Original Research Paper

Why Zombies Crave Brains: Impact of Teaching Nutritional Biochemistry Concepts Using Pop Culture

Kristy Henson[1,*], Greg Popovich[2]

[1]Department of Natural Sciences, Fairmont State University, Fairmont, USA;
[2]School of Exercise Science and Athletic Training, West Virginia Wesleyan College, Buckhannon, USA

Article history
Received: 27 December 2022
Revised: 27 December 2023
Accepted: 28 December 2023

**Corresponding Author*: Kristy Henson, Fairmont State University, Fairmont, US;
Email: Kristy.Henson@fairmontstate.edu

Abstract: In recent years, the allure of zombie culture has found its way into innovative teaching of biology and medical courses. In this current example, we employ zombie imagery and context to facilitate an understanding of applied nutritional biochemistry. This novel approach is compared to teaching identical material using traditional examples and context. Specifically, we investigated the impact on short-term and long-term learning by incorporating zombie lore into the delivery of a lecture on the inflammatory cascade as it relates to essential fatty acids. We hypothesized that given the popularity of zombies and dystopian/apocalyptic environments, intertwining nutritional concepts with these dramatic scenarios would enhance interest and attention, hence improving learning. Two presentations were offered in basic nutrition (synchronous) or introductory anatomy and physiology (asynchronous). This audience was selected to ensure minimal baseline knowledge on the topic of essential fatty acids. Half of the students received a non-zombie lecture while half received the same information as it relates to zombies. Learning was assessed using a five-question survey. Testing was conducted before, immediately following, and 4 weeks after the lecture. The mean score increase pre- versus post-test in both groups was dramatic but not significantly different between groups (zombie vs non-zombie and synchronous vs asynchronous). Results were as follows: the pre-test average for both groups was 42.37%; the immediate post-test average was 85.96%. At 4 weeks, the average performance dropped to 70.30%. On average, students indicated a mild interest in zombies. In this instance, teaching with pop culture did not significantly impact short-term or long-term retention.

Keywords: Pedagogy; STEM education; essential fatty acids; nutrition; zombies; pop culture

Introduction

Educators often seek to incorporate pop culture into teaching to help bring relevant entertainment influences from the student's daily life into learning (Tisdell & Thompson, 2007). Pop culture plays a meaningful role in how adults live their lives and form relationships (Tisdell & Thompson, 2007). Therefore, it stands to reason that making educational material relatable to something in which students take an interest might favorably impact reception to and retention of that information. Furthermore, the more novel a comparison, the more likely that it may pique interest and aid in memory. This paper describes the incorporation of zombies into a science lecture and its effect on learning.

Once the modern concept of flesh-eating zombies was introduced in 1968, the genre has become ever-popular on several media platforms, with feature films

and television series recently released or in current production (Luckhurst, 2015). The unwavering allure and undeniable popularity of zombie culture has found its way into innovative teaching of biology and medical courses (e.g., Zombie Apocalypse Medicine Meeting, or ZAMM). Zombies have been used in classroom activities such as computer modeling, mathematics, anatomy, and the very popular role-playing game, Humans vs Zombies (Flanagan, 2012; Beecher et al., 2008).

Over time, one branch of zombie mythology gave rise to the idea that zombies crave not simply human flesh, but more specifically brains. Subsequently, we used zombies' affinity for brains as a vehicle to teach essential fatty acid (EFA) metabolism related to the inflammatory cascade.

As conveyed to students, the conceptual underpinnings regarding why zombies would crave brains were predicated on the following premises (Popovich & Henson, 2021). (Note that all but the first point are firmly rooted in science.) First, zombies are sentient creatures who can perceive the pain of decomposition. Second, brain tissue is 60% lipid by dry weight, the majority of which is essential fatty acids (EFAs). Third, the majority of EFAs in the brain are of the omega-3 variety, though this is somewhat dependent upon diet. Furthermore, omega-3 fatty acids exert anti-inflammatory and anti-nociceptive (i.e., analgesic) effects. It can therefore be postulated that zombies crave brains to alleviate pain.

The purpose of this project was to determine if presenting nutritional concepts within a zombie apocalyptic environment enhances learning and if this impact is greatest among students with a strong interest in zombies.

Materials and Methods

To determine if zombie lore and imagery enhance the learning of EFA sources and functions, we tested four different combinations of learning: synchronous zombie and non-zombie groups and asynchronous zombie and non-zombie groups. Two hundred and twenty-seven students who were enrolled in either Human Anatomy and Physiology at Fairmont State University (FS) or Fundamentals of Human Nutrition at West Virginia Wesleyan College (WVWC) took part in this study. These introductory courses were used to guarantee minimal baseline knowledge of EFAs and maximize the potential learning effect. Demographic data for the sample is summarized in Table 1, with most students being freshmen. The average participant age was 22.4 years old.

Table 1. Basic demographic data of the participants.

Demographics	
Sex	**Class rank**
Male 57	*Freshmen 129*
Female 160	*Sophomore 66*
Nonbinary 11	*Junior 15*
	Senior 15
	Unanswered 2

This study ran four academic semesters, initially assessing only baseline and immediate learning, but later adding a long-term learning assessment by retesting students on the material four weeks after the lecture. Student participation was voluntary and incentivized with extra credit added to their final grade. Interested students were randomly assigned to receive either a zombie-related lecture or a non-zombie-related (normal) lecture.

Synchronous delivery occurred at WVWC, in person using a standard 'stand and deliver' lecture format supported by informative PowerPoint slides. The synchronous lectures were recorded and delivered asynchronously via Blackboard streaming to FS students. Both lectures were under 20 minutes (14 minutes non-zombie and 17.5 minutes zombie) with the same number of content slides. The brevity and similar duration of the lectures helped control for confounding variables such as motivation, hunger, and wakefulness that can become issues with longer lectures. To maintain consistency, students were instructed not to take notes or ask questions. Discouraging note-taking was thought to maximize students' likelihood of seeing the zombie-related visual elements integrated into the slideshow, which could be missed if students had been looking downward to take notes. Not permitting audience questions assured that all groups were receiving identical content within the same time parameters.

The lecture slides used the same layout and fonts, only exchanging the typical thematic imagery for zombie-related content (Figs. 1 & 2). Additionally, the zombie lecture contained exposition as it related to laying the foundation for the hypothetical reasoning for the importance of EFAs in the zombie diet.

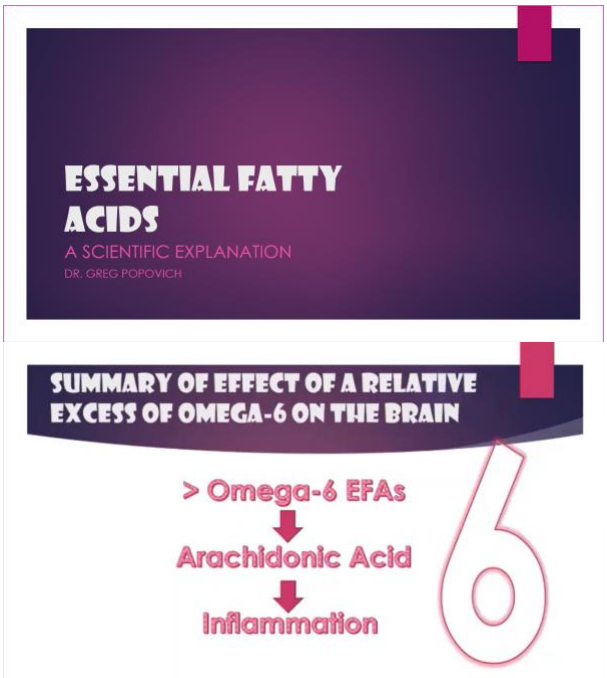

Figure 1. Sample slides from conventional lecture.

Figure 2. Sample slides from zombie-themed lecture.

During the first trial of this study, we administered only a pre and post-test to assess immediate learning. Students completed the pre-test in Blackboard, watched the lecture, and immediately completed the post-test in Blackboard. Students were not made aware of their test scores. After examining this data, we realized we should also assess long-term learning. Long-term learning would correspond to the typical time between content delivery and an exam, which led to the second trial of this study. During the long-term trial, students took the pre and post-test, but four weeks later took the post-test again with no intervening review of pertinent material.

Table 2. Number of participants for each study.

	Trial 1 short-term learning		**Trial 2 long-term learning**	
Group	**Zombie**	**Non-zombie**	**Zombie**	**Non-zombie**
Synchronous	10	9	21	23
Asynchronous	38	44	48	53

Students who did not complete the entire activity were removed from the statistical analysis but were included when examining completion percentages.

Survey Design

All tests asked the same five multiple-choice questions with four potential answers. The post-test captured demographic information for age, sex, class, first-generation status, prior instruction in EFAs, interest in nutrition, and interest in zombie culture (Survey available in the supplemental material).

Statistical Analysis

We examined the following variables:

- Completion percentage (i.e. did the student complete all surveys?).
- Percent change of pre, post, and follow-up scores.
- Paired t-tests of pre and post-test results, synchronous and asynchronous test results (significance p = < 0.05)

$$t = \frac{\sum d}{\sqrt{\frac{n(\sum d^2) - (\sum d)^2}{n-1}}}$$

  - The t-test was used to determine if two measurements are significantly different and not caused by chance (Lehman, 2005).
- Spearman's rs correlation between test score and demographic information

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

  - This correlation allows one to determine if two ranked variables are

significant using monotone instead of linear function (Lehman, 2005).

To standardize time allotment, students were given 5 minutes to complete the pre-test, all lectures were under 20 minutes, and students were given 10 minutes to complete the immediate post-test and the 4-week follow-up. The asynchronous students were given a short three-day window to complete the initial activity in one sitting and a similar window 4 weeks later for follow-up.

Results

In total 227/446 (50.9%) students took part in the project (Table 2). Sixty-five percent of the 227 students completed both the pre and post-test while only 50% of students in the long-term study completed the four-week follow-up test (Table 3). Slightly more students in the non-zombie group completed the entire activity sequence compared to the zombie group.

Table 3. The number of students enrolled in both classes and the number of students who completed each survey.

Group	Non-zombie	Zombie
Pretest	140/211 (66.35%)	141/215 (65.58%)
Post-test	142/211 (67.3%)	136/215 (63.26%)
Follow-up	79/138 (57.25%)	70/144 (48.61%)

Short-term learning results

Trial 1 examined only pre and post-test scores, assessing immediate short-term learning. Students received 1 point for the correct answer and 0 for an incorrect answer. Scores were compared using a t-test (Table 4). Pre and post-score differences between the zombie and non-zombie groups were significant. When comparing the post-survey scores of the zombie group to those of the non-zombie group, the results were not significant ($p = 0.25$).

Table 4. T-test results comparing pre and post-survey scores between groups.

Group	p-value
Zombie	3.15^{-15}
Non-zombie	7^{-11}

Long-term learning results

This trial examined pre, post, and follow-up test results, looking at long-term retention of the material. Similar to Trial 1, the pre and post-test results were statistically significant. The pre-test and the four-week follow-up test scores were also significant (Table 5). Again, the zombie group and non-zombie group follow-up survey results were not significantly different from each other ($p = 0.29$).

Table 5. T-test results comparing pre and post-survey scores and pre and follow-up survey scores between groups.

Group	Pre and post-test p-value	Pre and follow-up p-value
Zombie	2.21^{-26}	4.30^{-13}
Non-zombie	1.94^{-20}	1.78^{-7}

All data

All score averages are presented in Figure 3. The non-zombie group's average scores are slightly higher than the zombie group's, but the zombie group had a substantial increase when comparing the pre and post/follow-up averages.

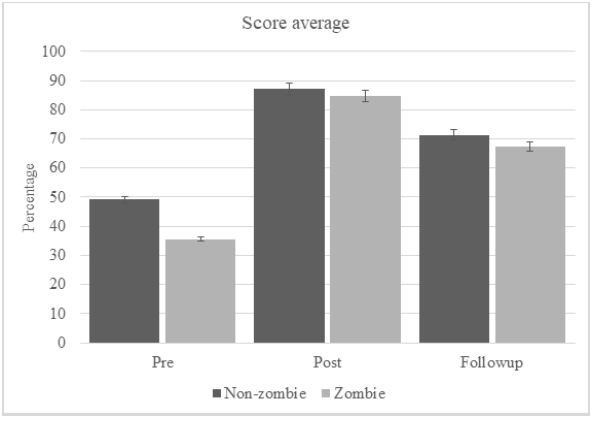

Figure 3. Average pre, post, and follow-up scores for the zombie and non-zombie groups.

Because there was no significant difference between the zombie and non-zombie groups ($p = 0.25$; $p = 0.29$, respectively) we examined the percent change of score averages. The non-zombie group percent change between the pre-survey and post-survey saw an increase of 77.46% while the zombie group increased by 137.96%. The zombie group had a substantial percent increase from pre to post-test scores. When comparing the pre- and follow-up percent change the non-zombie group saw an increase of 45.18% and the zombie group increased by 89.11%.

Next, we compared synchronous and asynchronous results (Table 6). As more institutions

move to online learning and hybrid-style classes, it is important to determine how these delivery alternatives compare to a standard lecture to promote learning. We found no significant difference in score results between either synchronous or asynchronous groups, and average follow-up scores were comparable (Fig. 4).

Table 6. Synchronous and asynchronous follow-up survey results compared for significance. There was no significant difference between either group.

Group	p-value
Zombie	0.430
Non-zombie	0.273

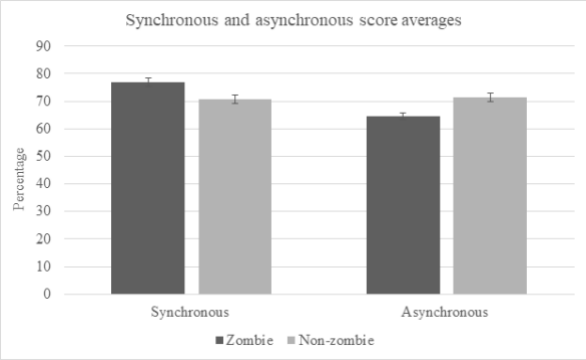

Figure 4. Synchronous and asynchronous follow-up score averages.

Finally, we evaluated if there were any correlations between follow-up survey results and demographic information. We applied a Spearman's rs correlation, which showed there was a moderate correlation (0.5) between interest in zombies and score, no correlation (0.1) between interest in nutrition and score, and high correlations between prior knowledge (0.7), interest in graduate school (0.7), and score. There was no correlation between gender and interest in zombies (0.03) while we saw a high correlation between gender and score (0.9). A multivariate PCA was also attempted to try to better understand the correlations but there were no substantial trends among the data.

Discussion

The purpose of this study was to determine if lectures tailored around popular culture increased student learning. Zombies were specifically chosen because of their close relationship to the biochemistry of EFA (e.g., eating brains to obtain omega 3s to alleviate pain). The moderate correlation between zombie interest and test scores along with the large percent increase from pre to post-test scores indicates that pop culture lectures increased student performance. The question, however, is if a pop culture lecture results in better outcomes compared to a normal lecture experience.

Profound short-term learning occurred in all groups (Tables 4 and 5). Students in all groups essentially went from failing grades to a high B range. The degree of learning was surprising to us given that there was no deliberate attempt to "teach to the test" and students were not permitted to take notes. Had the quiz questions been overly easy, one would have expected much higher baseline performance instead of a failing percentage. Our results strongly indicate that a brief lecture, synchronous or asynchronous, with audiovisual support, can significantly impact short-term learning.

We had hypothesized that the zombie lecture would prove to be most engaging, resulting in superior retention of information, and that this effect would be most pronounced in those students who expressed an interest in zombie lore. However, neither hypothesis was supported by the data. A limitation of our study design is that because participation was voluntary, our sample may have had a bias toward students with greater motivation. Perhaps a motivated student may perform well regardless of interest in the topic.

It appears that the mere suggestion of an immediate post-test, despite there being no consequences, may have enhanced attention and therefore contributed to short-term learning. This post-test improvement in both zombie and non-zombie groups is particularly striking given that students were not permitted to take notes. Although we were previously unaware of the literature on this possibility, a generous body of research over several decades supports our intuition. For example, Sana and colleagues (2020) concluded that using learning objectives in the form of a pre-test greatly enhances learning, even when feedback is not provided.

Interestingly, there was no difference in the performance of online versus in-person learners in our investigation. In an excellent review prefacing their original investigation, Chisadza et al. (2021) show that research on remote versus face-to-face learning remains equivocal and complicated, with considerable literature divided on the superiority of either approach. If questions had been entertained and there was an in-class

discussion, this may have favored a particular subgroup that was undetectable with our study design.

An additional, if not obvious, inference is that these findings indicate that acute mastery of material without reinforcement over one month leads to unsatisfactory retention. While performance did not quite regress to the original pre-test, a meaningful portion of knowledge at the immediate post-test had diminished to unsatisfactory performance (e.g., below 70%). This points to the need for reinforcement of material over time by the student and/or instructor.

Although our findings suggest that pop culture material did not impact learning either positively or negatively, it can be argued that an instructor has the latitude to include tangential information if it is enjoyable to the professor. Multiple lines of evidence point to the value of faculty autonomy in higher education job satisfaction, ranging from community college (Berry, 2016) to medical school (Chung et al., 2010). Furthermore, self-expression has been deemed essential for motivation and productivity among faculty (Cavise, 2019). Therefore, it would seem innocuous for faculty to make material relatable to something about which they are passionate, even if its impact on learning is neutral.

In conclusion, the data suggest that 1) Pre-testing may enhance short-term learning. 2) There was no difference between synchronous and asynchronous lectures and overall student performance. 3) Short lectures without student note-taking still show a meaningful increase in test scores. 4) Pop culture references do not affect short or long-term learning. 5) Topically relevant pop culture references used by instructors have no deleterious impact on short-term or long-term learning and thus may be included at the instructor's discretion.

Acknowledgments

The authors thank Dr. Deb Hemler for guidance in manuscript development.

Literature Cited

Beecher, B., Moorman, T., Quick, J., Sklover, J., Temkin, M., & Weed, C. (2008). *About HvZ*. Humans vs Zombies. Available at: http://humansvszombies.org/about (Accessed Nov. 21, 2022).

Berry, J. (2016). *Burnout, autonomy, and job satisfaction in full-time public community college faculty members: a regional survey and analysis.* [Doctoral dissertation, University of North Dakota]. UND Scholarly Commons.

Cavise, H. (2019). *Strategies for managing employee self-expression in the workplace*. [Doctoral dissertation, Walden University]. ScholarWorks.

Chisadza, C., Clance, M., Mthembu, T., Nicholls, N., & Yitbarek, E. (2021). Online and face-to-face learning: Evidence from students' performance during the Covid-19 pandemic. *African Development Review*, *33*(Supplement 1): S114-125. https://onlinelibrary.wiley.com/doi/10.1111/1467-8268.12520

Chung, K., Song, J., Kim, H., Woolliscroft, J., Quint, E., Lukacs, N., & Gyetko, M. (2010). Predictors of job satisfaction among academic faculty: Do instructional and clinical faculty differ? *Medical Education*, *44*(10): 985–995.

Flanagan, K. (2012). '*Zombie Attack! An Introduction to Quantitative Modeling*/' Nat Center for Case Study Teach in Sci. Available at: https://www.nsta.org/ncss-case-study/zombie-attack (Accessed Nov. 21, 2022)

Lehman, A. (2005). *Jmp for basic univariate and multivariate statistics: A step-by-step guide*. Cary, NC: SAS Press. 123.

Luckhurts, R. (2015). Zombies: A Cultural History. Reaktion Books Ltd: London.

Popovich, G. & Henson, K. (2021, June 10 – 12.) *Teaching nutrition concepts using pop culture: Why zombies crave brains.* [Poster session]. International Society of Sports Nutrition 18th annual meeting, St. Petersburg, FL. https://www.tandfonline.com/doi/full/10.1080/15502783.2022.2056381

Sana, F., Forrin, N., Sharma, M., Dubljevic, T., Ho, P., Ezza, J., & Kim, J. (2020). Optimizing the efficacy of learning objectives through pretests. *CBE—Life Sciences Education*, 19(3). https://doi.org/10.1187/cbe.19-11-0257

Tisdell, E. & Thompson, P. (2007). Seeing from a different angle: the role of pop culture in teaching for diversity and critical media literacy in adult education. *International Journal of Lifelong Education*, *25*(6): 651-673.