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## RETAIL QUEST: STUDENT PERCEPTIONS OF A VIRTUAL FIELD TRIP APP

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### ABSTRACT

Aim/Purpose	Two popular methods for encouraging active learning are Augmented Reality (AR) and Virtual Field Trips (VFTs). This exploratory case study examines college students' perceptions of a prototype AR and VFT app as an active learning strategy.
Background	AR allows students to learn as they physically explore a destination, while VFTs give students the opportunity to visit exciting destinations without leaving their homes. AR and VFTs promote active learning, which has been shown to increase college student success in Science, Technology, Engineering, and Math (STEM) courses. The aim of the VFT app in this study is to provide college students in a STEM course with an interactive lesson on modeling information systems using diagrams.
Methodology	This exploratory case study is intended to serve as a condensed case study performed with the prototype version of a VFT app before implementing a large-scale investigation of students' perceptions of a more refined version of the app. The study employed a qualitative approach involving a survey with open-ended questions to gather college students' perceptions of learning with a VFT. The data were analyzed using inductive coding. The participants are students at a mid-sized, urban, public university.
Contribution	This exploratory case study serves as a proof-of-concept and starting point for other faculty who may be interested in developing their own AR and VFT apps to engage students in active learning. Releasing the app to a common Open Educational Resources (OER) repository will give other faculty easy access to reuse the app and build upon it to create their own virtual field trips. OER are learning materials that are freely available for students and faculty to download and use in their coursework.
Findings	Students overwhelmingly perceived the VFT app helped them learn about the subject that was presented, citing the visual nature of the app, the real-life

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	scenarios presented in the app, and the app's ease of use as reasons why. The majority (over 89%) also agreed that the app motivated them to learn more about the subject, mainly due to the app's real-life scenarios, and over 83% of students cited at least one benefit to learning with the app, such as the navigation/location features, the easy-to-use interface, and the real-world scenarios.
Recommendations for Practitioners	The pedagogical implications of this study are that faculty should adopt VFTs as an active learning strategy, particularly in STEM college courses, based on the students' positive perceptions of learning, motivation, and benefits of VFTs.
Recommendations for Researchers	Researchers can expand on this exploratory case study by conducting a larger-scale study of the VFT app employed in the case study, or by developing their own VFT app based on the one in this study, to capture a broader group of students' perceptions of VFTs as an active learning strategy.
Impact on Society	The broad impact of this research on society is encouraging the adoption of VFTs as an active learning strategy since active learning strategies are shown to increase college students' success and engagement.
Future Research	Future research will be conducted in subsequent terms to gather additional data on students' perceptions of the VFT app, as well as their perceptions of the relationship between learning and the VFT technology. Further research is also needed to survey faculty on their perceptions of how engaging with the app impacts student learning, particularly in regards to the VFT technology within the app.
Keywords	Augmented Reality (AR), Virtual Field Trip (VFT), active learning, Systems Analysis and Design (SA&D), Science Technology Engineering, and Math (STEM)

## INTRODUCTION

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Two popular methods for encouraging students to explore the world around them are Augmented Reality (AR) and Virtual Field Trip (VFT) apps. AR allows students to learn as they physically explore a destination, while VFTs give students the opportunity to visit exciting destinations without leaving their homes. Both AR and VFTs promote active learning, which increases student success and engagement. This exploratory case study examines college students' perceptions of a prototype app that allows students to choose between physically exploring with AR or virtually exploring through a VFT. The app, called "Retail Quest", helps students to learn about systems modeling by observing sales systems at the Mall of America and then applying what they observe to systems models.

The aim of the VFT app is to provide students with an interactive lesson on modeling systems using use case and activity diagrams as a part of a Systems Analysis and Design (SA&D) course. The SA&D course is designated as a Science, Technology, Engineering, and Math (STEM) course at the university where it is taught. When students are engaging with the VFT app, they are observing Point-of-Sale (POS) systems at the Mall of America and applying what they observe to systems models, such as use case and activity diagrams. These types of diagrams are commonly taught within STEM courses such as SA&D by studying written case studies from a textbook, as opposed to an interactive VFT app.

This paper begins with an overview of the related work, which supports the rationale for the study and the development of the research questions. After the presentation of the research questions, the methodology is described, including the research study design, the participants, the materials, and the procedure. The results of this exploratory case study are presented and discussed in terms of how the findings supported the research questions. The limitations of this study and avenues for future

research are explored. Finally, the conclusions and broader implications for the field of technology education are presented.

## BACKGROUND

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The goal of the Retail Quest app is to provide college students in a Systems Analysis and Design (SA&D) course with active learning through AR and VFT. The SA&D course is a part of the broader disciplinary category of Science, Technology, Engineering, and Math (STEM) at the university. Students in STEM disciplines benefit from active learning because it has been shown to increase students' performance and narrow achievement gaps in STEM (Sandrone et al., 2021). Teaching strategies that integrate active learning improve college students' learning outcomes and increase students' performance (Chen & Liu, 2021; Freeman et al., 2014).

AR has a positive impact on learning outcomes and engagement (Iatsyshyn et al., 2020; Khan et al., 2019). Upper-division science students who participate in VFTs which employ AR exhibit significant increases in content knowledge over students who are presented with the same material via a traditional teaching strategy (Mead et al., 2019). Well-designed VFTs provide scaffolding that supports college students in addressing conceptual challenges (Kim et al., 2022).

### *VIRTUAL FIELD TRIPS IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH (STEM) COURSES*

VFTs are particularly effective in encouraging active learning in STEM courses and have been shown to improve college students' self-efficacy in STEM courses (Safadel & White, 2019). A longitudinal study that examined VFTs in a plant science college course over four years found that VFTs not only increased active learning, they also helped to foster student engagement with the course material (Kobayashi, 2017). One reason that VFTs are particularly effective for STEM courses is that they illustrate STEM concepts through a visit to a physical location, such as visiting Yosemite National Park to learn about geology, without the expense and time commitment associated with traditional field trips (Gutierrez & Bursztyn, 2019).

VFTs boost equity by providing flexibility and accessibility. VFTs offer college students the flexibility to learn at their own pace, on their own time, while yielding course outcomes in terms of students' grades and course evaluations that are comparable to traditional field trips (Shinneman et al., 2020). VFTs allow all students to participate in virtual exploration, providing greater equity for college students who may have transportation, accessibility, or income barriers that impact their participation in physical field trips (Dawkins & Young, 2020; Feig et al., 2019; Harron et al., 2019; Kobayashi, 2017; Ruberto, 2018; Shinneman et al., 2020).

### *PROVIDING SCAFFOLDING THROUGH VIRTUAL FIELD TRIPS*

VFTs are particularly useful for providing scaffolding for challenging concepts (Kim et al., 2022). Traditionally, instructional scaffolding is guidance and support provided by the professor that helps students to achieve their goals in learning (Jumaat & Tasir, 2014). However, a newer approach to providing scaffolding is through computer-based tools that support learning (Belland et al., 2015).


VFTs are one of the computer-based tools that provides scaffolding support by allowing students to engage in problem-centered learning (Kim, 2017; Patiar et al., 2017). A meta-analysis of seven studies on using computer-based scaffolding in college STEM courses found this type of scaffolding is particularly effective in helping students grasp the challenging concepts presented in STEM courses (Belland et al., 2015). Another meta-analysis demonstrated that computer-based scaffolding increases students' learning performance in STEM courses and also boosts their critical thinking skills (Kim et al., 2018).

## DESCRIPTION OF THE “RETAIL QUEST” APP

The Retail Quest app helps students to learn about systems modeling by observing Point-of-Sale (POS) systems at the Mall of America and applying what they observe to systems models, such as use case and activity diagrams. These types of diagrams are commonly taught within STEM courses such as Systems Analysis and Design (SA&D) by studying case studies from a textbook. The goal is to expose students to real-world examples of the systems that are illustrated in the systems diagrams that they will encounter as a part of their SA&D coursework. Figure 1 shows an example of one of the lessons from the app. The first section of the lesson on use case models is depicted in Figure 1.

Show Map
5 of 19
← →

### Use Case Models: Nestle Toll House Cafe



All of this shopping and learning about systems modeling has made you hungry. It's time for a snack, so you head to the Nestle Toll House cafe for a cookie. The café employee greets you from behind the counter. You order two chocolate chip cookies and a cup of coffee from the friendly employee, then pay using your credit card. You swipe your card as the employee pours your coffee and fetches your cookies from the glass case. As you settle onto a nearby bench to enjoy your sweet treat, you wonder if there is a way to model the Point-of-Sale (POS) system you just used, in a way that emphasizes the people using the system, like the friendly employee who served you coffee and you as the customer.

### What are Use Cases?

A use case is a written description of how users will perform tasks using the system. The use case describes, from a user's point of view, a system's behavior as it responds to a request. Each use case is represented as a sequence of simple steps, beginning with a user's goal, and ending when that goal is fulfilled.

### Benefits of Use Cases

Use cases add value because they help explain how the system should. Use cases also help us brainstorm what could go wrong. They provide a list of goals and this list can be used to establish the cost and complexity of the system. Project teams can then negotiate which functions become requirements that the development team will build.

What Use Cases Include	What Use Cases Do NOT Include
<ul style="list-style-type: none"> <li>Who is using the system</li> <li>What the user wants to do</li> <li>The user's goal</li> <li>The steps the user takes to accomplish a particular task</li> <li>How the system should respond to an action</li> </ul>	<ul style="list-style-type: none"> <li>Implementation-specific language</li> <li>Details about the user interfaces or screens</li> <li>Details about the technology</li> </ul>


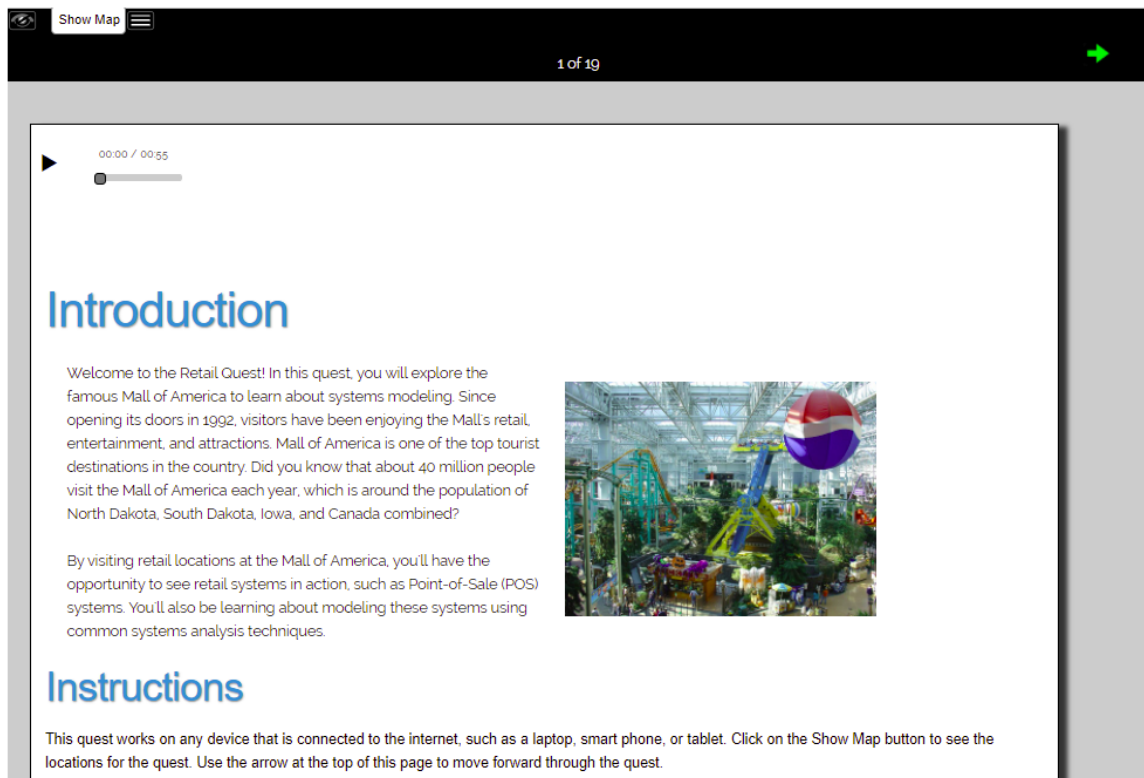


Figure 1. Use case models lesson in “Retail Quest” app

Students can engage with the app in two ways: they have the option to travel to the Mall of America to try out the AR features in the app or to engage with the virtual field trip from home. The university where this study took place is located close to the Mall of America. The mall houses a theme park, mini-golf, movie theater, arcade, and bowling alley, and is also served by public transportation such as light rail and bus service, making it an accessible and popular recreation destination for college students (Phillip, 2012). The long winters in Minnesota where the mall is located make it a popular winter destination for college students, as well as visitors of all ages, who are seeking fun indoor activities (Phillip, 2012). The Mall of America is one of the largest shopping malls in the United States and hosts over forty million visitors per year (Bloomington Convention & Visitors Bureau, 2021). Figure 2 shows the opening screen for the app, which provides students with background on the VFT and the instructions for using the app.



**Figure 2. Introduction screen for “Retail Quest” app**

A working prototype of the Retail Quest app was developed on the Lodestar Learning platform and the Google Maps platform. Lodestar employs HTML5 technology, which means the app will run within the browser on any type of smartphone, tablet, or laptop. The app utilizes geolocation technology to specify the latitude and longitude of stores within the Mall of America on a Google Map. When a student clicks on one of the stores on the map the app displays the interactive lesson for that location. Figure 3 shows the Google Map depicting the lesson locations in the Retail Quest app.

In addition to providing a VFT with Google Maps, the app also provides students with an AR experience based on geofencing. If the student chooses to visit the Mall of America in person, they can engage with the AR experience. The app relies on geofencing technology to detect when a student arrives at one of the stores, and then the app displays the interactive lesson for that location.

Once finished, the app will be released on a common Open Educational Resources (OER) repository under a Creative Commons license so that it will be accessible to faculty to use in their own courses or to build on to create their own virtual field trip. OER are learning materials that have been



theoretical perspective at a deeper level than a Likert-scale quantitative question could provide. In addition, the qualitative approach provides a more thorough description of the participants' perceptions for this case study.

Students completed the virtual field trip as a homework assignment in their Systems Analysis and Design (SA&D) course, which is designated as a STEM course at their university. During the class session where the homework assignment was due, students completed the survey anonymously to share their experiences with the field trip app. Credit was awarded based on the completion of the virtual field trip assignment, not based on completion of the survey since the survey was anonymous, and participation was optional.

Prior to conducting the research, a proposal for the research was submitted to the Institutional Review Board (IRB) at the researcher's home institution and was approved by the board. Respondents read and agreed to a consent form voluntarily prior to answering the survey questions.

### ***RESEARCH SETTING AND PARTICIPANTS***

For this study, the virtual field trip app was introduced as a homework assignment in the Spring 2022 semester of an undergraduate upper-division SA&D course designated as a STEM course. Since this course was an upper-division course, the students enrolled were juniors and seniors who were Management Information Systems (MIS) majors. The SA&D course is a required course for MIS majors.

The sample for this study consisted of eighty-one non-traditional upper-division undergraduates enrolled in an online Systems Analysis and Design (SA&D) course. Of the eighty-one students who were offered the opportunity to participate, thirty-six students elected to participate in the research study. The site of the study is a mid-size, urban, public university with an average student age of thirty. The University is a federally designated minority-serving institution, meaning the majority of students are students of color. 75% of the students at the university are Pell grant eligible, which serves as a proxy for lower household income since income limits determine Pell grant eligibility (Whelan 2019; Wolfston 2020). Around forty percent of the University's students are parenting minor children.

### ***MATERIALS***

The survey was conducted anonymously using the Qualtrics online platform. The following open-ended questions were asked, along with a single closed question to determine if students visited the mall to try the AR geofencing feature.

- Q1: Did the app help you to learn about the subject presented? Why or why not?
- Q2: Did the app motivate you to learn more about the subject?
- Q3: What are the benefits of using the app?
- Q4: What can be done to improve the app?
- Q5: Did you encounter any technical issues that got in the way of your learning? If so, please describe them.
- Q6: Did you physically travel to the Mall of America to use the app? [Yes or No]

### ***PROCEDURE***

A qualitative approach was employed to gather data. A survey instrument with open-ended questions was used to gather students' perceptions. The questions that were included in the survey instrument are described in the results section. The survey was administered anonymously on the Qualtrics platform, which is a professional survey tool.

Students participated in the virtual field trip between January 13, 2022, and January 20, 2022. Students completed the survey during their class session on January 20, 2022, after taking the virtual



field trip. The data was exported from Qualtrics into an Excel spreadsheet format for analysis. Then an indicative coding analysis was performed on the data to identify common themes in the responses.

## ANALYSIS

Qualitative data coding was employed to create and assign codes to categorize the responses to the survey questions. An inductive coding approach was used to examine the data and then develop codes based on the responses within the data. The inductive coding approach was chosen since this exploratory case study aims to investigate new ideas around Virtual Field Trips (VFTs) in order to later refine the survey questions and expand the survey to a larger group of respondents. The inductive coding process involved labeling and then grouping similar types of responses to arrive at categories, which were utilized to derive themes.

## RESULTS

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The survey response rate of over 44% was fairly high for an online survey, with thirty-six out of eighty-one students responding, yielding data to be analyzed for the case study. Four respondents began the survey and accepted the research agreement but then did not enter responses to any of the questions. Since they did not yield any data, the responses of those four participants were excluded from the thirty-six responses included in the results.

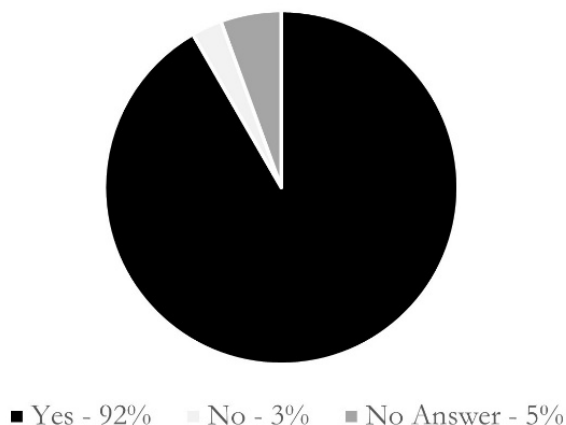
The results section describes the analysis and findings from the thirty-six respondents in the study. A description of the inductive coding analysis is given, followed by a presentation of the findings for each of the research questions in the study. The rationales students provided for their answers are included as well in the findings for each of the research questions.

### RESEARCH QUESTION 1:

#### *HOW DO STUDENTS PERCEIVE THE APP AS HELPING THEM LEARN?*

In response to the first question in the survey “Did the app help you to learn about the subject presented? Why or why not?”, 92% of students answered yes (thirty-three out of thirty-six responses), 3% of students answered no (one out of thirty-six responses), and 5% did not answer the question (two out of thirty-three responses). Figure 4 displays the breakdown of the responses.

Question 1: Did the app help you to learn about the subject presented? Why or why not?



**Figure 4. Responses to question 1:  
Did the app help you to learn about the subject presented? Why or why not?**



Students who answered that the app helped them learn about the subject gave various reasons why this was the case, as shown in Table 1. Out of the thirty-three students who answered yes, twenty-seven provided a rationale of why the app helped them learn about the subject presented. A single student answered no, the app did not help them learn about the subject, and their rationale is also shown in Table 1.

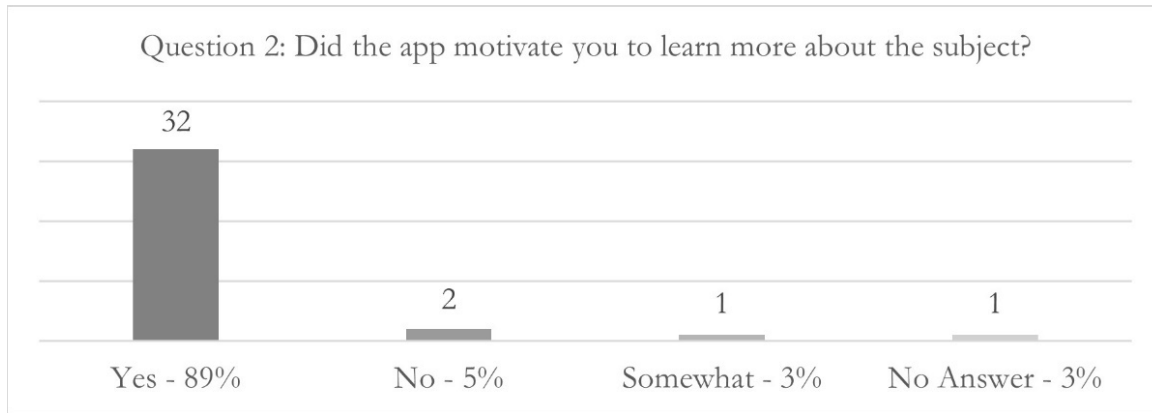
**Table 1. Rationales for responses to question 1:  
Did the app help you to learn about the subject presented? Why or why not?**

ID#	Response	Rationale
1	Yes	I liked how the examples used are in real scenarios. It is what some do whenever we visit the mall.
2	Yes	It presented many of the aspects at MOA, such as areas in MOA and the theme park.
3	Yes	The topics were presented and explained in a straightforward manor [sic] that was easy to understand and relatable to everyday experiences.
4	Yes	It helped retain information that was gone over this course.
5	Yes	It did help me learn about retail system and POS system.
6	Yes	It did due to visualization.
7	Yes	It explained how the subject involved could apply to real life senarios [sic].
11	Yes	Because it helped me view the way the app works and allows me to visualize.
13	Yes	I learned many interesting subject like the Activity diagram for point of Sale system.
14	Yes	The app help me learned how does a app developed and what are use cases.
15	Yes	It presented great examples with visuals.
17	Yes	Very detailed and easy to understand.
18	Yes	It explained it in a visual manner so I understood it by walking through the mall.
20	Yes	It was very informative.
21	Yes	I thought it was really helpful in explaining MIS subject matter in a real world context.
22	Yes	[The app] presented learnings in a meaningful way.
23	Yes	[The app] explained things clearly and the mini quizzes are a nice touch, further directing me on what should be taken away from the lesson.
24	Yes	Bringing real world examples helped me look at systems.
25	Yes	It helped me try a new technology.
26	Yes	It's easy to understand.
27	Yes	[The app] helped me get closer to the materials that I learned.
28	Yes	It helped me see the importance of documenting.
30	Yes	[The app] gave us good pictures to see what the business looked like in real life rather than just reading that there is a T-Mobile store in the mall.
31	Yes	It provided a rich unforgettable adventure.
33	Yes	It gave me a visual perspective of it.
34	Yes	It did help me learn in a similar way to how a slideshow would, i.e. a lesson supplemented by visual aids.
35	Yes	It gave me a better understanding of what it actually takes when purchasing an item.
29	No	Not really. I did not go in person, so a presentation would have sufficed.

## **RESEARCH QUESTION 2:**

### ***HOW DO STUDENTS PERCEIVE THE APP AS MOTIVATING THEM TO LEARN?***

In response to the second question in the survey “Did the app motivate you to learn more about the subject?”, 89% of students answered yes (thirty-two out of thirty-six responses), 5% of students answered no (two out of thirty-six responses), 3% of students answered “somewhat” (one out of thirty-six responses), and 3% of students did not respond to the question (one out of thirty-six responses). The responses to survey question Q2 are shown in Figure 5.



**Figure 5: Responses to question 2:**  
**Did the app motivate you to learn more about the subject?**

Students who answered that the app motivated them to learn about the subject gave a variety of reasons why this was the case. As shown in Table 2, out of the thirty-two students who answered yes, thirteen students provided a rationale of why the app motivated them to learn more about the subject presented. Two students answered no, the app did not motivate them to learn about the subject, and one student responded that the app somewhat motivated them to learn about the subject. The rationales for the students who responded no or somewhat are also shown in Table 2.

**Table 2. Rationales for responses to question 2:**  
**Did the app motivate you to learn more about the subject?**

ID#	Response	Rationale
1	Yes	Yes, it did. the visualization of the stores makes it real too.
2	Yes	The app motivated me to plan a trip to MOA* and use the app.
3	Yes	The app made the topics less intimidating since it gave relatable examples.
7	Yes	Like I mentioned earlier, since it relates the subject to real life scenarios I was more interested to see how these concepts related to real life.
12	Yes	It does rise an interest into different systems that are used everywhere we go.
15	Yes	It presented the material in a way where I felt more motivated to learn.
17	Yes	Would have loved to have this before starting my MIS classes.
18	Yes	The app definitely made me want to learn more about the subject.
20	Yes	It was very interesting.
22	Yes	The items were interesting and made me curious.
34	Yes	Yes, but I was also motivated to learn more before about the subject before using the app as well.
35	Yes	It seems like a simple but easy presentation that includes questions about the topic you're learning.
29	No	Not as much as actually going to the place, but still did a good job at teaching the subject.
30	No	Not really.
23	Somewhat	Somewhat? While it was interesting to see the subject in the real world, I still do not know how to feel about the subject, though this app did not make me hate it in any way.

\* The abbreviation MOA stands for "Mall of America".

**RESEARCH QUESTION 3:*****WHAT DO STUDENTS PERCEIVE AS BENEFITS OF USING THE APP?***

Thirty of the thirty-six students responding to the survey, over 83% of respondents, cited at least one benefit to learning with the app. The benefits that students cited are shown in Table 3.

**Table 3. Responses to question 3:  
What are the benefits of using the app?**

ID#	Rationale
1	You experience everything about the mall and have the chance to visit all while sitting on your couch. You will also get to see the retail system in action.
2	Navigation and information.
3	Straight forward information, clear, information easily applied to anyone to make the connection on how to look at things from a technology perspective.
4	It was interactive and showed processes.
5	The app is easy to manage.
6	It facilitates the customers to find their subjects easy.
7	It's related to real life and much more hands on.
8	It tracks the location.
9	Learning more about the Mall of America, locate different stores within the mall.
11	It allows timeframe and guidance to each location/store.
12	Straight forward and instructions were clear.
13	It helps you understand how the process of the other end works.
14	It let me learn deeper about how does each function work.
15	Easy tool for learning.
19	Interactive, Fun.
20	Having the comfort of doing a field [trip] from home is awesome.
21	Adds real world experiences to the ideas we are learning.
22	A form of gamification of the materials we are going to study.
23	I can take it multiple times and look back at the previous pages so that I don't feel rushed while taking notes.
24	Helped me with what to expect for the semester.
25	It helped me have a real life experience with technology.
26	Being able to go back and view the topic while answering questions.
28	Organized.
29	It was very simple to use.
30	Being able to see a good picture of the business that I am trying to understand.
31	It gives you a broader knowledge on using a visual app.
32	Don't have to leave the house.
33	I was able to learn more about the subject.
34	It's nice having quiz questions built right into the app, all in one place.
35	We don't need to go out the actual field to learn and when asking an employee, they might not know how to respond to our questions.

**RESEARCH QUESTION 4:*****WHAT IMPROVEMENTS DO STUDENTS BELIEVE SHOULD BE MADE TO THE APP?***

Seventeen of the thirty-six students responding to the survey, just over 42% of the respondents, described at least one improvement that could be made to the app. The improvements that students described are shown in Table 4.

**Table 4. Responses to question 4:  
What can be done to improve the app?**

ID#	Rationale
1	I think section 7 test your knowledge, the first question's answer is greyed out and Q6 too and I had to re-do couple times to get the first one right so that needs some attention.
3	For me personally, I struggle with music transitions. My brain doesn't let me focus on the screen or information when music is playing. That is personal preference, however. I like quiet yet my husband needs noise to work. To each their own.
6	It needs to be fully detailed.
7	When answering questions, it would be nice if you could select anywhere near the answer rather than only the check box by the answer.
10	Make it easier to use by placing buttons better and reducing noises.
11	The lag and update timeframe.
12	Add some Key Takeaway?
13	Having the app be translated in different languages.
17	Not all diagrams were visible using a mobile phone. The ability to resize the diagrams or photos would be helpful.
21	Make the visuals more interactive.
24	Perhaps a voice over? I didn't mind reading, but a voice over would've been fun.
25	It could update more colorful.
26	More user friendly.
31	A little more details can help.
32	More intuitive. Maybe a better way to go forward and backward or go to a specific page. I couldn't find a zoom button within the app, but this could've been just me. It was hard for me to select one of the answers all the way on the bottom of the page because something was kind of blocking it.
34	A bit of polishing, particularly the pages with the questions felt a little clunky. The page didn't fully display (a bit of the bottom was cut off) and I'd like to be able to select my answer anywhere along the text rather than just in the small bullet points.
35	For the questions, you should let us go back into the reading so we can see if what we are thinking is the right answer or not.

### ***RESEARCH QUESTION 5:***

#### ***DO STUDENTS IDENTIFY TECHNICAL ISSUES WHICH HAMPERED THEIR ABILITY TO LEARN WITH THE APP?***

Out of the thirty-six respondents, six respondents described technical issues that got in the way of their learning. Almost 17% of the students surveyed were affected by technical issues while engaging with the virtual field trip app. The technical issues students encountered are described in Table 5.

**Table 5. Responses to question 5:  
Did you encounter any technical issues that got in the way of your learning?**

ID#	Rationale
1	Not really but I had some issues with the questions.
7	I like to be able to look up answers using command+f control but I could not search the app.
16	Was unable to do virtually as the app was unable to get my GPS coordinates.
29	Some resolution problems. Nothing crazy, but would cut some of the text off.
31	At first try I couldn't figure out how it worked then I relaunched it and got through it.
36	Yes, it was cold.

### ***ANALYSIS OF COMMON THEMES***

An inductive coding analysis was performed to examine the data and then develop codes based on the responses within the data. While performing the inductive coding analysis, several common

categories emerged and were employed to assign codes to categorize the responses to the survey questions. Similar types of responses were grouped into categories in order to identify common themes. Common themes for responses to questions 1 and 2 on learning and motivation included the virtual field trip app's ease-of-use, real-life or real-world scenarios presented in the app, and the visual nature of the app. Navigation and location functionality and ease-of-use were common themes in the responses to question 3 on the app's benefits. Table 6 shows how the responses from survey questions 1-3 were coded based on their content. The full text of the responses is shown in Tables 1-3 and can be matched by respondent ID.

For questions 4 and 5, common themes in the suggested improvements as well as the technical issues were problems with the usability of the user interface and the quiz questions. Table 7 shows how the responses from survey questions 4 and 5 were coded, based on the full content of the responses, which is shown in Tables 4 and 5.

**Table 6. Inductive coding analysis results for questions 1-3**

Code	Respondent IDs		
	Question 1: Learning	Question 2: Motivation	Question 3: Benefits
Easy	1, 3, 17, 26		5, 6, 12, 15
Information	20		3
Interactive			4, 19
Navigation/ Location			2, 8, 9, 11
Quiz		35	
Real	3, 7, 17, 24, 30	3, 7, 23	7, 21, 25
Review			23, 26
Virtual			1, 20
Visual	6, 11, 15, 18, 33, 34	1	

**Table 7. Inductive coding analysis results for questions 4-5**

Code	Respondent IDs	
	Question 4: Improvements	Question 5: Technical Issues
Audio	3, 10, 24	
Content	6, 12, 31	
Language	13	
User Interface	10, 11, 17, 21, 25, 26, 32, 34, 35	29, 31
Quiz	1, 7, 34, 35	1, 3
Search Function	36	7

### ***PERCENTAGE OF VIRTUAL VERSUS IN-REAL-LIFE (IRL) FIELD TRIP VISITS***

Around 8% of the students responding to the survey indicated that they physically traveled to the Mall of America to learn with the virtual field trip app. Three of the thirty-six respondents replied to question 6 in the survey by saying “yes” that they visited the mall to use the app.

## **DISCUSSION**

The goal of the Retail Quest app is to provide college students with active learning through AR and VFT. Students in STEM courses, such as Systems Analysis and Design (SA&D), benefit from active learning because it has been shown to increase students' performance and narrow achievement gaps in STEM (Sandrone et al., 2021). The Retail Quest app exposes students to real-world examples of the systems that are illustrated in the systems diagrams that they will encounter as a part of their STEM coursework.

The lessons in the app provide scaffolding for understanding challenging concepts around modeling systems. VFTs have been shown to be particularly useful for providing scaffolding for challenging concepts (Kim et al., 2022). VFTs boost equity for college students by providing flexibility and accessibility, advantages over place-bound traditional field trips (Dawkins & Young, 2020; Feig et al., 2019; Harron et al., 2019; Kobayashi, 2017; Ruberto, 2018; Shinneman et al., 2020, 2020).

### ***STUDENTS' PERCEPTIONS OF LEARNING USING VIRTUAL FIELD TRIPS***

The results of the research show students overwhelmingly perceived the Retail Quest VFT app as helping them learn about the subject that was presented. The answer to research question RQ1 “How do students perceive the app as helping them learn?” is yes, since over 92% of students responded that the app has helped them to learn the subject presented. Three common themes emerged in the responses as to how the VFT app helped learning: the visual nature of the app, the real-life scenarios presented in the app, and the app's ease-of-use.

Students commented favorably on how the scenarios in the app helped them learn by describing how the app explains “MIS subject matter in a real world context” and “how the subject involved could apply to real life scenarios [sic]”. The real-life scenarios that are included in the app are intended to stimulate students' learning about information systems. For example, students use the VFT app to visit the bookstore at the mall and learn how activity diagrams are used to model the check-out process for buying a book. Since this study is an exploratory case study, a key takeaway for improving the app is to keep the real-world scenarios and even expand on them as the app is improved. The importance of including real-life scenarios is also a key takeaway for faculty who are planning to build their own VFT apps in the future.

Students also reported that the visual aspects of the app helped them to learn by mentioning that the app “gave a visual perspective”, “presented great examples with visuals”, and “used good pictures to see what the business looked like in real life”. The app contains pictures of the field trip destinations within the mall, as well as images of the systems diagrams that are utilized to model the information systems presented in the lessons. For example, when students virtually visit the bookstore, pictures of the bookstore are displayed in the app along with an image of the activity diagram used to model the process of purchasing a book. One of the significant discoveries of this study is that students found the visual nature of the app critical to learning, so improved versions of this VFT app as well as future new VFT apps should include the visual aspects of the lessons that are presented. This finding builds on previous research showing VFTs promote active learning (Mead et al., 2019).

In addition to the real-life scenarios and visual characteristics of the app, students reported that the app's ease-of-use also contributed to their learning. This is somewhat surprising, as the findings for research questions R5 and R6 showed that students experienced some technical difficulties with the user interface and the quiz function, and suggested improvements to both of these areas of the app. However, it seems that these difficulties were relatively minor since four of the thirty-three students who responded that the app helped them learn cited the app's ease-of-use as the reason. This indicates that while the app interface has room for improvement, the basic design was sufficient for enabling learning.

### ***STUDENTS' PERCEPTIONS OF MOTIVATION USING VIRTUAL FIELD TRIPS***

In addition to the majority of students agreeing that the app helped them learn the subject, the majority (over 89%) also agreed that the app motivated them to learn more about the subject. This shows that the answer to research question RQ2 is yes, the students perceive the VFT as motivating them to learn. Although the survey question Q2 did not specifically prompt for the research why the app motivated the students to learn, twelve of the students who responded that the app motivated them also provided a description of why this is the case. The most common reason that the app motivated students to learn more is the real-life scenarios described in the app. For example, one student

wrote that “since [the app] relates the subject to real life scenarios I was more interested to see how these concepts related to real life.” In conjunction with the responses from students citing the real-life scenarios as helping them to learn, it appears that the real-life scenarios also served as catalyst for motivation. This provides a secondary reason for keeping and expanding the scenarios in future versions of the app. Higher student motivation also provides a rationale for including real-life scenarios in future VFT apps that faculty are considering developing for their courses. This finding builds on previous research that shows VFTs provide valuable scaffolding for challenging concepts and increase motivation in STEM courses (Kim et al., 2022; Sandrone et al., 2021).

In addition to describing how the app stimulated learning and motivation, over 83% of students cited at least one benefit to learning with the app. The students’ responses provided ample answers to research question RQ3: “What do students perceive as benefits of using the app?” The most common benefits of using the app cited by students are the navigation/location features, the easy-to-use interface, and the real-world scenarios. Interestingly, while the majority of the students only engaged with the field trip app virtually, several students commented on the navigation and location features as benefits. Only three of the students responding to the survey actually traveled to the mall to learn with the app, however, four of them described these features as beneficial, such as the location tracking and the “guidance to each location/store”. This indicates that although students may choose to use the Retail Quest app only as a virtual field trip, they perceive the opportunity to also use the app for an In-Real-Life (IRL) field trip as a benefit. From the perspective of this exploratory case study, this finding shows even if most students are completing the field trip virtually, students find the inclusion of navigation/location features beneficial, so faculty should consider including these features in VFT apps.

### ***STUDENTS’ PERCEPTIONS OF THE BENEFITS OF VIRTUAL FIELD TRIPS***

In addition to citing the navigation/location features of the VFT app as a benefit, several students also cited the app’s ease-of-use and real-world scenarios as benefits. Given the responses to survey questions Q1 and Q2 where students described how the app’s ease-of-use helped them to learn the subject and how the real-world scenarios motivated them to learn, it is not surprising that students saw these two features as benefits of the VFT app. This finding indicates that faculty looking to develop their own VFT apps should test the interface for ease-of-use and should definitely consider including real-world scenarios. This finding expands on earlier research showing VFTs improve student success by increasing students’ motivation to learn (Gutierrez & Bursztyn, 2019).

Moreover, students mentioned the benefits of the VFT app-like interactivity and gamification, which describe aspects of active learning that are critical to success in STEM courses. A takeaway for faculty seeking to develop their own VFTs is to consider how they can make the VFT app as interactive as possible, while also conceivably including a game within the app. In addition to the benefits that described active learning strategies, like interactivity and gamification, several students described doing a field trip from home as a benefit. This shows how students may find the virtual option appealing, even if they also have the option to physically visit the field trip location, as they did with the mall featured in the VFT app. This finding supports the idea that VFTs are beneficial specifically because they allow students to participate without requiring transportation, childcare, and fees, like physical field trips usually do, expanding on previous research showing VFTs boost accessibility for students (Dawkins & Young, 2020; Feig et al., 2019; Harron et al., 2019; Kobayashi, 2017; Ruberto, 2018; Shinneman et al., 2020, 2020).

### ***STUDENTS’ SUGGESTIONS FOR IMPROVEMENT AND TECHNICAL ISSUES***

While research questions RQ1, RQ2, and RQ3 focused on positive perceptions around learning, motivation, and benefits of the VFT app, questions RQ4 and RQ5 focus on areas of improvement and technical issues in the VFT app. These are of crucial consideration for this exploratory case study since the findings will guide the process of refining the prototype version of the VFT app before a



larger research study is conducted. Likewise, the suggestions for improvement and description of technical issues will inform other faculty who are interested in developing their own VFT apps.

A fair number of the students suggested improvements to the VFT app, with just over 42% of the students suggesting at least one improvement. The most common suggestion by far was to improve the user interface. In response to survey question Q4, students suggested making the interface “more intuitive” by creating better navigation between the pages and by making it easier to select the answers to the quiz questions. Additionally, in response to survey question Q5, students mentioned technical problems with the app, such as that the text was cut off on the bottom of some of the pages and the diagrams were difficult to zoom or resize.

As it turns out, these concerns are endemic to the Lodestar platform, which controls the navigation between pages and the quiz question design. The platform uses small arrows to allow the user to move forward and backward through the lesson pages, as well as a drop-down menu to allow users to choose a specific page, as shown in Figures 1, 2, and 3, presented earlier in the Background section of this paper. However, the web design is an older style, which may seem less intuitive to the students.

The Lodestar platform also displays a pop-up of the geographic location coordinates at the bottom of the page when the geofencing is enabled, as shown at the bottom of Figure 3. On most pages, this is not an issue since it is possible to place a decorative image at the bottom of the page to prevent the text of the lesson from being obscured by the pop-up. However, on the pages with quiz questions, there is no option to edit the page directly to place a decorative image at the bottom of the page, so the pop-up may obscure the question answers. Two of the students also mentioned this problem in response to survey question Q5 on technical issues.

The Lodestar platform was primarily chosen for the VFT app because it relies on geofencing to automatically display the lesson for a particular location when the student physically arrives at the location. The user interface issues were known at the time of development, yet, competing platforms did not offer the geofencing feature. However, the research results reveal that only three of the thirty-six students physically visited the mall to learn with the app, so very few students chose to try out the geofencing. This finding is a bit surprising since the mall is centrally located in the metro area and easily accessible by public transportation, in addition to being a popular regional shopping destination and recreation location for college students. Although the pandemic was waning into an endemic at the time of this study, it is possible that students were reluctant to visit the mall during the study due to caution around COVID-19. Regardless, since so few students tried the geofencing, it may be worthwhile to re-develop the app on another platform that addresses the students’ concerns with the navigation between pages and the issue with the pop-up obscuring the quiz questions. Since students indicated the location/navigation guidance is beneficial, the new version of the app will still include Google Maps or another mapping tool, even if the geofencing is no longer included. New development platforms will be investigated to provide a more intuitive interface for the updated version of the VFT app.

The results of this exploratory case study show students perceive that using the VFT helped them learn the subject and also that engaging with the VFT motivated them to learn the subject, showing that the Retail Quest app met the goal of providing STEM students with active learning through VFT. This builds on previous research showing VFTs increase motivation and student success in STEM courses (Safadel & White, 2019; Sandrone et al., 2021). The lessons in the app provide scaffolding for understanding challenging concepts around modeling systems, expanding previous research on scaffolding for STEM courses (Kim et al., 2018; Patiar et al., 2017). Students also cited many benefits to learning with the VFT. The results of the study also showed that students found improvements could be made to the app and that some students encountered technical difficulties. The findings of this exploratory case study will be invaluable in refining this prototype of the Retail

Quest app and in launching a larger-scale study on students' perceptions of learning, motivation, and benefits of VFTs.

## **LIMITATIONS AND FUTURE RESEARCH**

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A key limitation of this exploratory case study is the sample size since the scope is limited to college students in a single course. The app will be refined based on the results of this case study and then released to an Open Education Resources (OER) platform to distribute to any faculty who wish to use it under a Creative Commons license. OER are learning materials that students and faculty can access freely and at no cost (Barrientos, 2022). This will open the door to allow the app to be used more broadly for future research by other faculty.

After the release of the app to the OER platform, future research will be conducted in subsequent terms to gather additional data on students' perceptions of the Retail Quest app, as well as their perceptions of the relationship between learning and the VFT technology. This study may employ a mixed-methods approach (both quantitative and qualitative) to gather responses to both open-ended questions and closed-ended questions based on a Likert scale. In addition, the study design could compare a group of students who are learning with VFT technology with those who are learning with a traditional method, such as a case study, in two different sections of the course.

Further research is also needed to survey faculty on their perceptions of how assigning the app impacts student learning, particularly in regards to the VFT technology within the app. Another possible future area of research is gathering demographic data on students to see if students from different backgrounds, like first-generation or BIPOC students, engage with the app differently or have different perceptions of learning with the app. Additionally, future research could be done on how VFTs and VR, in general, hinder or contribute to the development of interpersonal skills, since VFTs and VR provide a replacement for interactions in the real world.

## **SUMMARY AND IMPACT**

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Students overwhelmingly perceived the VFT app helped them learn about the subject that was presented, citing the visual nature of the app, the real-life scenarios presented in the app, and the app's ease-of-use as reasons why. The majority (over 89%) also agreed that the app motivated them to learn more about the subject. The real-life scenarios employed in the app were the most common reason students gave for feeling motivated to learn. Over 83% of students cited at least one benefit to learning with the app, such as the navigation/location features, the easy-to-use interface, and the real-world scenarios. Moreover, students mentioned benefits to the VFT app-like interactivity and gamification, which describe aspects of active learning that are critical to success in STEM courses. A fair number of the students suggested improvements to the VFT app, with just over 42% of the students suggesting at least one improvement. The most common suggestion by far was to improve the user interface, make navigation easier, and address issues with the quiz questions. These results will be utilized to refine the app prototype, as well as the research questions and the survey instrument, in preparation for a larger-scale study.

The broad impact of this exploratory case study is that it serves as a proof-of-concept and starting point for other faculty who are interested in developing their own AR and VFT apps to engage students in active learning. A key takeaway for faculty seeking to develop their own VFTs is to consider how they can add real-life scenarios to help students learn the subject and increase their motivation. The outcomes of this study will hopefully serve as an inspiration to other faculty to adopt VFTs as an active learning strategy, based on the students' positive perceptions of learning, motivation, and benefits of VFTs. The far-reaching impact of this research is encouraging the adoption of VFTs as an active learning strategy since active learning increases student success and engagement.

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