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Using Brightspace to Create Multi-Format Lab Manuals to Enhance Student Performance

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I. INTRODUCTION

Hands-on practices are crucial for every engineering technology student as they not only aid in comprehending classroom material but also provide practical applications of theoretical concepts, thereby fostering students' interest in their college education. Interest is a key motivator for student engagement [1] . However, some hands-on practices may discourage students, especially when gaps between fundamental theorems and new technologies on the market have been widening. Some basic theorems are difficult to be verified by using complex high-tech devices or may be too complicated to employ effectively. Students may require significant time to learn how to use these devices and may even waste time if immediate assistance is unavailable. Some students may give up if they face with excessive difficulties. Some old or out-date lab devices are easily used to support basic theorem, but they are rarely encountered outside the laboratory setting. It is easy to create illusions for students that hands-on practices in college will not be relevant in future real work, potentially leading to loss of interest or decreased attention to hands-on practices. As an integral part of professional trainings, hands-on practice with any weakness in college can limit not only students' education performance but also their future work abilities. According to the author's observation, there has been a significant change in student study habits nowadays, especially after the pandemic. While advanced technologies have been employed to aid students in education, they also present challenges. This work aims to enhance students' hands-on work in engineering technology field by utilizing new education platform, such as Brightspace, to accommodate different learning styles. An ideal of using the Quiz tool of Brightspace to create web-based multi-format lab manuals, which include general instructions with still picture, short demonstration videos, and quick questions, is introduced. It improved students' hands-on performance based on their feedback.

The paper is organized into the following sections: Section II discusses some challenges in guiding students in their hands-on work. Section III presents an example of using Brightspace to create web-based multi-format lab manuals, accompanies by a brief discussion. The conclusion is provided in section IV.

II. CHALLENGES IN GUIDING STUDENTS IN THEIR HANDS-ON WORK

As mentioned in previous section, hands-on work is an integral part of both college education and professional training. Although hands-on work can be incorporated into teaching, laboratories remain the predominant method for practical learning [2] . Consequently, most engineering courses are delivered through lectures supplemented by lab sections. Typically, students are provided with a lab manual to guide them through specific tasks relevant to the lecture topics. Lab manuals come in various formats; some publishers offer hardcopy manuals alongside textbooks. While these manuals are user-friendly and directly linked to the course material, they may present drawbacks. For instance, the equipment specified in the manual may not match the available resources in a real laboratory setting. Oscilloscopes, for example, may vary across campuses or even within the same campus. Consequently, instructors often customize lab manuals from publishers to suit their specific lab setups, resulting in customized manuals available in both hardcopies and electronic formats.

Customized lab manuals offer the advantage of easy updates and a close alignment with lecture content, making them increasingly popular. However, they also have limitations. Additionally, the file size of lab manuals can be an issue. Manuals usually cover only the hands-on work relevant to the current topic, potentially overlooking essential skills learned in previous labs or prerequisites. Although it's expected that students remember previously acquired knowledge, this assumption doesn't always hold true. Juniors or seniors may require assistance with skills learned in freshman or sophomore years. While instructors can provide additional resources like web links or appendices, it's challenging to incorporate old material into new manuals.

The widespread adoption of electronic books on campuses, exacerbated by the pandemic, has introduced new challenges. Many students now neglect reading textbooks and lab manuals, opting instead for instructor-provided notes. Studies suggest that reliance on e-books may negatively impact student performance [3] . Furthermore, preferences for textual versus visual instructions vary among students. While some benefit from detailed textual explanations, others prefer visual demonstrations. Demonstrative labs [4] , though effective, consume more time, especially in large groups. While posting demonstration videos online has received positive feedback, some students find them time-consuming and struggle to navigate them effectively when encountering problems.

Traditional lab manuals offer clear, concise instructions but demand meticulous reading and understanding. Visual instructions, on the other hand, provide efficient learning through simultaneous audio-visual cues [5] , though they can be challenging to navigate for specific topics within lengthy videos. The paper proposes a solution that combines both methods to create a multi-format lab manual within Brightspace, as detailed in the following section.

III. CREATE MULTI-FORMAT LAB MANUALS USING WEBSITE

Advantages of online learning platforms, such as Brightspace, make them widely used in colleges and K-12 education, especially during and after the pandemic. They provide a flexible learning environment for students with different learning styles. This paper leverages the advantages of Brightspace and utilizes its quiz tools to create a web-based multi-format lab manual.

The concept of the web-based multi-format lab manual involves using web pages to guide students in performing hands-on work through both reading and visual instructions. Each lab is carefully designed so that each step covers only one small topic or one specific hands-on task. Each step is presented as a quiz question, beginning with the process goal followed by a short video demonstrating the hands-on work. Detailed instructions follow the video, and additional visual aids such as pictures and hyperlinks may also be included. Students are required to answer each question in response to completing the related hands-on work in order to progress. Fig. 1 illustrates an example of the multi-format lab manual.

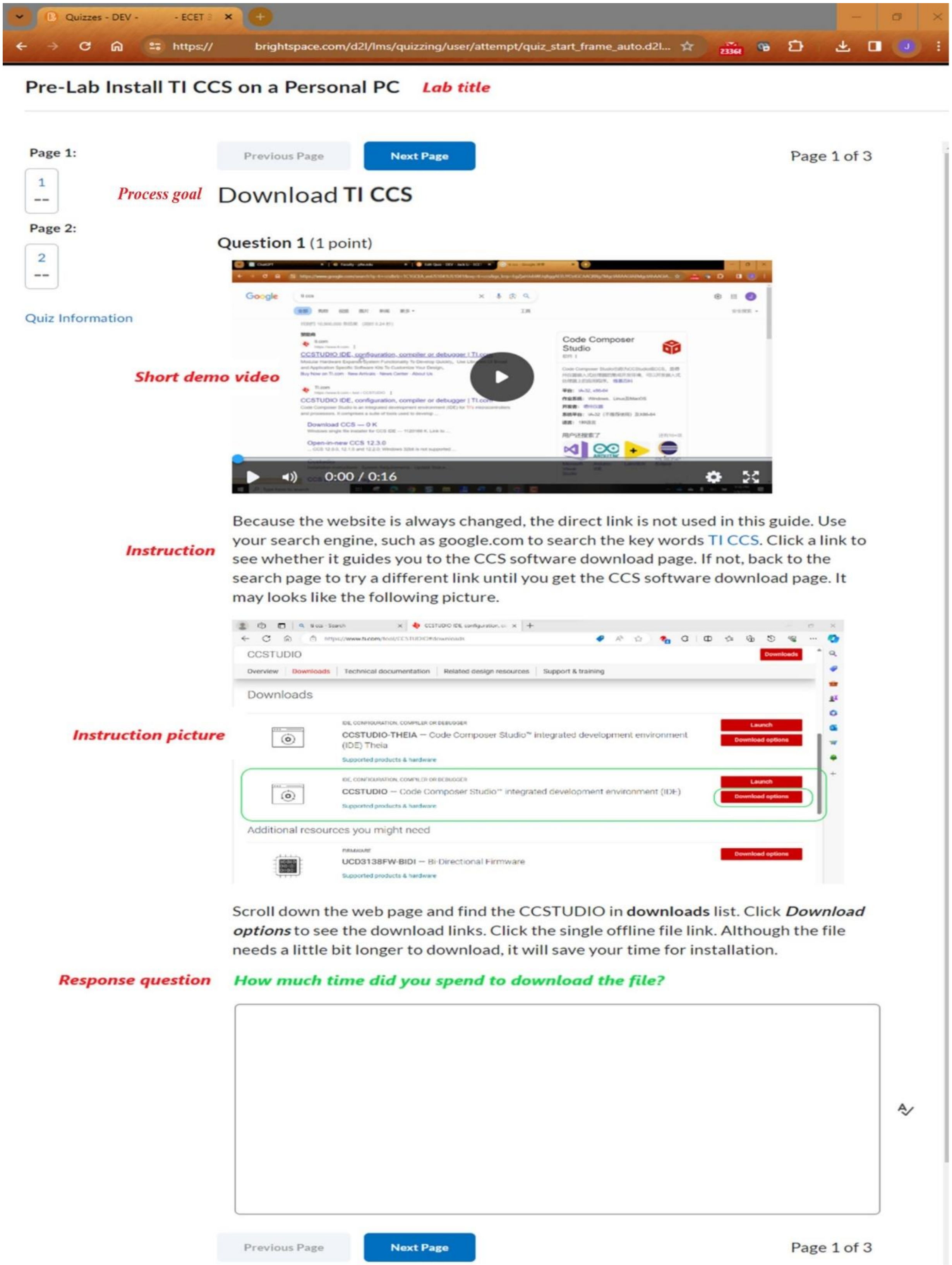

Fig. 1 A sample of web-based multi-format lab manual

There is a pre-lab session designed to help students install and set up the TI CCS software on their personal PCs before utilizing it in the subsequent labs. The first step guides students through downloading the appropriate software package, as illustrated in Fig. 1.

As shown in Fig. 1, there is a process goal for every step, and all process goals collectively provide general guidance to complete the entire lab process. Each process goal summarizes the main purpose of its corresponding step, such as the first step, which is to download TI's CCS installation package from the website, as illustrated in Fig. 1. Some students may rely on their experiences or previous lab practices to complete the hands-on work without reading the detailed instructions or watching the demonstration videos. These goals also aid students in self-evaluation after completing the lab. In classes, students are encouraged to redo the lab after completing the required tasks. During the redo, they are advised to complete it without relying on detailed instructions. Encountering any problems suggests that they may still need practice to remember the entire lab process. At this juncture, they can refer to these goals to determine their next steps. If they are unsure how to achieve a step goal, it indicates they need to practice that specific step and can refer to the demonstration video or detailed instructions until they can perform it independently.

The demonstration video shows how the instructor finishes hands-on work in a particular step, which is an efficient way to guide students in completing hands-on work because it delivers information using both visual and oral methods simultaneously. This reduces the time required for users to process information and provides more comprehensive guidance compared to relying solely on text in a manual. Additionally, it serves as an effective tool for helping students review what they have learned. Most of the time, students can quickly recall previous procedures when encountering similar tasks. For example, when they hear "Let's measure the voltage dropped across the resistor," the video demonstrates how to connect a voltmeter to the resistor in a real circuit. During these few seconds, the video shows the physical location of the resistor in the circuit and its connection to the meter. If a student already knows how to measure voltage in the real circuit, the instruction in video just acts as a reminder. However, for students who have forgotten or are unsure of the process, the video provides detailed guidance.

Handling hands-on work can be challenging for instructors, particularly in programs like a "2+2" joint program where students have varying educational backgrounds. Certain topics may be easier for some students but more difficult for others. Literal instructions, while potentially time-consuming for students already familiar with those procedures, are indispensable resources for those needing additional support. In contrast, demonstration videos provide a balanced solution to these conflicts.

The traditional literal instructions provide good guidance in hands-on work, although they can be time-consuming. In a short video, it is easy to miss some key points, such as failing to focus on a specific area in a picture. Although the video can be rewound to a specific point, pinpointing the exact moment may be difficult. Literal instructions compensate for this disadvantage. If students miss something in the short video, they can quickly scan the instructions and attempt to solve their problems. Students can take their time to read, think, and follow the process outlined in the literal instructions, which provides them with enough time and opportunity to comprehend the material. Compared to video, where all relevant information is presented visually, literal instructions prevent students from forgetting or missing any steps because all the necessary information is clearly listed. Furthermore, literal instructions are very helpful in providing detailed information. For example, it is challenging to capture computer code in a video, whereas the code can be presented in plain text in the instruction area or in a still picture with detailed explanations. Additionally, literal instructions provide a convenient way to keep hardcopy notes and are easy to link with different resources using web-based links.

Question	Average Grade	Standard Deviation	Discrimination Index	Point Biserial
Question 1	92.31 %	26.65 %	33.33 %	0.52
Question 2	61.54 %	48.65 %	0.00 %	-0.10
Question 3	92.31 %	26.65 %	-33.33 %	-0.28
Question 4	92.31 %	26.65 %	33.33 %	n/a
Question 5	84.62 %	36.08 %	33.33 %	n/a
Question 6	84.62 %	36.08 %	33.33 %	0.48
Question 7	38.46 %	48.65 %	33.33 %	0.10
Question 8	100 %	0.00 %	0.00 %	n/a
Question 9	92.31 %	26.65 %	0.00 %	0.12
Question 10	92.31 %	26.65 %	33.33 %	n/a

Fig. 2

A response question is utilized to assess student performance and ensure that they have completed the necessary steps. It can serve as a checklist or a practice question related to what they have learned in the step. Some students may focus solely on the hands-on part and overlook the explanation. However, the purpose of a laboratory is to help students understand lecture material. The response questions serve as effective links that connect the entire lab experience and bridge the gap between hands-on work and lectures. Furthermore, most online learning frameworks provide evaluation tools. Fig. 2 shows the statistic results of response questions of one lab in Brightspace. Response questions can also help instructors evaluate students' performance quickly. They make it easier to identify which steps may be difficult for most students, such as question 7 in Fig. 2, so instructors can address these problems promptly.

The method was studied in one student group enrolled in a digital signal processing (DSP) class, a senior-level course. Among the students, 20% had transferred from other programs after their sophomore year. The labs utilized a TI DSP microprocessor. In previous groups, one of the most significant challenges for students in the labs was familiarizing themselves with the new software package when only literal instructions were provided in lab manuals. Issues related to computer skills, such as toolchain setup, persisted across several labs, delaying student proficiency. After the first two labs, only about 45% of students could complete their labs independently. The instructor spent a significant amount of lab time assisting students with software-related challenges, thereby reducing the time available for DSP practice. Following the implementation of the multi-format lab manual, students were better equipped to address problems independently using the provided short videos. Compared to previous groups, 75% of students reported no difficulty using the software after the initial labs. Many software-related issues could be resolved using reference links and short videos. Students expressed appreciation for the short videos as a valuable supplement to literal instructions. The new format lab manual afforded students more time to engage in hands-on DSP practice. These results also indicate that the method assists students transitioning from other programs in becoming familiar with new lab setups.

IV. CONCLUSION

This paper explores the use of the quiz tool within an online learning framework to create a multi-format lab manual aimed at enhancing students' hands-on performance. Short videos, literal instructions accompanied by images, and various types of response questions are incorporated to accommodate different learning styles. The quiz tool facilitates rapid evaluation of student performance, enabling instructors to work with students more efficiently. The method was implemented in one group and evaluated based on students' feedback, demonstrating its efficacy in both regular lab classes and self-learning sessions. Future plans include implementing the method in different courses to further evaluate its effectiveness.

REFERENCES

[1] M. Ainley, "Connecting with Learning: Motivation, Affect and Cognition in Interest Processes." Educational psychology review 18.4 (2006): 391–405. Web.

[2] A. Elkhatatt, S. Al-Muhtaseb, "Hybrid online-flipped learning pedagogy for teaching laboratory courses to mitigate the pandemic COVID-19 confinement and enable effective sustainable delivery: investigation of attaining course learning outcome. https://link.springer.com/article/10.1007/s43545-021-00117-6

[3] J. MacArthur, "A groundbreaking study shows kids learn better on paper, not screens. Now what?". https://amp.theguardian.com/lifeandstyle/2024/jan/17/kids-reading-better-paper-vs-screen

[4] E. McKee, V. Williamson, L. Ruebush, "Effects of a Demonstration Laboratory on Student Learning." Journal of Science Education and Technology, 2007. Springer. DOI 10.1007/s10956-007-9064-4

[5] E. Bobek, B. Tversky, "Creating visual explanations improves learning." Cognitive research: principles and implications vol. 1,1 (2016): 27. doi:10.1186/s41235-016-0031-6