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Leveling the Playing Field: Amplifying Rural Student Voices in Game-Based Learning Design with a Rural User Experience (RUX) Kit

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Abstract. This paper introduces the Rural User Experience (RUX) initiative, developed to assess and address the unique challenges faced by rural users in educational technology testing, particularly for game-based learning applications. By piloting a RUX kit and its associated activities in rural Missouri, this initiative aims to minimize sampling bias in user experience (UX) testing, especially in underserved rural areas where transportation and communication barriers persist. This work-in-progress paper evaluates the feasibility of using iMotions, an advanced UX testing software, to conduct on-site and remote data collection, specifically through eye-tracking and facial expression analysis. Tests were performed on three games under development: *vSchool*, *Mission Vita Nova*, and *Mission HydroSci*, across laboratory, remote, and rural school settings. The paper discusses training provided to researchers, the tools employed, and the outcomes of rural student engagement. While this phase of the initiative revealed both successes and limitations in the applicability of iMotions, it also highlighted the need for further development and testing of alternative UX tools for rural contexts. This work contributes valuable insights for future researchers and practitioners interested in enhancing UX inclusivity in game-based learning environments.

Keywords: Rural User Experience, Educational Technology, Game-Based Learning, Sampling Bias, User Testing.

1 Introduction

Rural User Experience (RUX) describes how users in rural areas interact with technology, highlighting the unique perspectives, needs, and challenges they face. Addressing these considerations is crucial when designing and evaluating tools like educational games. To this end, we developed a RUX kit with accompanying activities to test educational games within rural school districts. We aimed to create a replicable framework that researchers and practitioners could adapt to develop similar toolkits for their faculty, staff, and student researchers.

This paper report reflects on our efforts, detailing the development of the RUX kit and its integration into ongoing research activities. The kit leverages tools such as eye tracking and facial expression analysis to evaluate immersive learning experiences. Eye tracking provides insights into learners' visual attention and focus, helping to understand navigation through complex 3D environments and interactions with game elements. Facial expression analysis captures emotional responses, offering valuable data on motivation and immersion. Together, these methods deliver a comprehensive perspective on how students experience and respond to educational games, offering lessons and guidance for future initiatives.

2 Rationale for Rural User Experience (RUX) Testing

The RUX initiative aimed to address sampling bias in educational games and other educational technologies research. Sampling bias describes the distortion that can occur when selecting and enrolling research participants into a study that may not accurately reflect the target population of interest. Sampling bias is not unique to game design, and approaching user testing with a foundation of inclusivity may assist in thwarting this bias [1, 2].

Transportation to user experience laboratories represents a barrier for students and their families to participate in on-site data collection. Recent inflation trends have increased transportation costs for rural families more so than urban ones [3]. Field trips, such as to a game studio or laboratory, also present educators and childcare providers with challenges, such as navigating initial site visits, permission slips and licensing rules, staff-child ratio, and other safety hazards [4].

Although remote user testing is one possibility for hard-to-reach participants, a persistent challenge of data collection in rural areas is poor communications infrastructure [5]. Missouri, where this initiative took place, is not immune from this challenge. From 2015-19, 37% of Missourians did not have wired broadband in their homes [6], and a Missouri Department of Elementary and Secondary Education internet connectivity survey found that 23% of students lacked sufficient internet access [7]. The primary reasons for limited access were affordability, cell coverage, physical access, and lack of a Wi-Fi-enabled device. Until the critical need for broadband connectivity is diminished through initiatives by the Missouri Department of Economic Development, we envisioned that the RUX initiative could model a short-term solution to persistent data collection challenges.

3 Creating the RUX Kit Initiative

3.1 Equipment Purchases

To create our RUX kit, we required research software for remote and on-site data collection and accompanying hardware. The following section of this report provides details on the tools we used.

We purchased iMotions to pilot this initiative. iMotions uses eye-tracking and facial expression analysis to determine where users' attention is located and suggests what emotions they might be experiencing while engaging with content. iMotions accomplishes this by recording the user's computer screen while simultaneously recording the user's face with the computer's built-in camera. iMotions also enables gaze mapping, allowing researchers to pinpoint a particular item on the screen for analyzing user attention. The total cost for this software with an additional module purchase for online data collection and its customer support program was $8,200 USD.

To evaluate iMotions as a tool for RUX initiatives, we required a high-performance laptop. The version of iMotions we used recommended a computer with the following specifications: CPU: Intel i7 10000 or better or AMD Ryzen 7 5000 or better; RAM: 16-32Gb is recommended; Storage: 1Tb SSD in total; Graphics: NVIDIA 1660 or better. Thus, we purchased Dell's Precision 3581 Workstation. The total cost for this laptop was $2342.88 USD.

3.2 Training Provided to Graduate Researchers

With the necessary tools purchased, we formed a team of three graduate research assistants to become familiar with the software and manage the pilot initiative. These training sessions were instrumental in equipping the team with the requisite knowledge and skills to leverage iMotions effectively for research projects.

The initial training session focused on navigating the basic features of iMotions. Team members were trained on setting up a study within the platform, adding participants to studies, and incorporating stimuli such as websites, images, and videos as per research requirements. This session aimed to provide a strong foundation for utilizing the software effectively for experimental setups. The subsequent training session was dedicated to understanding the data analysis processes within iMotions, particularly extracting facial expressions, eye-tracking trends, interpreting heat maps, and defining Areas of Interest (AOI) with sample videos. This interactive session enabled researchers to grasp the nuances of interpreting data insights for research purposes effectively. The final training session delved into the specifics of advanced analysis, focusing particularly on delineating and analyzing AOIs. Participants were guided through the process of drawing AOIs, as well as the thorough analysis pertaining to the identified AOIs.

We selected iMotions based on our prior experience with Tobii Pro 2, which uses eye-tracking glasses. While we recognized the value of using specialized glasses, our goal was to develop a system that could eventually be deployed on students' personal computers and their webcams without requiring costly hardware. The RUX kit served as an initial testbed, allowing us to evaluate its performance on our laboratory laptop before extending

trials to lower-specification devices. Furthermore, iMotions was chosen for potential integration into our learning analytics pipeline. This integration enables us to explore potential correlations between visual attention or emotional responses and specific 3D objects within non-linear gameplay sequences.

4 Tests and Results

We used iMotions to explore user experiences with three game-based learning applications in development at the Adroit Studios Gaming Laboratory: (1) *vSchool*, (2) *Mission Vita Nova*, and (3) *Mission HydroSci*. We chose these games because they were already scheduled for testing in rural schools, providing an opportunity to evaluate user experiences while piloting the iMotions system. This dual-purpose approach allowed us to efficiently validate the method and toolkit in real-world contexts while fostering student interest in game development and user experience design.

Due to the simultaneous research efforts involving multiple game applications, procedures varied across games and schools. Not all schools utilized the iMotions system, nor were all games tested in every school. Additionally, the surveys were tailored to the specific game being tested, resulting in students completing different surveys and participating in varied procedures. This variability was driven by the unique research goals and developmental stages of each game, rather than our specific use of iMotions.

Out of 170 students who participated in in-person lessons on STEM and language arts through video game creation and testing, only 12 were exposed to iMotions via our Rural Testing Kit. Of these, technical challenges and data quality issues reduced the number of valid datasets for eye-tracking or facial expression analysis to just six. Demographic details, such as gender and age, were not collected during this pilot phase, as the primary focus was on assessing the feasibility of the RUX Kit in rural school settings alongside other research activities. Future iterations of the study will aim to address these limitations by incorporating more detailed demographic data collection.

4.1 Testing AOIs and Gaze Patterns with vSchool

We used iMotions to gather data from middle school students as they engaged with *vSchool*, a game-based socio-emotional learning assessment tool. Data collection occurred in person with four students and eight students remotely online via their personal computers. We specifically tracked gaze patterns during 20-30 minutes of player interaction with the game interface, but data from only three participants were deemed as valid. (See *Lessons Learned* for further detail.). Beyond observational notes, we did not collect additional data during the RUX pilot test with *vSchool.*

Efforts are now underway to delineate Areas of Interest (AOIs) for scenes, including questions that require student reading. Preliminary findings suggest that students' attention was not consistently focused on the text-based questions or instructions, potentially impacting their comprehension of the context. Further data collection involving more participants is necessary to gain a comprehensive understanding of young players' reading behavior in educational technologies.

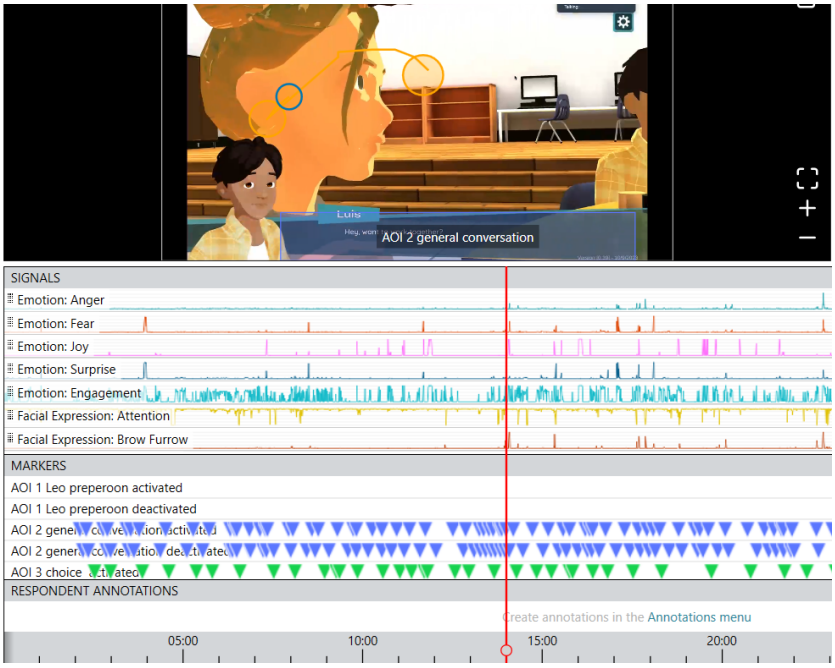

Fig. 1. Screen capture of iMotions data analysis. This screen presents the AOIs and Gaze Mapping for one sequence in *vSchool*.

4.2 Testing Facial Expression Analysis with Mission Vita Nova

We collected data from three middle school students' gameplay sessions with *Mission Vita Nova*, a virtual learning environment for media literacy and digital citizenship education. The gameplay sessions were typically fifteen minutes long and occurred with our designated iMotions laptop. In addition to monitoring gaze patterns and AOIs, we set iMotions to flag expressions on participants' faces, potentially indicating which elements of the game were of the most interest to the participants. Beyond observational notes, we did not collection additional data during the RUX pilot test with *Mission Vita Nova.*

Based on the analysis of signals by iMotions, we observed that these three children exhibited heightened levels of joy and/or surprise at certain points during gameplay, as indicated by their facial expressions. These instances included (1) player transitions to new environments, (2) interacting with characters for the first time, (3) scanning their first in-game social media posts, and (4) creating and sharing their own in-game posts.

Fig. 2. Screen capture of *Mission Vita Nova*. This screen presents an example of a sequence that resulted in heightened levels of joy or surprise.

4.3 Visiting Rural Schools with Mission HydroSci

We visited two rural schools in northeastern Missouri and one rural school in central Missouri to gather student feedback on the latest prototype of *Mission HydroSci*. *Mission HydroSci* is a game-based learning application focused on water science and scientific argument. Flyers were distributed to teachers informing them about the opportunity to participate in the project. After meeting with the project PI, teacher consent was obtained and opt-out notifications were provided to parents and students. Institutional Review Board IRB approval was secured, and participants were assured confidentiality using coded identifiers.

Although we were unable to incorporate iMotions testing into this visit, we included a custom survey for two of the schools that encompassed ratings of their game experiences, evaluating factors like difficulty and enjoyment. Additionally, students rated their preferences towards various game elements and shared feedback on their learning experience, including their understanding of scientific arguments and interest in science education. One example of a survey question asked participants to rate statements on a scale, such as "I learned something relevant to topography by playing this game."

We received 110 student responses to this survey. Initial findings highlight a correlation between students' game experiences and their learning experience. However, a notable observation from students' open-ended responses was the absence of mentions regarding the acquisition of argumentative skills, hinting at potential gaps in their unawareness of the learning process. Further analysis and exploration are warranted to delve deeper into these findings and gain a more comprehensive understanding of student perceptions.

Fig. 3. Over-the-shoulder photo of a child testing *Mission HydroSci* as a youth game consultant.

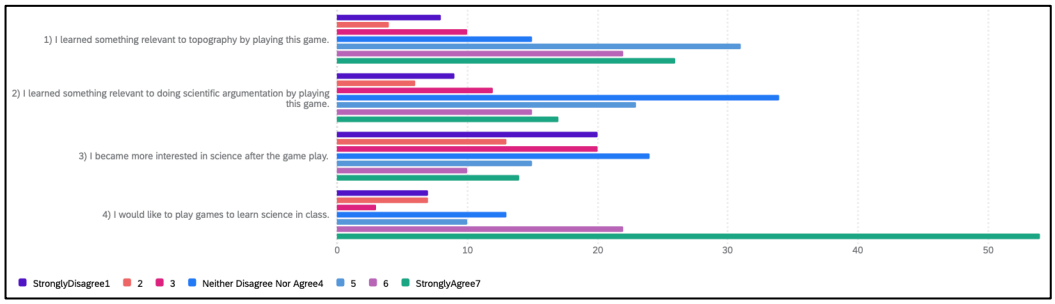

Fig. 4. Sample bar chart illustrating participant reactions to the core content in the *Mission HydroSci* unit included for testing.

5 Lessons Learned with Our RUX Kit

Our training and tests allowed us to evaluate the feasibility of a long-term RUX Kit. One of the goals of this project was to assess the ability to create RUX kits that could spur growth in our department's online program options and distance field experiences, especially those enrolled in user experience and usability certificate

programs. Before investing funds to scale our RUX kit initiative, the following challenges warrant further investigation.

5.1 Training Required

Originally, we envisioned creating an online portal for checking out and delivering the RUX kit to certificate students if the kit proved successful. By lending the RUX kit to graduate students working in rural areas, we could attract more working professionals interested in advancing their careers by gaining hands-on experience with advanced data collection tools. However, the extensive training required to prepare our on-campus PhD research assistants to use the software showed that the time commitment for students completing an internship at a distance would be burdensome without significant assistance.

5.2 Mislabeled Emotion Detection

Although the iMotions software provides accuracy percentages for each detected emotion, which can be adjusted to display within a specified threshold, there were occasions where decoding engagement, attention, and emotion suggestions required effort from researchers.

For instance, the software indicated high engagement during a student's gameplay when he simply glanced off-screen to answer a question. Similarly, when a student appeared disengaged with his head resting on his hand and his eyes unfocused, the software detected joy and surprise. These instances suggest that the software's emotion detection may not be highly accurate without exact guidance to participants on physical behavior during recorded gameplay.

Furthermore, it is important to acknowledge the cultural diversity of facial expressions worldwide, influenced by socialization and personal experiences. Certain viewpoints contend that physical facial movements lack inherent emotional significance [8]. Thus, while the software claims to measure emotions, neuroscience suggests there is no consistent method to directly link outward facial expressions with internal emotions.

5.3 Technical Limitations

Despite its intended functionality, we encountered difficulties with iMotions' eye-tracking capabilities, resulting in a loss of crucial data for our specific research. We also faced restrictions in recording duration, as the software imposed a limit of 20 minutes per session, hindering our ability to capture comprehensive data for longer experimental periods.

Moreover, when collecting data remotely, we experienced issues with participants' equipment, where the collected data failed to upload to the cloud, resulting in data loss. Asking participants to manually save facial recording data was also problematic and placed an undue workload on the child participants and their caregivers.

5.4 Next Steps

Given the successes and challenges we experienced while piloting our RUX Kit, we will take a two-pronged approach in our future endeavors for testing with students in rural areas.

First, we will extend our iMotions subscription for another year to facilitate further evaluation. UX testing at rural schools will still be conducted in person, but not every student will necessarily use the iMotions software. Instead, some students can opt to use it while others will be observed playing games on alternative devices. Additionally, we will utilize one of our laboratory laptops to assist students in accessing the online iMotions testing link. This approach will enable more students to have their UX testing recorded with eye tracking, allowing us to assess player engagement levels with specific aspects of the games.

While we proceed with further testing using iMotions, we have determined the need to explore alternative software options, too. We are allocating time for our research team to compile a list of companies for potential demonstrations. Our focus is on finding remote UX testing solutions tailored for video games with a robust software development kit to allow for games controlled by eye movement.

6 Conclusion

Creating environments where all students and teachers feel valued—whether physical or virtual—is essential for promoting inclusivity, diversity, and equity in education. Our goal with the RUX project was to broaden the voices

considered in game-based learning applications created by the Adroit Studios Gaming Laboratory. To date, in-depth UX testing has occurred primarily through connections with local public schools in a university town, thus perpetuating a sampling bias. By visiting six schools and approximately 170 students, we made significant inroads in establishing connections with rural schools and gained valuable feedback on Adroit's projects.

In addition to gathering data on rural student perspectives toward Adroit's games, we also provided students with the chance to interact with a professional in the field along with a fun presentation. As the demand for UX testers and researchers continues to grow in various industries, there is an increasing need to ensure that diverse perspectives are represented and considered in the design and evaluation of educational technologies. According to the Bureau of Labor Statistics [9], the field of UX research is projected to experience significant growth over the next decade, highlighting the importance of preparing a diverse and skilled workforce. Through our RUX initiative, students gained insight into the creative and technical aspects of game design, as well as the career opportunities available in the industry.

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