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Engagement in science content via online video

leveraging television science fiction (*Star Trek: Discovery*)

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19   ABSTRACT

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21   Using science fiction stories to teach real-world science concepts may improve student

22   engagement and motivate creativity. Here, we explore the effectiveness of a science outreach

23   video leveraging interest in science fiction television content at engaging an audience self-

24   selected through online social media. We find that responding audience members report

25   knowledge gains, that the science-fiction connection increased their interest, and that many may

26   not have viewed this science content without the science-fiction connection. Overall, these

27   findings support the use of fictional narrative connections to engage with non-student learners

28   around science topics, extending the findings from classroom settings to online videos.

29   INTRODUCTION

30

31   People appreciate narrative stories, which generally cover a temporal sequence of events that

32   impact particular characters (e.g., Dahlstrom, 2014). Narrative story formats are commonly

33   associated with fiction, both in print and in other modalities (Schank and Berman, 2002), but

34   various scholars have explored the use of narratives as a means of engaging or persuading

35   audiences about relevant natural or social scientific topics. Narrative formats have gained further

36   recent support for science communication (e.g., National Academies of Sciences, 2017;

37   Martinez-Conde and Macknik, 2017) particularly around topics controversial among the public

38   such as global climate change and common ancestry of species. While narratives have been used

39   in science communication primarily via historical or non-fiction stories (e.g., ElShafie, 2018;

40   Solomon, 2002), some authors have argued that fictional narratives may also be effective if used

41   ethically and if containing a basis in non-fictional elements (e.g., Dahlstrom and Ho, 2012;

42   Dahlstrom, 2014; Avraamidou and Osborne, 2009) given consumers often retain and apply what

43   they learn from such stories (e.g., Appel and Richter, 2007; Marsh et al., 2003).

44

45   Science fiction stories provide promising narratives because they are often grounded in real

46   science. STEM professionals are even sometimes recruited to serve as consultants to collaborate

47   with the fiction writers and producers to edit the content for accuracy (Loverd et al., 2018). The

48   narratives of such science fiction stories help with student engagement, motivate creativity, and

49   provide "a sense of meaning" (Vrasidas et al., 2015; Jordan and Silva, 2019). Critical analysis of

50   such science fiction has numerous advantages (e.g., Gough, 1993; Barnett and Kafka, 2007),

51   potentially even when there are errors that can be used as illustrative lessons regarding common

52   misconceptions (Marsh et al., 2012).

53

54   However, most studies that we found assessing the impact of lessons incorporating science

55   fiction on engagement and understanding focused on classroom settings. The public also

56   consumes science content after the end of their formal schooling, sometimes through scholarly

57   works aimed at them but arguably more often through representations in mass media. Unlike a

58   classroom setting, in which students are a "captive audience" potentially through college

59   requirements, the public have more freedom to choose which items to engage. This freedom

60   provides further rationale for STEM professionals leveraging interest in popular culture elements

61   such as science fiction as a venue for providing science education content to the broader public

62   (e.g., Noor, 2018).

63

64   In this study, we explore the effectiveness of a science outreach video leveraging science fiction

65   television content at engaging an audience self-selected through online social media. The main

66   questions we explore are 1) whether respondents report that they learned from the video, 2)

67   whether the science-fiction connection helped with their engagement & interest, and 3) whether

68   the science fiction connection is broadening the viewership of this educational content. We also

69   explore dependencies on how interesting they found the content relative to their familiarity with

70   the franchise or specific shows, or with the timing or venue of their last formal science

71   education. Importantly, we are not assessing whether this approach is "more" effective than a

72   traditional science video—such an analysis would have been biased by the self-selection of the

73 audience—but instead whether this approach is reaching and teaching at least some audience that

74 would not have otherwise consumed the science content.

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77 MATERIALS AND METHODS

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79 <u>Subjects</u>

80 The data for this qualitative research were collected through an anonymous Qualtrics survey

81 following informed consent. The link to the survey was posted to a variety of Star Trek-related

82 online groups and discussion forums as well as the personal social media accounts of the

83 researchers (see Supplemental Table 1). The survey link was also "shared" or "retweeted" by

84 many others on social media. All posts directed people to a website where they were invited to

85 watch a video and answer a few questions subsequently. The data collection protocol was

86 approved by the Duke University IRB (protocol 2022-0265). The survey remained open from

87 January 26, 2022, to April 18, 2022. During that time, 254 responses were recorded.

88

89 <u>Measures</u>

90 Eight questions were asked with a 5-option Likert-like scale:

91 1. How much did you enjoy the video? (Not at all / a little / a moderate amount / a lot / a

92   great deal)

93 2. How much do you feel you knew about prions prior to watching this video? (Not at all / a

94   little / a moderate amount / a lot / a great deal)

3. How much do you feel you know about prions now? (Not at all / a little / a moderate amount / a lot / a great deal)

4. Did the Star Trek connection make this video more engaging to you? (A lot less / a little less / no difference / a little more / a lot more)

5. Did watching this video increase your knowledge about prions? (Not at all / a little / a moderate amount / a lot / a great deal)

6. How likely would you be to watch a science video about prions that did not relate to Star Trek? (Extremely unlikely / somewhat unlikely / neither likely nor unlikely / somewhat likely / extremely likely)

7. How did you feel about the length of this video for conveying the science covered? (Much too short / somewhat too short / right length / somewhat too long / much too long)

8. How much of the science do you feel you understood from what was presented in this video? (Not at all / a little / a moderate amount / a lot / a great deal)

Five additional questions were also asked:

9. How often do you watch science videos or read about science (outside the context of science fiction)? (Never / a few times a year / once or twice a month / around once a week / several times a week or more often)

10. Where did you last take a formal science class? (Never / elementary or middle school / high school / 2-year college or training program / military / 4-year college / university graduate program / online platform)

11. How long ago was that class? (Taking now / within past year / 1-5 years ago / 5-10 years ago / more than 10 years ago)

117 12. Were you familiar with the Star Trek Discovery episode that this video discussed? (Not

118   familiar with Star Trek / familiar with Star Trek but not Discovery / familiar with

119   Discovery but not this episode / familiar with this episode but not prion connection /

120   familiar with the episode and remember prions being part of story)

121 13. Before you watched the video for this study, had you watched it elsewhere such as on

122   YouTube? (No / think watched before but didn't remember details / watched it and

123   remembered it)

124

125 <u>Procedures</u>

126 After informed consent, subjects were instructed to watch a 7-minute video

127 (https://youtu.be/kBGwj9ZInis) explaining "prions" and contextualizing with their usage in an

128 episode of *Star Trek: Discovery* (season 3, episode 5, "Die Trying"). Subjects included in the

129 analysis then submitted responses to the 13 questions described above. Because the video had

130 been available online for a year prior to this study, we excluded the 13 respondents who said they

131 had seen and remembered this video (question 13) from all analyses.

132

133 The first outcome of interest in this research is whether the Star Trek-themed video was an

134 effective way to teach people about prions. We tested this hypothesis in two ways: directly

135 through question 5 above as well as indirectly through the difference in response between

136 question 3 and question 2 above. This combination provided a secondary confirmation and

137 allowed us to test our outcome of interest in two ways using both the stand-alone item and a

138 calculated score. Research has demonstrated that asking people to retrospectively evaluate how

139 much they knew about a topic before and after a learning experience is an accurate way to

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140 measure learning gains (Lang and Savageau, 2017). For the indirect measure, we calculated

141 learning gains by subtracting the prior knowledge score from the subsequent knowledge score.

142 Finally, we removed responses in which people said they already knew a lot (score of 4: 9

143 respondents) or a great deal (score of 5: 11 respondents) since those participants would be unable

144 to experience meaningful learning gains by watching an introductory-level video.

145

146 Our second outcome of interest is whether the Star Trek connection helped make the videos

147 more interesting and engaging for the participants. This outcome was central to our question of

148 whether people would engage with science through popular culture connections. We measured

149 this by directly through question 4.

150

151 Our third outcome of interest, related to the second, is whether the science fiction connection is

152 broadening the viewership of this video content. Essentially, we sought whether some viewers

153 would have been unlikely to watch a video on prions that did not relate to science fiction, and

154 this was addressed with question 6.

155

156 Finally, we were interested in exploring how much people's interest and engagement with the

157 science video was affected by various parameters. The first was how familiar they were with the

158 specific popular culture tie-in referenced in the video. In this study, we measured that possibility

159 by asking people to indicate whether they were familiar with the *Star Trek: Discovery* episode

160 that the video discussed (question 12). Only 7 respondents selected not knowing anything at all

161 about Star Trek, so these responses were omitted from the test due to low sample size. We used

162   this measure to test whether people's engagement with the video varied based on their prior

163   knowledge of the popular culture referenced in the video.

164

165   We also explored whether the venue and timing of most recent science education affected

166   people's engagement (question 10). Although 8 categories were presented, we excluded

167   responses in 4 categories because of low sample size: never having had a formal science class

168   (N=1), elementary or middle school (N=0), in the military (N=2), and through an online platform

169   (N=12). This exclusion left the categories of high school (N=33), 2-year college or training

170   program (N=24), 4-year college (N=98), and university graduate program (N=51). We also

171   explored whether how long ago that class was affected engagement (question 11).

172

173   <u>Statistical analyses</u>

174   Given likely non-normality of the data, non-parametric tests were used. To assess whether

175   engagement in the content depended upon degree of familiarity with the series or episode, a

176   Kruskall-Wallis test was conducted comparing responses regarding engagement in the video for

177   respondents who are familiar with the Star Trek franchise vs. those familiar with *Star Trek:*

178   *Discovery* but not the specific episode vs. those familiar with the *Star Trek: Discovery* episode.

179   We used a Mann-Whitney U-test to then further explore whether those who remembered the

180   episode were more engaged if they specifically remembered the role of prions in it. We used a

181   Kruskall-Wallis test to explore if respondents with different levels of education exhibited

182   different levels of engagement in the video. Finally, we used linear regression to assess if how

183   long ago the most recent science class taken was associated with engagement.

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185   Many more assessments or analyses were possible, but the few specific analyses and approaches

186   described above were selected *a priori* so as to avoid statistical issues associated with multiple

187   comparisons as well as "p-hacking".

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189   All survey questions, raw data, and limited dataset following exclusions will be archived in

190   Dryad (datadryad.org) upon acceptance of this manuscript.

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192

193   RESULTS

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195   <u>Self-reported learning</u>

196   Respondents reported that the video increased their knowledge about prions. Figure 1 presents

197   the counts and percentages, showing that over 88% of respondents reported at least "some" and

198   over 99% reported at least "a little bit" of knowledge increase.

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Did watching this video increase your knowledge about prions?

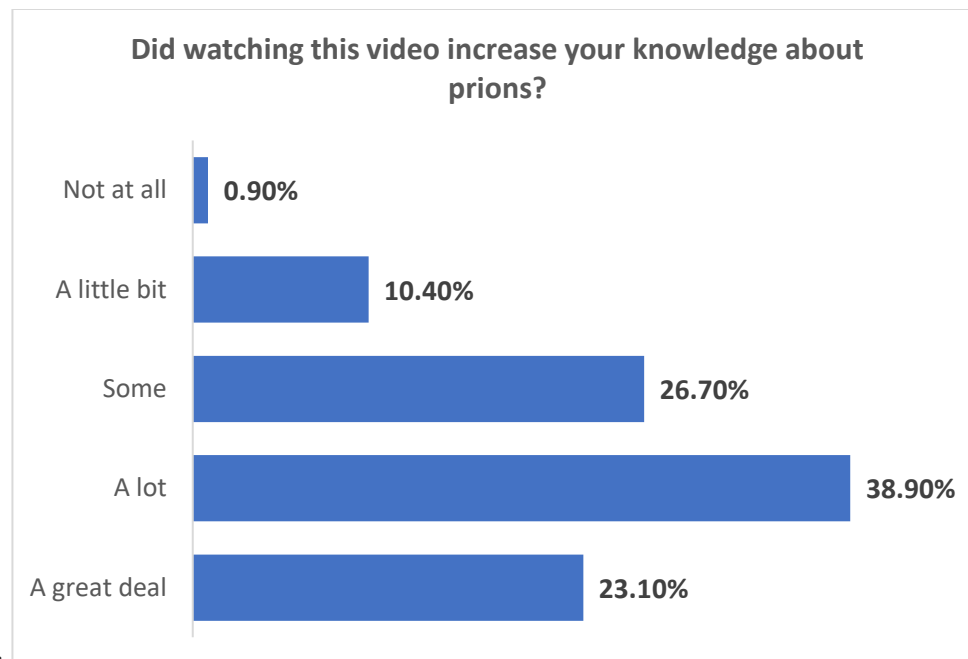|	
Not at all	0.90%
A little bit	10.40%
Some	26.70%
A lot	38.90%
A great deal	23.10%

202   Figure 1:

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204   Similarly, when we subtracted the responses for how much respondents identified knowing about

205   prions after watching the video minus before watching the video, only 7% (15) indicated no

206   learning, and none reported knowing less. All the rest reported higher knowledge after watching

207   the video relative to before watching the video.

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210   Science fiction connection and engagement/ interest

211   Respondents also overwhelmingly reported that the connection to the Star Trek franchise

212   increased their engagement (figure 2). Only 10% reported no effect or that the Star Trek
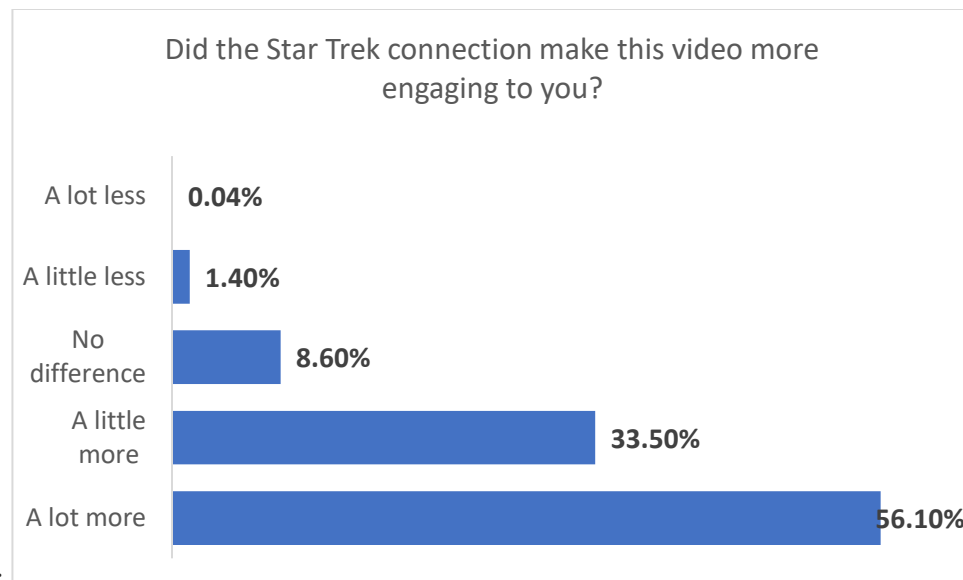
213   connection reduced their engagement.

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Did the Star Trek connection make this video more engaging to you?

A lot less	0.04%
A little less	1.40%
No difference	8.60%
A little more	33.50%
A lot more	56.10%

216   Figure 2:

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219   Science fiction connection broadening viewership

220   Relatedly, several (48%) reported that they were "somewhat" or "very" unlikely to engage with

221   such content if there were no Star Trek connection (figure 3). This fraction would likely be a

222   minimum estimate of the subset of these viewers who were drawn to this science content

223   primarily for the connection to Star Trek.

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How likely would you be to watch a science video about prions that did not relate to Star Trek?

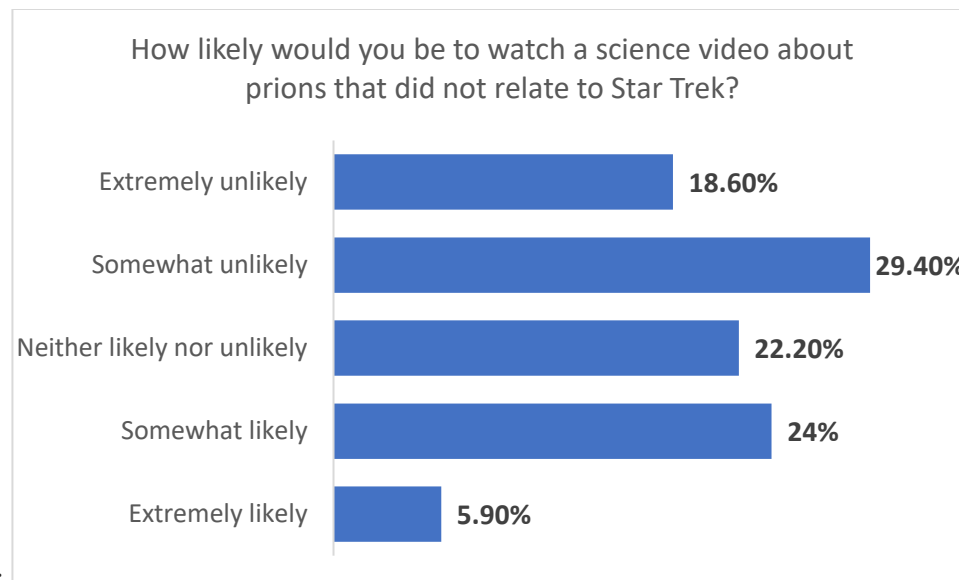|	
Extremely unlikely	18.60%
Somewhat unlikely	29.40%
Neither likely nor unlikely	22.20%
Somewhat likely	24%
Extremely likely	5.90%

226   Figure 3:

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229   <u>Dependencies on science fiction franchise knowledge and education</u>

230   We explored what parameters affected the self-reported engagement in this material: knowledge

231   of the series or episode in question, level of education, or time since last formal science

232   education. Knowledge of the series did seem to be associated with level of engagement, with

233   individuals who know the series *Star Trek: Discovery* exhibiting on average higher levels of

234   engagement than those who only knew the broader franchise (Kruskall Wallis test, 3 df, H=6.54,

235   p=0.038). Only 4 people in total reported any negative effects on engagement because of the Star

236   Trek connection, and these were spread among the categories of knowledge of the series. In

237   contrast, 40% of the respondents who know Trek but not Discovery, 58% of those who know

238   Discovery but not the episode, and 61% of those who know Discovery and the episode reported

239   that the Trek connection made the video "a lot more engaging". Specifically recalling the prion

240   connection in the episode had no detectable effect (Mann-Whitney U-test, Z=0.69, p=0.49).

241   However, we failed to detect any association between either venue of formal science education

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242   (Kruskall-Wallis test, 3 df, H=1.82, p=0.61) or time since last for formal science education (r=-

243   0.002, p>0.5) affected engagement with the video.

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246   DISCUSSION

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248   Our analysis found that the fictional narrative structure of an episode of *Star Trek: Discovery*

249   created a pathway for people to engage with a science subject that they otherwise may not have

250   sought out. This result demonstrates that using fictional stories from popular culture to

251   disseminate science knowledge is both effective and engaging, particularly when the learners

252   have a pre-existing interest or attachment to the popular culture works being leveraged. Further,

253   we found that people need not have a strong attachment to the specific work of fiction being

254   referenced. In our study, even people with only a general knowledge of the Star Trek franchise

255   reported that the video was an attractive and effective way to learn about prions.

256

257   Taken together, our findings further support the use of fictional narrative connections to engage

258   with non-student learners around science topics, extending the findings from classroom settings

259   (Marsh et al., 2012) to a public online venue. Connecting science education with fictional

260   narratives can make science content more attractive for at least a subset of learners and

261   potentially may help them retain more of the content through the connection with popular

262   culture, though we did not test this latter hypothesis.

263

264   Importantly, there is no *a priori* reason to assume that the results here are specific to the study

265   topic (prions, or even biology) nor the science fiction franchise. Given the challenges associated

266   with public science education, this approach of leveraging interest in science fiction to broaden

267   science education outreach via educational videos represents a promising additional pathway for

268   engagement.

269

270   Some caveats merit mention here. First, this qualitative study uses subjective self-reports on

271   knowledge gains and interest. If we assume respondents are truthful in having watched the video

272   per the instructions, at least some knowledge gain seems likely, but quantifying such a gain was

273   not the focus of this study. Instead, the findings that 1) at least a subset of viewers found this

274   mode of learning engaging and 2) a subset of viewers would have been unlikely to engage with

275   similar science content without the science fiction connection are more relevant and novel.

276   Second, this study does not attempt or purport to study a representative sample of the broader

277   public. Based on how respondents were obtained, many of the subjects likely were positively

278   predisposed to this particular popular culture franchise. One must not overinterpret the impact of

279   the approach studied here: the same video may be much less effective at engaging the interest of

280   a truly random sample of the public. Nonetheless, the goal of the study was to assess whether

281   existing interest and predisposition in a particular popular culture franchise could be leveraged

282   by even a subset of viewers predisposed to that franchise to teach scientific content, and this goal

283   was successfully accomplished. One can hypothesize based on these results that other popular

284   culture franchises can be leveraged in a similar manner to engage a different subset of viewers in

285   science content.

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