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ORIGINAL ARTICLE

Do not Believe Everything about Science Online: Revisiting the Fake Pacific Northwest Tree Octopus in an Introductory Biology College Course

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ABSTRACT

Evaluating the veracity and reliability of online media in science is an integral part of developing critical skills in science. Moreover, the 1st year biology courses should provide an avenue for students to acquire these skills for academic success. This study evaluated whether students (n = 90) exposed to an apparently credible website were able to distinguish whether a species existed as part of two short online activities. Surprisingly, a high number of students did not question the species in the initial activity and assumed it was real. However, most as part of the second assessment did report it was false. Some students failed to recognize the species as fake and thought the species was real even after watching a parody or satirical video on YouTube. All students agreed that critical thinking in science was important and the majority of students gave positive feedback on the activity. Potential explanations for students' inability to adequately assess information included students completing the assignment quickly and lack of further research. This kind of activity is recommended to expose the 1st year biology majors to critical thinking skills and accurate assessment of online information in science.

KEY WORDS: biology; critical thinking; engagement; Pedagogy; reasoning skills; reliability; science media

INTRODUCTION

Students at the secondary school levels have been found to believe easily false information online and often lack the ability to identify hoaxes (Dumitru, 2020). The inability of students to critically evaluate online sources is a problem stemming across middle school, high school, and even into college (McGrew et al., 2018). Recent high school graduates entering university for the 1st year often rely on online content as references or sources for information over more well-established scientific journals, textbooks, or other references (Perruso, 2016; Purdy, 2012). Moreover, students entering the college level utilize the internet as a digital tool and source of information as part of their daily lives (Metzger, 2007). While there has been an increasing amount of research on information and source credibility of online media (Metzger et al., 2010), this has been sparingly applied to the biological sciences to evaluate scientific media literacy (Archilla et al., 2019), particularly in the life sciences.

In general, over 70% of college graduates are considered scientifically illiterate on some level, meaning they lack the ability to understand basic scientific facts or knowledge related to scientific material (Miller, 2012). Moreover, the process of ascertaining facts and distinguishing between fact and fiction is central to science (Allchin, 2018). However, many undergraduate students either demonstrate false scientific reasoning skills or lack scientific comprehension skills (Woolley et al., 2018). For science majors, for example, biology, medical health, physics, chemistry, and astronomy majors, pedagogies which emphasize critical reasoning skills and competence are vital and result in important learning outcomes (Hager et al., 2003; Maudsley and Strivens, 2000). Consequently, the development of critical thinking is important for students to utilize the scientific method in practice, but also for promoting good citizen science for the populace to have basic scientific literacy and understand relevant scientific issues (Bonney, 2018; Girle, 2011). This problem among the 1st year biology students may scaffold to upper-level biology students resulting in majors which lack information literacy. Information literacy, specifically the ability to interpret digital information, is a critical component of scientific literacy (Schiffl, 2020). Students attending both high school and university need to develop the ability to evaluate and apply information. However, students often accept science information at face value or literately without question of veracity since scientific literacy is often not taught in schools. Inquiry-based teaching and learning in secondary school can help college students develop valuable skills in both information and scientific literacy and in general as biology graduates (Dorfman et al., 2017; Zion and Mendelovici, 2012).

One research activity that has been implemented previously at the middle school level but seldom at higher academic levels is the "Pacific Northwest Tree Octopus" activity (Loose et al., 2018). This study highlighted the need for increased development of critical thinking with web literacy skills, as

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the majority of students at the 7th grade level (students aged 11–13) identified the species to be real (Pilgrim et al., 2019). In addition, the use of creative activities using fantasy animals has also been used to teach the importance of biological adaptations with some success (Guidetti et al., 2007). University students also have variable ability to identify fake or valid sources of information (Musgrove et al., 2018). Implementing critical thinking in an undergraduate science course has been found to reduce students' reliance and perceived belief in pseudoscience (Wilson, 2018). However, a short, focused online activity on the validity of the fake Pacific Tree Octopus could be applied to older students entering college for the 1st time as a means to teach scientific literacy and the ability of students to evaluate false data on species.

Herein, the ability of the 1st year undergraduate biology majors to correctly determine if a species existed was evaluated, as well as their observations on a follow-up questionnaire when they were shown a clearly satirical video.

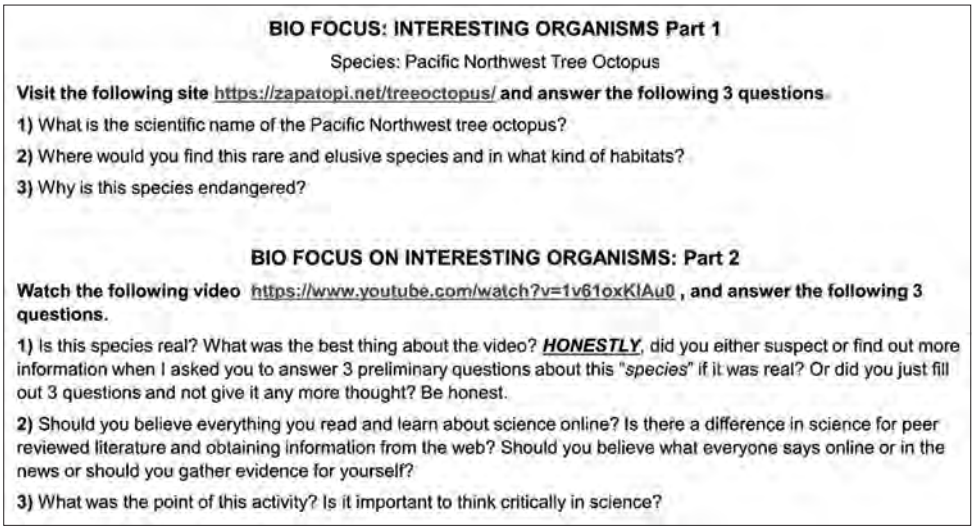
Research questions guiding this investigational in class activity were:

1. How did 1st year college students evaluate a fake, non-existent species using a seemingly real credible website?
2. How effective is this activity to engage students as part of a follow-up survey in promoting their awareness of false information from websites and the importance of developing critical thinking skills in science.

METHODOLOGY

In the fall semester of 2020 as part of an introductory 1st year organismal biology course at a small private liberal arts university, a concise short online activity was developed to introduce the concept of reliability of online websites for a false species. This two-part activity investigated whether students were willing to question the veracity of a website describing a false species over a 2-week period. All student participants agreed to this activity for use of their data, and student name and information were kept confidential and anonymous. All identifiers from completed activities were removed following downloading online from the class online software Canvas. Part 1 shown in Figure 1, consisted of three short questions including "*What is the scientific name of the Pacific Northwest tree octopus*?," "*Where would you find this rare and elusive species and in what kind of habitats*?," and finally "*Why is this species endangered*?." This initial assignment included a link to a specific website on the species which students were encouraged to visit for information (https://zapatopi.net/treeoctopus/). Part 2 shown in Figure 1, consisted of a follow-up activity including three questions, with part 2 including a satirical video which clearly shows the false nature of the species in question. Part 2 questions included more detailed questions such as "*Is this species real*?," "*Honestly, did you either suspect or find out more information when I asked you to answer 3 preliminary questions about this 'species' if it was real*?," "*Is there a difference in science for peer-reviewed literature and obtaining information from the web*?," and "*Is it important to think critically in science*?." The activity was delivered to students online as part of their weekly assignments, with part 1 provided for 1 week and part 2 the subsequent week. Authors followed the ethical guidelines of the supervising institution.

The content of two activities was quantitatively evaluated by analyzing the responses to the survey questions to determine if students successfully assessed the "believability" or "credibility" of content as an accurate or real source of information on the "Pacific Northwest Tree Octopus" according to Hovland et al. (1953). Responses were examined to questions for both parts 1 and 2 and evaluated based on responses if students thought that the species was real and assigned each student to either "yes" or "no" category for both



BIO FOCUS: INTERESTING ORGANISMS Part 1

Species: Pacific Northwest Tree Octopus

Visit the following site https://zapatopi.net/treeoctopus/ **and answer the following 3 questions**

1) What is the scientific name of the Pacific Northwest tree octopus?

2) Where would you find this rare and elusive species and in what kind of habitats?

3) Why is this species endangered?

BIO FOCUS ON INTERESTING ORGANISMS: Part 2

Watch the following video https://www.youtube.com/watch?v=1v61oxKIAu0 **, and answer the following 3 questions.**

1) Is this species real? What was the best thing about the video? ***HONESTLY***, did you either suspect or find out more information when I asked you to answer 3 preliminary questions about this "*species*" if it was real? Or did you just fill out 3 questions and not give it any more thought? Be honest.

2) Should you believe everything you read and learn about science online? Is there a difference in science for peer reviewed literature and obtaining information from the web? Should you believe what everyone says online or in the news or should you gather evidence for yourself?

3) What was the point of this activity? Is it important to think critically in science?

Figure 1: Part 1 and 2 Activity Questions. Students were shown part 1 during a normal semester week and part 2 the following week as a follow-up/reflection

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parts 1 and 2. Students participating in activity were asked to reflect on the importance of online content versus peer-reviewed literature and if it was important to think critically in science. Figure 2 shows the website included in the activity for part 1 to allow students to rely on the website as there only needed reference to complete activity. Finally, a Chi-square analysis was performed to detect differences between the frequency of responses between part 1 and part 2 on the beliefs of the species existence.

RESULTS

In total, 90 complete responses for both part 1 and part 2 were assessed with 10 students failing to respond and subsequently removed from analysis. Figure 3 shows for part 1, 90% of students thought that the species was real with only 10% thinking it was fake. For part 2, 7.8% of students still thought that the species was real, with 92.2% concluding it was fake. These results show that after watching a spurious YouTube video highlighting the species as clearly fake, a few students still answered that they thought that the species was real. Only two students specifically mentioned during part 1 responses that the species was in fact not real, with seven students mentioning they completed activity part 1 but recognized the species as fake (based on responses to part 2). All students responded during the part 2 follow-up activity that thinking critically is important in science, with most students providing various examples of positive feedback on the activity.

According to our data, there was a significant difference in the proportion of student responses on whether they thought that the species was real for part 1 and part 2 of this activity, Chi-square statistic χ^2 (1, n = 90) = 121.749, $\rho < 0.001$, with more students realizing the species was fake during part 2 than for part 1. Finally, there was some variability among students for responses and these are included for both parts of this activity in Table 1.

DISCUSSION

This study found that a large number of university students failed to determine this species as false. Based on responses, we noted a lack of students overall to conduct further research into this species, even if they were suspicious about the species existence. However, this activity was purposefully designed so it was concise, short, and consisted of only three basic questions from one website, that is, we did not specifically ask students to conduct further research. Little guidance other than the activity itself was given to students. It is possible that for those student responses indicating the species existed, they were not paying attention or did not spend adequate time evaluating the questions during part 1 and were just completing a short assignment as part of an introductory biology course. In fact, many responses by students either stated "*I filled out the three questions and did not give it more thought*" or "*I thought it was real and did not do any further research.*" Moreover, most students indicated that they initially thought that it was real and that they only thought that it was fake after watching the video. The majority of students did not conduct further research after reading about an octopus that lives terrestrially in the trees of the Pacific Northwest. Only two students out of the nine that recognized the species as being fake explicitly stated in their response to part 1 activity that the species was

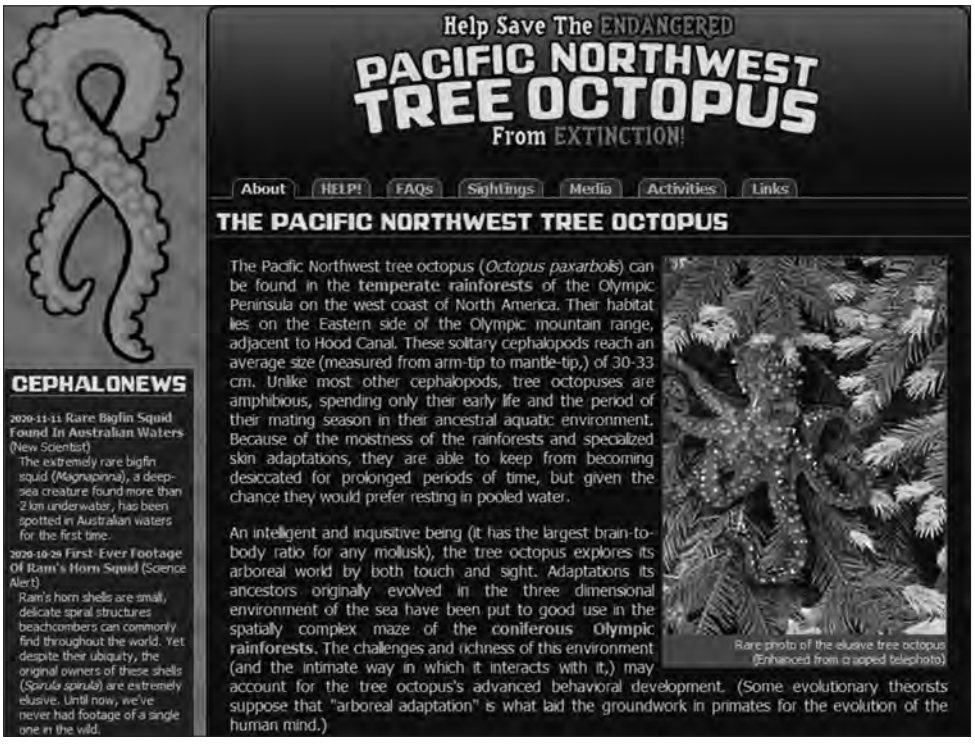

Figure 2: Screenshot of website for the Pacific Northwest Tree Octopus used in this activity (https://zapatopi.net/treeoctopus/). Retrieved August 25, 2020

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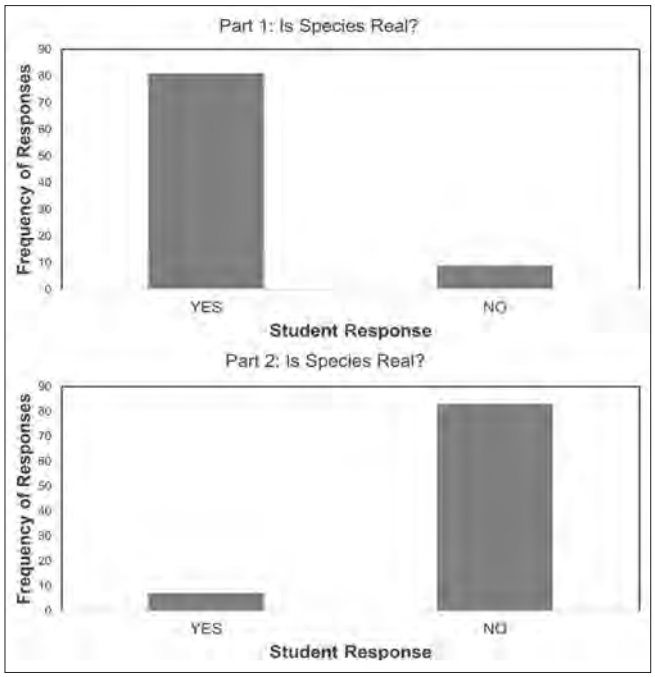

Figure 3: Student responses (n = 90) to whether they thought that the species was real during activity part 1 and part 2

Table 1: Example of individual student responses to activity for part 1 and part 2

Individual student responses to activity
Part 1
"The tree octopus can be found in the temperate rainforest and their habitat lies on the eastern side of the Olympic mountain range, adjacent to Hood Canal"
"Reasons for species being endangered include decimation of habitat by logging and suburban encroachment, building of roads that cut off access to water which is needed for spawning"
"Predation by house cats and booming populations of its natural predators, including the bald eagles and sasquatch"
"Its numbers are critically low, and it was a good animal to use as a hat"
Part 2
"The point of this activity was to let us know not everything you read on the internet is true including about science"
"When you gave us the preliminary questions about this 'species' I didn't give it a second thought about being fake due to it coming from a professor as well as the website"
"I just filled out the three questions last week not even thinking about if it was real or not"
"I had known that octopi could live outside of water for a limited time and didn't find it too outlandish for an arboreal species of octopus"

not real by commenting "*none of this article is actually true*" or "*it would also be pretty hard to find since it is not real.*" This observation may indicate that students do not invest time or mental energy in evaluating short assignments or do not expect the instructor to provide this type of inquiry activity regarding the veracity of obscure and ultimately fake species. In other words, they lack some level of critical independent thinking and took the instructor "at their word."

Students commented overwhelmingly that they appreciated the activity stating "*This was a great activity, I can't believe I fell for it*" or "*I thought the video during part 2 was funny*" with others commenting on it being their favorite activity in the course. Three students mentioned that they had been previously exposed to the species in high school and knew it was not real, accounting for some responses where students knew the species was fake. Most students realized that it was not real only after part 2, watching the video and answering questions from part 2. These results were surprising to say the least for a college level activity for the 1st year biology majors, given that many in their initial answer to questions for part 1 regarding "*Why is the species endangered*" included "*blooming populations of its natural predator, including the bald eagle and sasquatch*" which they obtained verbatim straight from the website.

As this activity, part 1 and part 2 (Figure 1) were taught online with little information provided by instructors (authors), this study's findings indicate further reflection during in class sessions to explore reliability of student feedback on why they failed to identify the species as fake is needed at the university level. For example, further exploration of why they "*just believed a college instructor*" or why they "*quickly completed the assignment with no further consideration*" and "*taking the instructor at their word*" indicates the need for the 1st year students to develop independent inquiry skills which question and recognize false data or information in science. Group-based learning offers an alternative opportunity to engage and help undergraduate science majors enhance critical thinking skills (Kim et al., 2013) and may be applied to this activity.

The development of critical reasoning may also warrant further investigation at the high school level in preparation for university. Studies have shown in some cases less than one-third of high school students were deemed college-ready in reading and math (Combs et al., 2010). Jensen and Moore (2008) analyzed 1st year biology students reflecting on how high school prepared them for college noted less than half felt challenged by high school courses and subsequently studied very little outside of class. However, there may be some hope as implementing advanced high school science and math coursework with an emphasis on deep conceptual understanding of biological concepts and investigations can be positively associated with introductory student academic success (Loehr et al., 2011). The importance of understanding not only key biological concepts and observation but also assessment of empirical evidence are potential avenues for how secondary biology teachers might help prepare students for higher learning in biology and increase biological literacy (Narguizian, 2019). Future implementation of this activity could alter whether it is provided within the classroom versus online (how we delivered this activity with little input from instructor), or even across 1st year students versus upper-level university students, as we suspect the unusually high responses on the species being real may change based on academic level or activity delivery method (i.e., online with little to no guidance vs. in lecture).

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RECOMMENDATIONS

Based on our findings, we make several recommendations for future research to increase science literacy and critical thinking. This type of inquiry activity should be incorporated in introductory biology courses or other similar activities which require development of critical thinking skills, possibly with the addition of group discussion the following week or throughout the semester. An additional recommendation to consider when implementing this activity is that instructors should follow up on this activity and encourage students to adopt the Sagan standard of "extraordinary claims require extraordinary evidence," or ECREE for short when presenting or discussing this activity (Kaufman, 2012). Instructors can recommend students emphasize the importance of relying on not only the quality of a source but also for students to rely on multiple sources in science. This follow-up can take the form of either an open class discussion or written reflection to further impart to students the importance of critical thinking and develop the tools to identifying false information. Science as a discipline often is subject to a great deal of misinformation, that is, climate change, spread of disease, etc. (Scheufele and Krause, 2019). Therefore, it is important for students as they progress both in academia and in their careers to identify falsehoods and think critically in science and be more informed citizen scientists. Moreover, introducing this activity to the 1st year students may benefit the scaffolding of other courses as they progress in upper-level science courses as part of their major. In conclusion, thinking critically regarding online information or having increased "web literacy" (Leu et al., 2015) may need to be further evaluated for incoming college students in science through this or other activities and discussions which align with biology course learning outcomes.

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