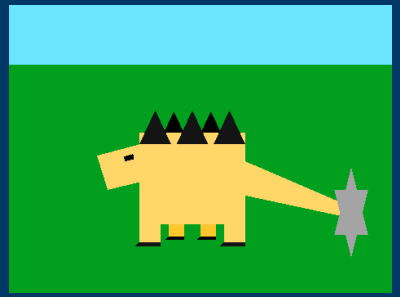
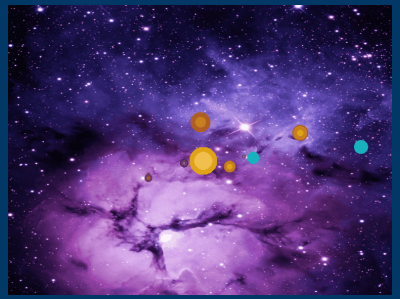
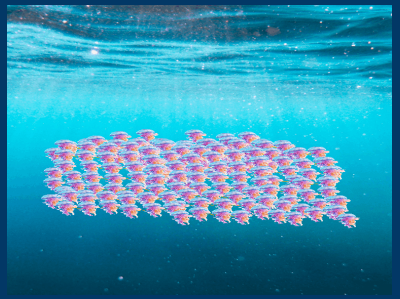
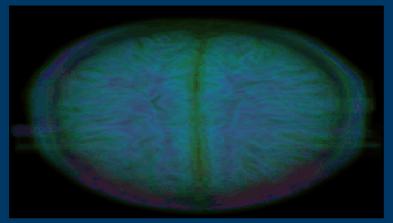
Computer Graphics Wizard Academy

Narrative-Driven and Shader-First Graphics Education for Liberal Arts

[Lee, CCSC SE '25]

Presented by Sing Chun LEE

COMPUTER GRAPHICS IN LIBERAL ARTS

In a liberal arts college, many of my students have *never taken Linear Algebra and/or Calculus*, yet they want to learn ***Computer Graphis***.

DESIGN GOAL

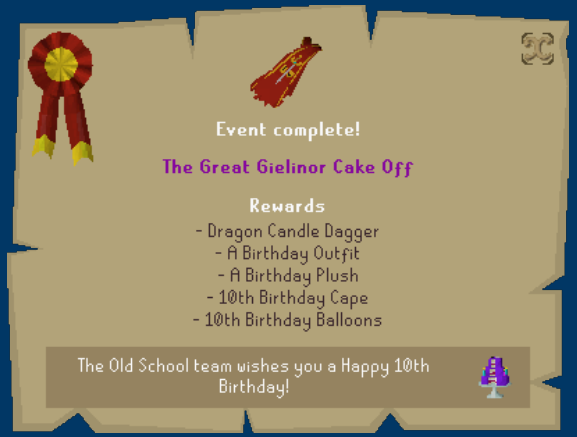
- Make Computer Graphics ***accessible and engaging*** using only high-school geometry.

Prerequisite: CS2 (Data Structures and Algorithms)

ACADEMIC OBJECTIVES

- Fundamental Computer Graphics Concepts
- GPU / Shader Programming
- Building E-Portfolio
- Foster Creative Solutions

CORE IDEAS



Quest-based

[Sheldon, Course Technology Press ‘11]

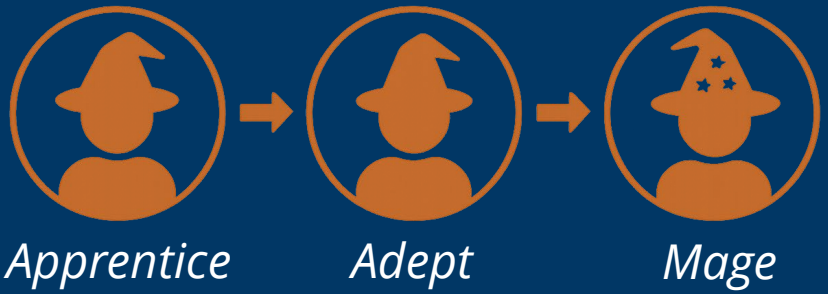
Interactive WebGPU

[W3C, WebGPU ‘25]

COMPUTER GRAPHICS WIZARD ACADEMY

Narrative-driven Learning e.g. Storytelling Alice [Kelleher, CHI '07]

Students become apprentice mages casting "graphics spells" (shader programs) with a magic wand (WebGPU).



COURSE STRUCTURE

- (20%) Lectures ➔ 27 Scrolls
- (30%) Assignments ➔ 10 Quests
- (20%) Exams/Quizzes ➔ Two Trials
- (30%) Final Project ➔ Grant Enchantment (four weeks)

27 SCROLLS

- Shader-first graphics pedagogy [e.g. Talton and Fitzpatrick, SIGCSE '07]
  - Active experiment with shaders
- Visual exploration similar to GraphicsMentor [Nikolic and Shene, SIGCSE '02]
  - Avoid starting with heavy mathematical formulations

10 WEEKLY QUESTS

- Open-ended Challenges
  - Built on top of the scrolls
  - Provided with instructor's demos
- Narrative-driven
  - Each quest is a ritual to cast the learned spells

TWO PROMOTION TRIALS

- Quest 1-5
  - 2D Graphics (WebGPU, Rendering Pipeline, Animation, Transformation, Camera, Computing Pipeline, Particle System, Collision Detection, Deformation)
- Quest 6-10
  - 3D Graphics (Projection Camera, Ray Tracing, Volume Rendering, Lighting, Keyframe Animation, Procedural Terrain & Noise, Acceleration Data Structures)
- Two Short Questions Trials (Rank Promotion)
  - Conceptual check-up

THE GRANT ENCHANTMENT (4-WEEK)

- They are now all mages
  - Work together as a team (to become arch-mages)

- Contract-based Grading
  - Mini Software Engineering Cycle (From Design to Delivery)
  - Effort Estimation and Plan Execution
  - Live Demo, Video, and Website Presentation

Course Structure:
https://eg.bucknell.edu/~scl019/Courses/CGSP25/index.php

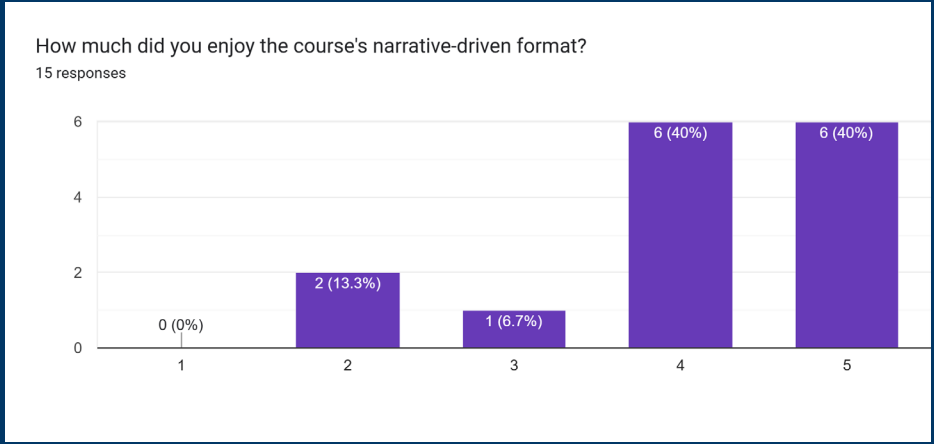
STUDENT SURVEY

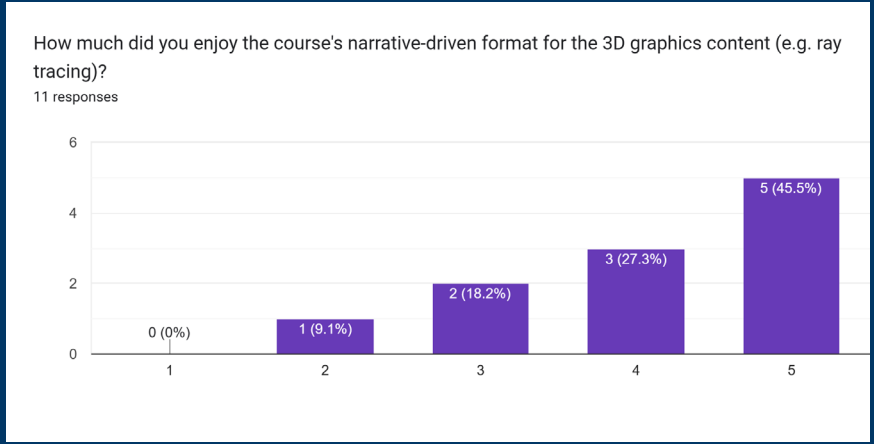
- Five 5-point Likert Learning Experience Questions
- Three Learning Preference Comparison Questions
- Three Open-Ended Questions

- Response Rates:
  - First Trial: 15/17 (88%)
  - Second Trial: 11/17 (65%)

5-POINT LIKERT Q1

- Enjoyment (1: Not at all, 5: Extremely)

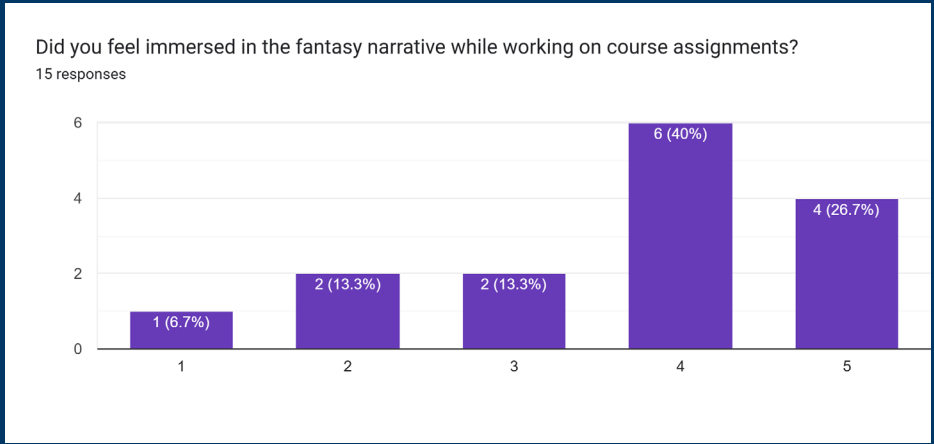


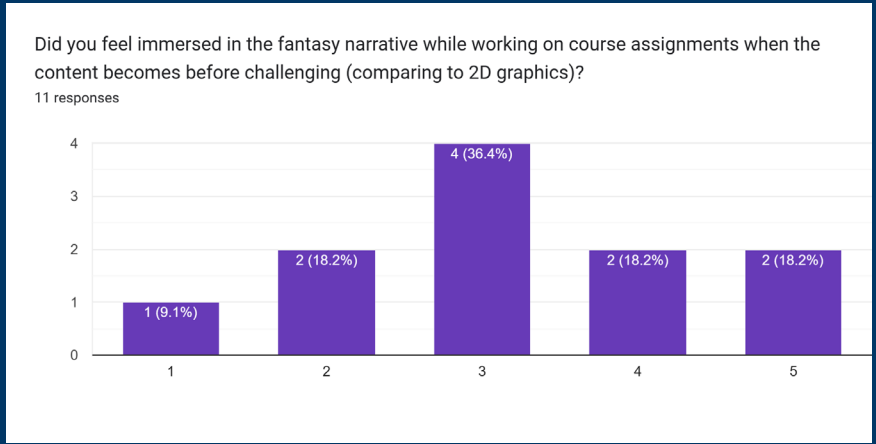


Most students enjoyed the quest-based narrative-driven format

5-POINT LIKERT Q2

- Fantasy (1: Strongly Disagree, 5: Strongly Agree)

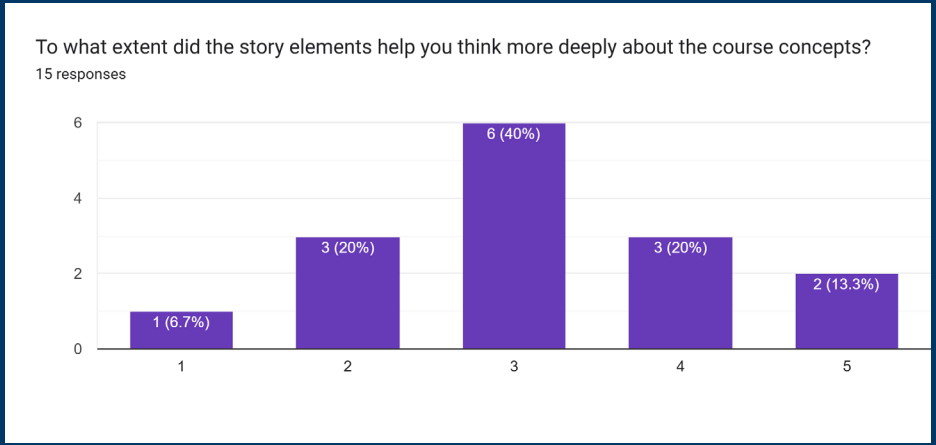


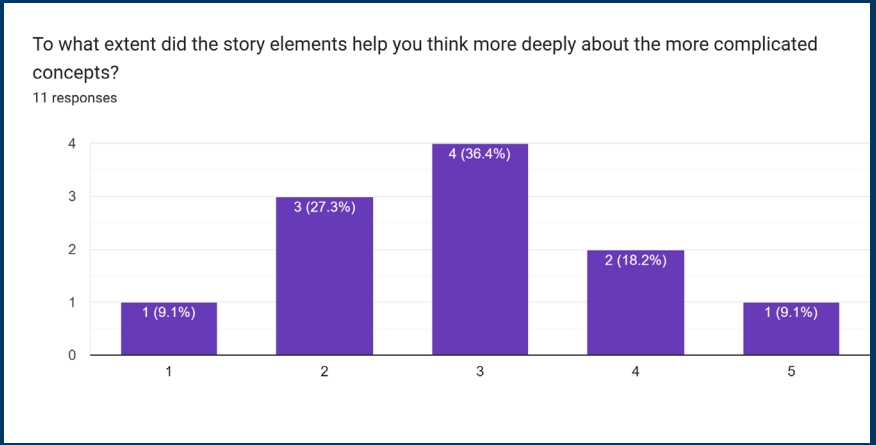


When the concept is ***denser***, students feel ***less immersive*** in the fantasy world

5-POINT LIKERT Q3

- Story vs Concepts (1: Not at all, 5: Extremely)

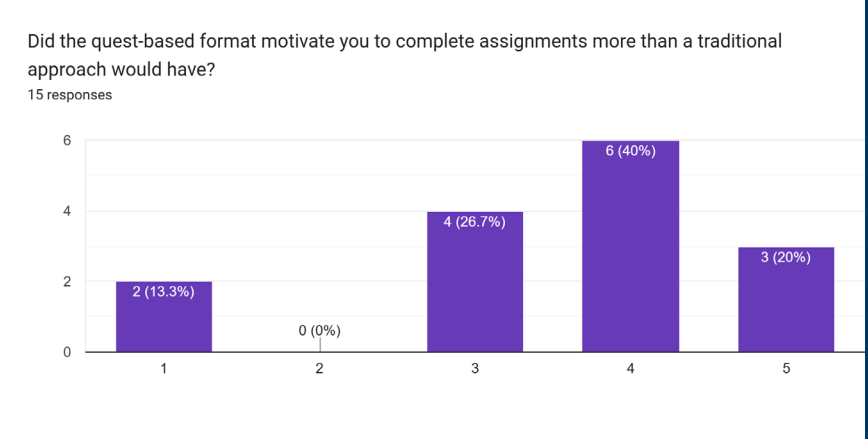


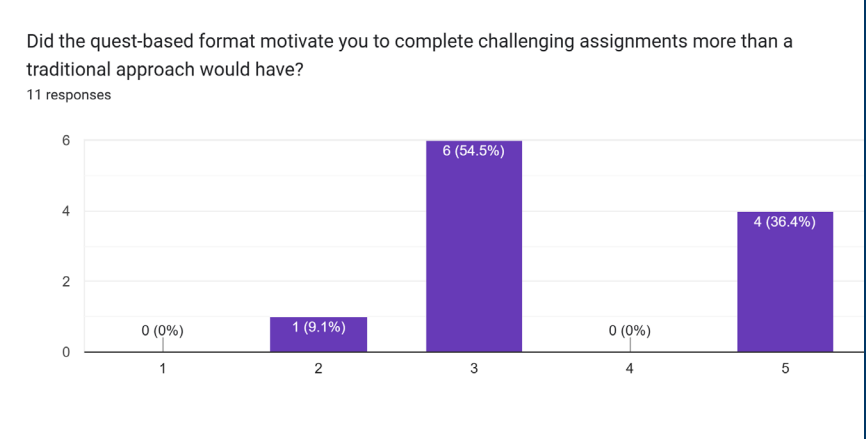


Whether story elements help deeper understand ***vary*** students to students

5-POINT LIKERT Q4

- Motivation (1: Much Less Motivating, 5: Much More)

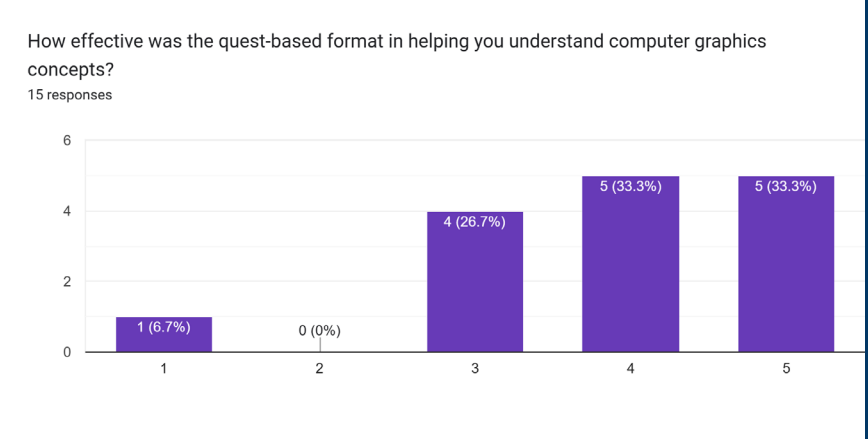


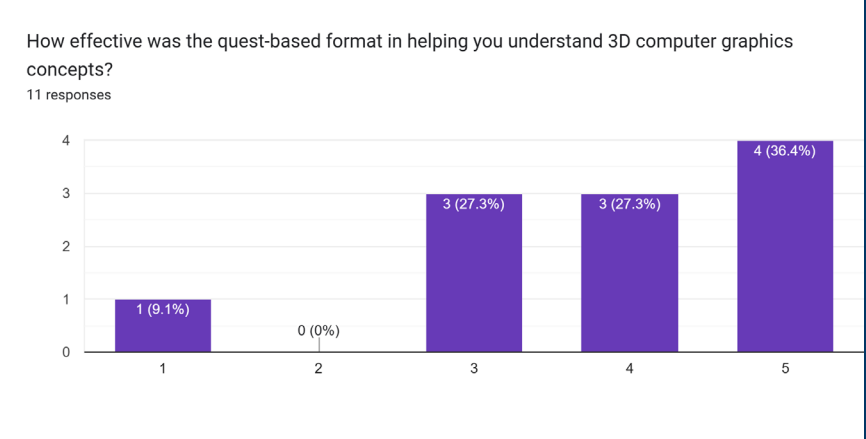


Most students found the format could motivate them to take on challenges

5-POINT LIKERT Q5

- Effectiveness (1: Very Ineffective, 5: Very Effective)

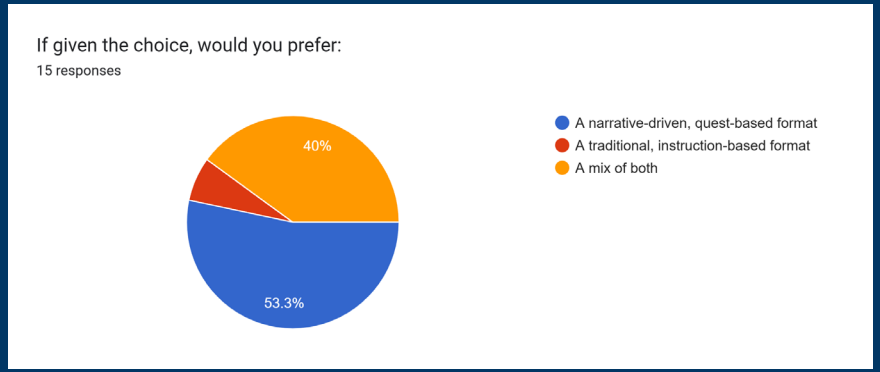


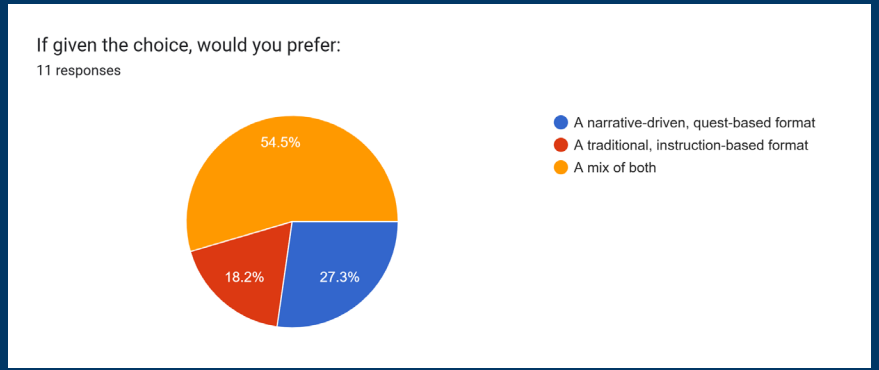


Most found the format help them understand the concepts effectively

COMPARISON Q1

- Preference

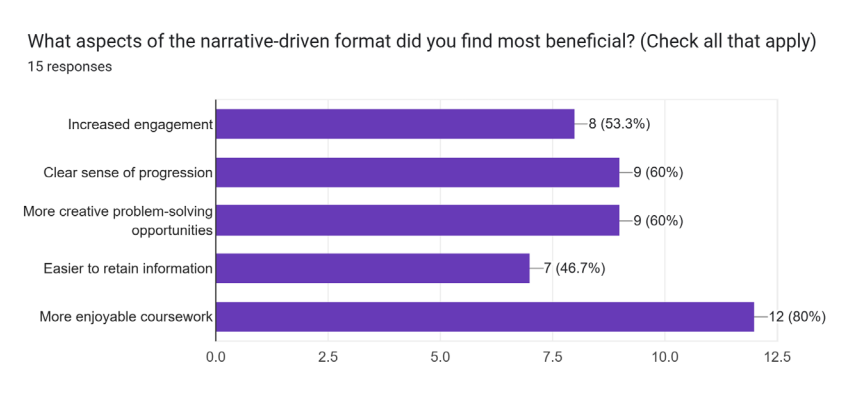


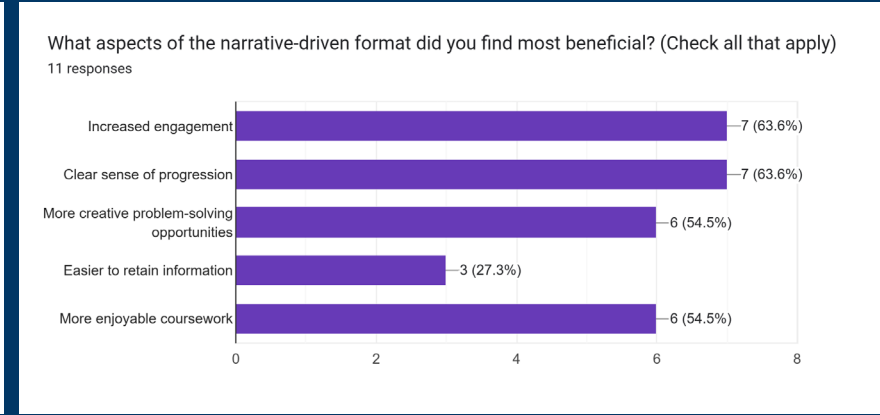


As the concepts get ***harder to grasp***, students ***lean more on instructions***.

COMPARISON Q2

- Benefits

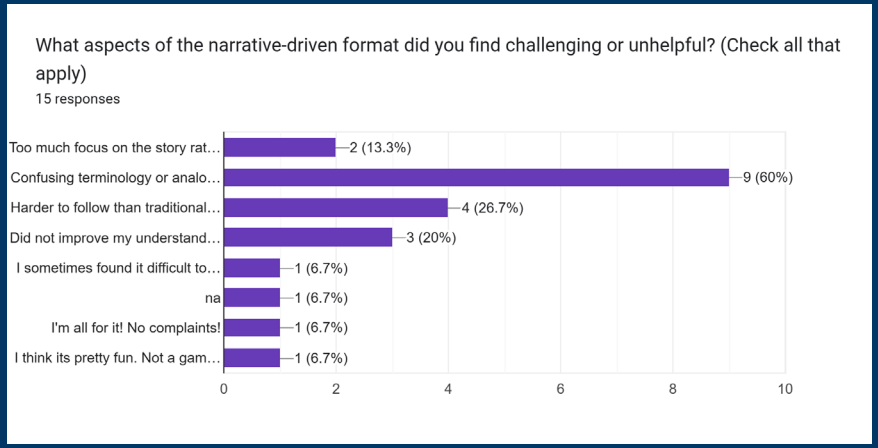


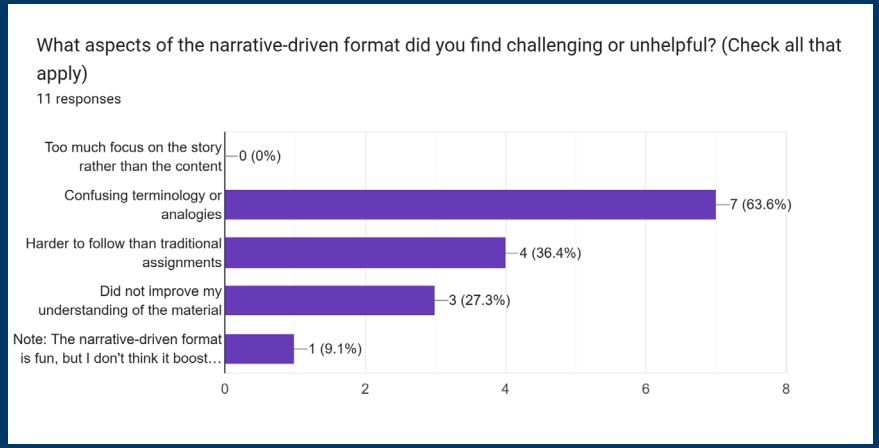


Enjoyable, engagement, creativity, and visualizing progression are the key benefits.

COMPARISON Q3

- Challenges





Confusing terminology/analogies is the main challenge.

STUDENT FEEDBACK 1

- How could the narrative-driven format be improved to better support learning? **Confusion ➔ Clear Instructions**

I think using the narrative format for abstract things is fine; calling daily class notes "scrolls" and weekly assignments "quests" is fine. However, I feel that calling actual concepts by these names is more confusing than anything. For example, calling bind groups "binding spells" just makes things more ***confusing***.

I would say that while it is nice to have the narrative, just be more ***direct[ion]*** with what we need to do

I think that having clear steps within the narrative and story, like the ***TODOs*** would help me better understand the tasks I need to complete.

I think offering a ***traditional explanation*** for those who prefer that could be helpful, but I like it how it is now!

I think that the ***overuse of fantasy*** can sometimes makes it ***confusing*** to learn technology, but overall I do think it makes the course more enjoyable

STUDENT FEEDBACK 2

- Would you recommend the use of narrative-driven learning in other computer science courses? Why or why not? **Student dependent**

Yes, it's super fun. It's computer science, we're all nerdy, who's going to complain??

Yes! I think it makes it less intimidating and more approachable as long as it's not overbearing

Yes, I enjoy the narrative aspects of the course to make the content more exciting, engaging and fun.

Yes, I think narrative-driven learning could be beneficial in other CS classes to make courses more engaging and memorable, and students can refer back to previously learned topics more easily if they are more memorable in a narrative-driven format.

No, I am used to very specific terms for assignments, and this throws me off.

I think it works particularly well **for this course only**

I think that **graphics is a specific place** where you can see your "spells" much more. Harder to suggest its use in something like Algorithms or Operating Systems

STUDENT FEEDBACK 3

- Do you have any final thoughts or feedback?

I think the structure of the course has been ***a good mix of lecture based and activities that help me to practice and understand the content in the lectures***. I also greatly appreciate the resources you have provided such as the scroll information and the scroll sample questions as they nicely summarized content

I really like the quest format of having a single larger assignment per week. Sometimes the scrolls are for work that does ***not [a]ffect the quest*** and it ***makes it hard to want to do them***. I would have the scrolls be very related to the work that needs to be done in the quest (which most of the time they are).

I think that the overall set up of the course works well, as the combination of scrolls, quests, and the tests allow students to learn on their own as well as test their understanding of the material. I think that having ***more of a flipped classroom with video components*** where students can learn more through following a tutorial would also be helpful.

COURSE EVALUATION – STUDENT FEEDBACK

Weekly quests and final project were a great deal of help when learning the more complex systems in WebGPU. ***The scrolls acted as daily activities to complete***, which given the complexity of WebGPU were difficult to capitalize on learning the material when you would have to fully interpret the source code given before writing any code of your own.

The final required too much estimated time. 40 hours per person is a lot to ask during the last 2 or 3 weeks of the class, especially if the last week is meant to be for debugging. ***I learned a lot during this class, but damn it was a lot of work.***

I was ***greatly challenged*** in this course and faced roadblocks I never thought I could get through. Professor Lee was very helpful in office hours and ***I am very proud of the work I was able to do***.

I like the structure of the scrolls and quests and final enchantment as they ***help me practice and understand the techniques learned*** from lecture.

LESSON LEARNED

- ***Well-received*** by the students (in a liberal arts college)
  - ➔Continue to refine and study this approach
    - Measure Learning Outcome
- ***Skipping scrolls*** to use starter code directly
  - ➔ Level of difficulties to cater various students
    - Application ⇔ Theoretical
- ***Balance*** between narrative and technical contents
  - ➔ Different story/theme options
    - Wizard Academy, Traditional Instructions, Game Development

LIMITATIONS

- Cognitive Load and Pacing
  - An additional layer of learning (the fantasy world and terms)
- Limited Mathematical Transferability
  - Students may not fully understand the mathematical formulation. They may simply finish it by trial and error
- Dependency on Visual Feedback
  - When visualization is removed, students may not difficulty in interpreting the mathematical formula

COMPUTER GRAPHICS IN LIBERAL ARTS

Computer Graphics can be rigorous, creative, and accessible, even without linear algebra, if we ***teach it as an adventure***.

Student Work

https://hungngo04.github.io/SP-25-Apprentice-Hung-s-Arcane-Portal/

https://kdd007.github.io/

https://ramonasuncion.github.io/quest/

ACKNOWLEDGMENT

Special thanks to thank the students of the Computer Graphics Wizard Academy course at Bucknell University for their creativity, enthusiasm, and consents for using their quests and enchantment in the presentation.

THANK YOU