Print

ASSIGNMENT # 1: LETTER OF INTRODUCTION

Welcome to Advanced Biology! We want you to be able enjoy this class and feel successful this year. We believe our job is to help you succeed the best you can. To help you we would like to get a head start on getting to know you. Your first assignment is to successfully send us a formal letter of introduction via Schoology or email. Please read the guidelines below

1. Use clearly written, **full sentences**. Do not abbreviate words like you are texting to a friend. Use **spell check**!

   This is a professional communication like you would have with a college professor, so let's practice for your rapidly nearing future! (6 pts)

2. Address it to us: Mrs. Spalding and Mrs. Boyd (1 pt)

3. Make the **Subject**: "**Advanced Bio: Introduction to <Insert Your Name Here>**" (1 pt)
   a. (Do not include the quote marks or the brackets, just your name)

4. Begin the letter with a **formal salutation**, like "Dear Mrs. Boyd/Mrs. Spalding," (1 pt)

5. Now introduce yourself (your name) and tell me a little bit about yourself, like: (10 pt)
   - What do you like to do (hobbies, sports, music, interests, etc.)?
   - Do you have a job?
   - Tell me a little bit about your family (Mom? Dad? Guardian? Siblings? Pets?) What do your parents/guardian do for a living?
   - What are your plans for the future/next year/after graduation/career goal?
   - What was the last book you read for fun?
   - What are your strengths and weaknesses as a student?
   - Tell me something about yourself that you are proud of.
   - Why did you sign up for Advanced Biology (Parents, Interest, GPA, etc.)?
   - What are your greatest concerns about taking Advanced Biology?
   - What other time commitments will you have this year in addition to Advanced Biology?
   - Who was your 8th grade Physical Science teacher, list one thing you liked about the course?
   - Is there anything else you would like me to know about you?

6. End the e-mail with a **formal closing**: "Respectfully", "Sincerely", "Warm regards", etc. and add your name as if you signed a letter. (1 pt)

Name:_____ Date:_____

Part 2: Read the article *Why Cats Have Nine Lives*

Essential Questions:

-Why do cats who fall from greater distances suffer fewer injuries?
-How do cats survive falls that would kill humans?

Why cats have nine lives

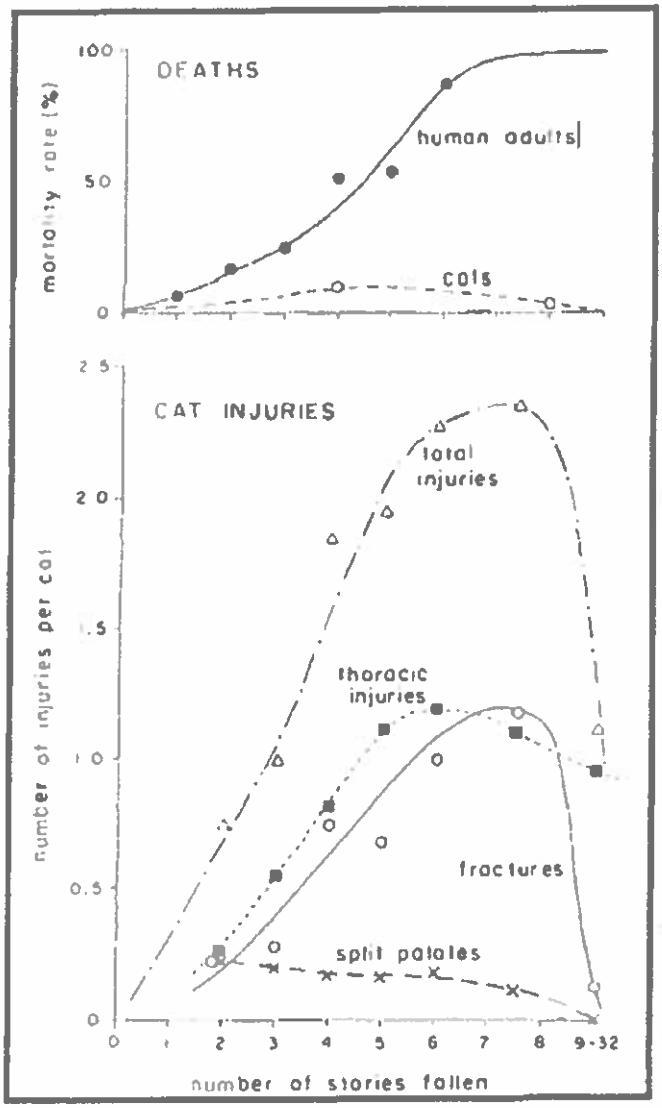
Jared M. Diamond Nature (volume 332) –abridged

The famous adage that cats have nine lives stems in part from their ability to survive falls lethal to most people. This phenomenon has not received the scientific attention that it deserves. A new study applies principles of anatomy, physics and evolutionary biology to falling cats.

The authors were veterinarians at an animal hospital in New York City, where skyscrapers, open windows and paved ground combined to generate a database of 132 cats injured by falls of 2 or more stories, with a maximum of 32 stories (1 storey= 15 feet). Most victims landed on concrete after a free fall. Omitting 17 cats that were euthanized by owners unable to afford treatment, 90 percent of the cats (104 of 115) survived, whereas 11 died (mainly because of thoracic injuries and shock). The most remarkable feature of the results (see figure) is that incidence both of injuries and of mortality peaked for falls of around seven stories and decreased for falls from greater heights. For instance, the cat that free-fell 32 stories onto concrete was released after 2 days of observation in the hospital, having suffered nothing worse than a chipped tooth and mild pneumothorax.

Falling adult humans differ from falling cats in their much higher mortality rate. As illustrated in the figure, higher falls are increasingly lethal for humans, and few adults survive falls of more than six stories onto concrete. The principal causes of death are head injuries and haemorrhage from visceral injuries. Although forelimb fractures are slightly commoner than hindlimb fractures in falling cats, falling adult humans most often break their legs, and falling children their arms.

Straightforward theory relates injuries from falls to three sets of variables. First, the height of the fall determines the impact velocity. Second, the softness of the surface of impact affects the stopping distance and hence the impact force. Those people surviving falls from aeroplanes have landed on mud or snow, not concrete. And third, at least five properties of the falling body itself are relevant: its mass, area, bone strength; cushioning of vital parts by fat and other soft tissue, and dissipation of impact forces through flexing of muscles and use of joints.



(Figure 2: Mortality rates for falling adult humans and cats (above), and number of total injuries and various types of injury per falling cat (below), as a function of number of stories fallen.

Name:_____ Date:_____

Part 1: Cats Falling Out of Windows

Feline High-Rise Syndrome (FHRS) is the term used in medical cases of cats falling from balconies or windows of high-rise buildings in urban areas. The cause of the fall in most cases happens when the animal jumps from the window or over the balcony, when chasing a bird or insect, or it slips while walking on the edge of the balcony or window.[1]

[2]

Essential Question: How do the number of injuries per cat relate to the number of stories a cat falls?

Good news, we have data[3]...

Number of Stories Fallen	Number of Total Injuries Per Cat (fractures, dental, thoracic trauma, contusions, shock)	Number of Cats Per Stories Fallen
1	0.00	0
2	0.75	8
3	1.00	14
4	1.60	27
5	2.00	34
6	2.30	21
7-8	2.40	9
9-32	1.10	13

1. Examine the data and look for trends. *What kind of graph would work best for this data?*

2. Write a claim that answers the essential question:

3. What evidence supports the claim? (Summarize key trends from the data table)

4. For each piece of evidence you collect, give your reasoning to why it supports your claim. (You might consider writing this as an "If-Then" statement.)

[1] Vnuk et al. 2004. Feline high-rise syndrome: 119 cases (1998-2001). *J Fel Med Surg* 6:305-312

[2] Whitlock, M. and Schluter, D. 2009. The analysis of biological data. *Roberts and Company*, Colorado. p 3

[3] W.O. Whitney, C.J. Mehlhaff. High-rise syndrome in cats. *Journal of the American Veterinary Medical Association*, 191 (1987), pp. 1399–1403. https://www.ncbi.nlm.nih.gov/pubmed/3692980

Name:_____ Date:_____

These theoretical considerations provide several reasons why cats survive falls that kill adult humans. Falling large animals are generally more injury-prone than small ones, as they suffer greater impact stress, their bones experience greater stress, and they reach higher terminal velocities in free-fall because of a less favourable area/mass ratio. Even a small drop breaks an elephant's leg, but falling mice reach terminal velocity in the atmosphere much sooner and at a much lower value that falling elephants.

Second, falling cats have a superb vestibular system and make gyroscopic turns such that all four feet are soon pointing downwards, regardless of the cat's orientation at the start of the fall. Hence, cats dissipate the impact force over all four limbs. Falling human adults tend to tumble uncontrollably but land most often on two feet, next most often on their heads. Falling babies, because their relatively large heads, tend to land head-first with arms reflexively extended to break the fall.

Third, a cat falling in the atmosphere reaches a terminal velocity of about 60 m.p.h. (compared with 120 m.p.h. for adult humans) after only about 100 feet. As long as it experiences acceleration, the cat probably extends its limbs reflexly, but on reaching terminal velocity it may relax and extend the limbs more horizontally in flying-squirrel fashion, thus not only reducing the velocity of fall but also absorbing the impact over a greater area of its body. This may explain the decrease of mortality and injury in cats that fall more than 100 feet.

Finally, cats that land with their limbs flexed dissipate much of the impact force through soft tissue. Parachutists are trained to dissipate impact forces by landing with knees and hips flexed, then rolling.

Evidently, falling cats have some advantages shared with any small animal of similar mass and shape but also have unique advantages of their own, notably their gyroscopic righting reflex and the limb flexing on landing. Small dogs that fall from buildings are prone to more serious injuries than cats. The cat-specific advantages have undoubtedly evolved through natural selection: most feline species are arboreal, so that millions of years of springing or falling from trees has favored those felines with the best vestibulocochlear systems. Thus, the nine lives of cats are a product of their evolutionary history.

1. Examine the number of total injuries per cat from figure 2. Discuss how this study corroborated claims from the previous study.

2. How do cats survive falls that would kill humans? What CLAIM is the author making to explain trends about mortality from figure 2.

3. Summarize his EVIDENCE for this claim

4. Why do cats who fall from greater distances suffer fewer injuries? What CLAIM does the author make to answer this question?

5. Summarize his EVIDENCE for this claim.

6. What type of REASONING was used in this study? (Inductive, deductive). Explain your choice.

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Print

The Impact of Smartphone Use on Course Comprehension and Psychological Well-Being in the College Classroom

Melissa Huey[1] · **David Giguere**[2]

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Abstract

The present study explores the impact of smartphone use on course comprehension and the psychological well-being of students during class. Students in four classes ($N = 106$) were assigned to either a control group or quasi-experimental group. Students in the quasi-experimental group were instructed to place their smartphones on the front desk upon entering the class, while the control group had no instructions regarding smartphone use. Students filled out a brief survey about their course comprehension and psychological state (anxiety and mindfulness) during class. Results indicated that students whose smartphones were physically removed during class had higher levels of course comprehension, lower levels of anxiety, and higher levels of mindfulness than the control group. This study gives a comprehensive picture of the impact of smartphone use on students' psychological well-being in the classroom. The findings can aide educators in curriculum design that reduces technology use in order to improve the student learning experience.

Keywords Smartphones · College students · Course comprehension · Learning · Student mindfulness · Student anxiety

The smartphone has become an integral part of society, including our educational and professional lives. Smartphone use is highest amongst people aged 18–29, and therefore is highly represented in the University setting. Statistics show that 97% of students own a smartphone (Pew Research Center, 2021), and 95% of students bring that smartphone to class (Tindell & Bohlander, 2012). Given the frequency of smartphone use in the college student population, it is not surprising ample research

✉ Melissa Huey
mhuey@nyit.edu

David Giguere
giguere@csus.edu

[1] New York Institute of Technology, New York City Campus, 16 West 61St Street, New York, NY 10023, USA

[2] California State University – Sacramento, 6000 J Street, Sacramento, CA 95819, USA

has investigated smartphone use in the University setting – both inside and outside the classroom. There is a large body of literature that looks at smartphone use and academic performance. Smartphone is associated with lower GPA's, both in self-reports (Ibrahim et al., 2018; Katz & Lambert, 2016; Kim et al., 2019), and actual GPA (Hawi & Samaha, 2017). Research has also found that smartphone use is associated with poor sleep quantity (Demirci et al., 2015), life satisfaction (Lachmann et al., 2018), and anxiety, loneliness, and depression (Boumosleh & Jaalouk, 2017) in college students.

Within the classroom, smartphones can often be a cause of distraction, as students use the phone during class to check social media (Gupta & Irwin, 2016), multi-task (Sana et al., 2013), or contact friends (Tindell & Bohlander, 2012). These activities deflect from instruction, and impede student learning. Although a substantial body of research has found that cell phone use in the classroom is associated with lower academic achievement (e.g. Amez & Baert, 2020), fewer studies have examined the effects of cell phone use on students' psychological well-being in the classroom setting, and even fewer have examined the impact of cell phone use using a quasi-experimental paradigm. The present study aims to further explore the impact that the smartphone has on course comprehension, and expand the research by investigating how smartphone use in the classroom impacts the psychological well-being of students during class.

Research on smartphones in the classroom is mixed, and primarily focuses on academic performance. On one hand, when used properly, smartphones are associated with better academic performance. The convenience of the smartphone allows students to access the internet anywhere, letting them connect with information, assignments, and e-mails related to school almost instantly (Lepp et al., 2014). Also, social networking sites and online applications contribute to easy communication amongst students and the professor, which allows for seamless collaboration (Chen & Ji, 2015). Some research has found that the more students engage in course-related activities on their phone, the more likely they are to seek out additional information to comprehend the material (Rashid & Asghar, 2016).

On the other hand, the smartphone is often a distraction for students, which takes away from the classroom experience and retention of information. The smartphone can serve as a source of entertainment for students, rather than a working instrument. It has been found to draw students' attention away from study time and time spent on homework and assignments (Junco & Cotten, 2012), ultimately taking away from the learning experience. Given this information, it is not surprising that smartphone use is associated with lower self-reported (Ibrahim et al., 2018; Katz & Lambert, 2016; Kim et al., 2019), and actual GPA (Hawi & Samaha, 2017; see Amez and Baert (2020) for full literature review).

There is ample research on the smartphones' impact on academic performance, but less is known about its potential impact on course-related psychological well-being. Anxiety is particularly problematic among college students, as it often impedes the learning experience (Mazzone et al., 2007). 60.8% of college students report feeling overwhelming amounts of anxiety last year alone (American College Health Association, 2022).

In general, research has found a negative correlation between smartphone use and psychological well-being, specifically in anxiety and depression (e.g. Demirci et al., 2012). While the majority of this research have examined smartphone use and overall levels psychological well-being, some studies have examined this relationship in the classroom setting. Again, the literature has found a negative relationship (e.g. Boumosleh & Jaalouk, 2017) Two, not mutually exclusive, explanations for this relationship have been suggested. One, the barrage of alerts on our phone and constant streams of information creates feelings of anxiousness, and distraction from the lecture (Al-Furaih & Al-Awidi, 2021). Two, smartphones in the class can create anxiety due to FOMO, or fear of missing out (e.g. Yildirim & Correia, 2015), as students notice other things going on amongst friends while they are in-class. Given these distractions, removing the smartphone from the classroom experience will likely reduce student anxiety (Stankovic et al., 2021).

Research has also found that mindfulness – defined as the quality or state of being conscious or aware of present surroundings—can significantly reduce anxiety (Hoffman et al., 2010). This is particularly true in the classroom. Mindfulness during lectures has been found to be associated with better grades (Caballero et al., 2019), and better overall psychological health while learning (Mahfouz et al., 2018). With the distraction of the smartphone, it is likely that smartphone use reduces students' mindfulness during lectures, inhibiting the learning experience and increasing anxiety.

Due to the conflicting research on the effects of smartphone use in the classroom, the current study seeks to clarify and expand the impact of academic achievement by investigating the effects of smartphone use on course comprehension using a quasi-experimental procedure. In addition, we hope to explore the effects of smartphone use on psychological well-being – operationally defined as classroom anxiety and mindfulness. In the present study, students were assigned to either a quasi-experimental group, where students were instructed to leave their smartphone on the windowsill / desk of the instructor as they entered the class – ensuring a physical distance from their phone – or a control group, where they received no instructions on smartphone use. Students then completed a survey to measure levels of course comprehension and psychological well-being based on these conditions. The present study tested three hypotheses:

H1: Based on previous research, students who were physically distanced from their cell phones would be less distracted, and therefore have significantly higher rates of course comprehension then students in the control group.
H2: Students who were physically distanced from their cell phones would be less distracted and more engaged in the lecture, therefore having lower levels of anxiety then students in the control group.
H3: Students who were physically distanced from their cell phones would be less distracted, and therefore have significantly higher rates of mindfulness then students in the control group.

Methods

Participants

Participants were undergraduate students at the [BLINDED], a primarily undergraduate institution in New York City. Four content courses in the Behavioral Sciences Department were selected for participation in the study in Spring 2020. The courses included were Introduction to Sociology ($n = 54$), Dynamics of Violence ($n = 18$), Educational Psychology ($n = 21$), and Health Psychology ($n = 15$). There were 36 participants (33%) in the quasi-experimental group, and 72 in the control group (67%).

The participants ($N = 108$) included 59 females (55%) and 49 males (45%). Of this total, 44 were Asian American (41%), 32 identified as White / Caucasian (30%), 11 identified as Latinx or Hispanic (10%), 11 identified as Black / African American (10%), and 10 were unidentified (10%). Students ranged in age from 18 to 47 ($M = 20.2$, $SD = 3.6$). Ethical approval was granted by [BLINDED] Review Board (Protocol number: ESB 1520).

Procedure

Of the four behavioral science courses, two courses – Introductory Sociology and Dynamics of Violence – were treated as controls. Students in these courses did not receive any instructions or specific restrictions on their smartphone use. Educational Psychology and Health Psychology were assigned as the quasi-experimental condition. At the beginning of class each day, students were instructed to place their phones on a desk at the front of the classroom before the lecture was given. The phones could not be physically on them or accessed throughout the duration of the course. In the beginning of March 2020 – after six weeks of in-person participation in the course—all students completed a self-report survey that measured their course comprehension, mindfulness, and anxiety throughout the course.

Instruments

Course comprehension

A 10-item questionnaire was created, which specifically assessed how engaged the student felt in the course material during the course. Sample items included, "I feel confident in my knowledge of the course material," or "It is clear to me what concepts I do not understand after the lecture." Questions ranged on a scale from "1" – *strongly disagree* – to "5" – *strongly agree*. The items were averaged and reliability was very good ($\alpha = 0.86$). A reliability analysis was conducted, and was best when all 10 items were included in the scale. In addition, a principal component analysis was conducted to investigate construct validity. All ten items had eigenvalues over Kaiser's criterion of 1 and the cumulative variance explained was 50.08%. See Appendix 1 for questions.

Table 1 Bivariate correlations, means, & standard deviations

Variable	1	2	3	Means	Standard Deviations
1. Course Comprehension	—			3.92	0.58
2. Mindfulness	.48**	—		3.87	0.87
3. Anxiety	−.18	−.32**	—	1.72	0.89

$N = 106$. * $p < .05$. ** $p < .01$ indicates a significant difference between groups

Anxiety

A 7-item questionnaire was created, which specifically assessed students' anxiety during class. Sample items included "During class, I feel nervous, anxious, or on edge" or "During class, I have trouble relaxing." Questions ranged on a scale from "1" – *not at all* – to "5" – *all the time*. The items were averaged and reliability was very good. ($\alpha = 0.93$). A reliability analysis was conducted, and was best when all 7 items were included in the scale. In addition, a principal component analysis was conducted to investigate construct validity. All seven items had eigenvalues over Kaiser's criterion of 1 and the cumulative variance explained by the 7 items was 71.49%. See Appendix 2 for questions.

Mindfulness

A 10-item questionnaire was created which specifically assessed students' mindfulness during their respective course. Sample items included, "I take notes on autopilot, without truly processing the information" and "I am focused on outside responsibilities or tasks during class." Questions ranged on a scale from "1" – *strongly disagree* – to "5" – *strongly agree*. The items were averaged and reliability was very good. ($\alpha = 0.94$). A reliability analysis was conducted, and was best when all 10 items were included in the scale. In addition, a principal component analysis was conducted to investigate construct validity. All ten items had eigenvalues over Kaiser's criterion of 1 and the cumulative variance explained was 64.49%. See Appendix 3 for questions. See Table 1 for correlations between study variables.

Results

Smartphone use and course comprehension

An independent sample t-test examined the effect that smartphone use in the classroom had on overall course comprehension. Results indicated statistically significant differences in course comprehension, $t(106) = -2.55$, $p = 0.01$, $d = 0.56$. The quasi-experimental group had significantly higher levels of course comprehension ($M = 4.16$, $SD = 0.56$) than the control group ($M = 3.86$, $SD = 0.56$).

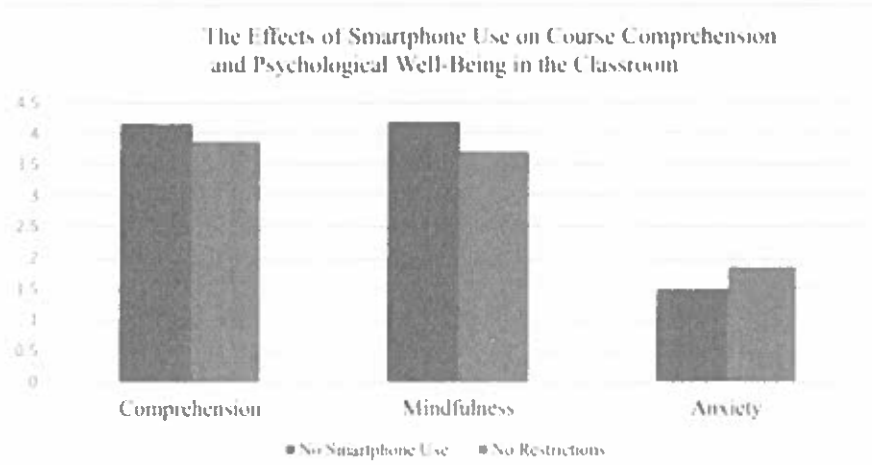

Fig. 1 The effects of smartphone use on course comprehension and psychological well-being in the classroom

Smartphone use and anxiety

An independent sample t-test examined the effect that smartphone use in the classroom had on anxiety during the course. Results indicated statistically significant differences in course anxiety, $t(106) = 2.27$, $p = 0.03$, $d = 0.88$. The experimental group had significantly lower levels of anxiety ($M = 1.48$, $SD = 0.67$) than the control group ($M = 1.84$, $SD = 0.97$). See Fig. 1 for results.

Smartphone use and mindfulness

An independent sample t-test examined the effect that smartphone use in the classroom had on overall mindfulness during class. Results indicated statistically significant differences in mindfulness, $t(106) = -2.84$, $p = 0.01$, $d = 0.84$. The experimental group had significantly higher levels of mindfulness ($M = 4.19$, $SD = 0.73$) than the control group ($M = 3.71$, $SD = 0.89$). See Fig. 1 for mean comparisons between study variables.

Discussion

The goal of this study was to explore whether smartphone use impacts course comprehension and the psychological state of students in the classroom. Results found that students who physically removed their smartphones from them throughout the duration of the class had significantly higher levels of comprehension and mindfulness in the course. In addition to that, students without their smartphones had significantly lower levels of anxiety. The data provides preliminary evidence that limiting

cell phone use creates a more positive psychological state for students, and in turn, may yield more positive learning outcomes (e.g. Bóo et al., 2020).

The negative association between cell phone use and course comprehension is consistent with previous studies (see e.g. De Shields & Riley, 2019; Kuznekoff & Titsworth, 2013). This finding adds to the growing body of literature that suggests that distracted students perform worse in the classroom. However, previous research has largely been correlational, leaving open the possibility of alternative explanations. The present study provides quasi-experimental evidence that smartphone use has a causal and negative influence on classroom experience. Additionally, the present study adds to the literature that cell phone use increases anxiety in the classroom and reduces mindfulness. This finding is consistent with Lepp et al. (2014), that also identified a negative association between cell phone use and college students' general level of anxiety. These findings provide preliminary evidence that the presence of cell phones in the class negatively affects student perceptions of their classroom experience.

It should be noted that the results from this study are prior to the COVID-19 outbreak, which may change the nature of psychological well-being in the classroom. Anxiety in the classroom prior to the COVID-19 pandemic focused on school work and grades, whereas post-pandemic may focus on transmission of diseases, vaccinations, and social anxiety due to lack of exposure to social settings. Future studies may investigate psychological well-being of students in the classroom post the COVID-19 pandemic.

Limitations

The conclusions we can draw are limited by the design of the study and the measures we used. With respect to study design, the participants came from four distinct classes, and different instructors taught each of those classes and the number of participants in each group were not equal. Although each class was a content class in the Behavioral Science Department, future studies may investigate the effects of smartphones in the classroom using the same classes or a single instructor in order to avoid potential confounds. Additionally, our design only examined whether smartphones affect the classroom experience across students. Future studies can include a baseline assessment of the outcomes at the beginning of the semester and again at the end to examine whether smart phones in the classroom have a within-student effect.

The outcomes of the study relied on self-report data from non-validated questionnaires. Self-report data can be biased and future studies should include objective measures of course comprehension (e.g., grade in class) and psychological well-being (e.g., current use of antidepressant drugs). While self-report measures have limitations, the bias associated with these measures were evenly distributed across conditions, therefore the effect of condition cannot be explained by reliance on self-report data. The use of non-validated questionnaires also limits the validity of the results. Future studies can use the items from the present study and items from

validity measures to ensure high convergent validity. While many valid and reliable measures of anxiety and mindfulness exist, none perfectly fit the aim of the present study— to examine these constructs confined to the experience in one specific classroom. Thus, questionnaires were created to fit the study design. Only items with face validity were included, and each item was meant to examine the larger construct directly and clearly. Additionally, the high reliability scores suggests that these items were testing a single construct.

Conclusion

The results from our study provide evidence that the use of smartphones in the classroom has a negative effect on levels of course comprehension and the psychological state of students during lecture. Given the psychological state of students is imperative to creating a positive learning environment (Febrilia et al., 2011), it is important that educators make informed decisions about technology use in the classroom, in order to maintain a high-quality learning experience. Something as simple as limiting smartphone use during scheduled class time can have an impact on the well-being of students, and in turn, create a better learning environment.

Appendix 1 – Course comprehension

1 – Strongly disagree
2 – Disagree
3 – Neutral
4 – Agree
5 – Strongly agree

1. I am learning a lot in this course.
2. I feel confident in my knowledge of the course material.
3. It is clear to me what concepts I do not understand after lecture.
4. I feel like I can apply the knowledge I learn in this course to new situations.
5. I have developed new study strategies that have helped me learn the material.
6. I feel like I can apply what I learn in this course to life outside of school.
7. I often feel confused after class (reverse-coded).
8. I feel like I am able to identify points of confusion.
9. I have been able to learn from my successes and struggles in this course
10. I feel confident explaining most of the concepts or principles learning in this course to someone else

Appendix 2 – Anxiety

1 – Strongly disagree
2 – Disagree
3 – Neutral
4 – Agree
5 – Strongly agree

1. During class, I feel nervous, anxious, or on edge.
2. During class, I am not able to stop or control worrying.
3. During class, I often worry too much about different things.
4. During class, I have trouble relaxing.
5. During class, I am so restless that it's hard to sit still.
6. During class, I become easily annoyed or irritable.
7. During class, I feel worried that something bad will happen.

Appendix 3 – Mindfulness

1 – Strongly disagree
2 – Disagree
3 – Neutral
4 – Agree
5 – Strongly agree

1. Although I am in class, I am often not paying attention
2. My mind if rarely focused on what is going on in class.
3. In class, it seems as I am running on autopilot without much attention to what the professor is saying.
4. I am often focused on outside responsibilities or tasks during class.
5. I take notes on autopilot, without truly processing the information.
6. During class, I find myself preoccupied with the future or the past.
7. Often in class I am listening, but not fully engaged in the material.
8. In class, I am often doing other activities.
9. I find it difficult to pay attention to what's happening during class.
10. I often think about class as an opportunity to do other work.

Author contributions All authors contributed to the manuscript conception. Material preparation, data collection and analysis were performed by Dr. Melissa Huey. The manuscript was prepared by Drs. Melissa Huey and David Giguere. All authors have read an approved the final manuscript.

Declarations

Ethics All procedures performance in studies involving human participants were in accordance with the ethical standards of the institution. The study was approved by the Institutional Review Board at New York Institute of Technology (IRB Protocol Number: ESB 1520). All participants included in the study were given a consent form prior to participation.

Financial interests The authors have no financial or non-financial interests to disclose.

Competing interests The authors have no competing interests to disclose.

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Melissa Huey is an Assistant Professor of Psychology at New York Tech. She received her master's in Psychology from City College of New York, and her doctorate in Experimental Psychology from Florida Atlantic University. Her research is focused on the psychological well-being of students in the University classroom.

David Giguere is an Assistant Professor of Psychology at California State University-Sacramento. He received his doctorate in Experimental Psychology from Florida Atlantic University. His research interests focuses on bilingualism and its role in executive function.

Advanced Biology Summer Work (Spalding/Boyd)

What was the Title of the Article:
Summary of article in own words of article no less than 300 words.
Identify the Following: Independent Variable, Dependent variable, Constants, Potential Errors
What was the conclusion found:

Possible implications in daily life/community:
What other topics/areas of interest that could be explored after reading this article? What further research could be done based on what you learned?

ACT Practice Science

Summer 2025

You will have twelve minutes to complete this practice ACT. Your score will be recorded in the comment section of the grade book. This will not count as a numerical grade, but your parents will be able to see it.

* Required

* This form will record your name, please fill your name.

1

Unmanned spacecraft taking images of Jupiter's moon Europa have found its surface to be very smooth with few meteorite craters. Europa's surface ice shows evidence of being continually resmoothed and reshaped. Cracks, dark bands, and pressure ridges (created when water or slush is squeezed up between 2 slabs of ice) are commonly seen in images of the surface. Two scientists express their views as to whether the presence of a deep ocean beneath the surface is responsible for Europa's surface features.

Scientist 1

A deep ocean of liquid water exists on Europa. Jupiter's gravitational field produces tides within Europa that can cause heating of the subsurface to a point where liquid water can exist. The numerous cracks and dark bands in the surface ice closely resemble the appearance of thawing ice covering the polar oceans on Earth. Only a substantial amount of circulating liquid water can crack and rotate such large slabs of ice. The few meteorite craters that exist are shallow and have been smoothed by liquid water that oozed up into the crater from the subsurface and then quickly froze.

Jupiter's magnetic field, sweeping past Europa, would interact with the salty, deep ocean and produce a second magnetic field around Europa. The spacecraft has found evidence of this second magnetic field.

Scientist 2

No deep, liquid water ocean exists on Europa. The heat generated by gravitational tides is quickly lost to space because of Europa's small size, as shown by its very low surface temperature (−160°C). Many of the features on Europa's surface resemble features created by flowing glaciers on Earth. Large amounts of liquid water are not required for the creation of these features. If a thin layer of ice below the surface is much warmer than the surface ice, it may be able to flow and cause cracking and movement of the surface ice. Few meteorite craters are observed because of Europa's very thin atmosphere; surface ice continually sublimes (changes from solid to gas) into this atmosphere, quickly eroding and removing any craters that may have formed.

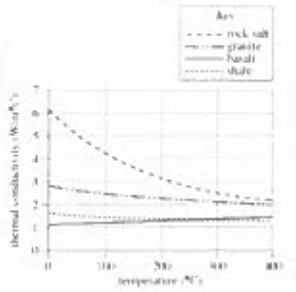
Which of the following best describes how the 2 scientists explain how craters are removed from Europa's surface? *

- ◯ Scientist 1: Sublimation, Scientist 2: Filled by water
- ◯ Scientist 1: Filled in by water, Scientist 2: Sublimation
- ◯ Scientist 1: Worn smooth by wind, Scientist 2: Sublimation
- ◯ Scientist 1: Worn smooth by wind, Scientist 2: Filled in by water

2

Study 2

The scientists determined the thermal conductivity of the 4 rock types at a number of different temperatures between 0°C and 400°C. The results are shown in Figure 1.



According to Study 2, the thermal conductivity of rock salt measured at a temperature of 500°C would be closest to which of the following values?

- 1.0 W/m°C
- 2.0 W/m°C
- 3.5 W/m°C
- 4.0 W/m°C

3

Conflicting Viewpoints

The presence of gases in earth's atmosphere is a constant. Certain gases can absorb and hold onto heat from their environment. These gases are typically comprised of three molecules held together tenuously, which causes them to vibrate when they absorb heat. The motion of their vibrations leads to the release of their stored heat to the outside environment. The heat they release is typically quickly absorbed by other similar gases nearby. These gases remain in earth's atmosphere for a long time after being introduced. Because of this they can trap heat within the atmosphere, preventing it from leaving, by absorbing heat and releasing heat to be absorbed by other nearby similar gases.

Hypothesis 1

Gases such as methane and nitrous oxide trap heat in the earth's atmosphere. Trapping heat in the earth's atmosphere leads to a greenhouse effect, gradually increasing the temperature of the earth. This increase in the earth's temperature will lead to the melting of glaciers, increasing sea level.

Hypothesis 2

Gases such as methane but not nitrous oxide trap heat in the earth's atmosphere. The heat methane traps in the earth's atmosphere is less than the heat that escapes the earth leading to a global cooling effect, gradually decreasing the temperature of the earth. This decrease in earth's temperature will lead to the development of more glaciers, decreasing sea level.

Hypothesis 3

Gases such as nitrous oxide but not methane trap heat in the earth's atmosphere. The heat nitrous oxide traps in the earth's atmosphere is equal to the heat that escapes the earth leaving the temperature of the earth generally unchanged. The earth's environment will remain largely unchanged by the heat trapping properties of nitrous oxide.

According to the author of hypothesis 2, would it be possible for earth's temperature to increase if the amount of heat methane traps in the atmosphere increased? *

- Yes, the hypothesis claims that increasing the quantity of heat will subsequently increase the quantity of heat nitrous oxide will trap.
- Yes, the hypothesis claims methane isn't currently trapping a sufficient quantity of heat.
- No, the hypothesis claims the sea level will decrease.
- No, the hypothesis claims the temperature will decrease.

4

Passage III

Experiment 2

Factors affecting the catalase activity were studied using yeast as the source for the catalase enzyme. Small disks of filter paper were soaked in a yeast solution. Ten milliliters of 1% hydrogen peroxide solution was added to five test tubes. One change was applied to each of five test tubes, as listed in Table 2. After enough oxygen was produced by the catalase enzyme within the paper disk, the disk floated to the surface of the solution. The time required for the disk to float to the top of the solution was measured and recorded.

Table 2

Applied Change	Effect on Solution	Time Required for Paper disk to Float (s)		
		Trial 1	Trial 2	Trial 3
Addition of 20 drops of acid	Increased acidity	33	32	33
Addition of 20 drops of base	Increased basicity	45	46	51
Placed into ice bath	Decreased Temperature	63	60	59
Placed into hot water bath	Increased temperature	29	28	25
Addition of 10 grams of salt	Increased salinity	40	42	45

In experiment 2, what additional change could be tested for its effect on catalase activity?

*

- A. Addition of sugar
- B. Addition of salt
- C. Change in pH
- D. Change in temperature

5

Passage III

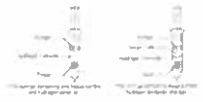
A group of students conducted three experiments to study the enzyme catalase, which is found in the cells of most organisms. Catalase increases the rate of the decomposition of hydrogen peroxide, H_2O_2, which can be toxic and harmful to the organism. The decomposition of hydrogen peroxide produces oxygen gas and liquid water, as shown in Equation 1:

Equation 1:

H_2O_2 (aq) → H_2O (l) + O_2(g)

Experiment 1

Eight tissue samples were tested to determine the relative amount of catalase in the cells of each type of tissue. Each tissue sample was placed into a syringe, and the plunger of the syringe was pushed in as much as possible without compressing the tissue sample. Equal volumes of 3% hydrogen peroxide were drawn into the syringe, and then the syringe was sealed. The syringes with tissue and peroxide were left overnight. The gas produced pushed the plunger of the syringe, allowing for a change in volume to be measured.



The volume of the contents of each syringe was measured to determine the amount of gas produced.

Table 1

Type of Tissue	Initial Volume of Syringe Contents	Final Volume of Syringe Contents	Change in Volume of Syringe Contents
Sliced raw potato	21	43	22
Yeast	20	54	34
Raw liver	20	72	52
Ground meat	20	50	30
Boiled potato	22	31	9
Cooked liver	21	56	35
Green leaves	20	44	24
Sliced raw carrot	23	49	26

Which of the following conclusions are supported by the results of experiment 1?

*

- A. Plant tissues contain more catalase than animal tissues
- B. I tissues contain about the same amount of catalase.
- C. Liver contained the least amount of catalase.
- D. Cooked tissues do not contain as much catalase as raw tissues.

6

Researchers studied sprinting ability to better understand differences between individuals in performance. After completion of the first study, researchers performed two follow up studies to explore the movement economy of and physiological response to sprinting. The same five subjects were used for each study.

Study 1

Five healthy adult subjects with similar body weight and height were familiarized with the sprinting technique. Each subject was instructed to sprint as fast as they could in a linear path for 20 yards. Infrared timing gates were placed at 5 yards (G1), 10 yards (G2), 15 yards (G3), and 20 yards (G4) into the route to record timing and later extrapolate speed.

In Study 1, which subject traveled fastest between G3 and G4? *

	G1 (seconds)	G2 (seconds)	G3 (seconds)	G4 (seconds)
Subject 1	0.98	1.71	2.45	3.49
Subject 2	0.88	1.63	2.42	3.51
Subject 3	0.93	1.65	2.39	3.47
Subject 4	1.24	2.01	2.88	3.94
Subject 5	1.11	1.83	2.66	3.72

Figure 1

- ◯ Subject 1
- ◯ Subject 2
- ◯ Subject 3
- ◯ Subject 5

7

I understand that ACT prep is a regular part of Advanced Biology and is for practice purposes only. *

- ◯ Yes
- ◯ No

8

Passage IV

Spent fuel (SF), a radioactive waste, is often buried underground in canisters for disposal. As it decays, SF generates high heat and raises the temperature of the surrounding rock, which may expand and crack, allowing radioactivity to escape into the environment. Scientists wanted to determine which of 4 rock types—rock salt, granite, basalt, or shale—would be least affected by the heat from SF. The thermal conductivity (how well heat is conducted through a material) and heating trends of the 4 rock types were studied.

Study 1

Fifty holes, each 0.5 m across and 20 m deep, were dug into each of the following: a rock salt deposit, granite bedrock, basalt bedrock, and shale bedrock. A stainless steel canister containing 0.4 metric tons of SF was buried in each hole. The rock temperature was measured next to each canister after 1 year had passed. The results are shown in Table 1, along with the typical thermal conductivity of each rock type, in Watts per meter per °C (W/m°C), at 25°C. The higher the thermal conductivity, the more quickly heat is conducted through the rock and away from the canisters.

Table 1

Rock	Thermal conductivity (W/m°C)	Rock temperature (°C)*
Rock salt	5.70	110
Granite	2.80	121
Basalt	1.26	165
Shale	1.57	146

*All rock types had an initial temperature of 10°C.

According to the results of Study 1, which of the following best describes the relationship between thermal conductivity and rock temperature? As thermal conductivity increases, the rock temperature recorded adjacent to buried SF canisters: *

- decreases only.
- increase only
- increase, then decrease
- remain the same

9

Passage III

Hydrogen peroxide is often used as a bleaching agent. It has been suggested that hydrogen peroxide produced within the body leads to gray hair. Considering this, what food might be suggested to prevent gray hair? *

- A. Potatoes
- B. Carrots
- C. Liver
- D. Dark green vegetables

10

Scientists want to see how any athlete's heart health is different from others. The scientists monitor four individual's (A, B, C and D) heart rates during sleep, rest and intense exercise. Only one athlete was tested and the data was recorded in the table below in heart beats per minute.

Which individual has the best overall fitness? *

	Sleep	Rest	Exercise
A	55	62	195
B	72	76	182
C	80	89	168
D	78	83	173

- ◯ Individual A
- ◯ Individual C
- ◯ Individual A and B
- ◯ Not enough information

11

Passage III

Why were the test tubes in the water bath for ten minutes? *

- ◯ F. The hydrogen peroxide only begins to decompose after ten minutes.
- ◯ G. To allow time to prepare other materials.
- ◯ H. To allow enough time for heat to be transferred from the water to the hydrogen peroxide until the temperatures are the same.
- ◯ J. There is no specific reason for this action.

12

Passage III
Experiment 2

Factors affecting the catalase activity were studied using yeast as the source for the catalase enzyme. Small disks of filter paper were soaked in a yeast solution. Ten milliliters of 1% hydrogen peroxide solution was added to five test tubes. One change was applied to each of five test tubes, as listed in Table 2. After enough oxygen was produced by the catalase enzyme within the paper disk, the disk floated to the surface of the solution. The time required for the disk to float to the top of the solution was measured and recorded.

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Placed into ice bath	Decreased Temperature	63	60	59
Placed into hot water bath	Increased temperature	29	28	25
Addition of 10 grams of salt	Increased salinity	40	42	45

Based on experiment 2, how much time is needed for enough oxygen to be produced by the yeast to make the filter paper buoyant in acidic conditions?

- A. 20 seconds
- B. 30 seconds
- C. 40 seconds
- D. 45 seconds

13

Passage III
Experiment 3

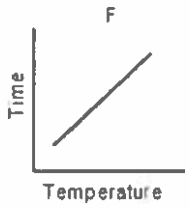
Experiment 2 was repeated, but only the temperature was varied. The test tubes of hydrogen peroxide were placed into water baths of varying temperatures. The yeast-soaked paper disks were placed into the test tubes of hydrogen peroxide after the test tubes sat in the water bath for ten minutes. The time required for the paper disk to float to the surface due to the production of oxygen is shown in Table 3.

Table 3

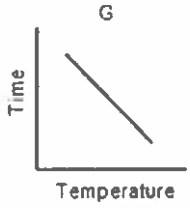
Temperature of Water Bath (°C)	Time Required for Paper Disk To Float (sec)
20	56
27	45
35	42
44	36
52	29
69	Did not float
73	Did not float

Which graph best represents the results of experiment 3?

F



G



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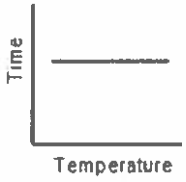

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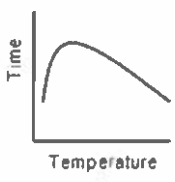

14

Passage III

A student performed 2 studies to investigate the factors that affect the germination of peony seeds.

Study 1

Peony seeds were placed in dry containers. Some of the containers were stored at 5°C for either 4, 6, 8, or 10 weeks. The temperature and time periods were defined as the *storage temperature* and the *storage period*, respectively.

The peony seeds were divided evenly so that there were 20 sets of 25 seeds. Twenty petri dishes were then prepared. Each contained damp paper. Each set of seeds was placed in a separate petri dish. Each petri dish was maintained at 1 of 4 temperatures for 30 days. The temperature and time periods were defined as the *germination temperature* and the *germination period*, respectively. Table 1 shows the number of seeds that germinated in each dish.

Table 1

Storage period (weeks)	Number of peony seeds that germinated when maintained at a germination temperature of:			
	13°C	18°C	23°C	28°C
0	0	0	0	0
4	0	2	0	0
6	3	8	5	0
8	7	22	10	0
10	15	24	21	1

In general, the results of Study 1 suggest that peony seeds that are placed in a petri dish containing damp paper are most likely to germinate when they are maintained at which of the following temperatures? *

- ◯ 13°C
- ◯ 18°C
- ◯ 23°C
- ◯ 28°C

15

Conflicting Viewpoints

The presence of gases in earth's atmosphere is a constant. Certain gases can absorb and hold onto heat from their environment. These gases are typically comprised of three molecules held together tenuously, which causes them to vibrate when they absorb heat. The motion of their vibrations leads to the release of their stored heat to the outside environment. The heat they release is typically quickly absorbed by other similar gases nearby. These gases remain in earth's atmosphere for a long time after being introduced. Because of this they can trap heat within the atmosphere, preventing it from leaving, by absorbing heat and releasing heat to be absorbed by other nearby similar gases.

Hypothesis 1

Gases such as methane and nitrous oxide trap heat in the earth's atmosphere. Trapping heat in the earth's atmosphere leads to a greenhouse effect, gradually increasing the temperature of the earth. This increase in the earth's temperature will lead to the melting of glaciers, increasing sea level.

Hypothesis 2

Gases such as methane but not nitrous oxide trap heat in the earth's atmosphere. The heat methane traps in the earth's atmosphere is less than the heat that escapes the earth leading to a global cooling effect, gradually decreasing the temperature of the earth. This decrease in earth's temperature will lead to the development of more glaciers, decreasing sea level.

Hypothesis 3

Gases such as nitrous oxide but not methane trap heat in the earth's atmosphere. The heat nitrous oxide traps in the earth's atmosphere is equal to the heat that escapes the earth leaving the temperature of the earth generally unchanged. The earth's environment will remain largely unchanged by the heat trapping properties of nitrous oxide.

Which hypothesis, if any, asserts that the effect on temperature of heat trapping gases is negligible? *

- ◯ Hypothesis 1
- ◯ Hypothesis 2
- ◯ Hypothesis 3
- ◯ None of the above

Variables

- The **dependent variable** is the variable that the researcher measures; it is called a dependent variable because it depends upon (is caused by) the independent variable.
- The **independent variable** is the one that the researcher manipulates.
- Example: If you are studying the effects of a new educational program on student achievement, the program is the independent variable, and your measures of achievement are the dependent ones.