



Final Report

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Abstract

Biology is generally considered as a subject that requires a high amount of memorization and conceptualization. Some students can easily get distracted or bored and struggle to memorize the vast amount of information required to learn. In this report, we will demonstrate how the application bEYEo can be used to make biology more engaging and help students learn better using Augmented Reality (AR). Interactive learning with AR promotes engaging learning activities that keeps students focused on the material and understand better through visualisation. Through researching various aspects of the study, for example using methods such as questionnaires and going through metrics, we acquired a better understanding of how the bEYEo application should be. We decided to use Unity to create the AR platform for bEYEo. The content of the bEYEo application will be tailored according to the class materials. The application will ask the users to take a quiz at the beginning and end of each lesson to evaluate how much they have learned. The end result of this will be that bEYEo will learn about each student's progress. Further development of bEYEo could provide enhancement of the gamification aspect, which along with reward and scores will craft a journey for the students. It can also extend and include other subjects such as physics and chemistry.

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Introduction

Interactive learning is a new type of teaching that was created with the help of cutting-edge technology. It provides a more hands-on, real-world experience for gaining knowledge in a non-traditional setting. Through our research, we discovered that not all students learn in the same way and might prefer interactive learning over traditional learning. They tend to lose interest or focus when studying by the traditional learning way which is learning from books and lectures and require some interaction and visual indicators to help them understand. Our application bEYEo provides students with an interactive learning platform through AR. This will not only enable them to understand better, but also make them collaborate in a fun way.

Hypothesis

Our hypothesis is that an AR application can help students pay more attention in biology class, keep them more engaged and develop interest in the subject. This will allow students to understand better, pass quizzes and hence do well in their academics. On the contrary our null hypothesis would be that AR does nothing to help students learn more and does not make biology more interesting.

The independent variables of our hypothesis would be the game assets, format and content. The dependent variables of our hypothesis would be the students quiz grades and student engagement during learning. These variables help us to identify what we require to change or measure about the application.

We have decided to perform an experimental design study in order to test our hypothesis. Initially, we will ask our research participants to take a quiz to test their current knowledge about the learning material. Next, we will ask them to go through the application and its learning contents. Following that, they will have to take another quiz to test their knowledge after exploring the application. We will therefore modify the independent variables accordingly based on their feedback. Additionally, we will compare their initial and final quiz results to test if they have learned anything new. This will allow us to evaluate our hypothesis, reach a conclusion and make the best version of our mobile application bEYEo.

Theoretical Contribution

Students can be very much interested in biology, but have a past of never doing good in that subject as they learn much better from interaction than from textbooks, and visualizing class material rather than reading about it. We personally have friends who have faced this situation and it inspired us to look for alternative ways that a student can use to learn a subject that would be helpful for them. Through research we learned about the 4 kinds of learners, different learning techniques and methods to peak interest in people in order to maintain their attention.

Fun is an important factor we have to consider while developing bEYEo to ensure students find it boring and disengaging or equivalent to having them reading the textbook. The application will teach students materials required to ace their academics. It should be flexible and user-friendly as too much overhead and bad UX/UI will cause students to just choose the traditional way of learning. AR has the advantage to make objects on screen feel more real and more immersive, thus more engaging. If bEYEo tends to be a success, we could extend it to other prerequisite classes such as physics and chemistry.



Figure 1: Shows a general view of bEYEo application with Augmented Reality (AR).

Background/Related Work

No additional background research was performed. The most relevant research points done on the proposal will be summarized and listed here:

There are four kinds of learners: visual, auditory, Kinesthetic, and read/write learners.[7][8][9][15][25]

Key Studying techniques involve proper scheduling of time beforehand, willingness to put ego aside to ask questions during as well as the removal of distractions. The importance of an appropriate study environment. The practicing concepts learned and teaching them to others also helps in the retention of information after study.[12][13][14][25]

Gamification of education: Give students freedom of choice when approaching education. Appeal to the 4 types of players from Bartles taxonomy: achievers, explorers, socializers, and killers. Make sure to balance out the appeal to all 4 types as having one of the types dominating can drive out players of the other types from participating within the game.[16][17][18][19][25]

Important teaching concepts such as making an effort to keep student engagement, creating novelty to inspire students to find material interesting, and including unmarked assessments to maintain student interaction.[28][29][30][31][32][25]

Previous research papers done on AR as a tool to teach biology to students. These papers showed that students took half the time to gain comprehension in class materials compared to traditional methods. AR was also found to save on costs in teaching as it circumvented the need to acquire specific materials to demonstrate biological concepts. The research also showed AR's rigidity in maintaining its capability in maintaining its degree of education to students in an online learning environment as students found it to be just as good as in person education.[20][25]

The app education focus will be slated to meet the requirements set by the Quebec Ministry of Education in biology materials.[23][24][25]

System Development and Design

The app bEYEo was created with the main aim of being a simple teaching tool for biology students. Thus, the flow of the app was developed to be intuitive and easy to follow. The initial wireframe flow, as seen in figure 3, shows what we envisioned for bEYEo. First, students login or sign-up so their experience becomes personalized to their educational needs. In the sign-up portions students must indicate which level of education they are currently studying in, since the material will differ for different levels. The material for a certain level follows the requirements established by the Quebec Ministry of Education for the subject of biology at that level. For example, in the flow we see what students at the cegep level would see in their syllabus [22][23]. The student can then go to the specific subtopic they want to study. For each subtopic there are 5 options available to the student: Review quiz, AR Lecture, Take Quiz, Help Sheet, and Scores. The review quiz lets the student take a preliminary quiz to see how they are doing in their biology subtopic. Then the student can go through the AR Lecture to get immersed in the subtopic's material. bEYEo covers all four types of learners. It appeals to the visual learners since it shows an actual 3D representation of the topic in the AR Lecture and a 2D representation in the Help Sheet portion. It helps the auditory learner since all elements of the material as well as the quizzes are voiced through the app and AR elements contain sound effects. bEYEo covers kinesthetic learners through physical interactions with the AR elements as well as having to manually touch answers in quizzes. The read/write learners are covered since all AR elements and 2D visual representations in Help Sheet have a written label attached to them, as well as all quizzes being written.

Once they have studied the subtopic's material using the AR Lecture and the Help Sheet, they can then take a quiz to assess their level of understanding. The students can retake the quiz as many times as needed to assess their learning after each study period. Moreover, the students can review all past quiz scores in the Quiz Score section to see their progression throughout the semester.

Due to time constraints, the login and sign-up portions weren't implemented, as well as the Quiz Score portion. Furthermore, the bEYEo prototype only includes one AR lecture subtopic for the cegep level of education, and this due to limited research resources and time constraints. The biology material covered in the current version of bEYEo was sourced from khan academy [24].

For the ui design of the app we decided to aim for a modern design with a vibrant contrasted colour palette to engage the students and keep their focus. The design

chosen is simple yet motivating, since the aim is to keep the students focused on the lecture material in a clear manner. The UI design elaboration is available in the following miro board: https://miro.com/app/board/o9J_IJZBATw=/. The final UI design choices can be seen in the following figure 4. The logo of the app is also vibrant yet clear, and the “EYE” of bEYEo is placed vertically to portray an “i” to spell out “bio”. The logo is present in figure 2.



Figure 2: The logo for bEYEo

A recorded demo of bEYEo is available in the following link:

<https://www.youtube.com/watch?v=JetB20v6-a0>

The apk for bEYEo is available in the following link:

https://drive.google.com/file/d/1mbwE_1exRSt-8u9nr4lY4207yyxl7lq4/view?usp=sharing

Unfortunately, the app was too big to be supported by a github repository.

This version of the app has also been submitted to the google app store and is pending approval.

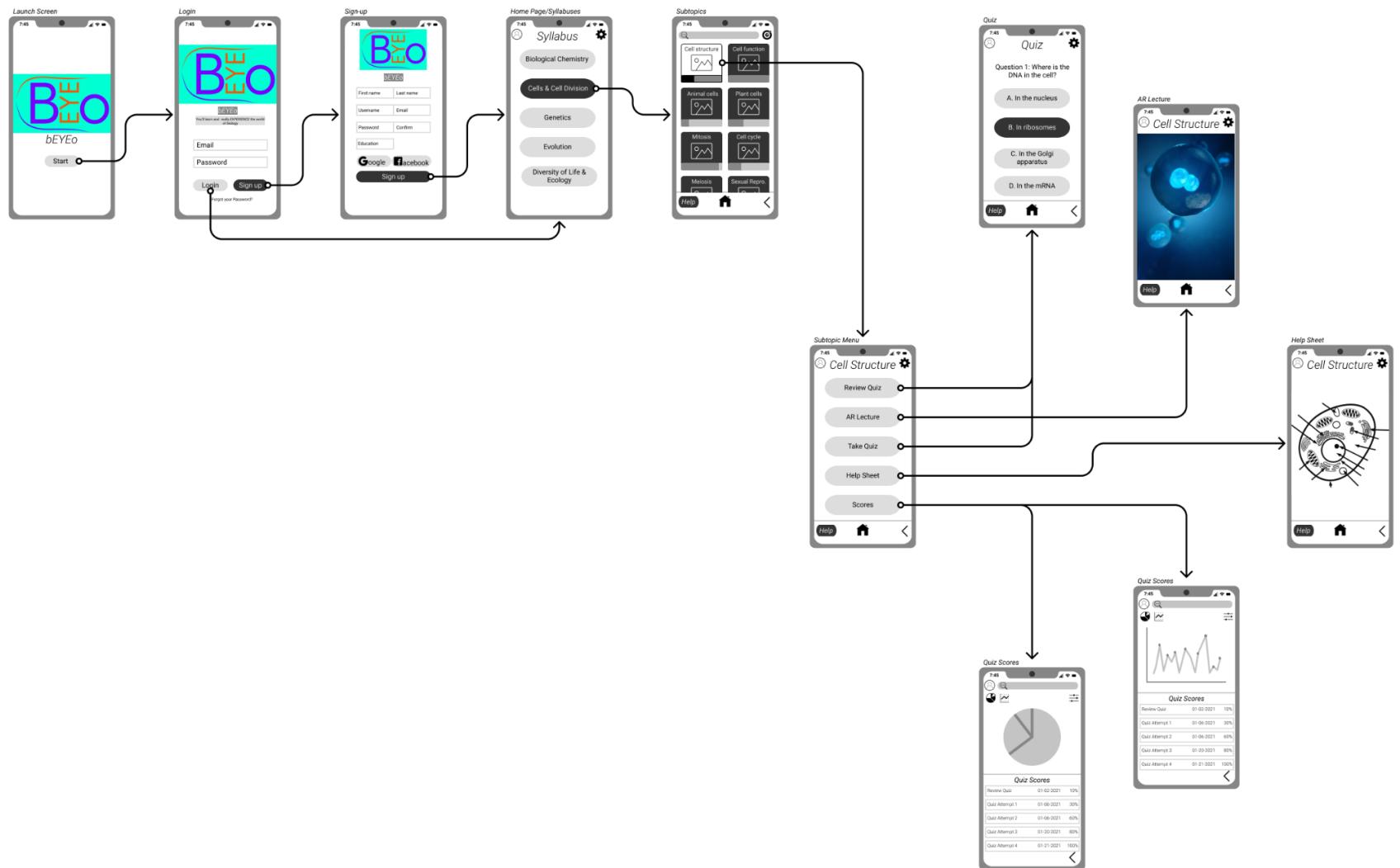


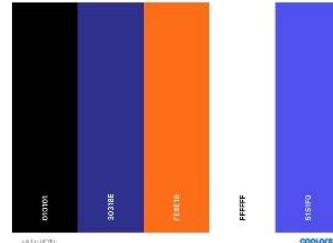
Figure 3: Initial Wireframe Flow of bEYEo

Typography



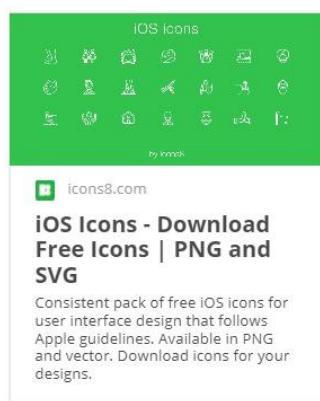
Source: <https://creativemarket.com/connary/674046-Greycliff-CF-geometric-sans-font-v2>

Colour Palette

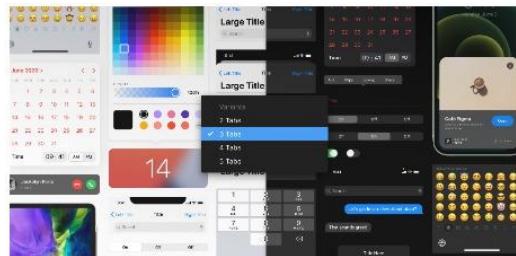


Background Start Illustration

Icons



Buttons/Components



(Variants) iOS & iPadOS 14 UI Kit for Figma

Source:

<https://www.figma.com/community/file/85814367356468985>

miro

Figure 4: Final UI design choices for bEYEo

Method

We tested our hypothesis by conducting two online questionnaires via google forms and ensured we had the research participants consent before starting the experiment. At the beginning, we sent the initial survey form to our research participants. This questionnaire allowed us to know a little about the research participants and their interest or involvement with biology and AR technology. Next, we asked them to explore the bEYEo application after downloading and installing it on their android phone. bEYEo is developed using Unity and works on android devices. Afterwards, we sent out a feedback survey form to all the research participants to know about their experience with the application and any comments they would like to provide to us for future improvements. This second questionnaire assisted us to evaluate how successful the experiment to validate our hypothesis has been. Additionally, it informed us about any potential new features that can be added or improvements that can be done to bEYEo. Due to the pandemic, we chose to only perform these online questionnaires and avoid in-person interviews.

Study Design

We chose a group of people to take part in the research. To take part in the study, participants had to sign a consent form beforehand. Two online surveys were conducted to evaluate our hypothesis. One of these questionnaires was to collect initial information and the other one was for feedback.

The initial survey had the following questions, in order for us to know a bit about the research participants and also to make the participants familiarize with the google forms which is widely known survey administration software.

- What is your age?
- To which gender identity do you most identify?
- What is your current level of education?
- Are you majoring/working in a discipline that requires knowledge of biology?

Additionally, the initial survey contained the following questions, in order for us to gather information regarding the participants' learning pattern, interest in biology and knowledge about AR technology.

- Rate your interest in biology on a scale of 1 to 5.
- Rate your level of difficulty in learning biology on a scale of 1 to 5.
- What is your last average grade in a biology course?
- What type of learner are you?
- Do you find staying focused and engaged in online classes is difficult?
- Are you familiar with augmented reality apps?
- Would you be interested in having an Augmented Reality app on your phone to study your biology material?
- What would you like to see in an Augmented Reality Biology app?

The feedback survey conducted allowed us to know about user experience after the research participants explored bEYEo application on their android phone. The following like sets of questions were in the feedback survey form.

- Could you run bEYEo on your phone, if not why not.
- Did bEYEo lag, if so how much and where.
- Did your phone overheat, if so at what point.
- How much do you like biology now?
- How much did you like this application?
- What is too hard or too easy to use?
- What part did you like most?
- What part did you like least?

- How much did you score on the quiz in bEYEo application?
- Is there anything you would like to add in bEYEo?
- Is there anything you would like to remove from bEYEo?

Here are the links to both the surveys:

https://docs.google.com/forms/d/e/1FAIpQLSdOBC8V-iGMGGKIp3Rb6D7oQB4oYkFIQpZFGFRoCwSc7bnDw/viewform?usp=sf_link

https://docs.google.com/forms/d/e/1FAIpQLSfwwoHukME2OnJx8IN2FdG3yj08rxLiqi_05DaH1iLaYRqFUg/viewform?usp=sf_link

These surveys assisted us to validate the success of our hypothesis and the progress of our application bEYEo. It allows us to know about potential improvements we need to work on but due to time limitations we are unable to work on it based on the research participants' feedback.

Evaluation

Our null hypothesis is proved wrong as after conducting the surveys we noticed that more than half of our research participants were interested in AR and using it for studying biology. As stated on our proposal we explored our hypothesis with the following approaches.

Accessibility

1. Time to find and download.
2. Did the application lag.

Fun

1. Which part of the application did you like the most.
2. Reactions, commentaries, feedback (should be positive).

Helpful

1. Pre/Post quiz (to demonstrate what the student knows before playing the game and equate it to what they know afterward).

Maintainable

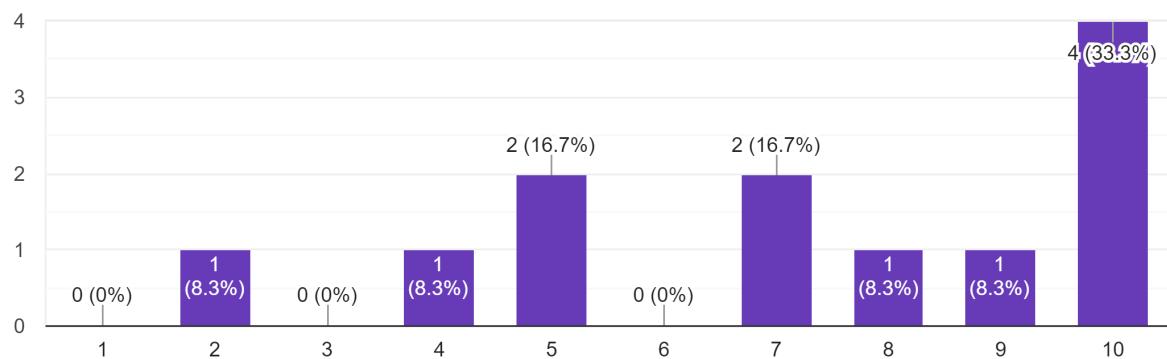
1. Does the coding follow clean code (clean code = long term maintenance)

The following above will show us how to measure such criterias to prove bEYEo heads in the right direction. Also, some of the criterias are not listed because we had time constraints.

Results

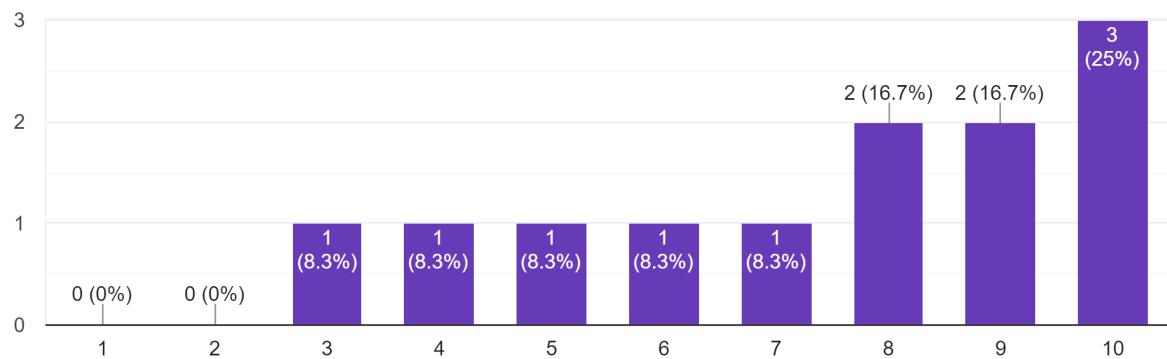
how much do you like biology

12 responses



how much did you like this application

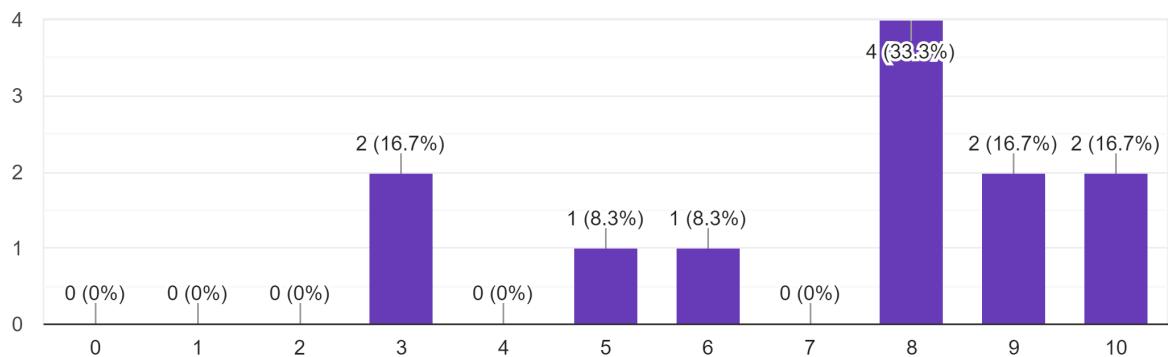
12 responses



The majority of participants showed an increased level of interest in the app compared to their level of interest in biology. When asked, many participants found the ability to physically interact with the cell in an augmented reality environment to peak their interest. This supports part of our hypothesis that an AR app will increase interest in learning biology.

how much did you score on the quiz in the game

12 responses



The majority of participants selected were determined to have had low scores in previous biology courses as determined and selected from the initial survey. Quiz scores after interacting with the app varied, however the majority showed passing to exceptional scores. This indicates a strong potential for AR to be a viable format to teach students in the fields of biology. However due to the small sample size further testing would be required before any solid conclusions could be drawn.

Discussion

The results indicate a strong potential for augmented reality apps to be used in education of biology, as interest in use of the app surveyed to be quite high.

We would have preferred in future testing to go more in depth in prior knowledge of biology participants had by assessing their initial knowledge through quizzes as we had initially intended. Going off of their marks in previous biology courses suffers as a comparative tool since their previous work could be in a whole different field of biology than what topics that were being covered within the bEYEo app.

Many of our participants were students preoccupied with other courses during finals, this may have interfered with quiz scoring as they may not have had the time to fully dedicate their attention to and learn about the quiz topics within the app.

Conclusion

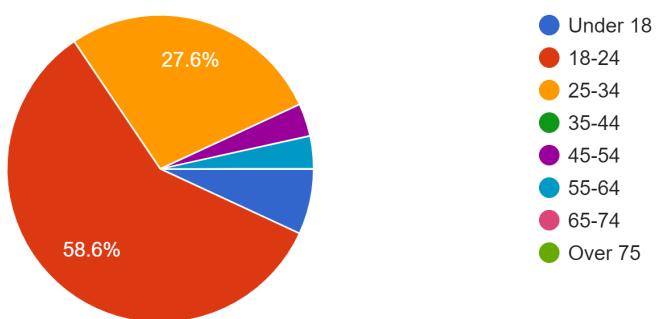
In conclusion, based on the results obtained from this study our hypothesis stating that an augmented reality app designed to teach biology would increase interest in biology as well as improve students' grades is confirmed, with the caveat that further testing would be required to indicate the effectiveness of AR as an improved format of education. The intractability of the cell within a 3D space increased user interest in learning about biology.

Appendices

Appendix A: Initial Survey Results

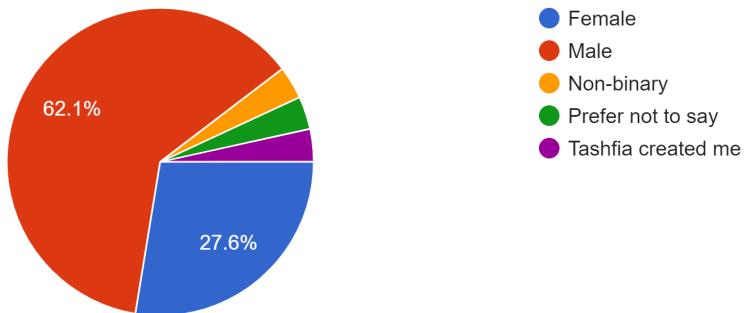
What is your age?

29 responses



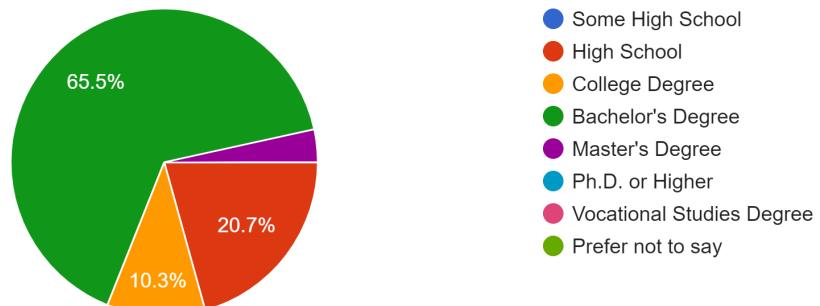
To which gender identity do you most identify?

29 responses



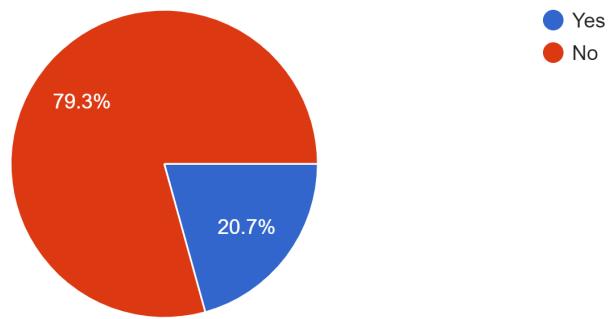
What is your current level of education?

29 responses



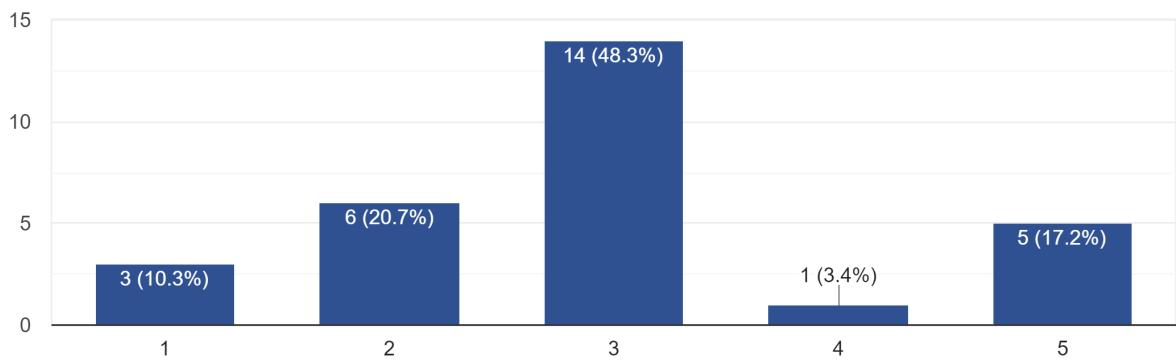
Are you majoring/working in a discipline that requires knowledge of biology?

29 responses



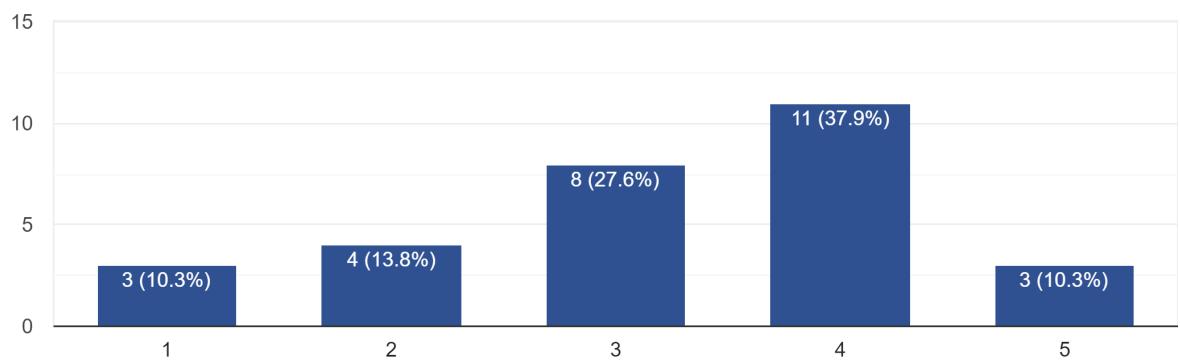
Rate your interest in biology on a scale of 1 to 5

29 responses



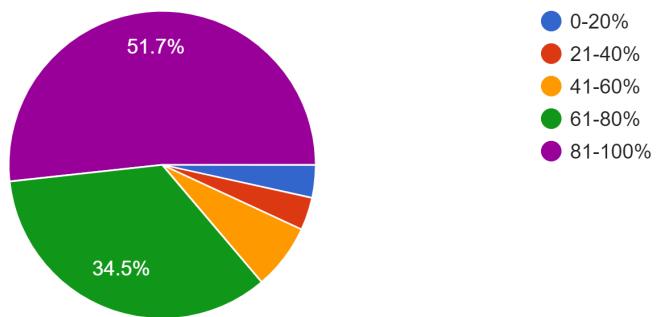
Rate your level of difficulty in learning biology on a scale of 1 to 5

29 responses



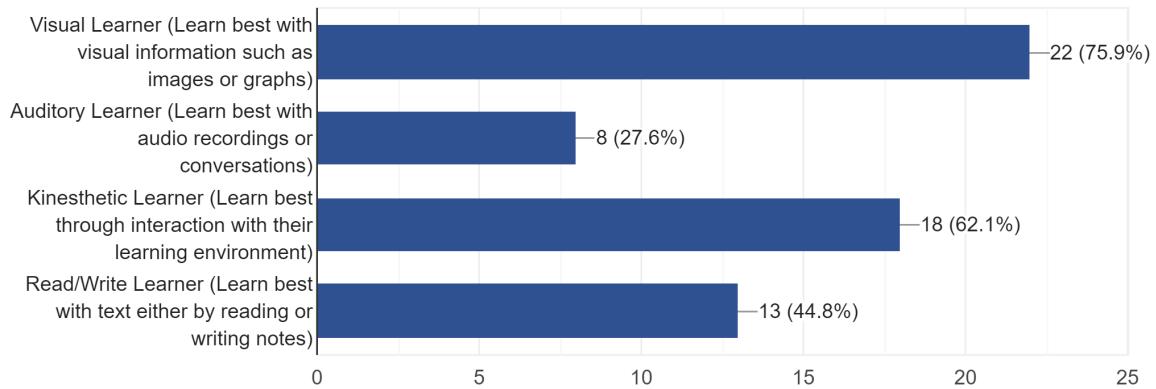
What is your last average grade in a biology course?

29 responses



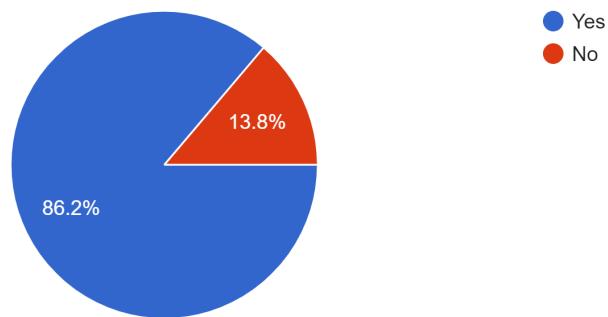
What type of learner are you? (check all that apply)

29 responses



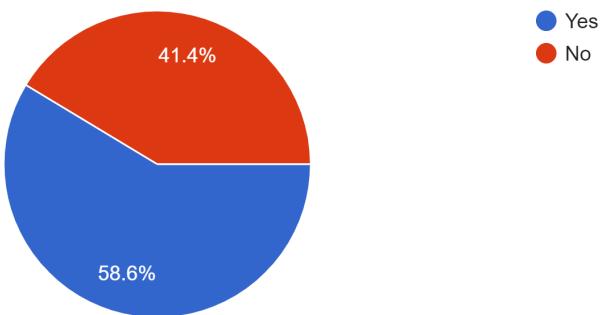
Do you find staying focused and engaged in online classes is difficult?

29 responses



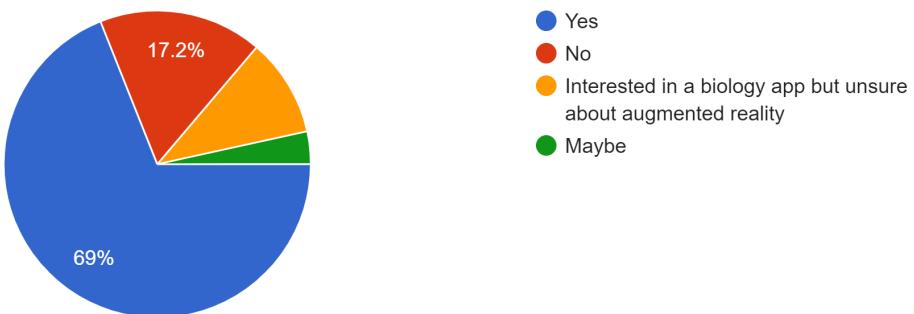
Are you familiar with augmented reality apps?

29 responses



Would you be interested in having an Augmented Reality app on your phone to study your biology material?

29 responses



What would you like to see in an Augmented Reality Biology app?

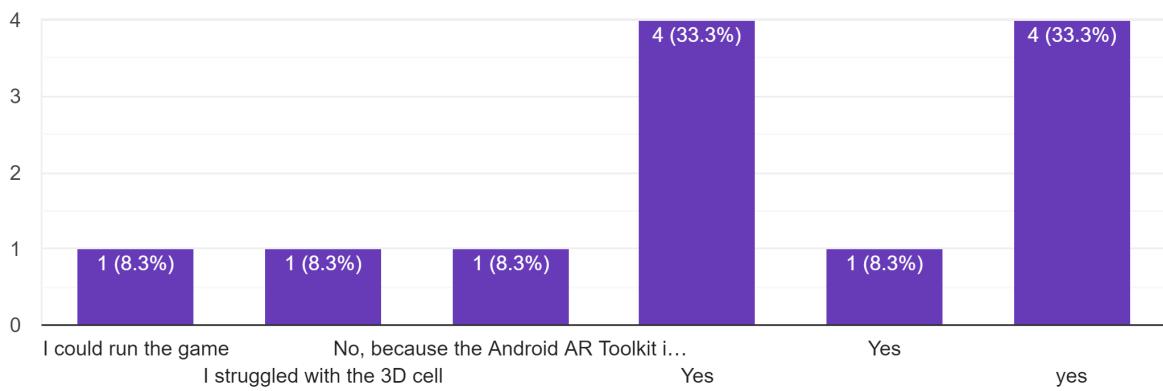
1. interactability with virtual cells
2. More instant feedback on assessments
3. -
4. Good visuals and accurate representation of what is being presented
5. Be able to interact with animal/plant cell models possibly? Little simulations for concepts such as osmosis? Unsure what would be best.
6. The app would let you see biology stuff in the real world, for example you could place a human body on your desk and scale it, rotate it etc...
7. It would be cool if with the touch of a specific part of the human body the app would name it and maybe describe it.

8. i'm not sure
9. 3D representations of biological structures such as cells would aid in students' understanding of their structure more effectively than flat textbook images
10. Do not know
11. I am unaware of what it is
12. Ease of use
13. 3D representations of topics, annotations and callouts, simple animations of mechanisms.
14. I don't know
15. Anything at the molecular level!
16. Id be interested to see how it is executed
17. Cell structure
18. I would like to see the exam papers before the exam lol
19. To do all the work for me
20. N/A
21. cue cards
22. Better visualizations of concepts that involve three dimensions would likely be made easier by this, sometimes this is done through videos and such but augmented reality could be more effective
23. How to stop a cardiac arrest
24. I don't know, but I think learning biology is difficult for memorizing the long names and the concepts and their definitions.. I'm not really informed on AR technology so not sure how it could help solve that problem.
25. include filters relating to biology
26. How to perform a heart surgery?
27. How to perform a heart surgery
28. No idea
29. An interactable version of the human body that will explain what each body parts does.
30. yes

Appendix B: Feedback Survey Results

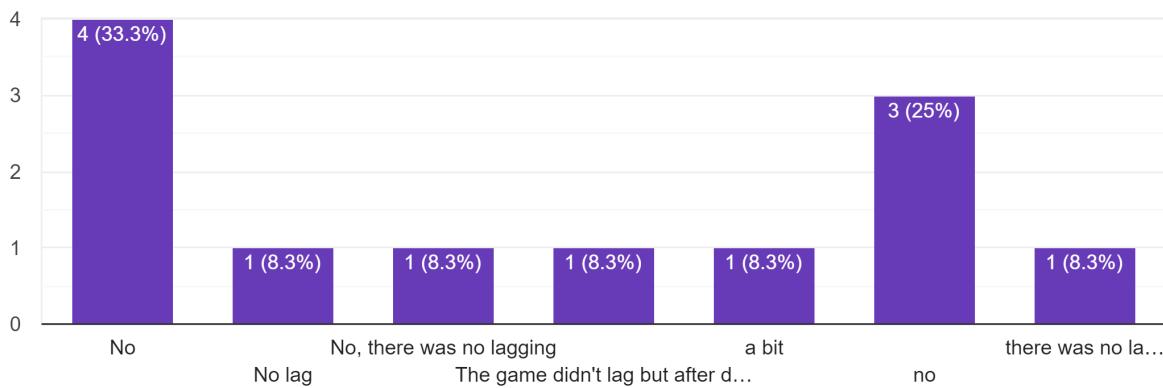
Could you run the game on your phone, if not why not

12 responses



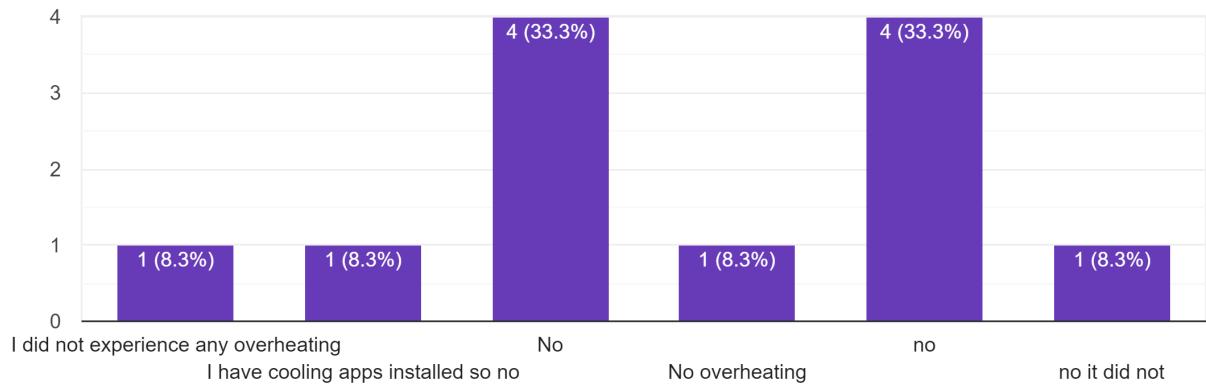
Did the game lag, if so how much and where

12 responses



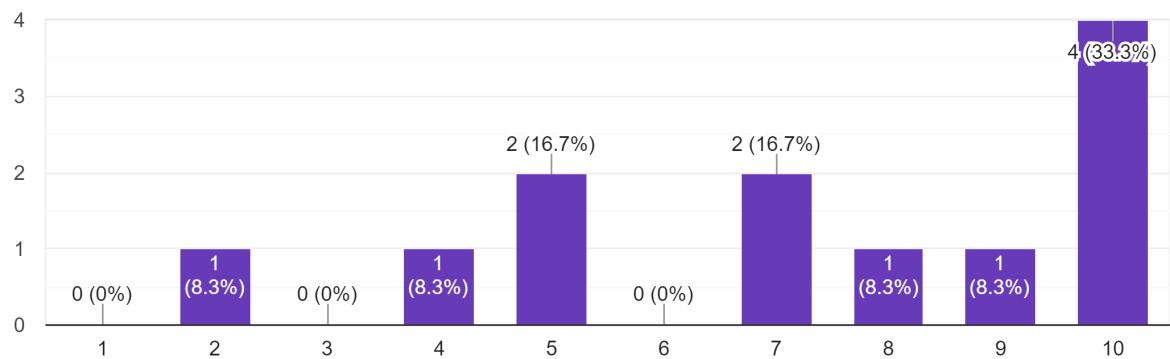
did you phone overheat, if so at what point

12 responses



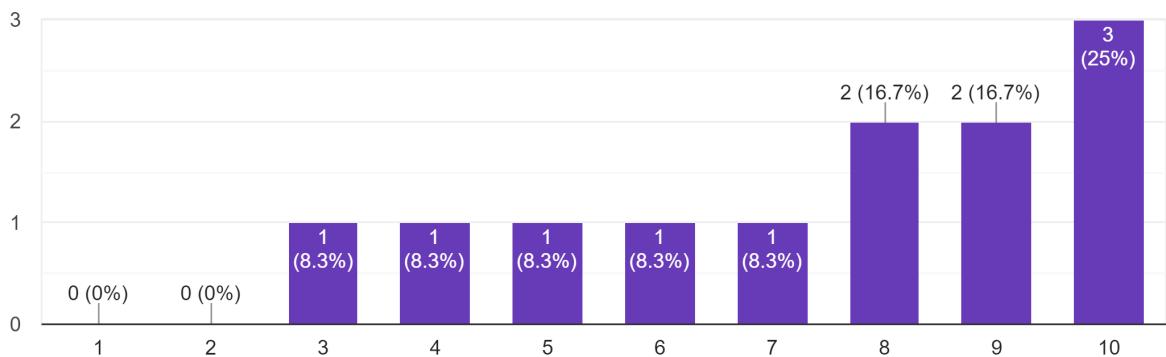
how much do you like biology

12 responses



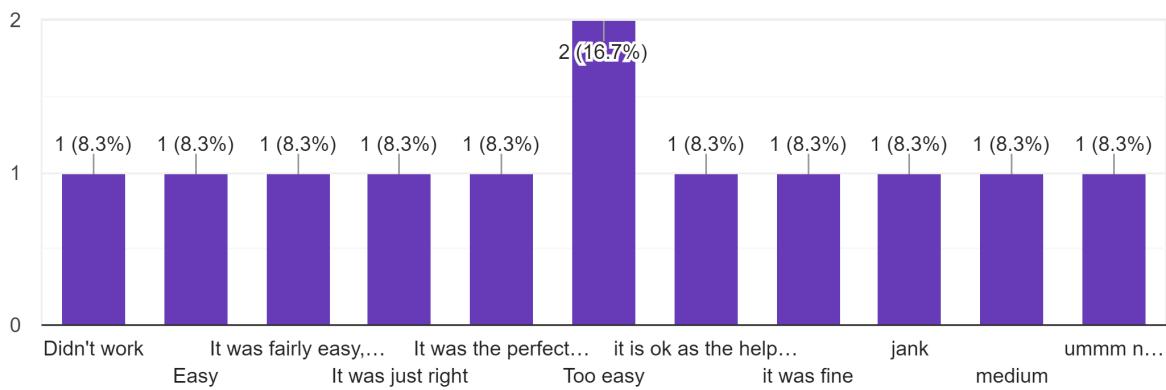
how much did you like this application

12 responses



what it too hard? too easy?

12 responses



What part did you like most?

1. Didn't work
2. physically stepping into the cell
3. i enjoyed the questions
4. Finding the cells
5. the design
6. Finding the cells
7. All
8. the interaction with the Cell
9. The sound the AR cell made
10. The animation
11. 3d
12. The cell showing up in my room was pretty cool!

What part did you like least

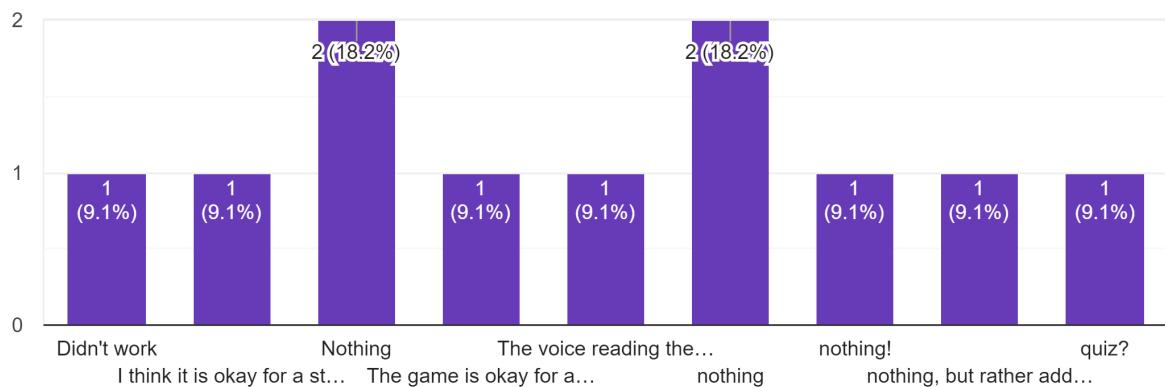
1. Didn't work
2. cheat sheet graphics
3. maybe reorder the options on screen to avoid confusion
4. Nothing
5. it is an android game
6. Nothing to be fair
7. None
8. finding the membrane
9. The sound the AR cell made (I know)
10. cell goes everywhere, easy to lose it
11. quiz/test
12. One of the quiz questions had "ribosome" as two of the answers

What would you add to the game

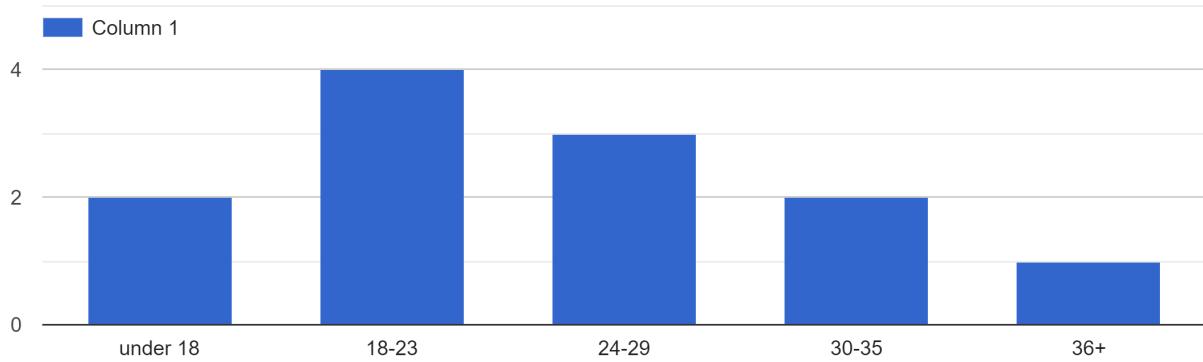
1. Didn't work
2. once u step into the cell, maybe a quick overview / explanation of all the stuff you see
3. different level of questions for different levels of understanding
4. More interactive sessions and notes like flashcards
5. more options
6. Flashcards and notes
7. Give right answer that I missed after answering the question
8. More options to learn about other parts
9. More topics other than just cell structure
10. better visuals
11. More details into the cell, more organelles and higher resolution images if possible

what would you remove to the game

11 responses

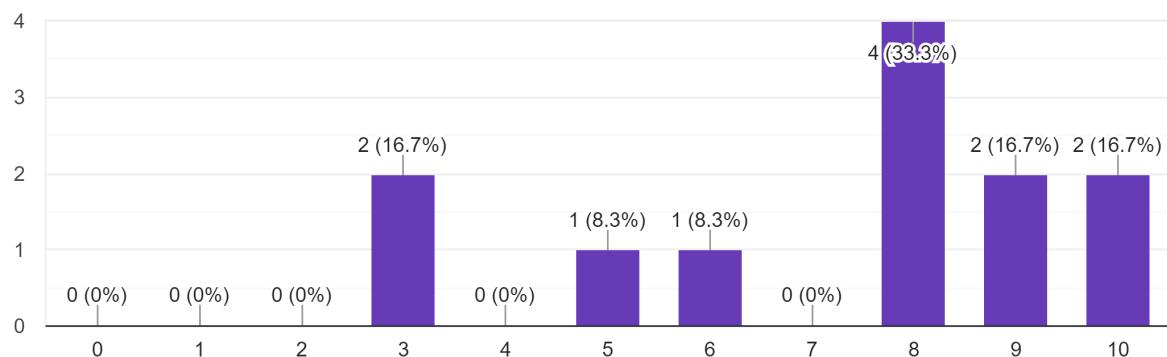


your age

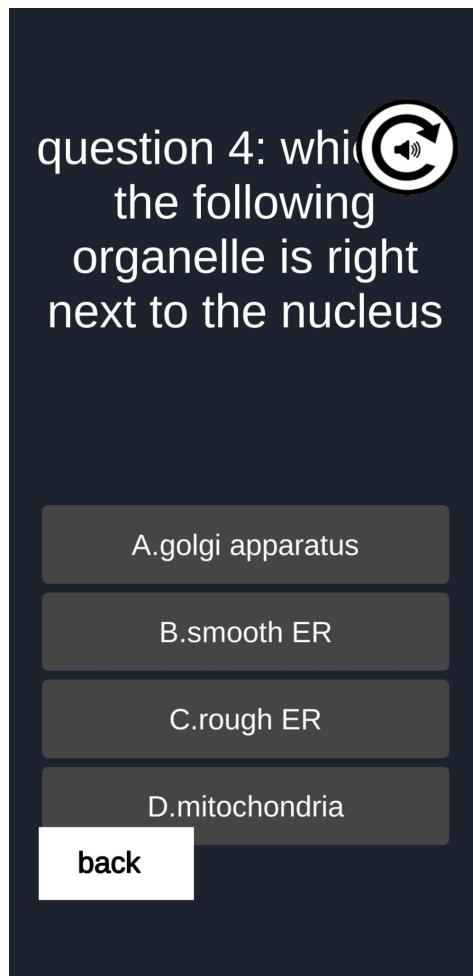


how much did you score on the quiz in the game

12 responses



Screenshots and comment feedback from test users:



Comment: “Maybe like change the volume buttons place”



Comment: "kinda like the moist noises it makes"

parts of cell

review quiz

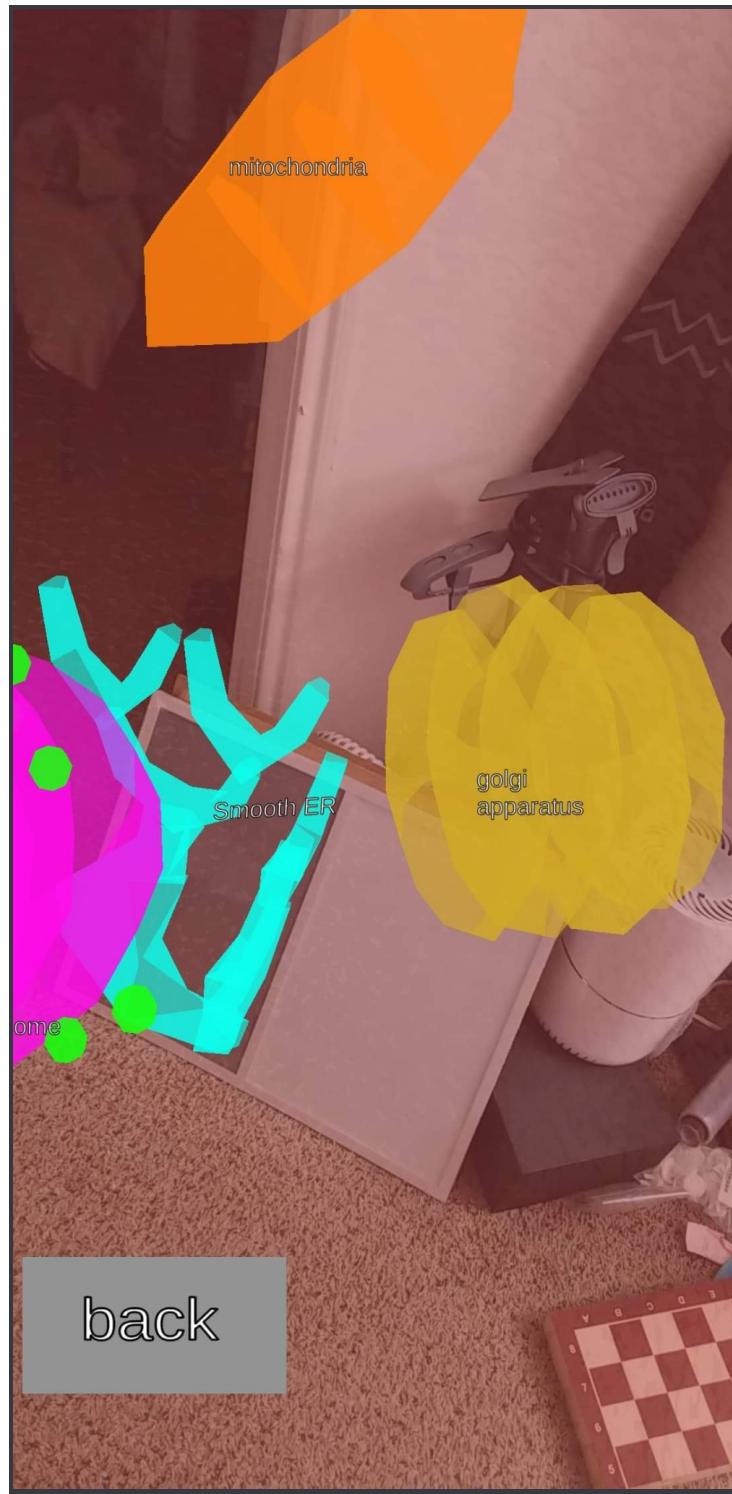
3D cell

help sheet

take Quiz 8/10

back

Comment: "liked the menu options and the marks displayed beside it"



Comment: "The text is a bit harder to read, increase the text size, loved the idea and everything else by the way"



question 7: what
organelle is the
smallest

A.ribosomes

B.nucleus

C.ribosomes

D.cell membrane

back

Comment: "The back button and replay the question button overlaps the answer and question. So move both of them down maybe"

Appendix C: References

Reference :

Research point 1.

[10]<https://www.youtube.com/watch?v=3voR1aEvEzE>

17 Types of Students in an Online Class-JianHao Tan

[11]<https://www.youtube.com/watch?v=bk31R0z4zjs>

17 Teachers You'll Meet in Every Online Class-JianHao Tan

[15]<https://www.youtube.com/watch?v=DF0RVbcvbp8>

how i take biology notes  study with me-
studyquill

Research Point 2.

[7]<https://www.youtube.com/watch?v=x2JUzzFQm7E>

What Type Of Learner Are You? Study Tips For Each Learning Style!-Study With Jess

[8]<https://www.youtube.com/watch?v=qcCtPgzIGTs>

What kind of learner are you? - The 4 different learning styles-Clipboard Classes

[9]<https://www.youtube.com/watch?v=oeNkS3aj9z8>

10 DIFFERENT STUDY METHODS for Different LEARNERS |

StudyWithKiki-tudyWithKiki

[10]<https://www.youtube.com/watch?v=RkbmMMXsfn0>

top 10 studying techniques-studyquill

Research Point 3.

[12] <https://www.youtube.com/watch?v=p60rN9JEapg>

The 9 BEST Scientific Study Tips-AsapSCIENCE

[13]<https://www.youtube.com/watch?v=SIswBsRpwXw>

6 terrible study habits to quit, like, yesterday- studyquill

[14]<https://www.youtube.com/watch?v=9eh8N8Eby-U>

how to trick yourself into being productive  at home, school, + work-studyquill

Research Point 4.

[16] <https://www.youtube.com/watch?v=mOssYTimQwM>

The Power of Gamification in Education | Scott Hebert | TEDxUAlberta-TEDx Talks

[17]<https://www.youtube.com/watch?v=yxpW2ItDNow>

Bartle's Taxonomy - What Type of Player are You? - Extra Credits

[18]https://www.youtube.com/watch?v=1drDuaQXm_U

Balancing an MMO Ecosystem - Getting a Mix of Player Types - Extra Credits

[19]<https://www.youtube.com/watch?v=vTI-zM8P8pw>

Dustin Browder Heart of the Swarm Interview-Tales of Lumin

Research Point 5.

[25] San Bolkan, Alan K. Goodboy & Scott A. Myers (2017) Conditional processes of effective instructor communication and increases in students' cognitive learning, Communication Education, 66:2, 129-147, DOI: 10.1080/03634523.2016.1241889

[26] A. Kareem, A . (2018). The use of Multimedia in Teaching Biology and Its Impact on Students' Learning Outcomes . The Eurasia Proceedings of Educational and Social Sciences , 9 , 157-165 . Retrieved from

<https://dergipark.org.tr/en/pub/epess/issue/38900/457937>

[27] Fuchssova, M., & Korenova, L. (2019). Visualisation in Basic Science and Engineering Education of Future Primary School Teachers in Human Biology Education Using Augmented Reality. European Journal of Contemporary Education, 8(1), 92-102.

Research Point 6.

[28] S. Xiao, W. Liang and Y. Tang, "Classroom Attention Restoration Using Computer Game Rewarding Mechanism," 2018 13th International Conference on Computer Science & Education (ICCSE), Colombo, Sri Lanka, 2018, pp. 1-6, doi: 10.1109/ICCSE.2018.8468797.

[29] Nafisa, Akhmedova, et al. "Attention Span and Maintaining the Attention of Students in Classes." JournalNX, 2020, pp. 173-176.

[30] Abdel Meguid, E., & Collins, M. (2017). Students' perceptions of lecturing approaches: traditional versus interactive teaching. Advances in medical education and practice, 8, 229–241. <https://doi.org/10.2147/AMEP.S131851>

[31] Oudeyer PY, Gottlieb J, Lopes M. Intrinsic motivation, curiosity, and learning: Theory and applications in educational technologies. Prog Brain Res. 2016;229:257-284. doi: 10.1016/bs.pbr.2016.05.005. Epub 2016 Jul 29. PMID: 27926442.

[32] <https://hechingerreport.org/piqued-the-case-for-curiosity/>

Piqued: The case for curiosity

Research Point 7.

[1] <https://www.youtube.com/watch?v=MArFzB6UM7o>

Augmented reality in the classroom - 8 fun AR apps-BookWidgets

[2]<https://youtu.be/nXa9FH5VJYc?t=425>

Augmented Reality App for Science education-Jasper Recitas

[3]<https://www.youtube.com/watch?v=gzUTT1Kygo4>

HoloAnatomy app helps medical students learn anatomy-Case Western Reserve University

[4] <https://www.youtube.com/watch?v=-DYqlaMWTVg>

Expeditions AR - Bringing the world into the classroom-Google

[5] <https://www.youtube.com/watch?v=EXYzj6qwCCk>

VR in Education-AMD

[6]<https://youtu.be/2TrDpwrHiBE?t=409>

Using AR in the classroom | ZDNet-ZDNet

[20]

Susanne Wish-Baratz, PhD, MBA; Andrew R. Crofton, PhD; Jorge Gutierrez, BA; Erin Henninger, MBA; Mark A. Griswold, PhD. 2020 Sep 17 *Assessment of Mixed-Reality Technology Use in Remote Online Anatomy Education*

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7499123/>

Research Point 8

[23]http://www.education.gouv.qc.ca/fileadmin/site_web/documents/enseignement-superieur/200.B0-Sciences-nature-VA.pdf

Science (200.B0) Pre-University Program College Education

[24]http://www.education.gouv.qc.ca/fileadmin/site_web/documents/education/jeunes/pfeq/PDA_PFEQ_science-environnement_2011.pdf

Progression des apprentissages au secondaire Science et technologie 1 cycle

Applications technologiques et scientifiques Science et environnement

[1]<https://www.youtube.com/watch?v=Hmwvj9X4GNY>

Parts of a cell- Khan Academy

Research Point 10

[22]Technologies, U. (n.d.). Powerful 2D, 3D, VR, & AR software for cross-platform development of games and mobile apps. Retrieved March 31, 2021, from <https://store.unity.com/>

Research Point 11

[21] Hoss, O. (2020, February 26). 5 powerful app marketing strategies for small budgets. Retrieved March 31, 2021, from <https://mobile-marketing-masterclass.com/blog/5-powerful-app-marketing-strategies-for-small-budgets/>

System Development and Design

[22]<https://www.vaniercollege.qc.ca/biology/files/2016/08/NYA-Course-Outline-Sample.pdf>

General Biology 1 NYA Course Outline Sample

[23]<https://www.vaniercollege.qc.ca/biology/files/2016/08/General-Biology-1-Learning-Outcomes.pdf>

General Biology 1 (101-NYA) Learning Outcomes

[24]<https://www.youtube.com/watch?v=Hmwvj9X4GNY>

Parts of a cell- Khan Academy

Research Paper itself

[25] Marcos, M., Guillemette, S., Proma, T., & Guimaraes, I. (2021). Research and Objectives.

picture/diagram references:

<https://en.bigbyteedu.com/news/blog/learner-kinds-and-the-best-learning-strategies> (4 kinds of learners)

<https://yello.co/blog/automated-interview-scheduling-recruiters-need/> (scheduling)

<https://www.how-to-study.com/learning-style-assessment/> (study)

<https://www.mysticmediasoft.com/blog/tag/bartle-types/> (bartles taxonomy)

Appendix D: Consent Form

CONSENT TO PARTICIPATE IN Course Project Research

I understand that I have been asked to participate in a research project being conducted under the supervision of Marta Kersten of Computer Science and Software Engineering of Concordia University (x5830, marta.kersten@concordia.ca).

A. PURPOSE

I have been informed that the purpose of the research is to look at the user experience and user interface (UX and UI) design for different types of technologies (e.g. VR, websites, wearables, etc.). Subjects in the study will be asked how they would like to use a personal data market place, what functionalities are important, what goals they would have in using such a market place etc.

B. PROCEDURES

I understand that by participating in the following research I will be requested to answer questions and discuss your feelings towards and opinions of different technologies (e.g. AR, wearables, online stores, etc.). I understand I will be asked about my perception and use of different websites, technologies, etc., what kind of functionality they would deem useful, what would make it usable etc. Furthermore, participants might be asked to look at designs and play around with prototypes and be asked about their opinions on the designs and experiences using these prototypes. Participation in this research will be carried out either using online questionnaires or through personal interviews.

C. RISKS AND BENEFITS

It is not anticipated that you will experience any discomfort from the procedures, and this research is not intended to benefit you personally.

D. CONDITIONS OF PARTICIPATION

- I understand that I am free to withdraw my consent and discontinue my participation at any time without negative consequences.
- I understand that my participation in this study is: CONFIDENTIAL (i.e., the researcher will know, but will not disclose my identity)
- I understand that the data from this study may be published.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. BY WRITING MY FULL NAME, THIS COUNTS AS AN E-SIGNATURE AND I FREELY CONSENT AND VOLUNTARILY AGREE TO PARTICIPATE IN THIS STUDY.

*If at any time you have questions about the proposed research, please contact the study's PrincipalInvestigator Marta Kersten of CSSE of Concordia University (x5830, marta.kersten@concordia.ca). If at any time you have questions about your rights as a research participant, please contact the Manager, Research Ethics, Concordia University, 514.848.2424 ex. 7481 oor.ethics@concordia.ca.