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UX design research for improving student experience in online laboratories

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UX design research for improving student experience in online laboratories

Abstract

The COVID-19 pandemic forced educators and students to transition to online instruction. This change brought the importance of user interfaces into stark relief for engineering lab classes, compelling educators to consider how the design of online courses and virtual laboratory experiences either served or worked against student learning. In summer 2020, we began educational and user experience (UX) research with the online laboratory experiences in an electrical engineering lab classroom at the University of Georgia's College of Engineering. The NSF-funded project work draws on ready-to-use remote labs for electronics applied to several courses. It seeks to explore the faculty and student perspective on online experimentation in engineering curricula. However, the UX thrust of the project rounds out a holistic view of the online learning ecosystem and might specifically uncover barriers or factors of success related to the implementation of online labs. This project highlighted the importance of UX design in delivering science curriculum via virtual laboratory exercises with the specific conclusion that deficits in perspicuity in the UX create an obstacle to learning for engineering students.

1. Introduction

In 2020 the COVID-19 crisis forced universities to suspend face-to-face instruction and shift educational activities online in a rapid manner. Transitioning to fully online instruction in a short time frame creates a unique challenge for engineering faculty to provide alternative laboratory experiences. 70% of our institution's required Electrical Engineering (EE) and Computer Systems Engineering (CSE) curricula include required hands-on laboratory components tied to critical learning outcomes. The rapid change to online delivery brought the importance of overall usability into stark relief for engineering lab classes, forcing educators to consider how the design of online courses and virtual laboratory experiences either served or worked against student learning. This phenomenon requires consideration and led to the formation of this study where we consider the user's perception of a system.

For the study presented in this paper, the goal is to investigate the user experience (UX)—a user's perception and response that results from the use and/or anticipated use of a system, product, or service [1]—of the online experimentation experience in an electrical engineering lab classroom at the University of Georgia's College of Engineering. While other studies may compare traditional classroom experiences with online learning to strengthen learning and assessment, this study is taking the step before these studies to understand the pain points within the online learning environment that serve as barriers for students. The project draws on a ready-to-use remote lab already used in the College of Engineering which allows students to build electronic circuits online. Again, this study is only concerned with the interface students use within these labs. Research investigating student achievement within such courses is a step beyond what this study seeks to do. Instead, it explores the students' perspective of the online learning ecosystem and attempts to uncover barriers or factors of success related to the implementation of online labs. The goal was to establish a usability and UX baseline of an existing course's remote laboratory experience by which we could continue to improve and measure the tools and design of the course.

While establishing this baseline, the research also considers two other points of interest: the faculty perspective on implementing online laboratory experiences and the student's motivation level when approaching online labs. These factors also contribute to the quality of learning within the online environment and will be presented in separate studies. However, the study presented here is scoped to mark a UX baseline for further research into how these three aspects can potentially work synergistically to enhance online labs.

2. User experience and online labs

UX design and research have theoretical underpinnings in Gibson's Theory of Affordances [2] - [3], which examined the relationship between an individual's perceptions, the environment, and the resulting actions or behaviors. Donald Norman expanded on Gibson's work by taking a cognitive psychology approach to perception, arguing that users do not directly perceive the affordances in their environments but need to process and interpret the information to make sense of the affordances of what they are viewing, leading to significant contributions in the field of user-centered or human-centered design [4] - [6].

The success of a design depends on how well the design explains itself to users, and in the context of online courses, users are learners. Learner perceptions and experiences can impact emotions and deepen cognitive processes, which can influence future actions and attitudes [7]. UX research, evaluating a design with real users to uncover problems and understand their impact on the user, is used widely in other disciplines but is not as common in the online learning domain. The rapid transition to fully online teaching and learning offered a unique opportunity to study course design and user experience of the online environment. Our research team seized this occasion to investigate the impact of instructional and user experience design in online lab experimentation on learner experience.

In this work-in-progress paper, we apply user experience research in the area of online laboratory exercises in the context of electrical and computer science instruction. Broadly speaking, online laboratory experiments cover all instructional laboratory exercises that make use of online technology for the delivery of the experimentation experience to the user [8] - [9]. This experience may be based on remote laboratory equipment to be used over distance, augmented reality technology complementing the physical equipment, or virtual reality technology or simulations offering a fully virtual experimentation experience. In the case of our study, we refer to the remote laboratory, LabsLand VISIR, in electrical and computer science instruction [10] - [11]. That means that the students can study electrical circuits by carrying out building tasks and related experimentation activities online over distance from wherever it may be but still using physically existing real equipment. Practically seen, this has advantages in terms of the students' flexibility and the experimentation results themselves. In context with electrical equipment, pure simulations often lack aspects of reality such as unwanted noise in the electrical signal measurements.

3. Study design

The thrust of this work is to discover how students interact with online lab tools and what pain points and success factors can be discovered through surveys and observations via moderated user panels with undergraduate students from ECSE 2170 Fundamentals of Circuit Analysis, an introductory electrical engineering course. Using a mixed methods approach allows us to identify if there are usability issues and remote moderated user panels affords us the opportunity to observe how and why students experience challenges or successes.

For this paper, we focus specifically on the remote laboratory platform LabsLand VISIR [12]. Several faculty members had been working with the VISIR technology prior to the impact of COVID-19 [13] – [14] and students have access to the remote laboratory using their university issued credentials allowing us to build upon existing structures.

The VISIR online platform emulates a workbench equipped with online versions of familiar instruments, such as a virtual breadboard, multimeter, and basic electronic components (see Fig. 1 and YouTube video). This representation aims to reproduce tactile learning by mirroring the required operating functions, such as moving components and rotating instrument knobs. It is important to note that this is not a simulation but a remote access laboratory where students manipulate physical circuit elements and take actual electrical measurements.

Quantitative data was gathered through surveys beginning in the summer semester of 2020. To collect data on the usability of the VISIR remote laboratory environment, we used the User Experience Questionnaire (UEQ) survey [15], collected through links embedded on the online lab assignment drop boxes and using the Course Announcements tool. Developed by Laugwitz, Schrepp, and Held, the UEQ measures users' perspectives on the usability of a system using six scales containing 26 items (attractiveness, perspicuity, efficiency, dependability, simulation, novelty) with Cronbach alpha levels above 0.6 for all factors [16] - [17].

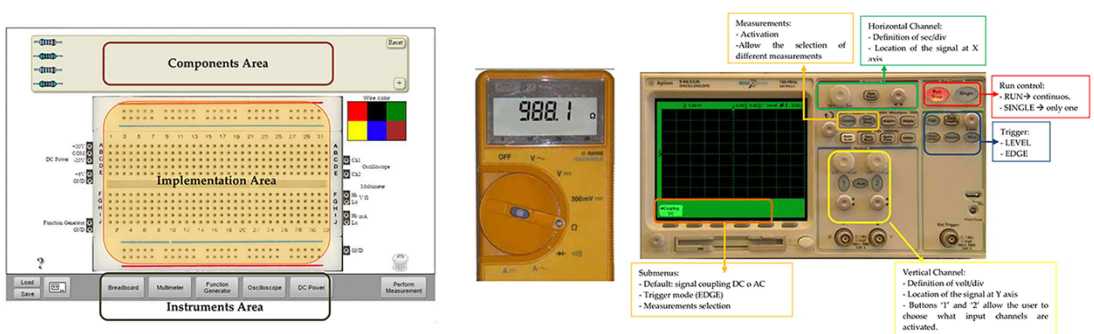


Fig. 1. VISIR web interface with the breadboard, digital multimeter, and oscilloscope

In addition to UEQ results, we also wanted an environment where we could observe students use of the tools to identify where they were successful and where they became frustrated. With the data points, we could assess where the most significant pain points lie and adjust for those findings. A remote moderated user experience test was developed and piloted to observe how students completed tasks in the online interface.

Qualitative data, gathered through user observation via a moderated remote user panel capturing screen recordings and think-aloud narration, was collected for at least one lab module on Ohm's Law using the VISIR remote lab platform [18] - [20]. Students met with a moderator online and were given tasks to complete using the VISIR remote lab. The students were asked to think out loud as they worked through the tasks, and the moderator asked questions to elicit more information as needed. The moderator used a script to guide the sessions to provide a systematic approach and reduce the influence of bias. These panels were screen recorded and analyzed for emerging trends.

The combination of these methods allows us to use UX benchmarking to guide an iterative redesign process as the quantitative data from the UEQ identifies if there are usability issues and the qualitative data from the observational research using moderated user panels help identify what challenges are creating the usability issues. Revisions and changes can be made based on the information gained from both the surveys and observations and then evaluated to see if there is improvement in usability and user experience. The research activities and initial results from Summer 2020 through Fall 2021 will be discussed here.

4. Results

The number of UEQ responses are fairly low and too low for a detailed quantitative analysis of the results. As shown in Table I, the largest number of survey responses was from the summer of 2020, with numbers falling off each semester and no survey participants in the summer of 2021. Pandemic uncertainty and fatigue from completing things online may have contributed to students lack of participation. As the numbers decreased, we attempted to recruit participants via email, course announcements, and faculty reminders. Recruiting in face-to-face classrooms and increasing the incentive amount might help increase participation as moving forward. Nonetheless, some trends have emerged that are worth noting.

TABLE I
Number of UEQ Participants per Semester

Semester	**Number of UEQ Responses**
Summer 2020	23
Fall 2020	7
Spring 2021	9
Summer 2021	0
Fall 2021	7
	Total: 46

Students reported that the initial learning curve for the online labs required different resources than what was provided (mainly in the form of a pdf user manual), and students commented they needed more time to learn the lab interface. All students expressed a sense of confusion over how to operate the various functions of the labs. The lack of intuitive, responsive error messages was an obstacle to student engagement within the labs and created frustration that there was no process to ask for immediate help. Students commented that they missed the presence of a professor to act as a coach or mentor for the assignments. The lack of just-in-time support and quick access to a professor stem from the online classes being fully asynchronous at that time. However, there was a degree of satisfaction with the labs themselves, and students appreciated the opportunity to complete the lab experiments in an environment where they would not damage equipment. Students welcomed the ability to complete the activities in an intimate setting over a face-to-face class environment, which made them feel more comfortable making mistakes.

4.1 UEQ survey results

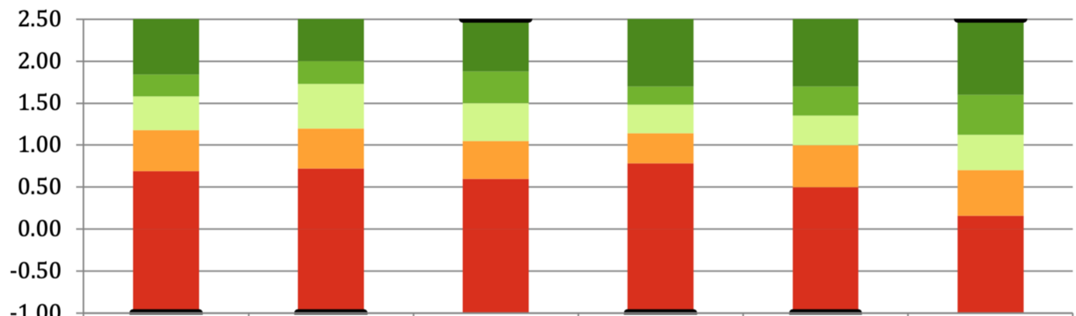
The User Experience Questionnaire [15] measures how students feel about the online labs based on six scales with 26 items. The goal is not just to measure satisfaction with the design of the online labs but also to measure how comfortable students felt with the function and overall user experience. Students need to feel a measure of control over the environment in order to move through the learning effectively and feeling a lack of ability to influence the environment can lead to lower student engagement. The survey considered six areas of overall engagement:

1. Attractiveness: Overall impression of the product. Do users like or dislike the product?
2. Perspicuity: Is it easy to get familiar with the product? Is it easy to learn how to use the product?
3. Efficiency: Can users solve their tasks without unnecessary effort? Does it react fast?
4. Dependability: Does the user feel in control of the interaction? Is it secure and predictable?
5. Stimulation: Is it exciting and motivating to use the product? Is it fun to use?
6. Novelty: Is the product innovative and creative? Does the product catch the interest of users?

The User Experience Questionnaire (UEQ) questions can be found in Appendix A.

For the purpose of this paper, we are focusing on the LabsLand VISIR online lab using the Ohm's Law assignment from ECSE 2170 Fundamentals of Circuit Analysis. It is the first remote lab experience the students encounter in the course. Across the board, students rated the VISIR remote lab usability in the Bad category which is in the range of 25% of the worst results. As evidenced in Fig. 2 of the UEQ results shown below, students consistently rated Perspicuity, meaning how easy it was to learn how to use the remote lab, and Dependability, how in control of the interaction the user feels, the lowest. These results establish a clear baseline and indicate there is much we can do to improve the user experience with and usability of the VISIR online lab platform.

At this point, we want to acknowledge some considerations with regard to the remote lab itself and how the initial results impacted our next steps. As we are only applying the specific remote lab technology, we do not have any way to work on the user interface itself. The results shown in the UEQ graph clearly show much room for improvement. One could stop here and simply say the technology or the user interface are not working the users' experience favor and simply change to other solutions. However, on the one hand the pandemic put many instructors in a situation in which this decision making was not possible. They either used the online technology available or needed to find completely different solutions. On the other hand, we wanted to go beyond the quantitative research approach in our project and wanted to understand the results and how they could be explained. Hence, the fairly negative results in the surveys also served as a motivation for looking deeper into the students' online laboratory experience by applying further qualitative measures.



	Attractiveness	Perspicuity	Efficiency	Dependability	Stimulation	Novelty
Mean	-0.24	-0.42	0.13	-0.09	-0.08	0.04
Excellent	0.66	0.5	0.62	0.8	0.8	0.9
Good	0.26	0.27	0.38	0.22	0.35	0.48
Above Average	0.4	0.53	0.45	0.34	0.35	0.42
Below Average	0.49	0.48	0.45	0.36	0.5	0.54
Bad	0.69	0.72	0.6	0.78	0.5	0.16
Lower Border	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00

Fig. 2. UEQ Benchmark Results for LabsLand VISIR Summer 2020 through Fall 2021

4.2 Moderated user panel results

For the user experience panels we partnered with UserZoom to leverage their platform and make the panel experience seamless for the students. So far, three moderated user experience panels/interviews have been conducted. These results are starting points for the themes that emerged during the interviews, and we will later combine with the findings from the five additional participants' user panels coming in the future. The research objective for the moderated panels was to identify points of friction where users struggle with the online lab using LabsLand VISIR in ECSE 2170 Fundamentals of Circuit Analysis in the Ohm's Law assignment.

The guiding questions used for the panels were:

- What problems or frustrations do students experience?
- How should we prioritize improvements?

The script used to run the panels is featured in Appendix B.

In general, one can observe that the online classes and labs in this study offer flexibility in terms of time but sacrifice quick help and high fidelity. Those sacrifices are noted in student feedback, which pointed out the ways in which the online labs differed from the physical labs students have more experience with. There are two distinct areas where students identified issues relating to the online labs and the way they approached their classes:

- Students appreciate the flexibility of online classes and labs but feel they may be more vulnerable to distractions.
- Students indicated that in-person classes allow for instant access to teachers, teaching assistants, and fellow classmates for help.

One student's quote sums up the difficulty for an online student: "Sometimes it's helpful to have it online, you can access it whenever and wherever you want, but other times having it in person it's nice to have a TA to go to; for online labs I still have access to a TA I can email but it's not as instant." The instant access to feedback was lacking in this online lab, and students specifically mentioned moments when that lack of access led to frustration with learning new and challenging concepts.

5. Discussion

Based on the results displayed above, we were able to identify preliminary research results that are relevant in the context of UX design of the focused remote lab technology. Those results will be discussed in the following and can be separated into four overarching themes and four additional aspects more closely related to the interaction with the system itself during the experimentation activity.

5.1 Overarching themes

Throughout the surveys and experience panels, students reported four issues that specifically worked against their learning in the online lab. First, the students indicated that they needed to use trial and error to learn how to interact with the breadboard. That time needed to experiment with the breadboard gave them the impression of a lack of control of their learning, which negatively affected their experience with the online lab environment. Second, the interface itself cost them time switching between screens to access the tools needed to complete the experiment. One student suggested putting the breadboard and multimeter on one screen for ease of use. Third, students reported that getting help for virtual labs takes more effort and time than in-person labs. The time needed to locate tutorials and information on the web outside of the learning tools took away from the affordances online spaces offer in terms of time efficiency. Students most requested just-in-time resources that they could access while working with the online tools, without the need to exit the lab area to find help. Finally, students were concerned about skill transfer from working with virtual equipment to working with the tools in real life.

The following sections detail the areas where students found particular frustration and where opportunity exists to lessen the frustration for students and increase engagement.

5.2 Opening the lab

The three students in the user experience panel quickly found the Lab 1 Ohm's Law assignment in the learning management system and successfully opened the instructions file. Each reported that the layout made the overall information seem overwhelming. When reading the directions in the assignment, students could find the instructions for exercise 2, but they had to sift through a lot of text to locate them. In addition, students felt the instructions, links, and tools for each exercise could be better partitioned (e.g., have everything pertaining to each exercise be grouped and put additional information/objectives in a separate section). This partitioning would allow them to identify the needed resources quickly before proceeding with the lab.

Another area where students encountered issues within the lab was selecting the correct breadboard to complete the activity. In LabsLand VISIR, students were unsure of which lab to navigate to for the correct breadboard and did not seem to know there were differences between the options.

Students reported that they wanted more outlined instructions that showed how a lesson flowed. As one student said, "Sometimes we have a tendency to see this (the top instructions) as fluff but I don't really have that problem because I've come to expect the links up here. I guess you could partition the instructions for each exercise; ok here's exercise 1, here's the objectives and here's the link to access the lab." Another student reported that the instructions didn't seem to help the overall flow of the lesson: "I'd just glance through. We're doing a series circuit according to our lab instructions. I'd probably choose this because it says Ohm's Law. I think these change what equipment or what devices we have to use, but honestly I would just click on a few of them to see which has the equipment I would need to build the circuit we're trying to build. One thing they could do to fix that would be to say here's Lab 1B or Lab 2B." In both cases, these students were searching for both additional information at particular times and the correct information displayed in a way that led them through the exercise.

5.3 Find and apply instructions

While the need for better instructions existed in opening and accessing the correct remote lab environment, students also reported a need for better availability of instructions throughout the exercise. In this theme, students reported that the lab instructions were confusing and LabsLand VISIR equipment did not match a real-world counterpart. One area that they identified that needed clearer instructions was how figures and voltages were displayed and assessed. They were confused by the instructions about which figure and voltages to use and what reading they would get for a correct circuit. When that confusion occurred, students wondered if their learning was mimicking real-world experience.

Students also reported creating workarounds for the lack of display agility by switching back and forth between the lab instructions and breadboard to build the appropriate circuit; some had both opened in a split-screen for efficiency. While this solution did work at the moment, the students expressed frustration that they needed to develop a workaround in the first place. Just as flipping between the instruction window and breadboard caused frustration, the need to switch between the breadboard and the multimeter was frustrating, and the full multimeter was not displayed (the bottom was cut off).

Within the interface itself, interacting with the breadboard was somewhat challenging with regard to manipulating the wires. Again, students wondered if the virtual experience was equal to the real-world equivalent since the complications seemed more based in the virtual lab itself than the activity. Students felt the digital experience was not the same as the in-person experience, in that extra steps are required for the virtual lab (e.g., "perform measurement”), the breadboard and multimeter were on separate screens, and troubleshooting/asking for help virtually was more difficult.

One student suggested that the interface didn't seem intuitive, often doing the opposite of what is expected: "I guess I would assume it would be this little white button even though I don't know what it is. I would look for the color code chart." Another student expressed frustration with the inability to match instructions to the performance of the LabsLand VISIR equipment itself: "If I were to do this in person, the multimeter would maybe just read 0, and then you could have your instructor come over to help you figure out what you did wrong with your circuit. They (this software) doesn't really give you enough information about what you did wrong; I have no way of knowing what I did wrong because I can't get help."

5.4 Get help

One important stressor/pain point was the need for just-in-time resources to help students work through an exercise, as an instructor or lab assistant would do in a real-world space. When needing help, rather than reading the document provided, a pdf of the lab manual, students would get help via Google and YouTube and/or emailing professors and classmates. Students preferred to troubleshoot an issue themselves, but if they could not fix the issue, they would reach out to classmates/teachers via email or direct message in an attempt to get timely help, though these efforts did not always meet with success when these people were not immediately available. When messages did not meet with success, students mentioned Google and YouTube as possible help resources that they would use. The issue, of course, is that when students are left to find their own resources on the internet, the quality of those resources can be questionable.

Rather than relying on outside sources, students felt having access to help in LabsLand VISIR would be useful (e.g., a bulleted list of potential issues and fixes, an FAQ, or access to instructional/help videos). These resources need to be accessible from within the LabsLand VISIR system itself since students did not know where to look for guidance in the LabsLand VISIR instruction manual and did not make widespread use of it. In addition, help was needed to decode error messages that came up during the lab activities. Students reported error messages in LabsLand VISIR were indecipherable and were not problem and solution focused. Accessing help proved frustrating to the user panel participants, especially not understanding the meaning of the errors they were receiving and how to resolve them. One participant stated, “I think a bullet list of what might be wrong with the circuit might be helpful than just saying this is wrong (a help/troubleshoot/debug function) ... I think some sort of hint function would be useful."

5. Final considerations and future steps

First, we should acknowledge that the sample size for this project was small. Overall, 46 students completed the User Experience Survey, and three students participated in moderated user experience panels. Our goal was to have 40 surveys and 5 UX panels per semester. Students were offered compensation for completing both the surveys and the panels, but the participant count still did not reach our goal. We are still recruiting students for the UX panels to add to the results. Increasing the amount of compensation is being considered in an effort to increase student participation if future work.

While students appreciate the flexibility of online learning, the initial results indicate that more attention should be paid to the design of both courses and lab tools in creating online lab spaces for electrical engineering students. The shift to the online modality for the laboratory workspace generates a steep learning curve in terms of the interface's usability and the challenges presented by understanding error messages and how to access help to resolve them. Early indications suggest that more robust instructions and help resources would enable students to feel in control of their learning while also taking advantage of the flexibility of the online environment.

This initial research points toward the need for more robust practice lab work ahead of the lab assignments and resources to guide students through the additional cognitive load of learning a new system while engaging with new content. Additionally, some redesign work can be done within the learning management system by chunking content and embedded links and providing short, direct, and explicit support materials for users' errors. Adding synchronous sessions with the professor or teaching assistant to provide more immediate support should also be considered. Next steps are to redesign the course based on our findings and complete a second round of data collection to see if the changes impact the usability and UX of the VISIR lab.

The future work in this project from the UI/UX standpoint will synthesize faculty and student perspectives from the other thrusts of this project to imagine ways to lessen the stress for students while also allowing faculty the opportunity to assess and assist their classes. By understanding these perspectives, we hope to develop a process whereby students and faculty alike find the online environment a place of academic success. Online learning will continue to grow in higher education, so the goal of this project–to assess the quality of online electrical engineering labs–will grow in importance as more students and faculty embrace the flexibility of the online space.

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Appendix A

User Experience Questionnaire (English)

Please make your evaluation now.

For the assessment of the product, please fill out the following questionnaire. The questionnaire consists of pairs of contrasting attributes that may apply to the product. The circles between the attributes represent gradations between the opposites. You can express your agreement with the attributes by ticking the circle that most closely reflects your impression.

Example:

attractive	○	⊗	○	○	○	○	○	unattractive

This response would mean that you rate the application as more attractive than unattractive.

Please decide spontaneously. Don't think too long about your decision to make sure that you convey your original impression.

Sometimes you may not be completely sure about your agreement with a particular attribute or you may find that the attribute does not apply completely to the particular product. Nevertheless, please tick a circle in every line.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Please assess the product now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23
attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Appendix B

University of Georgia Online Lab Study Script

[pilot dates: April 26 - May 8
recruit dates: June 7 - 11,
potential run dates: June 14 - 18]

Link to tech check to verify mic/camera/connection: https://sourcing.userzoom.com/participant-flow/self-recruit/5fff34a8741ce002949f872b

Study Objectives

The Electrical Engineering department at the University of Georgia wants to redesign their online lab to be more learner/user centric. They'd like to understand the usability issues that students are facing and the pain points that are getting in the way of them learning the content.

Research Questions

- What problems or frustrations do they experience?
- How should we prioritize improvements?
- Where do they experience problems?
- What can be changed in the set up that UGA has control over? What can be improved and where?
- How can we put the focus on the assignment (Ohm's Law) and not the tech issues?
- How can we present results in such a way that proves this method of teaching is adoptable and will work, particularly for underrepresented populations?
- [future questions] Is this a perception that the tech is a problem? Is tech actually the problem?

*can communicate problems to Lab's Land but not direct impact by UGA

Method

- Moderated

Stimuli

- Lab assignments page

Welcome Message

Hi (participant's name)! My name is (your name), and I'm going to be your researcher for this session. Thank you so much for taking the time to meet with me today and give me your feedback. Today I'm going to have you go through some tasks, and I'd like your help to evaluate how well the site is working for students. Keep in mind that I am not affiliated with your class at the University of Georgia and your anonymity will be maintained, so feel free to speak your mind about what problems you might encounter today. Before we begin, you can take a moment and close any tabs that you don't want open while sharing your screen - because I'll eventually have you share your screen. If you could also silence any notifications too, that would be greatly appreciated.

Good to go? Great!

I'm going to start recording the study and then get started with the study introduction. Is that okay? [Start Recording]

We'll go through some tasks for the website. Talk me through what you're doing and why, and I may have some follow-up questions. It's important to talk out loud as you scroll through items on the page and/or click on things. Let us know what you're thinking and where you're going next. Be especially mindful to note any times where you get frustrated or confused.

There are no right or wrong answers! Please don't hold back.

Any questions?

Initial Questionnaire

1. Is this your first time taking an engineering course?
2. If this isn't their first engineering class: Was the previous course you attended in-person, online, or both?
3. Is your current course in-person, online, or both?

Study Script

First, I'm going to have you log into your account with your UGA username and password.
[Send student the link for the course page:
https://uga.view.usg.edu/d2l/le/content/2252060/Home?itemIdentifier=D2L.LE.Content.ContentObject.ModuleCO-32964811]
And then I'm going to send you a link to request screen share, so you should see that pop up.
[click request screen share].
Great! The course that you are enrolled in for this session is UX Research 2021. You can go ahead and click on that and pretend that this is an Intro Electrical Engineering class.

Now, let's move on to the first task.

Task 1. Opening the Lab (easiest)

Starting URL: Lab Assignments page
Task Instruction: It's the first week of instruction and you're looking to get started on your first lab. You've logged in and now you're ready to start on Lab 1. **Show me how you would get into the online Lab 1 assignment on Ohm's Law.**

Remember to think out loud. Point out anything you find to be **useful, interesting, or confusing**.

Great! Take a few minutes to review this page and let me know your thoughts if anything stands out to you (good or bad) and if anything is confusing.

We're going to focus on Exercise 2. From what you read, how would you get to the site where you can complete Exercise 2 (e.g., where you can see the breadboard)?

Success path: Lab Assignments -> Lab1_Ohm's_Law PDF -> Lab's Land page -> Experiment Ohm and Kirchhoff Laws -> Access -> https://weblab.deusto.es/weblab/labs/Visir%20experiments/visir_html5/?locale=en

Questions:

- Is it obvious which lab you should be going to once on the Labs Land page?
- In what ways did the provided documentation help?
- In what ways could the documentation be improved to make this process easier for you?
- How confident are you that you've found the correct information? (1-Very difficult, 5-Very easy)
- How easy or difficult was it to complete this task? (1-Very difficult, 5-Very easy)
- Please explain your ratings

Task 2a. Find instructions for Ohm's Lab (build 2b - hard)

You're doing great! Let's move onto the next task:

Starting URL: https://ugaLabsLand.com/standalone/groups/agZDTE9D9c7ZZh6-IBdXdrYJWgI1464WNMB8p-T9j28

Task Instruction: It looks like the lab has begun. Let's say you're confused about what the instructions are for Exercise 2 (we're going to focus on prompt b). How would you find the instructions for this task?

Series Circuit

Figure 6 gives a series circuit.

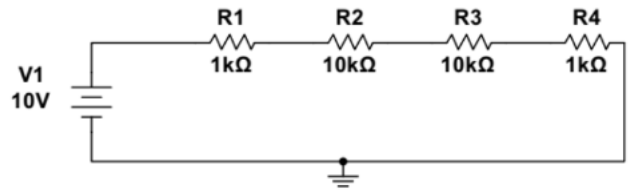

Figure 6: Series Circuit.

(b) Log into your Labsland account. Also, navigate to: `https://labsland.com/docs/experiments/VISIR/labsland_available_circuits_VISIR_en.pdf` to build the circuit shown in Figure 6. Take a screenshot. *Record the answers in your laboratory report.*

- Measure and record the voltage across each resistor.
- Measure and record the current in the loop.
- Calculate the power dissipation at each resistor.

Remember to think out loud. Point out anything you find to be **useful, interesting, or confusing**.

Success path: Return to Lab 1 Ohm's Law tab -> Arrives at https:/uga.view.usg/d2l/le/content/2252060/viewContent/32964823/View

Questions:

- How do you know that you're succeeding or failing the task?
- How confident are you that you've found the correct information?
- How easy or difficult was it to complete this task? (1-Very difficult, 5-Very easy)
- Please explain your rating

Task 2b. Apply what you learned from instructions

Task Instruction: For this task, please read the instructions for Exercise 2b, and show me how you would follow these instructions to complete this task.

Success path: Switch to Labs Land tab → https://weblab.deusto.es/weblab/labs/Visir%20experiments/visir_html5/?locale=en

Questions:
- How confident are you that you're doing the assignment correctly?
- If not confident, why not?
- What would help improve your experience?
- How easy or difficult was it to complete this task? (1-Very difficult, 5-Very easy)

Task 3. Get Help

Task Instruction: Let's say you were struggling to complete this assignment and are at a loss for what to do next. How would you ask for help? Show me where you would go and why.

Remember to think out loud. Point out anything you find to be **useful, interesting, or confusing**.

Success path:

Questions:
- Was the help option where you would expect it to be?
- What are your expectations for help options? Should there be an option on Labs Land? An option on the UGA assignments page?
- How easy or difficult was it to complete this task? (1-Very difficult, 5-Very easy)
- Please explain your rating

Follow up Questions:
- What has your previous experience been like when it comes to engineering labs (or labs in general, if engineering lab NA)
- How does this compare to an in-person experience? What's similar? What is different?

Alright, well that concludes today's session. Is there anything else you would like to share with me about your experience today?

Do you have any questions for me?

Well, thank you so much for taking the time to share your feedback with me today, and I can let you go. If you have any questions about the session or how you will get compensated, please feel free to reach out to (name) who scheduled this meeting.

Thank you and have a great day!