [5].

ENGAGEMENT TO STORIES

While many articles emphasize the role of stories in the corporate world [6], few consider the impact of storytelling on engagement in the engineering and design world. Stories connect engineers with designers, users with new technologies and all of us as a collective audience. Storytelling as a technique to facilitate and improve design and mobilize innovation continues to be a recent feature in the literature [7].

"A well-timed, well-aimed story can trigger emotions that transform an employee's point of view and motivate the desired reaction." An effective story can often motivate and compel employees to work in unison to reach a desired company goal. In a recent study, employees that are deemed "engaged" statistically have fewer sick days and even generate an average of 43% more revenue [8].

We all know famous leader-created stories that have often defined their company's policies and mission in the commercial market. Lee Lacocca of Chrysler decreased his salary to $1 in order to teach his employees the necessity of sacrifice. In part to Lacocca's story of sacrifice, Chrysler was saved [9]. Recognized start-up innovators tell compelling stories of their designs [10]. While not all leaders in engineering and design are immediately recognizable, they all tell a story that threads a common theme of engaging people within and outside of their project group with a story that transforms [11].

Other articles discuss the importance of pairing storytelling with audio and visual media to engage people in the organization. These stories (in turn) "create the opportunity for people to tell stories that illustrate, reinforce, and personalize the behaviors that are most critical to future success" [12]. Despite everything that is known about the power of storytelling, there is little that describes the process of disengagement from ineffective stories.

Every year, disengagement costs U.S. employers $300 billion [13]. It is crucial for company management to understand the signs of disengagement, thus understanding how their stories are ineffective. Previous findings offer engineers, designers and leaders a structured opportunity to articulate themselves toward progress because the process of engaging people was made explicit [14] and to support reflection [15], and commitment.

Engaging with another person has been defined as an apparently contradictory and often confusing dynamic within individuals and the group as a whole evoked by the issue of engagement in groups [16]. The paradoxes of engaging are deeply rooted in psychological theory that defines engaging as a form of self-reflection and as an unconscious boundary.

The psychiatric literature helps us understand engagement as a therapeutic process. One such example of engagement is with a study [17] on sex offenders in group therapy and shows the delicate relationship between engagement and denial and how that influenced level of progress. The sex offenders that were engaged showed progress in their treatment. On the other hand, "denial has been found to interfere with the willingness to engage in therapy and to increase resistance" [18].

In the current work we are interested in engagement as connection to an organizational message of discovery, and for new and untried ideas to be practiced through storytelling for real progress.

WHAT MAKES STORIES SO POWERFUL?

What makes stories so powerful? At a high level, we know that the human brain is built for stories [19]. Stories are memorable and can create effective mental models. Because stories are readily understandable, they create a shared vocabulary that leads to efficiency [20]. Finally, stories, especially engineering and design stories, are filled with action and a chase towards discovery, which leads to high levels of engagement.

Researchers have begun to realize that the process of engaging is fundamental for effective storytelling and organizational progress. Yet, no one has defined disengaging to a story within and outside of the organizational group. Either engaging has not been defined at all, or as a qualitative description of an effective story content or plot [21].

Understanding how people engage is particularly powerful in the engineering design world [22]. The inability of D/Es to successfully tell stories leads to a number of problems: 1) By telling stories that do not reflect the D/E's vision, stories can mislead not only the audience but the D/Es themselves; 2) D/Es who cannot tell a compelling story before and during the developmental stages of a project cannot get everyone on board with a single vision, and thus fail to generate effective designs and artifacts; and 3) ineffective story prevent D/Es from communicating back to the user, turning an ideally interactive process into a monologue. Even if the D/E's idea could revolutionize the world as we know it, by telling it in a way that is disengaging, the audience is likely to view the idea as even less appealing and to form an even more negative opinion about the idea. That is why it is important to tell the story in a way that engages the audience on your first attempt. The amount of time we spend on a task can be representative of how much we learn, but we must be focused on learning for the time invested to be productive. Likewise, the amount of time spent telling a story is not representative of the effectiveness

of the message. The story must be told on a way that is clear and engaging to attain measureable progress. In a learning environment, students don't always engage in the learning process to their fullest. By analyzing student disengagement, we can use response time and correctness of the response to determine the probability that a student was actively engaged in trying to answer a question [23].

RESEARCH APPROACH

By looking at ineffective storytelling, we can establish the commonalities/key elements among those stories that cause disengagement and understand the way in which the key elements of a story can be manipulated to create engagement. We will use 1 entrepreneurial story drawn from existing data [24] and manipulate the key elements that engage to discover a pattern that will show the commonalities amongst the disengaging stories. Once these commonalities are established, we are able to create an efficient recipe for storytelling that engages and will lead to quantifiable progress.

Operational Definitions of Variables
The independent variables: the story on a continuum of effectiveness: identified by source characteristics and content characteristics.
Story line of ineffective stories as poor delivery: lack of energy in non-verbal, verbal and paralinguistic communication cues; and (content) characteristics of artifact creation/discovery, including the audience.
The dependent variables: the audience engagement/disengagement as connection response - capturing attention, instilling achievement, interest in what will happen next.
The degree of Disengagement as the presence or absence of respondent's connection to a story: if the story captured their attention, if the participant wanted to know what would happen next, if the participant was motivated by the story.
Existing methodologies helped framed our approach. The existing methodologies are:
-Narratology [25] is an approach that assumes that there are a limited number of distinct story structures that are universal, and provides a method for identifying these underlying structures. Nass's laboratory has developed a "Narratology Toolkit" that is a software package that virtually represents the narrative structure for the storyteller that can identify deviation from the classical patterns.
-projective cue test-Encouraging respondents to imagine what happens next in a story; and to imagine how they picture themselves responding to the story. Using validated techniques from projective psychology [26, 27, 28], we can use the results to identify content or omissions from the existing narratives that are alienating the audience.
- We will: determine the test-retest and cross person reliability of each of the characterizations; use statistical techniques including T tests, Anovas, and other statistical tests to determine the extent to which each of these characterizations can support the outcomes listed above to produce engaging through: source energy in non-verbal,

verbal, and paralinguistic cues, support artifact creation and discovery, support level of connection to a story, and support effective content message communication.

METHOD AND CONTENT FOR ANALYSIS

Our first task was to write story about a person who was a design entrepreneur. Written in first person viewpoint, we wrote about a person named Pat who designed a product for the film industry. Based on existing data from the researcher's previous work, the story focuses on Pat's discovery, company, and current adversity. Once we had finalized the story, we made a duplicate that was missing specific components of the first story. The original story had elements of inclusion of the audience and various positive non-verbal and paralinguistic cues. This story is the effective story. The copied story lacked elements of inclusion of the audience and had various negative non-verbal and paralinguistic cues. This story is the ineffective story. Once we had the effective and ineffective story, we were able to get underway with our experiment.

For the experiment, we had participants sign up for one of four different time slots. Each of the four sessions had an average of nine people. In each session, we hired an actor to tell the story we previously wrote. For the first two sessions we had a man tell the two stories respectively. For sessions three and four, we had a woman tell the two stories. We split the acting between a man and a woman to ensure a gender-neutral bias in the data results.
In all four sessions, we had the same one of our researchers welcome the audience to the experiment and give them detailed instructions into what they we going to do. The instructions read as follows:
You are here because an entrepreneurial leader has a message for you. After listening to Pat's story we would like you to complete a short task and answer a set of questions. After listening, it will only take 10 minutes of your time. Pat will be available immediately after to answer any questions you have.
Once the instructions were read, our actor Pat came to the front of the room and shared his/her story. Once Pat finished with the story, we handed each of the participants a paper with various questions in it. Once they finished answering the questions, they turned their paper to the researcher and left.

PARTICIPANTS
The participants in this study consisted of 37 male and female students, ranging in age from 19-31, from a West Coast university, mostly enrolled in Communication classes, and receiving credit for research participation. Other students were enrolled in engineering design classes. Non-probability sampling was used due to a very limited budget and a ten week time line to create a research design and test the participants.

PROCEDURE
This experiment was completed in the context of an audience invited to listen to a message from an

entrepreneurial leader. Four separate sets of participants were informed in advance that they would be part of an experiment and scheduled across four different 30 minute time slots. All participants were thanked for their time. Professional actors were hired to deliver the story to groups of participants. One male actor delivered the effective story to audience one, and the ineffective story to audience two. One female actor delivered the effective story to audience three and the ineffective story to audience four. Each actor received a small honorarium for their role. One constant gender neutral story was delivered.

The same researcher delivered the introduction to the instructions to each audience with the preface, "An entrepreneurial leader has a message for you. Let me introduce you to Pat."

MANIPULATION

One story is varied with two versions for two source characteristics, and two content characteristics:

Effective Story- With use of specifics/details inclusion of audience, conveying love of work to audience, and uses energetic non-verbal, paralinguistic cues:

"Hello **everyone**! My name is Pat and I am a film-company founder and entrepreneurial leader. I have been in the business for a while now **and I love what I am doing.** I got to where I am today because of a **revolutionary** film-cutting discovery that I made ten years ago. **Back when I was in college like you guys**, I was in the lab searching to improve new ways of film handling. One late night, I discovered a technique that cut and spliced film almost simultaneously. I knew from that point on that I had discovered something magnificent and started my own production company. We worked hard, even though we failed often, to get to where we are today and changed the industry!

Today, my business is located in Mountain View, which, as you know, is close to your school, Stanford University. Although our company's headquarters are in northern California, our work is at the intersection of Hollywood and Silicon Valley. In my work, I encounter leading production designers, digital effect stars and prominent filmmakers. Several of these professionals are a vital part of my team. **They share my vision,** and utilize my product for great success. However, in a recent engagement with some new designers and filmmakers, I had a hard time conveying to them the relevance of my work. When I last spoke with them at a meeting, I noticed that they had trouble paying attention when I spoke **{act out head nodding, closed eyes, drooling—you know when you are in class—as a planned spontaneous illustration}.** Many of them did not make eye contact with me throughout my message and some even had the nerve to get up and leave in the middle of my presentation.

I am currently working with consultants to find a solution to my problem. I hope that with their help and advice, I will be able to find out how to properly convey my message. In fact, the very reason I am here today with you guys is to work on conveying a clear and concise message to my audience. I am hoping that with a little practice, I will be able to persuade new designers and filmmakers to use my product. Thank you for listening."

Ineffective Story - Without use of specifics/details, inclusion of audience, and conveying love of work to audience:

"Hello. My name is Pat and I am a film-company founder and entrepreneurial leader. I got to were I am today because of a revolutionary film-cutting discovery that I made many years ago while I was in college. The technique I discovered cut and spliced film almost simultaneously. My work turned out to **be fairly well received** in the marketplace so I started my own production company. I wish that I had encouraged our team to fail more often to change the industry.

Today, my company's headquarters are located in Mountain View. While we are located in Northern California, our work is at the intersection of Hollywood and Silicon Valley. In my work, I encounter production designers, digital effect stars and filmmakers. Several of these professionals are a vital part of my team. **Sometimes I am sure that they share my vision** and utilize my product for success. However, in a recent engagement with some new designers and filmmakers, I had a hard time conveying to them the relevance of my work to them. When I last spoke with them at a meeting, I noticed that they had trouble paying attention when I spoke **{no acting out non-verbals, paralinguistic cues of actor here are monotone voice, and multiple use of umms}**. Many of them did not make eye contact with me throughout my message and some even got up and left during my presentation.

I am currently working with consultants to find a solution to my problem. I hope that with their help and advice, I will be able to find out how to properly convey my message. In fact, the very reason I am here today is to work on conveying a clearer message to my audience. I am hoping that with a little practice, I will be able to persuade new designers and filmmakers to use my product. Thank you for listening."

MEASURES

Measures occurred in two parts. Part one included Question Set I and II and was comprised of a paper and pencil test with 8 + 5 questions. Part two was a projective cue prompt. All items were questions to predict the power of disengagement and based on previous work [29]: use 10 point Likert scale for each. 1 for poorly…10 for very well. Effectiveness of the story is an index composed of questions.

How well do the following statements describe your response to the story?
With the following use a 9-point scale of
1 *extremely poorly*………9 *extremely well.*
1. I have a question for Pat.
2. I like Pat.
3. Pat likes his work.
4. The story includes a message of discovery.
5. I am guessing that Pat is as excited now about his work as he was years ago.
6. Pat makes me want to accomplish, create, and solve problems that change the world.
7. I want to know what will happen next.
8. Pat did not capture my attention.

Engagement is an index composed of the following questions:

In your response to the story, how true are the following statements?
With the following use a 9-point scale of
1 *extremely false*……….9 *extremely true.*
1. While you listened, how much did you feel connected to the story?
2. While you listened, did you find Pat's story was believable?
3. How interested are you in what will happen next in Pat's story?
4. Pat's story captures your attention.
5. Pat's story conveyed a common short term/long term company goal

Now it's your turn! Imagine that you can tell us a story about what will happen next. Try to have a beginning, middle, and an end. Be as creative as you like. The next time Pat tells the organizational story…………………….

(Multiple coders rated for the presence or absence of themes and images of achievement motives, and words or word phrases as non-verbal, verbal, paralinguistic communication cues suggestions, or other.)

RESULTS

The results of this study were based on analysis derived from the use of a combination of statistical measures.

Means, Standard deviations, and a Single Factor Anova Test were used to compare the four experimental groups with one another. Additionally, the participants' projective cue prompt *story* response was rated by multiple coders for finding an emerging trend of themes and images. After reviewing stories once, multiple raters coded emerging images and themes in three categories: presence of achievement motives, presence of communication cue suggestions, and a general 'other' projective responses.

There is support for Research Questions 1a (Will there be a correlation between the effectiveness of the story and the engagement of the audience?). According to our analysis there is a correlation between effectiveness of the story and the engagement of the audience. As shown in Fig. 1, on Question Set I, we observed higher averages for participant responses when an effective story was presented. The results of the Anova analysis, shown in Fig. 2, yielded F=2.20086, p < .17, SS = 3.49026. Furthermore as shown in Fig .3, on Question Set II, we also observed higher averages for participant responses when an effective story was presented. The results of the Anova test, shown on Fig. 4, on question set 2 yielded F=11.99444, p < 0.01341, SS = 6.8068. The combination of averages observed and the significant p-value for Question Set II provides support for our hypothesis.

More support for RQ1a come from responses to statement 8 in the first question set (Pat did not capture my attention). In order to support our expectation, we expected that participants who had experienced an ineffective story would convey that their attention was less captured than participants who had experienced an effective story. Our hypothesis was confirmed. As seen in Fig .1, on average participants reported a lower level of attention when the presented with an ineffective story than they did when presented with an effective story.
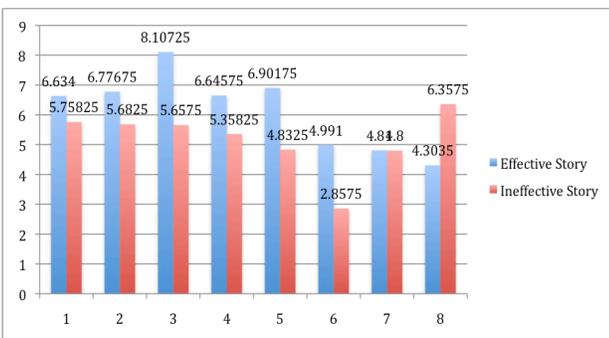

Figure 1. Question set 1-response comparisons - effective and ineffective stories.

Analysis of Variance (One-Way)

Summary					
Groups	Sample size	Sum	Mean	Variance	
6.634	7	42.536	6.07657	1.92421	
5.75825	7	35.54575	5.07796	1.24751	

ANOVA					
Source of Variation	SS	df	MS	F	p-level	F crit
Between Groups	3.49026	1	3.49026	2.20086	0.16372	7.18775
Within Groups	19.03032	12	1.58586			
Total	22.52057	13				

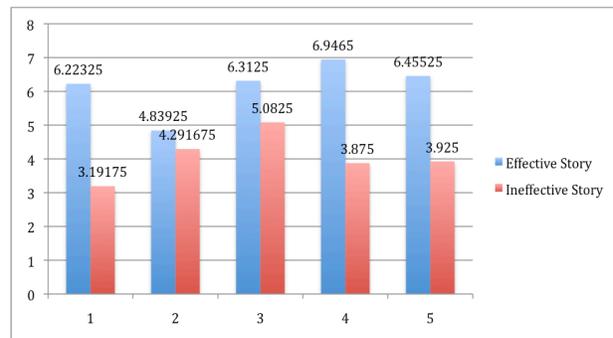Figure 2. Single Factor Anova Test for Question set 1-response comparison between effective and ineffective stories.

Figure 3. Question set 2-response comparisons - effective and ineffective stories.

Analysis of Variance (One-Way)

Summary					
Groups	Sample size	Sum	Mean	Variance	
6.22325	4	24.5535	6.13838	0.82384	
3.19175	4	17.17418	4.29354	0.31115	

ANOVA					
Source of Variation	SS	df	MS	F	p-level	F crit
Between Groups	6.8068	1	6.8068	11.99444	0.01341	9.87636
Within Groups	3.40498	6	0.5675			
Total	10.21178	7				

Figure 4. Single Factor Anova Test for Question set 1-response comparison between effective and ineffective stories.

Need achievement Motives phrases	1	2	3	4
	34/12	31/12	12/5	25/8

Communication Cue phrases	1	2	3	4
	10/12	23/12	6/5	16/8

FIGURE 5 PROJECTIVE CUE RESPONSES- ACH AND COMM BY STORY/PARTICIPANTS

The projective prompt results present us with two surprises. First, all responses regardless of ineffective story (2, 4) or effective story (1, 3) included achievement motive images and word phrases indicating a high need for achievement (citation, McClelland). Words and word phrases included: fixing the problem, finding a solution, motivated to succeed,

goals, creating, improving, practice, get better, etc. Second, projective cue responses that included communication message suggestions appeared higher for the ineffective stories (2, 4) than when the effective stories (1, 3) were delivered (see Figure 5). An apparent trend in response included multiple communication cue suggestions for ineffective stories. Verbal, non-verbal and paralinguistic communication cue suggestions included: phrases about word use, order of presenting, use of examples, smiling, not looking at the floor, making eye contact, stepping forward, not using 'um' and considering tone of voice.

It is worth noting other responses: the words: "sad" and "depressed" occurred once separately for the ineffective male story. For the effective male story: the phrase, "unbelievable" occurred once. The results of these projective cues lead us to believe that there is support for RQ1b. Using these projective cues and the support for RQ1a we can infer that there are readily identifiable elements within a story that we can identity to make a story of discovery more effective.

The results of the experiment showed that there were no significant gender differences between how effective and ineffective stories predict disengagement. Based on our analysis both male and female participants showed similar levels of engagement regardless of whether or not the speaker was effective or ineffective. Figures 1 -4 in Appendix A reflect these results.

DISCUSSION

Our preliminary investigation has provided us with promising evidence to suggest that we are able to connect audience engagement with the level of effectiveness of a story. Our findings support our approach in two important ways. First, we have seen that audience engagement does vary as expected with the delivery of an ineffective and effective story. People are more engaged by stories that are delivered energetically with particular non-verbal and paralinguistic cues, as we predicted in RQ1a. There is an observable and noticeable difference in those stories' ability to capture the audience's attention. There is also a noticeable difference in the participants' response that the effective stories' are more believable than the ineffective stories. Simultaneously, it suggests that our way of characterizing these stories and identifying the presence or absence of those particular cues is in alignment with the audience response. As such, we can be confident in our ability to identify, construct or reconstruct effective stories, as suggested by RQ1b. This gives credibility to our research design and provides us with a solid conceptual grounding to continue in our study.

However, though we did identify a trend in the results that confirmed our expectations, there were some elements of the data that were less clear. Several of the responses did not vary substantially between effective and ineffective stories. For example, the response to the question "I want to know

what will happen next" did not appear to align with our expectations (i.e., that response would be higher for effective and engaging stories). This suggests that some of our questions do not get at the phenomenon we are hoping to observe, and there are adjustments to make in the future if we are to reliably obtain engagement information from the audience. Similarly, there was no significant difference dependent upon the gender of the storyteller or the gender composition of the audience. While preliminary evidence suggests that this is one element that can be removed from future study, we believe that gender is a covariate that requires further attention.

Thankfully, our preliminary investigation was successful both in supporting our approach and offering ways in which to improve it. In addition, there were a number of surprising outcomes which will influence our future work. In the open-response portion of the questionnaire, we identified a high degree of achievement motives for both ineffective and effective stories. How to attribute this result is unclear; it is possible that the very nature of the story (namely, entrepreneurial discovery) influenced the audience to frame their responses in terms of achievement or future progress. It is also possible that the audience sample itself was biased; as a group of high-performing college students at a top university world-wide, it is likely that they are "achievement-minded" to begin with. Lastly, it is possible that there is a counter-balancing effect; for effective stories, the audience may be encouraged and inspired to report achievement; whereas for ineffective stories, they may feel a desire to contribute their own feelings of achievement when the storyteller seems in need of help or advice.

Another surprising result was the noticeable jump in suggested communication cues for ineffective stories in the open-ended portion of the responses. These suggestions spanned the verbal (begin with an example), paralinguistic ("don't say 'um'") and non-verbal ("make more eye contact" "step forward") aspects of communication. It is interesting that the students seemed to want to help more in the ineffective case, by offering this kind of advice. As the audience was composed primarily of psychology students, it is not surprising that they would be familiar with these kinds of cues, and this may be responsible for the increased reporting. However, it is still interesting that they correlated so strongly with the effective/ineffective distinction; this offers us another possible avenue to explore in future studies. This also supports the notion that a perceived need for help or advice is likely to bring out certain cues in the responses.

IMPLICATIONS

The sample size and the non-representativeness of the participant group are limitations of this study. We believe that an expanded and more broadly representative subject group would help to create more significant differentials in the effective and ineffective cases.

Though response data was collected at the individual level, the story-telling event occurred in a group setting. It is possible that this group-level setting allowed the audience members to have some effect on each other during the event. For example, laughter is a contagious group event that may inflate positive emotions and, in turn, may carry over into reporting. This kind of group effect would not be apparent given our current experiment design. As we seek to expand the subject pool, we must pay careful attention both to the possibility of these group effects, as well as to the influence of variations in the size of the audience. Both are likely to alter the responses in some way.

Among the positive implications of this study are its promising contributions in the field of engineering design education. Particularly useful is the format of participative education and student-teacher relationships. This study should highlight the value of student and team written reflections as meaningful representations of student progress on many levels. It should also offer helpful methods for how to interpret and understand those reflections. Likewise, it may offer insight into what cues to observe in instructor reports on student performance, and how those cues (when given as feedback to students) could be adjusted to encourage progress and engagement. A question emerges for specific entrepreneuring cases. What are ways to combine these findings with theories of storytelling to help engineers and designers make real progress towards innovation?

NEXT STEPS

This preliminary investigation has revealed several possible routes for further exploration into the effectiveness of stories and audience engagement. First, we must adjust our data collection and reporting methods to reflect specifically those indicators of engagement that we are after. Questions that yielded no significant difference between the two cases must be removed, replaced or reworked to achieve more polarized results. Additionally, some instances of confusing wording arose, and those details must be refined for future study. We also have the possibility to explore more novel ways of observing and characterizing audience engagement that may be more (or differently) telling than self-reported questionnaires.

While the bounded questions provided us with some very interesting data, the open-ended projective cue question captured data hard to find in paper and pencil tests. The two trends in response—achievement motive phrases and communication cue suggestions—offer us ways to incorporate surprising results into future research designs. Responses to the projective cue prompt (that asked participants to imagine what would happen next and write a story with a beginning, middle, and end) suggests value in exploring the audience's process for filling in the gaps of the story. There may be other than achievement motives

that provide hints at a collective imagination for a story of discovery.

Further examination into the peripheral effects of the story-telling environment should also be conducted. Based on these preliminary results, we have no way to determine what the potential group effects may have been; future studies could compare one-on-one story-telling with the group results, as well as examine reporting over different audience sizes (from small group to lecture hall). Similarly, we have no results that immediately indicate a difference due to gender, but it is possible that this would require a different or more extensive approach as well.

A computer interface research approach would contribute to understanding the audience engagement effect. We believe that staging a video taped company storytelling blog from an entrepreneurial leader delivering a message to an audience under conditions of both individual participant response compared to a large audience condition response would illuminate.

In addition to expanding the subject pool, we must also strive to get participation from much more broadly representative groups of people. This should negate the effects that may have resulted from a biased population of achievement-minded students with a background in psychology, as well as any pre-existing associations with entrepreneurship or other story-specific content.

Finally, if the full experiment offers strong support for our approach, then there is the possibility to construct interventions along these lines that will help people in many contexts to improve their stories, get effective, create engagement and achieve inventive action. For example, such interventions could be organized into a workshop format for engineering design students participating in problem- and project-based learning courses, or for corporations seeking a fresh perspective or a way to meaningfully understand and communicate their vision.

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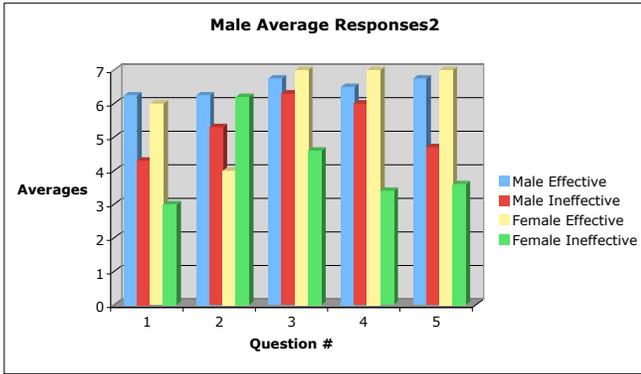FINAL ANALYSIS AND COMPILATION IN PROCESS – FOR EDITS

Appendix A:

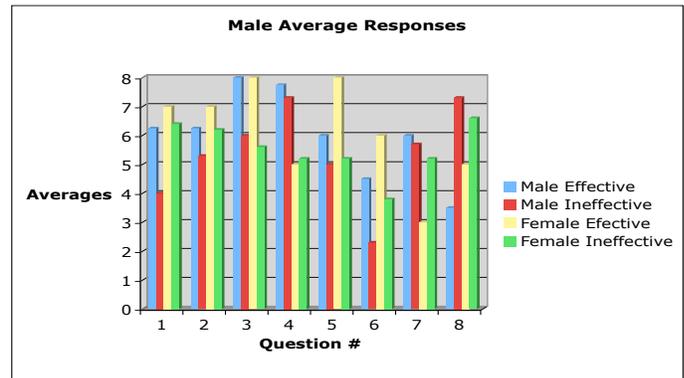**Figure 1. Question set 2-response comparisons -Male effective and ineffective stories.**

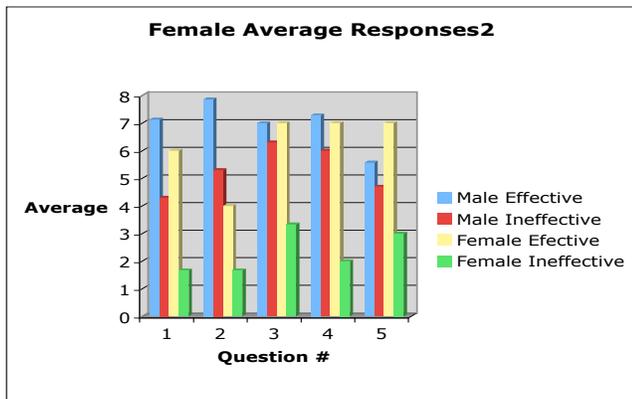**Figure 1. Question set 1-response comparisons - Male effective and ineffective stories.**

Figure 1. Question set 2-response comparisons - Female effective and ineffective stories.
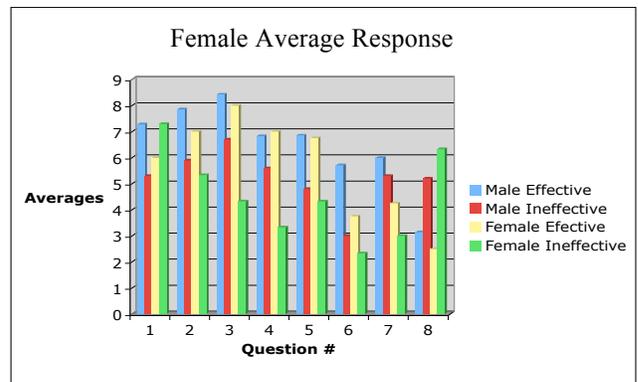

Figure 1. Question set 1-response comparisons – Female effective and ineffective stories.