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## Message from the Editor-in-Chief

**Dear Colleagues,**

The Online Journal of New Horizon in Education (TOJNED) welcomes you. TOJNED also thanks all researchers, practitioners, administrators, educators, teachers, parents, and students from all around the world for visiting the volume 10 and issue 3. TOJNED has diffused successfully innovation on new development in education science around the World.

TOJNED is a quarterly journal (January, April, July and October). This online periodical is devoted to the issues and applications of education. Reviewed by leaders in the field, this publication is designed to provide a multi-disciplinary forum to present and discuss all aspects of education.

TOJNED provides new development in education forum and focal point for readers to share and exchange their experiences and knowledge each other to create better research experiences on education. The main purpose of this sharing and exchange should result in the growth of ideas and practical solutions that can contribute toward the improvement of education.

TOJNED records its appreciation of the voluntary work by the following persons, who have acted as reviewers for one or more submissions to TOJNED for v10 i4. The reviewers of this issue are drawn quite widely from education field. Reviewers' interests and experiences match with the reviewed articles.

I am always honored to be the editor-in-chief of TOJNED. Many persons gave their valuable contributions for this issue. I would like to thank the editorial board of this issue.

TOJNED invites you article contributions. Submitted articles should be about all aspects of education science. The articles should also discuss the perspectives of students, teachers, school administrators and communities. The articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to TOJNED.

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## EFFECTIVE STRATEGIES FOR INCREASING STUDENT-TO-INSTRUCTOR INTERACTION IN AN ONLINE COURSE

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### ABSTRACT

Student-to-instructor interaction is crucial in online education. Through this interaction, the instructors guide students on contents and create a learning environment that allows students to communicate between themselves. The student-to-instructor interaction is one of the factors that determine student participation and satisfaction. Thus, this study uses a systematic review to discuss the strategies that instructors can use to increase student-to-instructor interaction in online courses. This study highlights four strategies, including the instructor's participation in online courses, the feedback from an online instructor, the availability of an online instructor and timely response, and pre- and during class communications in online courses. The online instructors and instructional designers may use these strategies to improve interaction with the students. These strategies may also assist instructional designers and instructors who develop and teach hybrid or blended courses.

**Keywords:** student-to-instructor, online course, instructor participation, instructor feedback, instructor availability, and class communication

### INTRODUCTION

The main difference between traditional and online learning is that the instructions and learning take place in a virtual environment in online learning as opposed to physical classrooms in traditional learning. Due to the virtual learning environment in online education, there are concerns that online learning may not provide a similar learning experience and quality of education as traditional learning. Allen, Seaman, Poulin, and Straut (2016) surveyed the academic leaders of the higher institutions in the United States based on the enrolment of fall 2014. Among the academic leaders at some institutions with at least 10,000 distance students, 41.7% reported that the quality of online education was superior to face-to-face instruction versus 42.3% who agreed that the quality is the same in both online and face-to-face. In contrast, 16% pointed out that the quality of online education is inferior to face-to-face. The responses of the academic leaders at the institutions that did not offer distance courses were different, with 51% reported that the quality of online education is inferior to face-to-face.

Instructors play a significant role in both traditional and online learning. Teachers determine the content and pedagogical strategies for the students to interact and different ways to communicate with the students. Student-to-instructor interaction in online courses creates an opportunity for other interactions, such as student-to-content and student-to-student. Due to the flexibility of online education, including working remotely and an opportunity for universities and colleges to attract students to increase enrolment, a number of online courses are growing every year (Mucundanyi, 2019). As a result, instructors may be pressured to teach online by converting their traditional courses into online courses. Changing a traditional course into an online course without clear preparation in teaching online affects the quality of the course. Thus, online instructors should be well prepared to teach in the virtual learning environment.

Even though online courses face the criticism of the quality of teaching and student participation, online courses with committed instructors provide a learning experience of traditional classrooms. The online instructors use the pedagogical and technology tools to communicate, interact, and engage students to meet the learning objectives and complete the courses. Online courses with clear communications involve students in learning through proper guidance. However, the lack of clear guidance disconnects students from learning and may cause students to drop online courses. Thus, online instructors must design courses by incorporating interaction strategies that encourage students to communicate with the instructors and engage with their classmates and content.

### STUDENT-TO-INSTRUCTOR INTERACTIONS IN ONLINE LEARNING

Online instructors rely on the Learning Management Systems (LMSs) to create a virtual learning environment that allows students to interact among themselves, communicate with the instructors, and reach the learning objectives. These LMSs have embedded tools that facilitate synchronous and asynchronous communications between instructors and students. Instructors must always design courses with students in mind and create



online courses that engage students (Jackson, 2019). Communications of online instructors and students before and during the online courses strengthen the student-to-instructor interactions.

It is a good practice to assume that there are new students to online education. Besides, students need time to understand the course requirements and expectations. In addition, students are required to have the required textbooks before or on the first day of class. Thus, it is always essential to send emails or announcements to the students before classes start and communicate the general objectives of courses and create an opportunity for students to ask questions, including textbooks and dates of publishing the courses. Starting the communications earlier makes students feel comfortable and becomes easier to introduce the course. After publishing courses, students navigate online courses to see the content and classmates. Creating a video on course navigation helps students to understand the course design and requirements. The course navigation video prevents students from spending time familiarizing themselves with the navigation and allows them to reserve more time on content and completing assignments. Online instructors must be consistent in communicating with the students through weekly announcements by providing updates on the courses and reminding the students to complete assignments.

The participation of instructors in an online course is key to student learning and satisfaction. An online instructor participates in a course in multiple ways, including providing instructions on assignments and assessments. It is essential to provide a detailed grading rubric for the students to know ahead the requirements and criteria for grading the assignments. Moreover, the online instructors interact with the students in the discussion boards. The presence of an instructor in an online course is crucial to student participation (Hoey, 2017). When students know that the instructors are participating in the discussions, they follow the assignment guidelines carefully and check their posts to make sure that they respect the standards of the assignments. In addition, online instructors enforce the netiquette rules to create a learning environment for all students to provide ideas in a very respected environment, including the posts of students and comments in the discussion boards (Woodley, Mucundanyi, & Lockard, 2017).

Online instructors also interact with the students in providing clear feedback. This feedback helps the students to understand and see their progress in the course. The clear feedback shows the students what to improve and also guides them to determine the support they need from instructors and classmates (Ward et al., 2019). Through this feedback, students develop strategies for upcoming assignments. In addition, the instructors use the feedback to direct the students to the resources in the course. Finally, online students expect a timely response from the instructors. Online students need to feel that instructors are present to give feedback on time and respond to their questions. The online instructors must specify the response time for emails and the timeline to grade the assignment. Online instructors also should check emails regularly and respond to the students' questions within 24 hours, however, the response time between 24 and 48 hours is more reasonable. Moreover, office hours for the students is an opportunity for the student to ask questions.

As online education continues to grow, it is crucial for the researchers interested in improving online education to examine the strategies of student-to-instructor interaction. Instructors are the center of online education, and the strategies they use to communicate and engage the students motivate and encourage students to feel comfortable, valued, and focus on the learning. Hence, this study uses a systematic review to analyze the strategies of student-to-instructor interaction for the last five years. The following research question guides this systematic review, what strategies can online instructors use to increase student-to-instructor interactions?

## **METHODS**

The author has experience of more than four years in teaching undergraduate and graduate online courses. In addition, the author has more than four years of working as an instructional designer for undergraduate, master, and doctoral courses. Therefore, the author used his experience and existing literature review to conduct a systematic review of peer-reviewed articles published on student and instructor interactions in online courses. The author utilized the digital library of a public research university in the southwestern United States and limited the search on three electronic databases, Academic Search Complete, Education Research Complete, and Education Resources Information Center (ERIC).

The initial search with a combination of keywords, 'student and instructor interactions', yielded 1849 resources. Then the author used the 'AND' option and added another combination of keywords 'online course' to narrow the search and focus on the topic; the new search generated 550 resources. The author was interested in examining the recent strategies on student and instructor interactions and limited the search on the articles published between 2016 and 2020; the new search yielded 152 resources. Besides, the author selected 'full-text and Scholarly (Peer Reviewed Journals)', the new search provided 56 peer-reviewed articles. When the 'exact

duplicates' were removed, the last search produced 37 peer-reviewed articles. Thus, the author downloaded all 37 peer-review articles and read the articles to select the articles that fulfill the inclusion criteria, namely student and instructor interactions, online courses, and postsecondary education'. It is vital to highlight that this study excluded the articles with the studies on blended or hybrid learning, K-12 education, and Massive Open Online Course (MOOC). Therefore, the final list of this systematic review consisted of the following eleven peer-reviewed articles:

Çardak (2016)  
 Gray and DiLoreto (2016)  
 Hicks, Gray, and Bond (2019)  
 Hoey (2017)  
 Jackson (2019)  
 Kuo and Belland (2016)  
 Parks-Stamm, Zafonte, and Palenque (2017)  
 Rios, Elliott, and Mandernach (2018)  
 Selvaggi (2016)  
 Thompson, Ballenger, and Templeton (2018)  
 Ward, Ward, Lester, and Tao (2019)

## RESULTS

The author read the eleven articles and identified the themes in each article. Then the author organized the themes using MAXQDA. After the analysis, the author ranked the occurrence of all themes and selected the four themes with the most occurrences.

### **Instructor's participation in an online course**

The instructor's participation enhanced the communication between online students and instructors and occurred in seven articles (Çardak, 2016; Gray & DiLoreto, 2016; Hoey, 2017; Kuo, & Belland, 2016; Parks-Stamm et al., 2017; Rios et al., 2018; Selvaggi, 2016). Online instructors participate in a course by providing instructional guidance in a course (Çardak, 2016; Hoey, 2017; Jackson, 2019; Kuo, & Belland, 2016). The instructional guidance does not only motivate and encourage students to engage in the content, but it also improves the student perception of learning (Hoey, 2017). Thus, clear instructional guidance shifts the center of learning from an instructor to the students. The instructional guidance can be in different formats, such as audio, video, and text post.

Another way for the instructor to interact with the students is to participate in the discussion boards (Gray & DiLoreto, 2016; Rios et al., 2018; Selvaggi, 2016). The online instructors use discussion boards to create a virtual environment that allows students to interact. The main purpose of an instructor's participation is to guide students on content and motivate them to interact between themselves. The instructors must always be a member in the discussion boards (Gray & DiLoreto, 2016). However, it essential for the online instructors not to lead the discussions as the students tend to reply to the posts of their instructors instead of focusing on the posts of their classmates. Equally important, online instructors could not correct the students who did not respect the guidelines of the assignments in the discussion boards. According to Hoey (2017), "it may be more beneficial to reserve critical evaluation and redirection for feedback directly with the student, not in the public venue of a discussion forum" (Hoey, 2017, p. 14). The online instructors provide individual feedback on the discussion boards using other communication tools, such as email or requesting a student to meet with the instructor during office house. Even though the instructor participation is crucial to student learning, Parks-Stamm et al. (2017) examined the effect of instructor participation on student participation and found that the instructor participation was only effective in small classes with the students lesser than fifteen.

### **Feedback from an online instructor**

This theme emerged from six articles (Çardak, 2016; Rios et al., 2018; Hicks et al., 2019; Jackson, 2019; Thompson et al., 2018; Ward et al., 2019). The feedback from an instructor appeared in different forms. The assignment was an excellent opportunity for online instructors to provide individual or group feedback based on the type of assignment (Thompson et al., 2018; Ward et al., 2019). Although the feedback on the group assignment is addressed to the members of the group, this feedback also contributes to individual growth and deepens learning. According to Ward et al. (2019), in providing feedback to online students, the instructors must be clear as possible.

### **Availability of an online instructor and timely response**

The theme appeared in four articles (Hicks et al., 2019; Rios et al., 2018; Selvaggi, 2016; Thompson et al., 2018). One of the main challenges of online education is the lack of physical interaction between students and instructors, which is the center of the traditional classroom. However, online instructors create a virtual learning environment that ensures that the instructors are available to support and guide the students to reach the learning objectives of the courses and have the experience similar to the traditional classroom. Therefore, online instructors rely on different tools to increase the interaction between students and themselves, including emails, phone calls, and office hours (Rios et al., 2018; Selvaggi, 2016; Thompson et al., 2018). An email is an essential tool in teaching online, and LMSs may have an embedded email communication system that allows the instructors to receive the emails per class. The instructors could encourage the students to use the email system available in the LMS for efficient communications. The online instructors committed to teaching online check their emails daily and determine the timeline to respond to the emails and commit to the timeline (Selvaggi, 2016; Thompson et al., 2018). Rios et al. (2018) recommended to online instructors to “respond to students’ questions or phone calls within 24 hours” (p. 4).

### **Pre- and during class communications**

This theme emerged from two articles (Hicks, 2019; Rios et al., 2018). The online instructors could communicate with the students before the beginning of the course. Unlike the traditional classrooms where students access the bookstores on and around campus, the online students live in different geographical areas and order the books ahead of time. Hence, online students need to know the instructors and have the required textbooks on time. Besides, the interaction between the online instructors and students before the start of class answers the preliminary questions of the students and makes it more comfortable for both the students and instructors to continue engaging in the communications during the courses. After classes start, online instructors have different ways of communicating with students through emails and announcements (Hicks, 2019). The announcements focus on various issues, such as changes in the syllabus and content, grade postings, and reminders.

## **DISCUSSIONS**

In responding to the research question of identifying student-to-instructor interaction strategies, this study revealed four strategies. First, the instructor’s participation in an online course increases the interaction of students with the instructors. Instructional guidance from instructors explains to students what they are expected to do (Çardak, 2016; Hoey, 2017; Jackson, 2019). Providing clear instructions helps students to spend time on content and working on the assignments. Moreover, the instructor’s presence in the discussion boards engages students to participate. As students may only focus on responding to the instructors’ posts, the instructions on commenting to posts in the discussion boards can include a minimum number of posts between students. This finding is consistent with other studies that emphasized on improving the instructor’s participation in online courses (Woodley et al., 2017; Mucundanyi, 2019).

Second, the feedback from an online instructor helps the students to understand the courses’ requirements and expectations. The instructor’s feedback on assignments is crucial to student learning and progress. Although students are curious to know the grades of the previous assignments, the instructor’s feedback also helps the students to self-assess and improve in the remaining assignments. Assignments also create an opportunity for the instructors to see the level of the students and provide the support needed (Hicks et al., 2019; Thompson et al., 2018). Jackson (2019) recommended using the Frequently Asked Questions (FAQ) to address the general questions of the students and provide a learning resource that students can refer to for the whole semester. Therefore, clear feedback contributes to student understanding of the content and course expectations.

Third, the availability of an online instructor and timely response allows students to feel the presence of instructors and create a learning environment where the instructors respond to student questions and guide them through the learning process. Online instructors are available to students when they respond to student questions on time and reserve office hours to meet with students (Hicks et al., 2019; Selvaggi, 2016). Even though this study supports the response time to be within 24 hours (Rios et al., 2018), the online instructors need to select the response time they can respect, but not beyond 48 hours without responding to students.

Finally, pre- and during class communications in online courses inform the students what to do and to pay attention to the specific requirements of the course. Instructors committed to online education communicate to students for a quick introduction and information related to textbooks before starting the course. These instructors also allow students to ask questions related to the class. Preannouncement is a valuable tool to prepare the students to be a participating member in a course (Hicks, 2019; Rios et al., 2018). During the course,

instructors continue to build on the preannouncement and communicate to students using announcements, emails, and reminders.

### CONCLUSION AND RECOMMENDATIONS

In sum, the student-to-instructor interaction motivates and encourages the students to learn and participate in online courses. This article discusses four strategies for student-to-instructor interaction, namely the instructor's participation in online courses, the feedback from an online instructor, the availability of an online instructor and timely response, and pre- and during class communications in online courses. Therefore, the instructors and instructional designers can use these strategies in designing and teaching online. Although the strategies discussed in this article focus on online education at a postsecondary education, they are also beneficial to hybrid or blended learning as well as online education in K-12.

As many universities and colleges continue to provide online courses, the researchers need to provide strategies for student-to-instructor interactions. Thus, the author recommends further research on student-to-instructor interactions by doing systematic analysis. Moreover, there are three main types of interactions in online learning, student-to-student, student-to-content, and student-to-instructor. This article focused only on one type of interaction, student-to-instructor. Hence, the author recommends further research on the strategies for each type of interaction.

### Limitations

This study used the peer-reviewed articles published in three databases. There may be other articles that fit the inclusion criteria published in other databases. Besides, some articles that were not electronically available in three databases were excluded from the study. Finally, this study included the articles published in the year of writing this article; unfortunately, no article was selected in the final list of articles.

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## LINEAR ALGEBRA ONLINE LEARNING OBJECTS: RAPID DEVELOPMENT WHILE STILL FOCUSING ON PEDAGOGY

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### ABSTRACT

Due to the COVID-19 pandemic, faculty were asked to migrate courses into an online format within ten days. This study will share the research-based pedagogy used while creating online learning objects for a Linear Algebra II course. Six different data collection instruments were used including two Course Syllabus (prior face-to-face and current online); Before and After Response to Self-Efficacy Survey; How to Make Awesome Math Videos; Example Instructor Communication with Online Students; Instructor Responses to an Instrument for Teaching Online; and Midterm Student Perceptions of Online Learning. The findings indicate that factors affecting the effectiveness of the online course include implementing effective course design; awareness that learning outcomes should not be modified when migrating online; having an openness to quickly integrate teaching research; time management is critical; eliciting input from students can be helpful; early, humanistic communication is key to reduce anxiety and create a helpful classroom culture; and student perceptions indicate that they appreciated the use of VoiceThread platform; course design; instructor creating a welcome classroom; and feedback; would prefer some synchronous opportunities; more examples [many indicated nothing needed improved]; and have a very good disposition towards the online course, sharing word such as Great, Awesome and Excellent!

**Keywords:** Online Learning, High Impact Teaching Strategies (HITS), Inclusive Environments, Online Learning Objects (OLO), Learning Communities

### INTRODUCTION

This study was performed at a small, private university in China where half of the student population is from China and the other half are international students. The mission of this university is preparing students to be well-educated and globally-minded citizens and provide a solid academic foundation for success along with nurturing the creativity needed to become leaders and innovators in every field.

On January 26, 2020, the university was informed that the first day of class would be postponed; on January 30, the date was pushed back again; and on January 31, the faculty received official word that we could begin classes on February 17, although they would be held online until further notice. As the weeks progressed, faculty received updates which indicated in continuing to teach online until notified of the possibility of returning to campus. Due to COVID-19, other universities began to experience similar fluid schedules. This manuscript is prepared in the middle of the spring term to share the intense process taken to migrate a face-to-face (F2F) course online.

This study has an overarching research question focusing on creating online learning objects (OLO) for a Linear Algebra II course while maintaining a focus on research-based higher education pedagogy.

Creating an inclusive, accessible environment was found to be a major asset of online teaching and creating OLOs. When creating OLOs, we were able to attend to major attributes which Lawrie, et al. (2017) found to help all students connect to the learning. Some of these include helping students connect their prior knowledge to new learning; using a variety of teaching methods and modalities; provide multiple modes which are helpful to non-native English speakers; and clearly communicate the expectations and grading scheme for each assignment.

Due to the COVID-19 pandemic, it has forced colleges and universities to shut down their F2F instruction and transition to teaching courses remotely (Supiano, 2020). The move towards online comes as social distancing has been deemed as the most effective way to prevent cluster infections of COVID-19 (Park, 2020). Lecture halls empty, labs closed, concerts cancelled, sports practices called off, a massive shift unprecedented in higher education (Pfleger, 2020). It has changed how millions of students are educated around the world. Yet, in unprecedented times worldwide, COVID-19 has become a catalyst for educational institutions to search for



innovative solutions in a short period of time. There are signs suggesting that there could be a lasting impact on learning innovation (Tam & El-Azar, 2020). Faculty and campus centers for teaching and learning have supported each other by sharing their discoveries and tips as they navigate the online realm and thus promoting faculty development (Lau, Yang, & Dasgupta, 2020).

With the COVID-19 pandemic, there have been concerns from faculty on how to replicate the experience of their on-ground course to online and faculty are having to rethink assignments, especially the logistics of group work (Lau, Yang, & Dasgupta, 2020). The quick turn and shift online to platforms such as Zoom created a flurry of chaos and disrupting curricula, particularly faculty less familiar with managing a class virtually. Some faculty frustrated with technical difficulties or simply panicked with the prospect of teaching over a new platform (Iwai, 2020). Asking an instructor to go from an on-ground course to an online course without any previous online teaching experience can be a large undertaking and not done overnight (Pfleger, 2020). Prior to the circumstances of having to go online due to the COVID-19 pandemic, many faculty members avoided online teaching like the plague (Gannon, 2019). Faculty have had to scramble to revise syllabi, update presentations to be more appealing online, upload required reading, and post other teaching material online while coming to an understanding of what online instruction involves. IT and staff from other support departments have been working around the clock and stretched by the transition to all online (Lau, Yang, & Dasgupta, 2020). Although faculty and students have had challenges teaching and learning remotely, faculty are searching for better means to conduct their classes online (Park, 2020). The reality is that some subjects are much harder to transfer from on-ground to the online realm (Iwai, 2020). In cases of labs, many campuses have postponed them due to the difficulty of adapting it to an online setting at present (Lau, Yang, & Dasgupta, 2020).

Over the last few decades, there have been many studies done on online learning in higher education. The benefits of offering classes that can be taken anywhere and a lack of commute and yet, online learning has complemented and not threatened the traditional model of F2F learning. However, due to COVID-19, institutions of higher education around the world at the time of this writing have been scrambling with switching on-ground instruction to online/virtual in a matter of days. However, universities in China were at the forefront of having to make such decisions in late January 2020 and offered a blueprint on ways to continue instruction when teaching F2F was no longer a possibility. Decisions made to shift to virtual classrooms was to prevent the spread of COVID-19 from entering university populations and spreading to local communities (Iwai, 2020).

The outbreaks that occurred with SARS (2003), H1N1 (2009), and Ebola (2014) have given precedence on how technology can help to provide instruction when meeting F2F in a classroom was not possible. For example, during the SARS epidemic in 2003, China Educational TV provided a 'Classroom on the Air' program that provided a large-scale, short-term substitute for students looking to continue their education while confined to their homes (Trucano, 2014). The importance of closing campuses was realized as a means to create social distancing in helping to slow the spread of infection. When looking back to the Spanish Influenza, cities that closed schools earlier had lower death rates (Bailey, 2020).

There are benefits to a virtual classroom especially during times of a health emergency. Students can continue participating in the safety of their home or dorm room without having the anxiety of riding public transportation and being in a classroom during an ongoing health crisis. Another benefit is providing a safe environment to not have to experience potential in-person harassment due to the current outbreak (Iwai, 2020). Between the end of January and the beginning of online courses starting on February 17, 2020, the instructor has had substantial interactions with other colleagues also exiled. The instructor has been designing an online version of Linear Algebra II course with 35 students enrolled, while integrating high impact teaching strategies. During the two weeks prior to the first day of class, the instructor in the case study indicated that he benefited enormously from the intense exchanges on the topic of online learning with the campus's Center for Teaching & Learning (CTL). Conversations focused on designing and redesigning online learning objects based on the research of integrating functional technology into higher education.

One week prior to the first day of class, the instructor invited students to experiment with an audio/video software program called VoiceThread (VT) with his students. He first shared a VT and walked the students through the syllabus and they made their comments and questions. Then he shared another VT whose purpose was for him and each of the students to introduce ourselves. The last VT before the beginning of classes was one where he asked students to solve an exercise from Linear Algebra I which most of them completed in the Fall 2019. Prior to asking students to create videos, The instructor produced three different styles of video presentations: capturing a video of a piece of blank white paper while he wrote a mathematical proof; capturing the same piece of paper with the proof previously written, just explaining the proof with a pointer (finger or a pen); and recording the screen of his tablet while using effective software for handwriting. The instructor then

shared the process of how he had created his videos so the students would have at least one concrete technique on how to create their own videos (He also provided them flexibility to create videos in formats that they were already using). On the first attempt, almost all students created high quality videos for their assignments. During the weekend just prior to the first day of class, he used the Lecture 01 VT to explain an extremely detailed quantitative policy on how student participation and interaction would be graded. The goal was to disrupt the inertia caused and sustained by wallflower effect - introduce a social dynamic that might be artificial in the first day, but later would sustain itself spontaneously, by wallflower effect now playing in their favor to increase engagement in a low threshold way.

In the morning of the first class, while the instructor was sleeping in another time zone, the online class officially began. This is when a twenty-minute VT that he had created using a dozen slides became a complete two-hour interactive lecture. While and after viewing his VT, students began proving theorems themselves (instead of watching a talking head video); answering each other's questions; and providing constructive suggestions on how to improve their videos. When he awoke, he opened the student videos, pressed "play" and was delighted to view a "discussion-lecture" created by the students - on day one! The first two interactive lectures offered three hours of content, and we (as a learning community) discussed how to shorten the time. Now the duration of each lecture has been reduced to an average of 75 minutes. Throughout this entire process the instructor offered optimism and enthusiasm to his students, during a time of anxiety and fear.

To further create an engaging classroom culture, he asks students to submit two small assignments, one for each "interactive lecture," using a software program called Gradescope. These assignments are graded and returned swiftly, using an analytical rubric for consistent, timely formative feedback. To encourage a broad and inclusive student voice, he used Google Forms for them to provide timely feedback every day. In their responses, students have praised how helpful it is being connected to their colleagues' approach on the same theorem or proof. One student shared recently that, "Sometimes VoiceThread is better than face-to-face teaching."

## LITERATURE REVIEW

### Online Learning

Over the last 10 to 15 years, enrollment and fiscal pressures have pushed many institutions of higher education towards having an online presence that was once considered outside the higher education mainstream and opposite of what a college experience should be (Gannon, 2019). Online instruction has matured into the mainstream and legitimization (Lau, Yang, & Dasgupta, 2020). Perry and Steck (2019) found that faculty strive to provide quality online instruction, while promoting student engagement and active learning must be a priority. While technological advancements support online course delivery, the faculty member bears the responsibility for instruction quality and control.

### High Impact Teaching Strategies (HITS)

With the near sudden shift for universities to move their F2F instruction to online, measurable learning outcomes aligned with authentic assessments and active teaching methods that empower students to engage is critical for effective course delivery. High Impact Teaching Strategies (HITS) provides reliable instructional practices for teachers and professional learning communities can anchor their interventions in evidence-based practices and increase the likelihood of them being effective (Victoria State, 2019). Rodriguez and Koubek (2019) found that faculty in preservice teacher preparation programs had positive outcomes with students responding with stronger reported learning outcomes and high levels of engagement when several HITS were employed. Integrating HITS into an online environment can also be accomplished effectively (Puentedura, 2012).

Kuh et al. (2017) detailed eight features of HITS: 1) Performance expectations set at appropriately high levels; 2) Significant investment of concentrated effort by students over an extended period of time; 3) Interactions with faculty and peers about substantive matters; 4) Experiences with diversity, wherein students engage in ideas that differ from their own; 5) Frequent, timely, and constructive formative feedback; 6) Opportunities to discover relevance of learning through real-world applications; 7) Public demonstration of competence; and 8) Periodic, structured opportunities to reflect and integrate learning.

### Inclusive Environments

When designing learning opportunities, we should ensure that a safe, inclusive and accessible environment is created. During the migration of F2F courses to online, this may present another layer of challenge. The Center for Research on Learning and Teaching at the University of Michigan discusses the use of inclusive teaching to cultivate a learning environment where all students are treated equitably, have equal access to learning, attend to social identities, and influence course and curriculum design (Center, 2019). Rice University's Center for Teaching Excellence created a resource to address unequal access to technology, hardware, and software;

provide a balance between asynchronous and synchronous tools and course materials; and create an environment that includes and values all students (Rice University, 2020). To address cognitive diversity through pedagogical design, multiple means of representation through assistive technologies with access to different types of tools for content creation would provide more means of engagement for individual learning, collaboration, and teamwork (Holeton, 2020).

### **Online Learning Objects**

Online Learning Objects (OLO) are derivatives of Learning Objects developed in the 1990s with the goal of creating a method for students to engage in material that provides scaffolded means to empower their processing of information on a concept. Learning Objects can be a “packet” of lessons, activities and assessment while being designed in a linear or non-linear way and the objects can be modified, reused and adapted (Hargis, 2014). This conceptual model for content creation and distribution can increase and improve the effectiveness of learning and performance. Learning Objects can also bring about high levels of efficiency in content development and delivery (Hodgins, 2006). When teaching online, OLO can help to break the instructional materials down and then reassemble in ways that support instructional goals via digital instruction. This can help to potentially increase the efficiency and speed of instructional development (University of Toronto, 2019).

During online instruction, much of the advantages of the objects can be maintained and at times, heightened. An advantage of OLO’s is that learners can use preview and review based on their way of learning, time frame prior knowledge, which they connect to increase current conceptual understanding. If designed and implemented effectively, OLO’s can create inclusive, accessible learning opportunities for students (Hargis, 2014). Information technology allows the means to capture knowledge, so that the data can be analyzed, reused, shared with others, and used to create new knowledge (Hodgins, 2006).

### **Learning Communities**

Learning communities (LC) are groups of individuals that engage collaboratively in a learning endeavor that works toward a common goal for a set period of time in a safe and secure learning environment. The instructor’s role in fostering a strong learning community is to model best practice, believe in students’ abilities to achieve, and create an effective learning culture. Major attributes of a LC include Shared Goals, Objectives, Values, Vision; Connectedness and Trust; Supportive Environment; Open Communication; and the Instructor Role is primarily as a facilitator (Northern Illinois, 2019). Laufgraben and Shapiro (2004) defined the concept as an instructional strategy of people working together toward a common outcome. A course management concern for faculty switching over their F2F courses to online and impeding LC has been witnessing students preferring to turn off their cameras, leaving instructors with lecturing to blank screens and tended to be fewer questions online for some. Others have been encouraged to see more participation from students who were typically shy about speaking in F2F and utilizing the chat feature or written format to engage in an online setting (Lau, Yang, & Dasgupta, 2020).

## **METHODS AND RESULTS**

This study was conducted at a small private joint China/US international university. Data was collected during the spring semester, 2020. A qualitative case-study design was used to collect and analyze the data. The participants for this case study is one higher education mathematics assistant professor teaching Honors Linear Algebra II. Data collection using six different instruments:

1. Syllabus (Includes learning outcomes, assessments and online active learning methods compared to a prior F2F syllabus of the same course)
2. Before and After Response to Self-Efficacy Survey
3. How to Make Awesome Math Videos
4. Example Instructor Communication with Online Students
5. Instructor Responses to an Instrument for Teaching Online (Benton, 2012)
6. Midterm Student Perceptions of Online Learning

A qualitative analysis was performed on the following data collection instruments:

1. Course Syllabus. A prior F2F syllabus from last spring 2019 and a current spring 2020 syllabus was requested of the author.



**Table 1:** Comparison of Syllabus Components Between Online and F2F.

Online Course (Spring 2020*)	F2F Course (Spring 2019)	Major Differences Between the Courses
<p><b>Learning Outcomes:</b> Upon completion of this course, students will be able to recognize, analyze and describe linear operators in abstract vector spaces, find orthonormal bases, diagonalize operators, analyze self-adjoint operators, perform singular-value decomposition, and find Jordan decomposition.</p>	<p><b>Learning Outcomes:</b> Upon completion of this course, students will be able to recognize, analyze and describe linear operators in abstract vector spaces, find orthonormal bases, diagonalize operators, compute self-adjoint operators, perform singular-value decomposition and find Jordan decomposition.</p>	<p><b>Learning Outcomes:</b> None (expected)</p>
<p><b>Assessment:</b> Active Participation 30% Homework 20% Midterm Exam #1 20% Midterm Exam #2 30%</p>	<p><b>Assessment:</b> Active Participation 0% Assignments 20% Exam #1 40% Exam #2 40%</p>	<p><b>Assessment:</b> 30% more for participation  Homework is worth the same, but modified  Less emphasis on exams</p>
<p><b>Instructional Methods:</b> Twice a week: Lecture, didactic Instructor explaining and students asking questions.  Once a week: discussion, collaborative, problem solving Students split into groups, sent to the board to discuss, collaborate, solve problems</p>	<p><b>Instructional Methods:</b> Both lectures (2x/w) and recitation (1x/w) mix: Lecture, didactic Active learning Students at board Discussion Collaborative Problem solving First one is exclusive for lectures; last three are more present in recitation</p>	<p><b>Instructional Methods:</b> More student engagement  Less instructor explaining  More discussion, more student solving, talking about problem-solving  More use of functional technology</p>

\*Spring 2020 Specific Sections. Subject to Change Statement. The syllabus and course schedule may be subject to change. Changes will be communicated via email. It is your responsibility to check email messages and course announcements to stay current in the online phase of the course. We will use mostly VoiceThread and Gradescope instructional technology resources in this class. You are responsible for communicating with me in a timely fashion if you are facing any challenges using these tools.

## 2. Before and After Response to Self-Efficacy Survey

In this modified Tschannen-Moran, Woolfolk-Hoy, and Hoy (1998) survey, we collected three types of responses: 1) general information regarding faculty's discipline areas, years they have been teaching in higher education and in the current institution, as well as their own reporting of experience in teaching with online tools; 2) a self-efficacy scale survey composed of ten statements, where respondents choose a score between 1 and 4 (from 1 Not at all True; 2 Somewhat True; 3 Moderately True; and 4 Exactly True); 3) open-ended input where respondents can share the major difficulties when they were trying to migrate courses online and details of their plan; and an optional blank box where they can share the details of the percentage of lecture in their usual F2F courses, their decision of the online format (a/synchronous), and the percentage of active learning components.

**Table 2:** Case Study (n=1) Self-Efficacy Responses

Question	Survey #1: Four Days Prior to the Start of the Term	Survey #2: Five Weeks After the Start of the Term
Academic Area	Mathematics	Mathematics
How long have you been teaching in higher ed?	3-5 years	3-5 years
How long have you been teaching at this university?	5 years	5 years
What is your experience in teaching with online tools?	No experience at all	5 weeks

**Table 3:** Faculty Response to Self-Efficacy Surveys

Directions. Please read each question and respond using the scale 1-4, where: 1 is Not at all True; 2 is Somewhat True; 3 is Moderately True; and 4 is Exactly True.

Self-Efficacy Attribute	Survey #1	Survey #2
I am confident that I can create and deliver high-quality online teaching.	4	4
I understand the effort I need to create and offer effective online teaching	4	4
I believe there are big differences between F2F and online teaching	3	4
I am able to offer the same type of active learning and engagement while online	3	2
I will have to modify my assessment strategies significantly for online teaching	2	2
I am confident that I could adjust my teaching efficiently with unexpected events	3	4
I know how and where to seek help if I meet any difficulties with online teaching	3	3
I know how and where to seek help if I meet any difficulties with technology	3	2
I will be able to develop a similar rapport with my students online	3	2
I have built a network of resources to help resolve challenges while offering online learning opportunities.	3	3

<p>What are the major difficulties you have encountered when migrating your course to an online model?</p>	<p>Planning methods that would ensure student engagement.</p>	<p>Understanding the implications of each proposed activity on the social dynamics in the student population and planning accordingly.</p>
<p>Please share with us more about your teaching. Here are several questions, which could guide your response: In your face-to-face (F2F) course format, what percent of the course is lecture? What percent of the F2F course is a group discussion or other active learning format? What is your chosen online format (a/synchronous) and why did you choose this?</p>	<p>Two lectures with instructor speaking, 1 recitation with group discussion. I chose asynchronous because synchronous technology is not ideal. If the technology allowed me to quickly see each of my student's faces and students to see each other in real time, and it was failproof, also if there was no time zone issue, I would go synchronous, even though the speed of light would play a role here (a couple of seconds of delay between China and US, even with futuristic science-fiction-level of technology). However, the current situation is so far from ideal that synchronous teaching became unfeasible.</p>	<p>F2F 66% is lecture F2F 33% is a group discussion or other active learning  Completely asynchronous. When I chose it, I thought synchronous for a large class would be impractical. Now I think I made the right choice but for the wrong reasons. I am happy with asynchronous because it allows all students the opportunity to reflect and make their thoughtful contribution regardless of being shy, outspoken, confident, fast-thinking, etc. Students don't feel self-conscious about "interrupting the professor" and "taking away precious lecture time from their peers."</p>

### 3. How to Make Awesome Math Videos

The instructor shared the following information on students creating videos for the course assignments. *“Making a video solving exercise was an awesome experience! It was so nice to see students choosing beautiful problems and confidently showing a video with their solution! Now let’s each one of us watch a dozen different videos and add to our table of what makes a good math video so we can continue to enhance our videos in the future - this is a sign of a successful person, continuous improvement.”*

**Table 4: Do’s and Don’ts of Making an Awesome Math Video**

Try to Do	Try to Avoid
<ul style="list-style-type: none"> <li>● Use landscape format</li> <li>● Zoom in when emphasizing words and zoom out after</li> <li>● Capture your work in a well-lit space</li> <li>● Make sure all the video area is occupied by your presentation</li> <li>● Keep camera stable and close to the paper</li> <li>● Film only part of solution rather than whole</li> <li>● Let the camera follow your explanation</li> <li>● Imagine how solutions will look in a small window</li> <li>● Elevate your voice and project it toward the microphone</li> <li>● Pronounce and articulate each word clearly</li> <li>● Change the tone of your voice to emphasize major points</li> <li>● Speak confidently</li> <li>● Make the handwriting big and clear</li> <li>● Write the proof on a single page</li> <li>● Be concise, focus more on the main steps</li> <li>● Write all the steps before the presentation</li> <li>● Limit the time of the video</li> </ul>	<ul style="list-style-type: none"> <li>● Using portrait format</li> <li>● Forgetting to check proper orientation (upside up)</li> <li>● Making long videos (longer than 2 minutes is too much)</li> <li>● Skipping important steps</li> <li>● Writing with unclear small letters</li> <li>● Covering previous work when writing</li> <li>● Pronouncing your words in an unclear way or mumbling</li> <li>● Being afraid to use color to highlight the meaning</li> <li>● Cramming your writing into one part of the paper</li> <li>● Simply saying “clearly or instantly” without explaining why</li> <li>● Posting a video that reproduces a mistake that has already been pointed out in another solution</li> </ul>

The goal of this data was to empower students to be part of the online learning objects and offer an opportunity for them to guide the direction, quality and function. For this major aspect to be effective, the instructor needed to motivate students to not only create media, but useful, high quality video, which this shared Google Document was able to accomplish. Ultimately, this teaching approach mimicked a similar method which the faculty employs in F2F, which is to ask his students to stand up and solve problems on a physical whiteboard in class.

#### 4. Example Instructor Communication with Online Students

**Table 5:** Example of Instructor to Student Communications

<p>Dear students,</p> <p>We are all anxious and excited about the beginning of classes, aren't we?!</p> <p>On page "Week 01" of our CMS, I shared the resources and guiding material that should make our beginning of classes smooth and easy. That includes a preview of Lecture 01. Your comments and suggestions are more than welcome.</p> <p>The VoiceThread of Lecture 01 is open for preview but not yet for comments. It will be open on Monday morning. Participation in Lecture 01 is already counting towards your final grade. I will send an email one hour before opening it for comments, so you don't need to refresh your browser every 2 minutes.</p> <p>There will be a small written assignment as follow-up to Lecture 01. Gradescope will open the exercise on Tuesday at 06:00 (China) and accept submissions until 22:00 of the same day. If extenuating circumstances make this time window unfeasible for you, please let me know by Monday morning. Lecture 02 will become available on Wed, both for view and comment.</p> <p>Please do not hesitate in contacting me if you have any questions. I mean -any- questions! Looking forward to Monday!!! Best regards,</p> <p>PS: A few of you have not yet submitted our mock assignment on Gradescope and any of the mock tasks on VoiceThread. They will remain available until Monday evening. Anyway, they do not count for grade and will eventually be removed from the Gradebook.</p> <p>Best Regards, Instructor</p>
<p>Dear students,</p> <p>Our two first lectures were fantastic!!!</p> <p>But a bit too long... For Lectures 03 and 04 on Week 02, you are only asked to produce one video solution and one reply. The video solution will be required either on Monday or on Wednesday, and the reply will be required on the other day.</p> <p>Monday or Wednesday?</p> <p>Please use this <a href="#">webform</a> to indicate your preference by Friday afternoon (and also to give feedback about our first two lectures). Priority will be given first to students who have a strong preference for one of the days, and second to students who have a slight preference. If more than 17 students have the same preference, priority will be given to those who complete the webform earlier.</p> <p>About your videos</p> <p>Please go back to the video you posted last week and the two videos you posted this week. There is feedback both by students and by me. A path to success includes being open to feedback and seeking continued improvement.</p> <p>About your replies</p> <p>When you reply to someone's video, try to include: (0) Mathematical mistakes or omissions, if any (1) Aspects that impressed you positively (2) One aspect that can be improved for the future. A path to success includes knowing how to give constructive feedback.</p> <p>Accidental posts on VT</p> <p>If you wanted to make a Reply but accidentally made a new Comment:</p>

- 0) Read these instructions slowly and carefully
- 1) Add a Reply to your own Comment asking other viewers to reconsider it
- 2) Add the Reply to the Comment that you originally wanted to reply to
- 3) Add a Reply to my Comment on the slide asking me to delete your accidental comment
- 4) Try not to do it again

Please let me know if you have any questions or comments. Best wishes, Instructor

Note: The goal here was to quickly assure students that this online experience would take a humanistic approach. Students were anxious and worried due to the current world events, many of them having family members and friends who are in poor health. Thus, the instructor had to be empathetic, yet also maintain rigor and clear expectations of course learning outcomes.

5. Instructor Responses to an Instrument for Teaching Online (Benton, 2012).

- How would you describe your prior experiences teaching online?

None.

- How did you feel when you heard that you would be teaching online?

Vertigo, Pressed, Challenged, Responsible.

- Describe the type of training you had before you began teaching online?

Only email exchanges with the Center for Teaching & Learning (CTL).

- How do you collaborate with colleagues when teaching online?

With my teaching assistant (TA) we use WhatsApp and email. I propose the work, we discuss, then we do it. With my peers (not on the same course) we exchange ideas, tips, do's and don'ts, ask each other for advice.

- How have you overcome the challenges of teaching online?

I think I have.

- If I were a student in your online class, how would my learning experience be different?

You would be having much more access to the way the material is seen by students rather than conveyed by the instructor.

- Describe the planning process required for developing an online lesson.

Know your students' background with respect to the material of your course.

Make a first draft of a weekly routine, learning objects, and how these are connected.

Discuss with experts in pedagogy, get feedback, update your draft, repeat this step n times.

- Share specific activities in which your students have engaged online.

My lecture is like a movie, I'm the director and the students are the protagonists. 80% of the contents of this movie are produced by students based on guiding questions and hints spread over the slide, but without any real-time help from me. They ask questions about the theory, provide analyses of the examples I propose, proofs of the theorems that I state, and sometimes they even answer each other's questions with precise explanations.

- Describe your beliefs about the impact that online will have on student learning.

Asynchronous online teaching favors deliberate thinking and gives a chance to all students to formulate their thoughts without time pressure to think or social pressure for interrupting the lecture. It fosters the participation of students that would otherwise have remained quiet for the entire semester.

- Additional Instructor Comments

"I want to share that the 'shy and introverted' students of Linear Algebra II, were confident enough to produce two hours of lecture in only one morning. They are answering each other's questions and giving each other suggestions on how to improve their solutions."

"I don't think synchronous or even F2F would allow for the program to be covered using these instructional methods with the same intensity. Didactic would have been predominant (but not exclusive) in lectures, unless I had a whole day with the students instead of 75 minutes."

“It’s amazing how I was overconfident when I filled the survey five weeks ago! When I filled the form for the second time, I was sure that my level of self-confidence had increased. It was an interesting surprise (after answering the self-efficacy survey for the second time).”

#### 6. Midterm Student Perceptions of Online Learning

The instructor administered an online midterm student perception form, with only the author of this research having access. A summary of 29 of the 33 students enrolled, who responded are presented.

1. What is contributing to your online learning in this class, i.e., what is going well?
  - Voicethread (VT) was cited as very helpful to their learning (9 times)
    - VT creates an academic atmosphere for students to fully engage in the class. I benefit a lot from my peers’ comments and questions. Using VT, each student has an equal chance to participate in the lecture.
  - For me, everything is beyond expectation right now.
  - The instructor has been devoted to establishing an environment where students are encouraged to interact.
  - This is better than sitting in the classroom and letting the professor prove the theorem.
  - Almost everything is helpful. The lectures are very engaging and provide a great chance for us to communicate with other students.
  - The instructor sends careful feedback to every student's comments and this can help students to make sure that their understandings are correct.
  - Online learning allows more time for us to raise questions and digest the knowledge by listening to what we don't understand many times.
  - Being able to slow down and try to prove the theorem on my own makes me understand them better to some extent.
  - In terms of teaching methodology, this is the best among five courses I take this semester.
2. What might need improvement to enhance your online learning?
  - Nothing (4)
  - More examples (3)
  - I am longing for a synchronous office hour supported by Zoom, which provides direct interactions with the instructor (2)
  - I think the recitation mode is not perfect since it is really hard to get together with the group members and discuss online (2)
  - My Wifi speed. A dedicated period of time when we can discuss problems in real time.
  - maybe the recitation also need to upload some videos
3. What is one concrete action which the instructor can do now to improve your online learning?
  - Nothing, it’s all good (7)
  - Regular synchronous meetings can be held to serve as the office hours (3)
  - Provide a written proof (2)
  - The TA select more challenging exercises in our recitation (2)
    - More challenging exercises occasionally, as well as showing the relationship between what we are learning with coding more often
  - Maybe we can hold some discussion or send some tips on the common mistakes that students made or nice proofs shown in lectures
  - One thing that I think is helpful is that after the professor watches all our questions and answers, can he summarize the important parts?
  - Give Sample Midterm
4. What is one word that describes how you feel about this online course now?
  - Great (5)
  - Awesome (4)
  - Excellent! (3)
  - Acceptable (3)
  - Comfortable (2)
  - Smooth (2)
  - Brilliant (2)
  - Helpful (2)
  - Productive
  - Beneficial



- Interesting
- Nice
- Intrigued

## DISCUSSION

This study has an overarching research question focusing on creating online learning objects for a linear algebra II course while maintaining a focus on research-based pedagogy. The research was conducted during intensive, stressful times, which was both an asset (of capturing authentic data); and a disadvantage (of finding time).

### Data Collection Instruments

1. Syllabus (Includes learning outcomes, assessments and online active learning methods compared to a prior F2F syllabus of the same course)
2. Before and After response to Self-Efficacy Survey
3. How to Make Awesome Math Videos
4. Example Instructor Communication with Online Students
5. Instructor Responses to an Instrument for Teaching Online (Benton, 2012)
6. Midterm Student Perceptions of Online Learning

There were several major findings of this research (each supported by at least two data collection instruments):

1. Understanding and implementing effective Course Design (well-written, measurable learning outcomes; authentic assessment and active teaching methods) is critical (Wiggins & McTighe, 2011) [from Data Collection Instruments #1, 5].
2. Aware that Learning Outcomes should not be modified when migrating online, although assessments can be more authentic and interactive; and teaching methods should be significantly modified to capitalize on available useful technology [from Data Collection Instruments #1, 2, 5].
3. Possessing a background in pedagogy or at least an openness to quickly integrate research on effective teaching is critical [from Data Collection Instruments #2, 5, 6].
4. Time management is critical for effective online course delivery (Perry & Steck, 2019) [from Data Collection Instruments #2, 3, 4, 6].
5. Initial perceptions of self-efficacy for teaching online can be falsely elevated, even for faculty who have little experience with online teaching. This can result in unsuspected insights throughout the experience [from Data Collection Instruments #2, 5, 6].
6. Eliciting assistance from students and their perceptions can be helpful, especially when they are asked about how they can create electronic artifacts (videos) [from Data Collection Instruments #3, 4].
7. Early, humanistic communication with students is key to reduce anxiety and create a helpful classroom culture [from Data Collection Instruments #1, 3, 4, 6].
8. Highlights of the midterm student perceptions of online learning indicates that students
  - a. appreciated the use of VT videos; course design; instructor creating a welcome classroom; and feedback;
  - b. would prefer some synchronous opportunities; more examples [many indicated nothing needed improved]; and
  - c. have a very good disposition towards the online course, sharing words such as Great, Awesome and Excellent! [from Data Collection Instruments #3, 6]

Our findings align with earlier concepts of how instructors can “develop effective classroom culture within a learning community through creating a humanistic approach (Raygoza, León, & Norris, 2020).” Attributes which support this approach include being present, start and end on time, engage students in a “temperature check” at the beginning of class, have an agenda with learning outcomes and activities, provide an array of instructional activities, engage students in reflective, metacognitive activities such as exit tickets, and be flexible and patient. In addition, we found that offering a midterm student perception session can provide useful anonymous feedback to an instructor at a time when they can make modifications (Achen & Lumpkin, 2015).

### Further Work

The instructor plans on using some of the approaches that he has created and used this term in future F2F classes. He has indicated that he plans to keep the basic format where didactics is predominant in lectures and group discussions predominant in exercise sessions and plans to incorporate more discussions into the lectures. He will collect homework electronically if there is a convenient tool available such as Gradescope. He will increase students' voices and ask for feedback more regularly. He will build roadmaps and send students more detailed guidance on how to learn more effectively. The instructor plans on requesting or accepting to teach online in the future if the institution is willing to take into account that it takes 3-4 times more work to teach an online course

and provide corresponding preparation time and credit. The instructor is and will continue to assist other faculty in teaching online in the future as he has been receiving questions from other colleagues and for this reason he started a YouTube channel and blog.

Through the current crisis, it seems apparent that higher education does not have a culture built on how to teach effectively online. This research shares ideas and data collection instruments that worked for this instructor and might work for others. One final suggestion from this research is that when we plan to migrate our courses online, it may serve instructors well to contact teaching and learning experts (such as in Center for Teaching and Learning departments) to create effective online learning objects.

### List of Abbreviations

CTL - Center for Teaching & Learning  
 CMS/LMS - Course Management System/Learning Management System  
 COVID-19 - Coronavirus  
 F2F - face-to-face  
 H1N1 - Influenza Type A  
 HITS - High Impact Teaching Strategies  
 LC - Learning Community  
 OLO - Online Learning Object  
 SARS - Severe Acute Respiratory Syndrome  
 TA - teaching assistant  
 VT - Voice Thread

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## OPINIONS OF THE SECONDARY AND PRIMARY EDUCATION ADMINISTRATORS IN THE TRNC ABOUT THE USE OF TECHNOLOGY

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### ABSTRACT:

The aim of this study is to determine in detail the difficulties experienced by administrators in primary and secondary education institutions affiliated to the Ministry of National Education and Culture in TRNC. regarding technology use tools and to examine the problems and views of principals and assistant principals on this issue. to evaluate, to determine the causes of these problems and possible solutions. The qualitative research method was used in this study. The maximum diversity sampling method was used from purposeful sampling in sampling selection. Based on maximum diversity sampling, different gender, age, seniority, branch, education level etc. Participants of the research were determined by paying attention to such features. The working group consists of 47 people. This study consists of 15 Principals, 15 Assistant Principals in primary education, 5 Principals and 12 Assistant Principals in Secondary Schools working in primary and secondary schools in Nicosia region. Semi-structured interview forms were used as data collection tools. The data were analyzed with a descriptive analysis method and presented within the framework of determined themes. Findings revealed, determining the problems they experienced (Lack of knowledge, financial difficulties, lack of repair unit of the ministry, in-service insufficiency of training, insufficient internet infrastructure, fear of spoiling the relevant tools, not every school having equal opportunities etc.). Another result of the study is the widespread use of technology usage tools. Since the facilities of the school are limited, the participants expressed the view that this can only be done by finding sponsor companies and donating technological tools to the school. The use of technological tools in the field of education is one of the conditions of the modern education system. Besides, another result that came out of the interview forums was that the participants firstly followed the technology and developed themselves and set an example for other teachers by their leadership qualities.

**Keywords:** Training manager, technology, technological tools, in-service training

### INTRODUCTION

In today's world where knowledge and technology are increasing day by day, understanding in education also changes in parallel with these. Developments and changes in world education should be followed in TRNC. Thanks to technological tools that administrators can use efficiently, schools can be brought to a more modern level and the quality of education can be increased.

The concept of technology is a concept that started to be studied in ancient times. As the word meaning technology uses tools and equipment, application knowledge covering their usage patterns is defined as the science of application. (TDK, 2020). Technology is a phenomenon that is effective in enriching education-training environments in which determined skills and interests are developed (İşman, 2008).

Education systems have undoubtedly played a major role in ensuring technological change. To perform this role, their educational activities are required to efficiently utilize technology (Alkan, 1997).

According to McDermott; technology in a concrete and empirical sense is a small group of technically competent people, with the help of an organized hierarchy, to gain control over the rest of the whole (people, events, machines, etc.) (McDermott, 1981: 142).

In addition to being important in human life, technology has also gained great importance on education. The concept of technology in terms of education is explained with the following definitions:

All methods and techniques applied to educational principles constitute educational technology. (Cleary, 1976). It is the functional structuring of learning or training processes by employing relevant knowledge and skills to

dominate education and learning situations. With the development of information technologies, education systems and educational activities in educational environments are also affected (Pala, 2006).

School administrators have to lead their teachers about technology. G. Valdez defines technological leadership as a combination of strategies and techniques that require technology-specific attention, encompassing an understanding of how technology can be developed in teaching practices and strategies to help teachers use technology in their classroom. (Valdez, 2004)

The school administrator is one of the most important elements that play a role in the effective use of information technologies in school and the learning-teaching process in this context. In terms of effective use of technology in school, teaching-learning process, management and support systems, evaluation system necessitates having a new perspective on many issues in social and moral aspects (Şeyhoğlu, 2005).

When we look at similar studies in the literature, M.Yılmaz, and A. Pala, examined the effect of teachers and administrators' having personal computers and Internet access on their computer self-efficacy beliefs and attitudes towards computer-assisted teaching in their studies. (Yılmaz,2016; Pala, 2006)

Education systems are expected to raise modern individuals who are technology literate and keep up with the information age. Recently, one of the issues that have come to the agenda is that teachers and administrators are expected to increase their ability to use new technologies by the information society. In the light of all these developments, individuals who are trained in educational institutions should have access to today's technology and know how to use it effectively. (Seferoğlu, 2009)

Turkey and Turkish Republic of Northern Cyprus Universities did not reveal any research related to information management in universities. It has been observed that information management systems are studied in very few primary and secondary education institutions and the current situation has been tried to be revealed. According to the research of Muratoğlu and Özmen among these studies, it has concluded that school administrators and teachers do not effectively implement knowledge management in schools, that making comparisons and forming an information team in schools is not done effectively, and that there is no serious information store and knowledge bank in schools to reach the desired information instantly (Muratoğlu & Özmen, 2005).

Knowledge management has to be designed as an organizational process and constantly improved. This process has made knowledge management a necessity for all kinds of contemporary organizations. (Dagli, Silman & Birol, 2009)

Today's administrators are expected to know themselves while managing the school, to identify their strengths and weaknesses, to reflect on them and to have the skills to produce solutions to problems by doing the necessary studies. (Keman, 2019)

According to Görgülü & all, it is important in terms of determining the variables that affect the school administrators' receiving and using education about information technologies and developing solutions for them ( Görgülü, Küçükali & Ada, 2016).

When M.Yılmaz, (2016) Pala, A. (2006) and Çetin & Güngör (2014) examined the effect of teachers and administrators' having a personal computer and Internet access on their computer self-efficacy beliefs and their attitudes towards computer-assisted teaching. It is seen that both the self-efficacy beliefs and attitudes of having a personal computer and internet access affect the use of technology tools positively.

The study is presented by using sub-problems to determine in detail the difficulties of the administrators in the primary and secondary education in TRNC Public Schools in using Technology Tools and to show possible solutions.

- What are the in-service training problems in the TRNC education system?
- What are the infrastructural problems in education and training in the TRNC education system?
- What are the problems of a lack of technical support in the TRNC education system?
- Financial difficulties in the TRNC education system?
- How can it be ensured that the use of technology tools of TRNC Administrators are popularized?

## **METHOD**

### *The working group (Participants)*

Qualitative research techniques were used to examine the subject in more detail. While concluding qualitative research, he examines it in general. The working group consisted of 47 people. The problems determined in line with the data analyzed with the descriptive analysis method, sub-problems were identified and shown.

The data obtained according to the descriptive analysis approach are summarized according to predetermined themes. The data were analyzed considering the questions used in the interview and presented in the findings section.

The maximum diversity sampling method was used from purposeful sampling in sampling selection. Based on maximum diversity sampling, different gender, age, seniority, branch, education level etc. Participants of the study were determined by paying attention to such features.

The purpose of maximum diversity sampling is to reflect the diversity of the participants who may be a party to the problem being studied. Because of this reason the demographic information asked the participants is shown in Table 1.

## **DATA COLLECTION TOOL**

In this study, the interview form was sent to 15 primary school principals and 15 primary school assistant principals in Nicosia central schools and 5 principals in secondary schools and 12 assistant principals in Nicosia central schools via e-mail and received. The results obtained according to the answers given by the participants were grouped under certain headings and analyzed with Microsoft Excel program. (Table 1)

## **VALIDITY**

The collected data are written in detail and the results are explained in a clear and understandable way. In this context, teachers' opinions expressed with direct quotations were explained accordingly. Thus, the validity study of the study was conducted. Findings in the research constitute a coherent, meaningful and whole. Because of this reason the findings obtained are compatible with the conceptual framework. The researcher who conducted the study constantly questioned themselves and their research processes with a critical eye; checked whether the findings and the results of these findings reflect the reality (Yıldırım & Şimşek, 2005).

In this study, "semi-structured interview" technique was used as a data collection method. Interview forms were sent to 47 participants from different schools in the Nicosia region. The data collected in the Interview form with 5 questions were written in detail and transferred to an Excel table (Table 4.). The validity check was also made by explaining how the results were reached clearly and understandably.

## **RELIABILITY**

The researcher avoided directing the interviewed participants and tried to make the teachers speak in line with the subject and purpose of the study. Since the data are stored so that they can be examined by others, other researchers who conduct similar research can take into account the data defined by the individuals who are the data sources while creating samples.

In this study, the collected data were analyzed using the descriptive analysis technique and the findings obtained were summarized according to predetermined themes. The data were analyzed considering the questions used in the interview and presented in the findings section. Participants were asked about their demographic information in the interview form to identify the defects in the TRNC education system. These are information such as gender, age, seniority, education level, and branch. This information was transferred to the Excel program and analyzed. The results are shown in Table 1, Table 2, Table 3, Table 4.

For reliability, the data is kept in an Excel table so that the data can be viewed by anyone. A few examples of the questions in the interview form are shown in the findings section (Table 1).

The interview form prepared by the researcher consists primarily of one curriculum development specialist, one education management expert, one Turkish language expert and one assessment-evaluation expert.

## **COLLECTION OF DATA**

The interviews were held in Nicosia, between September and January in the 2019-2020 academic year. The opinions of 27 Assistant Principals and 20 Principals from different schools were requested. For this purpose, the interview form containing 7 questions we have collected under 3 headings above was sent to the relevant participants by mail.

In the interview forms, managers were asked to indicate the technological tools they use as well as their demographic information. Participants were asked which tools and equipment they could use such as a desktop computer, portable computer, tablet computer, camera, printer, smartboard, projector, smartphone, internet. These tools are the most basic modern training tools used in education. These and similar tools are necessary to provide quality education.

**DATA ANALYSIS**

In this study, the data were analyzed by considering the questions used in the interview and presented in the findings section. The form on questions were sent to the relevant participants by email through interview forms and the results were also received back by mail. The results obtained according to the answers given by the participants were grouped under certain headings and analyzed with Microsoft Excel program. All tables are in the Findings section

**FINDINGS AND COMMENTS**

Views of 47 administrators from different schools were requested. For this purpose, an interview form including 5 questions that we have gathered under 4 headings below has been prepared. Few of the questions in the interview form were shown in Table 4. Findings from the study were grouped according to interview questions under 4 main themes.

**Table 1.** Information About School Administrators

		n	%	
School Type	Kindergarten	10	21.3	
	Primary School	20	42.6	
	Secondary School	17	36.2	
Education Level	Undergraduate	28	59.6	
	Master's degree	14	29.8	
	PhD	5	10.6	
Occupational Seniority	<15	19	40.4	
	>15	28	59.6	
Gender	Female	<40	7	14.9
		>40	21	44.7
	Male	<40	5	10.6
		>40	14	29.8
Total		47	100	

When Table 1. was examined, the majority of the administrators out of the 47 people who participated in the interview were working in primary school (n = 20; p = 42.6%). We see that the education level of most of the managers remained at the undergraduate level (n = 28; p = 59.6%). It is seen that the number of doctorate managers is very low. (n = 5; p = 10.6%). It was observed that most of the administrators were women and over the age of 40 (n = 21; p = 44.7%). However, in the data obtained from the interview forms, it was observed that men over the age of 40 were in the minority (n = 5; p = 10.6%). It has been observed that the professional seniority (staff year) of the managers is mostly over 15 years (n = 28; p = 59.6%). When we correlate the data in Table 2. it is seen that women over the age of 40 use more technology.

**Table 2.** Use of Technological Tools by Managers

Technological Tools	Number of users	%
Smartphone	47	100.0
Internet	47	100.0
Desktop	47	100.0
Printer/Scanner	47	100.0

Laptop	15	31.9
Camera	13	27.7
Smart Board	7	14.9
Tablet PC	5	10.6
Projection	5	10.6
Smartschool Education Portal	28	59.6
MEB Education Portal	19	40.4
EDMS (Electronic Document Management System)	20	42.6

Difficulties experienced by the administrators in the use of technological tools in the TRNC, the responses of the relevant participants. All participants can use Smartphone, Desktop PC, Printer and Scanner (n=47, p=100) but it is difficult to use tablet PC and projection for them (n=47, p=100).

**Table3:** Problems experienced by administrators in educational institutions while using technological tools

Problems Experienced	n	%
Lack of in-service training	21	44.7
Ministry's lack of technical support	10	21.3
Inadequate internet infrastructure	7	14.9
Financial impossibilities	7	14.9
The necessity of expanding the use of technological tools	2	4.3
Total:	47	

When Table 3 was examined, it was seen that the most desired problem to be solved is inadequate in-service training opportunities (n = 21; p = 44.7%). Participants suggested the Ministry's lack of technical support and increasing the quality of in-service training (n = 10; p = 21.3%). Internet infrastructure and financial problems are the third major problems (n = 7; p = 14.9%). It was observed that the least desired problem is “expanding the use of technological tools” (n = 2; p = 4.3%).

**Table 4.** Interview Questions Asked To Managers

INTERVIEW QUESTIONS
1. Can you follow the ever-evolving technology that interests you in the field of education? What are the problems?
2. What technological tools do you use in your school?
3. What are the problems you have with the technological tools you use?
4. Have you attended any courses, seminars on the use of technological tools? Was it helpful? Your feedback.
5. What are your suggestions for popularizing technology use tools and minimizing problems?

### HOW IS IT ENABLED TO DISSEMINATE THE TECHNOLOGY USAGE TOOLS OF TRNC MANAGERS?

According to the opinions of the administrators working in the primary and secondary schools in the Nicosia centre under the TRNC Ministry of National Education, the technology use tools and the difficulties they have experienced in the evaluation form, the administrators are behind the educational-personal progress. They do not follow technological developments sufficiently. Unfortunately, some teachers working in primary and secondary

schools in Nicosia center under the TRNC Ministry of Education are not innovative enough. Other problems are lack of in-service training, financial difficulties, the ministry's failure to send sufficient technological tools. It shows that among the participants of the study, who are women and whose seniority years are over 15, are more



curious about the use of technological tools. It shows that he follows in-service training. Also, looking at the managers, it is observed that the young generation managers can use technological tools more easily.

### **CAN IT FOLLOW THE CONTINUOUS DEVELOPING TECHNOLOGY RELATED TO THE MANAGERS 'USE OF TECHNOLOGICAL TOOLS IN THE TRNC, AND TAKE IN-SERVICE COURSES ON THIS SITE?**

Among the responses given by the interviewees, the administrators did not follow the ever-developing technology, the Ministry of National Education did not open the necessary in-service courses, and some emphasized that the administrators did not find time due to the workload and some of them stated that the young people should now attend the courses as there is only a little time left for their retirement.

### **CONCLUSION & RECOMMENDATION**

- According to the findings obtained from the interviews, it is up to the Ministry of National Education to solve the problems of the administrators working in the schools where the research was conducted regarding the use of technology use tools.
- The Ministry has to provide internet infrastructure and technological tools to every school under equal conditions.
- It is the direction of the administrators to follow technology, develop themselves and set an example for other teachers by their leadership qualities.
- It shows that women and those with seniority of over 15 years are more curious about the use of technological tools.

### **SUGGESTIONS**

- TRNC Ministry of National Education And Culture administrators should plan in-service training courses regarding the use of technological tools that will not leave them behind technology and meet their demands and needs.
  - In case the TRNC Ministry of National Education And Culture and the school's facilities are not sufficient, financial support should be provided for the purchase of technological tools from the school family association or sponsor companies.

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## THE EFFECT OF LEARNING INTEREST ON RESULTS OF COMPUTER LEARNING APPLICATIONS

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### ABSTRACT

Education is a supporting factor for the progress of the nation. The purpose of education is essentially to change behavior, intellectual and moral as well as socially so that they can be independent in people's lives. To achieve educational goals that have been set, then the need for teaching and learning process which is an activity in order to implement the curriculum at an educational institution. The intention of this study was to reflect the effect of interest in studying on student learning outcomes in Computer Application Programs in Accounting Study Program. This research adds insight and knowledge about the influence of learning is explored on student learning products in the future. The saturated sample in this research is 45 students of Accounting Study Program. Research result are that there is a significant influences of learning interest learning outcomes.

**Keywords:** interest in learning, learning outcomes.

### Introduction

According to Regulation in National Education, namely Education a fundamental and is a programmed activity to create a learning environment and a learning process thus all students can optimally develop their competencies to gain the strength of self-control, religious spirituality, personality, noble character, intelligence and skills. what is needed by himself, the people of the nation and the State.

Education plays an important role because education will be able to be able to develop an ability and improve quality of life of the Indonesian people. Besides that, skilled, potential and quality human resources will be realized as the implementation of development in an effort to realize national goals. Human resources can be realized optimally in accordance with expectations through education because with education students learn various things about science (Lin, 2017). So by learning students are expected to later be the next generation to develop into a skilled, potential and quality human being. One of the problems facing education in Indonesia is the low the quality of each educations at every levels as well as from the education unit. So the way taken is through improving the quality of formal educations that is applied in elementary class for tertiary institutions.

So that efforts in preparing quality human resources can be achieved, in the field of education it is necessary to consider factors that are the cause of educational failure. The factors causing the failure of education are environmental factors, facilities and infrastructure factors as well as internal factors of students themselves (Lin, 2017). Success in education depends on the learning process undertaken by each educational institution, especially formal education. Expected learning outcomes are usually in the form of good or optimal learning achievement. But in the achievement of good learning outcomes are still experiencing difficulties so that the achievements obtained can not be achieved optimally.

According to Slameto (2003: 2) learning is a business process undertaken by a person to obtains a news changes in behavior as all, as a product of an experience of his own in interactions with his habitat. By learning, students can develop the potential they have brought since they were born (Kahu, 2017). Actualization of this potential is useful for students to be able to adjust themselves to meet their needs. The development of science and technology from time to time is increasingly rapid, increasingly intense globalization. Therefore the world of education is required to be able to create quality human resources and achievement.

One of the main factors to achieve success in all fields, whether in the form of studies or lessons, work, hobbies or other activities is interest. According to Sardiman (2007: 76) interest can be interpreted as a condition that occurs when someone sees the characteristics or meanings of a situation that is associated with their own desires or needs.

In formal education is always followed by measurement and assessment, as well as in a part of a series of learning and teaching activities, by knowing the studying outcomes can be known its existence of students who are moderate, lacking or smart. Students learnings outcomes reports are submitted within a certain period or semester in the form of a score transcript. So learning products are products that are achieveds after student hold a learnings activity that is formed in a value of learning outcomes provided by the lecturer.

Higher education has the function to carry out higher education, research and development to the community. In addition, tertiary institutions also provide tertiary education with religious nuances with information technology insight.

The existence of computer laboratories greatly supports students' interest in learning, especially accounting education with the availability of adequate computers. With high learning interest and complete facilities, it is hoped that optimal learning outcomes will be obtained. The use of computers themselves have now entered all fields. In the course Computer applications are taught about the introduction and correct operation of computers (Lin, 2017). The ability to operate a computer is a requirement that must be possessed by students who will work. Students should have early awareness so that they are able to equip themselves with skills in operating computers through Computer Application courses that are already in lectures, so students have the opportunity to learn about computers in the campus environment. Therefore in this accounting education study program there are Computer Application courses which were held in the sixth semester yesterday. With the Computer Application course students are given the knowledge or insight regarding the use of Computers.

Based on the background above, the writer takes the following issues: Does interest in learning affect student learning outcomes in Computer Application Programs in Accounting Study Programs. Based on the above problem formulation, the target of this research is to determine the effect of interest in learning students learnings products in computers Application Programs in Accounting Study Program.

### **Literature review**

#### **Learn**

Students are determinants of the occurrence or non-occurrence of a learning process. The learning process occurs because students get something that is in the surrounding environment. Students take action to learn by studying and observing about the surrounding environment such as natural conditions, objects or things that are used as teaching material.

According to Slameto (2003: 2) defines learning as follows: learning is a business process carried out by someone to obtain a new behavior change as a whole, as a result of his own experiences in interactions with his environments. According to Gagne in Wasty (2006: 4) elements that are interrelated to produce behavioral changes, namely: Learners can become students, trainees and learning citizens. Students also have sensory tools that can be used to respond to which brain stimulus is used to be able to convert the results of a sensing into complex memory and nerves or muscles can be used to display the workforce showing what they have studied. Events that affect student senses are known as stimulus conditions. Examples of these stimuli are lights, sounds, colors, heat, cold, people and buildings. So that students to learn with optimal effort, they must remain focused on a particular stimulus of interest. The memory power of students can contain various ability in the forms of skills, attitudes and knowledge resulting from past learning activities. Responses are actions resulting from memory actualizations. Learners who are watching stimulus, memory that is in then respond to the stimulus.

According to Wasty (2006: 13) in learning, there are many factors that influence learning, but of the many factors that influence learning, can only be classified into three types, namely: Stimulus learning is anything outside the individual that stimulates the individual to make a reaction or making learning, for example the length of study material, the difficulty of study material. The teaching method used by the teacher greatly influences the learning method used by the student, so the method used by the teacher makes a significant difference to the learning process. Individual factors are also very big influence on one's learning, for example about individual maturity, age, gender differences, previous experience, motivation, health conditions.

#### **Interest to learn**

Interest is awareness, passion and pleasure in something. According to Sardiman (2007: 76) interest can be interpreted as a condition that occurs when someone sees the characteristics or meanings of a situation that is associated with their own desires or needs. If someone is not interested in learning something, it cannot be expected that someone will succeed well in learning it, conversely if someone learns something with an interest, it is hoped that it will be better. Every person has an interest and of course an interest between one person with other people are certainly not the same. No matter what interests students have, it is the duty of teachers in the school environment to foster the interests of students.

Students who enter a school may not necessarily have an interest in existing activities. Therefore teachers must show students and if students already have an interest, then the teacher's task is to develop it (Vainikainen, 2015). Measurement of interest needs to be done because it is an initial process in preparation for students to

continue their studies. Even though it is just the beginning, it is very important for the next process and will determine student success. From the effort to generate interest, it is hoped that a new interest can arise in students, especially interest in applying their knowledge to accounting subjects. For this reason, a measurement of student interest is needed. Measurement of interest can be done in various ways, one of them with the structure forming interest in behaving namely; The cognitive component is the knowledge and perception obtained through experience with an attitude object and information from various sources (Kahu, 2017). Knowledge and perception are usually in the form of trust, and the belief in question is the existence of a sense of trust that an object of attitudes has various specific attributes and behaviors.

Affective components describe feelings and emotions towards objects (Zane, 2015). A person's feelings and attitudes are a thorough evaluation of the object of attitude. The affective component here shows a direct and general assessment of an object. A person's feelings and emotions are primarily aimed at the object as a whole, not feelings and emotions to the attributes possessed by an object. Feelings and emotions are described by expressing two different traits to evaluate the object. Psychomotor components indicate a person's or behavioral tendencies towards an object.

### **Learning outcomes**

Student learning outcomes are a direct measure that is often used by teachers to determine the extent to which students understand the contents of the lessons that have been delivered. According to Sudjana (2005) learning outcomes are abilities possessed by students after they have received their learning experiences. Learning outcomes as objects of assessment can be divided into several categories, including skills and habits, knowledge and understanding, attitudes and ideals. Meanwhile, according to Djamarah (2002) stated that learning outcomes are the results of an activity that has been done, created both individually and in groups to determine the extent to which the teaching and the process of learning has been successful, shown in the form of values obtained by students after an evaluation.

refer to what happened above understanding can be ascertained that the result of a study is to assess the success of the learning and teaching process that students have after receiving their learning experiences in teaching. The learning outcomes will be seen if the individual already has the desired attitudes and values likewise as mastering a science and a skill in accordances and objectives to be achieved (Lile, 2014).

### **Method**

This research is a population research in the type of quantitative descriptive research that describes the result of researchs in the forms of numbers or counts then described in words or sentences. The research design used shows the influences of learning interests on students learning outcomes in the Computer Study Program in Accounting. Population is the subject of research. The population in this study as well as a saturated sample are 45 students of Accounting Studys Programs. The numbers of samples to taken is the same as the population studied.

The author in collecting data uses several methods of data collection, namely: The documentation method is applied, namely to find data about things and variables in the form of notes or transcript. This technique is used to reveal data about student achievement in Computer Application subjects. Based on Sugiyono (2005: 135) Questionnaires is a techniques of data collections that can be dones by givings questions or written statement to respondent to be answered. Before processing further data, the researchers first analyzed the data. Data analysis is done by examining the problems in the research hypothesis. The purpose of data analysis is to process data in a form that is easier to read and interpret. Data analysis technique used is to use simple linear regression analysis techniques. This analysis technique is used to provide an explanation / description of the variable participation of members and the remaining results of operations each year in tables, percentages and graphs. Then all information obtained is analyzed, and described in accordance with the objectives of the study.

### **Result**

Learning is part of the process of assimilating and connecting an experience or material that can be learned with that understanding is already owned, so thats understandings develops. To achieve learning achievement students will go through a process that is the learning process. Students have the right to get a good learning process, as well as in a safe and conducive atmosphere. In the learning process there are many factors that influence student success that need to be considered in addition to the ability to understand previous lecture material.

Interest is an internal factor that influences learning success. Interest is one of the things that determines a person's learning success. A student who is not interested in a particular subject then he will be lazy to attend the course. Interest can be formed from experience and habits in learning. If a student feels that he needs a certain

subject then he will be interested in attending it and will give great attention to the subject and will try to achieve good results in the same course.

Reviewing the learning outcomes that must be achieved by student and also reviewing the learning process towards learning achievement, there are instructional steps that can be taken by lecturers to help student learning formulated in five categories including verbal information. In this case students must learn various fields of science both practical and theoretical. Then in intellectual skills, students must be able to demonstrate their abilities with the environment, be able to compete with the outside world. To measure the effect of independent variable on the dependent variables. In this case the influence of interest in learning on student learning outcomes Computer Application courses, then used a simple linear regression technique, Simple Linear Regression.

This analysis is used to search the extent of the influence of independent variable on variables, then a simple regression equation is used to find out how much influence the independent variables has on the dependent variables adjusted for regression coefficient table.

**Tabel 1. Models Summary**

Modl	R	R Sqre	Adjusted R Sqre	Std. Err of the Estim	Change Statistics				
					R Sqre Chang	F Chge	df 1	df 2	Sig. F Chge
1	,602 <sup>a</sup>	,363	,348	8,26873	,363	24,466	1	43	,000
a. Predictors: (Constant), x									
b. Dependent Variable: y									

From the results of statistical calculations using the summary model, it is known that the value of the regression coefficient R Square of 0.363 indicates an understanding that there is an influence of the variable interest in learning on student study outcomes by 36.3%. The coefficient of a regression is 0.363 which means that the effect of an interest in study on student learning outcomes in the Computer Application course is low. So it can be summarized that the effect of a learning motivation on student outcomes in the Computer Application course is 36.6% so while the remaining 63.4% is influenced by other factors.

**Tabel 2. Anova**

Modl		Sum of Sqrs	df	Mean Sqre	F	Sig.
1	Regression	1672,806	1	1672,806	24,466	,000 <sup>b</sup>
	Residual	2939,994	43	68,372		
	Total	4612,800	44			

- a. Dependent Variable: y
- b. Predictors: (Constant), x

The F test is used to find out the truth of the hypothesis of the independent variable on the dependent variable simultaneously (together). Based on anova calculation results described that the determination of hypotheses, the value of the test results are as follows: this means that the variable interest in learning Computer Applications simultaneously does not significantly influence the student learning outcomes variable Computer Applications courses. means that the variable interest in learning Computer Applications simultaneously has a significant effect on student learning outcomes Computer Application subjects. Given the significances values of 000b <0.05, Ho rejected. With a significance level (sig) value If the values of sig <0.05 then Ho rejected. From the tables above it can be noticed that the values of sig is 000b, which means less than 0.05. So it is proven that Ho was rejected. Thus there is a significant influence between interest in learning towards student learning outcomes in Computer Application courses.

Interest in learning is one of the ways that students can use to improve their knowledge, so they are expected to achieve learning outcomes in accordance with what is expected. To be able to find out how much interest in learning students Computer Application courses are used questionnaire media that are distributed to accounting education students.

Refer to the distribution results student interest questionnaires conducted by the author to students, respondents' assessment conducted by Accounting education students there are four indicators namely feeling happy, student attention, student relevance, student involvement distributed questionnaires per question item according to the indicator. That the results obtained for indicators of feeling happy, if students increase interest in learning in the Computer Application course, the student must be happy when hearing the news about the Computer Application course exam. In an indicator of student attention if students increase interest in learning in Computer Application courses, the student should prefer to pay attention to Computer Application courses rather than other subjects, in addition students have more than one other Computer Application book as material for learning, then students must read the Computer Application book is complete even though the lecturer has not finished discussing it.

In the indicator of student relevance if students add interest in learning in a computer application course, the student must feel satisfied learning a computer application compared to other subjects. Whereas in the indicator of student involvement, if students are interested in learning in the Computer Application course, the student must be fond of reading books that are related to Computer Applications and looking for exercises that are in the book to be studied, add or frequently record complete Computer Applications.

Interest in learnings that has an influences on student learning outcomes. With the interest in learning, students will be more motivated to learn. Learning based on strong interests will get good results. A student who is interested in a course will show a positive attitude towards the course. Conversely learning without being based on strong learning interest, will produce results that are less than optimal.

To be able to know the learnings outcome achieveds by student, documentation is needed can provide information on learnings outcomes achieveds by student while attending the Computer Applications course. Based on the documentation of the value of Computer Application courses in the sixth semester there are student learning outcomes. That of the 45 students, there are some students who get good grades, most of them get enough grades and some do not graduate. Overall results achieved by students in the Computer Application course are less than optimal. This is due to the lacks of interested in learnings that is low so the presence of other factors that affect interest in learning apart from the indicators mentioned in learning interest that are feeling of pleasure, student attention, student relevance, student involvement.

In answering the formulation of the problem that refers to the results hypothesis and data analysis testing using a regressions program it can be seen that interest in learning Computer Applications has a significant positive effect on students learnings outcomes in Computer Application courses. This shows that interest in learning Computer Applications has a positive impact on students learnings outcomes Computers Application courses. In testing the regression coefficient the influences of learnings interest on student learnings outcomes Computer Application courses have a low influence and the others are influenced by other factors. Whereas in hypothesis testing the influence of learning interest is significant on students learnings outcomes in Computer Application courses.

Based on the questionnaire of student interest in learning, it is known that there is a learning interest that is most supportive but the effect is low is a feeling of pleasure towards the course, student attention to the course, student intervention, student involvement in learning. While others are influenced by other factors outside the student's interest in learning. Increased learning interest will be a driver to achieve the desired goals or objectives in learning so as to achieve satisfying learning outcomes.

Interest is one of the things that helps determine one's success in all fields of study, work and other activities. Likewise a student's learning outcomes also determine his interest in learning. Besides interest can affect learning outcomes, learning outcomes can affect learning interest. If someone is not interested in learning something, it cannot be expected that someone will succeed well in learning it, conversely if someone learns something with an interest, then it is hoped that it will be better. Good learning outcomes in a particular field of study can increase one's interest in the field of study., Even in other matters relating to the field of study. So it cans be concludeds that interests in learnings and learning outcome influence each other.

Having a good interest in learning from students will be an incentive to work towards achieving their learning goals and objectives optimally because students are confident and aware of the goodness, interests and benefits of learning. For students, interest in learning is very important because it can move student behavior in a positive direction so that they are able to face all the demands, difficulties and bear the risks in their studies. Interest in learning can determine whether or not to achieve goals so that the greater the interest in student learning the greater the success or learning outcomes in learning.



Student learning outcomes of Computer Application courses have values based on documentation obtained in the fifth semester yesterday. In these values most of the students graduated and a small portion of students who did not graduate. This is due to the lack of student interest in learning about Computer Application courses. This learning outcome is very influential on student interest in learning, conversely interest in learning is also very influential on student learning outcomes.

Student learning outcomes are a direct measure that is often used by teachers to determine the extent to which students understand the content of subject matter that has been delivered. Learning outcomes are essentially a reflection of learning endeavors. The better the business or interest in learning the better the results achieved. To determine student learning outcomes, a lecturer conducts an evaluation of learning both individually and in groups.

In the research results where it is known that interests in learnings has an effects on student learning outcomes in Computer Application courses, for students and lecturers to pay attention to this so that the learning process can obtain satisfying learning outcomes. Therefore, in the context of increasing interest in learning that also affects student outcome

To strengthen this study, researchers compared with previous research journals. That the results of previous and current research have a relationship that is equally researching about interest in learning, and has a positive and significant impact on learning outcomes.

### Conclusion

From the result of data analysis so the discussions that have been clearly explained in the discussion, the following conclusions can be drawn: That in the interest of learning there is a significant influences on students learnings outcomes Computer Accounting Study Program Applications. Suggestions based on the conclusions above are as follows: Students should increase their interest in learning, especially Computer Application courses so that the learning outcomes of Computer Applications increase and as desired. It is expected that readers and researchers who will come in conducting research on learning outcomes to be more careful in determining the independent variables, because not all problems of learning outcomes, learning interests and courses are the same.

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## WORKING WITH ELECTRONS: INTEGRATING “KITS” FOR HANDS-ON ONLINE LEARNING IN HOMES

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### ABSTRACT

Teaching online can be a challenge, especially for courses which offer laboratory sessions. This research explores one method of replicating hands-on lab skills during an online course by developing a “Kit” which includes the necessary tools and components for students to complete the course labs at their homes. The intent is to provide an option for online courses, especially during unusual times, such as what occurred this semester during the closing of campus due to the COVID-19 situation. The study will share the approach, methods and components of the lab kit, as well as direct and indirect evidence of success of the research questions. The research focus is on how home lab Kits are effective for online learning to support lectures and reading; encourage self-efficacy; help students to become better researchers; create more meaningful project artifacts; keep students engaged in offline activities that are recurrent and periodic; and motivate students' dispositions to continue their efforts. Findings indicate that students do believe home Lab Kits are effective for supporting lectures and reading online; showed an increase of self efficacy when building circuits and interpreting results from their experiments; Kits are effective for helping them to become better researchers; projects created online were similar to projects created in a F2F setting; Kits kept them engaged in recurring offline activities; and Kits are effective for motivating them to continue their efforts.

**Keywords:** Online Teaching, Online Labs, Kits, Informal Learning, Hands-On Learning

### Introduction

Our university is a young private research university that has in total approximately 200 faculty members and 1,800 undergraduate students. The institution has a diverse international make-up of both faculty members (from more than 20 countries) and students (half from China and half from 70 other countries). The recent worldwide health challenges required all classes, including laboratories to migrate online quickly. Virtually all colleges and universities made the transition to conduct academic functions online amid the hazards of COVID-19 (Grush, 2020). Over the years, instructors have tried with varying degrees of success to provide students with valid laboratory experiences when learning in other setups than a traditional classroom (Jeschofnig & Jeschofnig, 2011). The belief was there was a critical need to create a hands on learning experience as close to (or better) than what had been offered to students in the past.

“Working with Electrons” is a project-based class which focuses on the discovery of electromagnetism. Along with lectures introducing major theoretical models that explain electromagnetic phenomena, students spend more than half of the class producing laboratory work, which includes assembling circuits, making self-oscillating inductive heaters, and other physical science concepts.

Seventeen students from eleven different locations around the world were enrolled in the online class. To ensure that the lectures and the experiments can be conducted with high quality through digital learning, the instructor designed the class including online sessions with at home interactive experiments using kits. Each student was asked to purchase basic kit equipment which included small electronics workbench with tools, instruments and materials to enable hands-on practice. Synchronous and asynchronous discussions were held via various digital platforms to guide students through the theories and the experiments.

The students met weekly using Zoom teleconference for synchronous interactions to discuss concepts and engage in group discussions. These sessions are recorded so that students who cannot attend can view later. In addition to synchronous interactions, the instructor also used Google Docs, Google Jamboard, and FlipGrid to facilitate asynchronous discussions among students. In Google Docs, questions are posted for each week and students are asked to provide responses connecting conceptual frameworks from each session so that everyone can view and comment on each other's thoughts. Google Jamboard is an interactive online whiteboard where students outline their thoughts and make annotations collaboratively. Students also post videos to present the originators of electromagnetic theory on FlipGrid.

Figure 1. Student Visual Representations



Figure 1 represents students' [visual representation](#) of the syllabus content. Students work in groups of different sizes, allowing them to collaborate with each other, so that they can foster connections that will allow them to work during the self-proposed projects for midterm and final together. The class uses Discord (<https://discord.com>), an online chat tool for groups similar to Slack, to improve the efficiency of multiple group communications and allow groups working simultaneously.

For the laboratory work, each student was provided with a multimeter, soldering station, prototyping tools and an assortment of components that allow them to work at their own rhythm. The concepts applied during the experiments are delivered with slides, notes and short video lectures recorded outdoors. To create a dynamic of team work where each participant is a stakeholder in the experiment, synchronous Question and Answer sessions are held separately for each group.

Every week, the students are asked to reflect on their learning experience and how they are able to connect the concepts among the theoretical readings, the practical knowledge delivered in the lectures and the experiments they complete. By the fourth week of a 14 week term, all students had run a one-on-one online video conference with the instructor to discuss their learning experience and how they are working remotely. On May 4, during week #11 of the term, the campus was reopened and six of the 16 students returned to F2F instruction.

The **Research Questions** for this study are focused on the introduction of Home Lab Kits for remote instruction and their effectiveness

1. Supporting lectures and reading;
2. Self-efficacy;
3. Helping the students to become better researchers;
4. Creating more meaningful project artifacts;
5. Keeping students engaged in offline activities that are recurrent and periodic (Self-regulated learning); and
6. Motivating students' dispositions to continue their efforts.

### Literature Review

Transition to Online Learning due to COVID-19

In a volatile world, institutions of higher education that cannot determine how to work differently may not work at all (LeBlanc, 2020). Campuses that use a significant part of their funds as investment for resources such as hiring instructional designers have been able to manage the transition from face-to-face (F2F) to COVID-19 required remote teaching and learning (Kim, 2020). Campus IT support staff scurried to assist faculty from those who already have it covered to others who had been trying to ignore online opportunities for years (Grush,



2020). The move to online teaching has become a university collective and proactive endeavor to overcome the adverse situation due to COVID-19. The pandemic proved to be a catalyst of leading an infrastructure and technology upgrade that was put in place in a month or less rather than over a few years (Schaffhauser, 2020).

#### Online Labs and Lab Kits

Due to the vast shift to online teaching due to COVID-19, a question raised was about lab classes and if it is even possible to do so remotely while still meeting the learning objectives (Taft, 2020). Professors of courses that involve laboratory work have been trying to transition from hands-on labs to remote activities such as having students follow audiovisual guides of teaching assistants performing the experiments to complete their lab reports (Gross, 2020). In a F2F lab setting, monitoring student learning and providing feedback is reasonably straightforward. However, in an online lab setting, addressing the means to formative assessment is crucial. Formative assessments assist faculty to help students identify strengths and areas of improvement (Purkayastha, Surapaneni, Maity, Rajapuri & Gichoya, 2019).

Lab kits, if commercially designed or by faculty, can be a means to provide strong formative assessments. It should have the same standards applied from an on-campus setting to online labs. Unlike computer simulations, lab kits engage students physically in active learning. A well designed and equipped lab kit that is academically aligned to specific course learning outcomes can mirror the types of experiments students normally perform at on-campus labs (Jeschofnig & Jeschofnig, 2011). Using lab kits at home can be a good learning experience by having students share a photo of the experiment results to help verify that they performed the activity (Taft, 2020). Commercially assembled lab kits are an avenue to potentially meet the needs of science laboratory experience for online students. It provides engaging laboratory opportunities for online students while providing instructors more valuable time to interact with students (Jeschofnig & Jeschofnig, 2011).

#### Informal Learning and Hands-On

With the rules of organization in formal learning, there are shortcomings to keeping up with the development of new knowledge and informal learning serves to reduce the gap and complement through accessing contents that are somewhat inaccessible. Instructors have a responsibility with informal learning to bring the topic closer to students and ensuring the quality level. Although informal learning does not have directly defined rules, there should be a framework, pre-defined outcomes and tasks that will be followed (Konjalić, Jević & Fodolović, 2018). With no instructor or lab assistant to set-up experiments, organize materials, clean up after, online students must take more responsibility for their own learning. Online students using lab kits to experiment independently tend to more seriously contemplate the laboratory experience (Jeschofnig & Jeschofnig, 2011).

#### Methods

This study was performed at a small private research university with a US/China partnership. The participants for this study were 17 second semester senior students (4 seniors, 11 sophomore, 1 freshman, and 1 junior), ten male and seven female students between the ages of 18-24 located in 11 different cities.

#### Procedure

The instructor attempted to provide a consistent method to create, deploy and integrate the lab kits in the course design. He secured additional lab fee funds from academic affairs; created a list of necessary materials, found the materials in various vendor websites, and placed the order through local and international suppliers. Specifically, the instructor created a document detailing how supplies were purchased by the students during the campus closure and shelter in place circumstances. He made sure the material and procedures aligned with the maturity level and capabilities of the students according to a pre-assessment form.

The syllabus was approved in the fall of 2018 with the general course structure of having offline classes with little to none online interactions. The scheduled time of the class was a weekly physical meeting of three hours, composed of 50% theory and discussion and other 50% of laboratory work. Given the situation of the virus outbreak COVID-19, the decision to move online the class brought also the challenge of running the experiments with remote instruction. The initial plan was to gather supplies that would facilitate installing in each of the homes of the students tools, instruments and supplies to perform the experiments that could help to have a similar learning experience to the one they would have had at the University's laboratory.

When it was close to the shipping date, the supplier reported difficulties given that their employees were also under strict quarantine. The instructor shared the challenges to have all the materials delivered and shared with the students a list of suggested materials with reference suppliers. The whole class collaborated to filter them and suggest replacements based on the location of the suppliers and the characteristics of the materials. The students contributed with alternative links that were quality was higher, shipping faster and had better customer service.

Having the students research and purchase their own materials brought a class dynamic where the students found themselves as collaborators and they worked with the materials more responsibly than when they worked at the laboratory on campus. For example, they were aware of the different models of instruments and tools, how complicated technical specifications could be for electronic components, etc. Not all aspects were improving the learning experience and one anecdote that is a good example is how students got capacitors from different suppliers that were of similar electrical characteristics but with different outlook, shape or color.

These differences added yet another obstacle when working remotely, by representing an obstacle for students who were not familiar with the components like capacitors and they asked for descriptions like “the orange round thing” when they actually had in their hands the right component but it was “the blue squarish thing”. These small complications somehow built into the course and the group could overcome them easily. But other issues brought challenges that some students saw as an obstacle. One example of this was when required to measure electrical parameters, some students had an instrument that did not measure frequency.

One of the initial observations from the experiences was that using the kits had great results with activities that can be clearly replicated by students (using a breadboard), because it helped to reinforce concepts understood from lectures and text readings. In some few cases, when the activity included some level of handcraft with manual skills, students showed a higher level of frustration with remote instruction (building a motor with a wire and a magnet) than in a face to face format.

Another tangible outcome is how the whole group’s vocabulary shifted towards a more mature terminology when they started having hands on activities with components. In the first activity the class did, they were asked to talk about the electromagnetic phenomena they experience in their daily life and the most abundant terms was “electricity” and after using components this term unfolded in terms like “electrical charge”, “magnetic field” and “radio waves”, showing a great development in the confidence they talk about the topic.

### Data Collection Instruments

From the research questions (RQ), we have identified and aligned the following data collection instruments:

**RQ1.** Are the Home Lab Kits Effective Online for Supporting Lectures and Reading?

**Indirect Measure #A.** Day one [Pre-Assessment](#) with challenging ([Results](#)).

Table 1. *Pre-Assessment Survey Questionnaire*

- |  |
|--|
| <ol style="list-style-type: none"> <li>1. Maxwell equations are             <ol style="list-style-type: none"> <li>a. something I watched in a documentary</li> <li>b. something I used in other courses</li> <li>c. nothing I ever heard of</li> </ol> </li> <li>2. What is a multimeter used for?             <ol style="list-style-type: none"> <li>a. to measure many meters</li> <li>b. to measure resistance</li> <li>c. to measure current in [kA] and voltage in [nV to GV]</li> <li>d. to measure voltage in [mV to V] and current in [uA to A]</li> <li>e. some people use it to measure Qi energy and vitality</li> </ol> </li> <li>3. Can you solder?             <ol style="list-style-type: none"> <li>a. No and I don't want to try</li> <li>b. No but I want to try!</li> <li>c. Last time I grabbed a soldering iron, I smelled fried chicken</li> <li>d. I'm OK with cables but PCBs are more difficult</li> <li>e. SMT or PTH?</li> </ol> </li> <li>4. How familiar with a breadboard are you?             <ol style="list-style-type: none"> <li>a. I use it for having breakfast</li> <li>b. I used it in the course Interaction Lab</li> <li>c. I used many times and I know that the convention for ground is to use black color</li> <li>d. Yes, I can build a Tetris with NAND gates if you give me a schematic</li> <li>e. All of the above</li> </ol> </li> </ol> |
|--|

**Indirect Measure #B.** Course Student Perception Data.

On April 13, 2020 students received a link to a Google Document which was made available to all students with the following information.

**“Student Perception of Online Class”**

Students, please read the items below carefully and share your honest feedback. Remember, please focus on the current online learning environment for this course, how you are learning and processing information. Your instructor is committed to assisting and providing the best support for your learning. The data you share will be anonymous and aggregated, so that your instructor will only receive your ideas.

**Most of the following questions are on the topic of the Home Lab Kits**

1. Please Share How the Home Lab Kits are Supporting the Online Lectures?
2. Please Share How the Home Lab Kits are Supporting the Online Readings?
3. Are the Home Lab Kits increasing your self-confidence for the topics learned? If so, please share how.
4. Are the Home Lab Kits helping you to become a better researcher? If so, please share how.
5. Do you believe the Home Lab Kits are helping you create more meaningful projects?
6. Do the Home Lab Kits help motivate you to continue your efforts?
7. What is one word that describes how you feel about the Home Lab Kits?
8. Overall, what is contributing to your learning in this online class?
9. What is one concrete action which the instructor can do now to improve online learning?"

**Direct Measure.** An analytical [rubric](#) was created to evaluate student projects. The rubric includes Concept Creativity; Concept Definition Clarity; Technique Subject Knowledge; Technique Research; Technique Feedback and Revision; Presentation Effort & Perseverance; Presentation Coherence; Presentation Outlook; Documentation References; Documentation Process; and Documentation Result Interpretation.

**RQ2.** Are Home Lab Kits Effective at Increasing Self-Efficacy Online?

**Indirect Measure.** Administered a subset on Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & DeGroot, 1990; Pintrich, Smith, García & McKeachie, 1991; 1993) addressing Self-Efficacy.

Table 2..*Self-Efficacy Learning Questionnaire*

- |   |
|---|
| <ol style="list-style-type: none"> <li>1. Compared with other students in this class I expect to do well.</li> <li>2. I'm certain I can understand the ideas taught in this course.</li> <li>3. I expect to do very well in this class.</li> <li>4. Compared with others in this class, I think I'm a good student.</li> <li>5. I am sure I can do an excellent job on the problems and tasks assigned for this class.</li> <li>6. I think I will receive a good grade in this class.</li> <li>7. My study skills are excellent compared with others in this class.</li> <li>8. Compared with other students in this class I think I know a great deal about the subject.</li> <li>9. I know that I will be able to learn the material for this class.</li> </ol> |
|---|

**RQ3.** Are Home Lab Kits Effective Online for Helping the students to become better researchers?

**Indirect Measure.** This data will be derived from the initial student perception survey on April 13, 2020, “Are the Home Lab Kits helping you to become a better researcher?”

**Direct Measure.** A comparison of 2018 student artifacts will be compared with the student artifacts generated this term using a [rubric](#) to measure research skills, and ability to integrate research questions.

**RQ4.** Are Home Lab Kits Effective Online for Creating more meaningful project artifacts?

**Indirect Measure.** This data will be derived from the initial student perception survey on April 13, 2020, “Do you believe the Home Lab Kits are helping you create more meaningful projects?”

**Direct Measure.** An analytical [rubric](#) was created to evaluate student projects. The rubric includes Concept Creativity; Concept Definition Clarity; Technique Subject Knowledge; Technique Research; Technique Feedback and Revision; Presentation Effort & Perseverance; Presentation Coherence; Presentation Outlook; Documentation References; Documentation Process; and Documentation Result Interpretation.

**RQ5.** Are Home Lab Kits Effective Online for Keeping students engaged in offline activities that are recurrent and periodic (Self-regulated learning)?

**Indirect Measure.** Administered a subset on Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & DeGroot, 1990; Pintrich, Smith, Garcia & McKeachie, 1991; 1993; Hargis, 2014; Hargis, 2000) addressing Self-Regulated Learning.

Table 3. *Self-Regulated Learning Questionnaire*

1.	I ask myself questions to make sure I know the material I have been studying.
2.	When work is hard I either give up or study only the easy parts.
3.	I work on practice exercises and answer end of chapter questions even when I don't have to.
4.	Even when study materials are dull and uninteresting, I keep working until I finish.
5.	Before I begin studying I think about the things I will need to do to learn.
6.	I often find that I have been reading for class but don't know what it is all about.
7.	My study skills are excellent compared with others in this class.
8.	When I'm reading I stop once in a while and go over what I have read.
9.	I work hard to get a good grade even when I don't like the class.

**RQ6.** Are Home Lab Kits Effective Online for Motivating students' dispositions to continue their efforts?

**Indirect Measure.** This data will be derived from the weekly surveys where the instructor asks students, "How do you feel?" on a scale from 1 to 5.

**Direct Measure.** Instructor [documentation](#) on how he perceives students are feeling and direct conversations documented on students sharing their feelings, and stories of anxiety, and stress.

**Results**

**Instrument #1.** Weekly surveys where the instructor asks students, "How do you feel?"

Table 4. *Quantitative data from survey question, "How do you feel?"*

Week	Standard Deviation	Mean
1	0.636	3.82
2	0.600	4.12
3	0.772	4.06
4	0.655	4.00
5	0.786	4.29
6	0.726	4.35
7	0.650	4.59
8	no data	no data
9	no data	no data
10	0.873	3.71
11	0.799	3.82
12	0.775	4.20

**Instrument #2.** Course Student Perception Data (the number in the parenthesis is the number of students who agreed with this comment). (Appendix A)

**Instrument #3.** An analytical [rubric](#) was created to evaluate student projects. The rubric includes Concept Creativity; Concept Definition Clarity; Technique Subject Knowledge; Technique Research; Technique Feedback and Revision; Presentation Effort and Perseverance; Presentation Coherence; Presentation Outlook; Documentation References; Documentation Process; and Documentation Result Interpretation. This rubric will measure attributes of deep learning, meaningfulness, connection to concepts, alignment to learning outcomes.

Table 5. Summary for Midterm Projects Mean Values [categorized through the pre-assessment scores]

Student Scores in Three Categories (n)	Concept: Creativity	Concept: Definition	Technique: Knowledge	Technique: Revision
Low (5)	2.72	2.52	2.58	2.68
Middle (5)	2.68	2.74	2.80	2.64
Top (6)	2.68	2.67	2.65	2.62

Notes: Student pre-assessment scores were divided into three categories (Bottom group between 0-4; Middle group between 5-6; Top group between 7-9).

Table 6. Summary for Final Projects [categorized through the pre-assessment scores]

Student Scores in Three Categories (n)	Concept: Creativity	Concept: Definition	Technique: Knowledge	Technique: Revision
Low (5)	2.50	2.63	2.30	2.30
Middle (5)	2.58	2.59	2.63	2.24
Top (6)	2.59	2.60	2.42	2.31

Notes: Student pre-assessment scores were divided into three categories (Bottom group between 0-4; Middle group between 5-6; Top group between 7-9)

Table 7. Summary for Overall Evaluation Midterm Project Presentations [categorized through the pre-assessment scores]

Student Scores in Three Categories (n)	Effort	Coherence	Outlook
Low (5)	2.82	2.68	2.66
Middle (5)	2.78	2.74	2.64
Top (6)	2.73	2.65	2.68

Notes: Student pre-assessment scores were divided into three categories (Bottom group between 0-4; Middle group between 5-6; Top group between 7-9)

Table 8. Summary for Overall Evaluation Final Project Presentations [categorized through the pre-assessment scores]

Student Scores in Three Categories (n)	Effort	Coherence	Outlook
Low (5)	2.63	2.63	2.43
Middle (5)	2.72	2.49	2.73
Top (6)	2.81	2.57	2.59

Notes: Student pre-assessment scores were divided into three categories (Bottom group between 0-4; Middle group between 5-6; Top group between 7-9)

**Instrument #4.** Motivated Strategies for Learning Questionnaire (MSLQ) for Self-Efficacy and Self-Regulated Questionnaires, specified on Table 2 and on Table 3.

Table 9. Summary for Self Efficacy *Data* (collected week #10 and #14)

Item	Low (5) Week 10 Week 14	Middle (5) Week 10 Week 14	Top (6) Week 10 Week 14
Compared with others in this class I expect to do well.	1.50	1.83	1.80
	1.00	2.00	1.60
I'm certain I can understand the ideas taught in this course.	1.25	1.50	1.40
	1.50	2.00	1.60
I expect to do very well in this class.	1.00	1.50	1.80
	1.25	1.83	1.60
Compared with others, I think I'm a good student.	0.75	1.83	1.40
	1.25	2.00	1.80
I am sure I can do an excellent job on the tasks assigned.	1.00	1.67	1.60
	1.25	1.83	1.60
I think I will receive a good grade in this class.	1.00	1.67	1.60
	1.50	2.00	1.60
My study skills are excellent compared with others.	0.50	1.33	1.20
	0.50	1.83	1.40
Compared with others, I think I know a great deal about the subject.	0.50	1.50	1.20
	0.50	1.67	1.40
I know that I will be able to learn the material for this class.	1.25	1.67	1.60
	1.75	2.00	1.80

Notes: Student pre-assessment scores were divided into three categories (Bottom group between 0-4; Middle group between 5-6; Top group between 7-9)



Table 10. Summary for Self Regulated Learning [Data](#) (collected week #10 and #14)

Item	Low (5) Week 10 Week 14	Middle (5) Week 10 Week 14	Top (6) Week 10 Week 14
I ask myself questions to make sure I know the material I have been studying.	1.75	1.83	1.2
	1.5	2.00	1.4
When work is hard I either give up or study only the easy parts.	0.5	0.17	0.2
	0.75	0.67	0.6
I work on practice exercises and answer end of chapter questions even when I don't have to.	0.75	1.0	1.2
	0.5	1.83	1.2
Even when study materials are dull and uninteresting, I keep working until I finish.	1.75	1.67	1.8
	1.75	1.83	1.8
Before I begin studying I think about the things I will need to do to learn.	1.5	1.83	1.6
	1.5	1.67	1.8
I often find that I have been reading for class but don't know what it is all about.	1.25	1.0	0.8
	1.0	1.50	0.6
My study skills are excellent compared with others.	1.25	1.0	1.0
	0.75	1.67	1.2
When I'm reading I stop once in a while and go over what I have read.	1.5	1.5	1.2
	1.75	1.50	1.0
I work hard to get a good grade even when I don't like the class.	0.75	1.33	1.2
	0.75	1.17	1.2

Notes: Student pre-assessment scores were divided into three categories (Bottom group between 0-4; Middle group between 5-6; Top group between 7-9)

Table 11.  
Comparison of Content [Pre/Post-Assessment \(Results\) Averages](#)

Pre/Post Assessment Items	Pre (% in Common)	Post (% in Common)
1. Maxwell equations	43.1	100
2. Using a multimeter	60.3	57.1
3. Familiarity with soldering	56.8	88.1
4. Familiarity with a solderless breadboard	23.5	71.1

## Discussion

The following narrative connects the data collected to each Research Question (RQ). Are Home Lab Kits Effective Online for:

1. Supporting lectures and reading.
2. Self-efficacy.
3. Helping the students to become better researchers.
4. Creating more meaningful project artifacts.
5. Keeping students engaged in offline activities that are recurrent and periodic (Self-regulated learning)
6. Motivating students' dispositions to continue their efforts.

The data supports that students do believe that the home Lab Kits are effective for supporting lectures and reading online. Students commented in the Course Student Perception (see Appendix) “Kits help me better understand the theories learned during class by allowing hands on learning; give us actual experience in operating soldering, building circuits, etc; include most of the materials we need for class; Were a great help, allowing me to do a lot of real-world experiments, thus discovering more details of digital circuits that any simulations couldn't show; and helps me understand more about the concepts mentioned in class.”

Lectures along the course included theoretical explanations, historical context of the discoveries of different phenomena and practical applications. Readings, videos and audio recordings were also contributing to have different perspectives and help to analyze and utilize the different tools to work through projects. From the instructors' perspective, the results when using the kits at home were at least as effective as student work accomplished in a F2F studio doing physical laboratory work. And their explanation was that lectures and readings put students in a listening mode, as the Home Lab Kits were more effective at bringing real scenarios where those high level concepts needed to be applied.

An unexpected finding was the depth that students could relate theory to the self-directed exercises with the kits. Originally, the main focus when designing the kits was to limit the type of experiments, based on the idea that students would not have physical contact with laboratory instruments. This shifted very quickly when the kits started being used and the students expressed high expectations about the complexity of the projects they could build, even though some had a degree of frustration when they needed to debug the circuits themselves.

The working methodology with the kits was using the online platform “Discord” in small groups of two or three students about the progress, each participant building circuits, aiming at lowering the frustration levels, clarifying the instructions about the objectives to obtain from the exercise, being able to relate the topics of the class and how to explain what they were experiencing in real life. While the summary of Self Efficacy (Table 6) doesn't show a significant difference in the experience of the students, some teams reported that they were able to understand the underlying theory despite having difficulties building the circuits and experiments. Their main reason they reported was the contact with the physical material (Appendix)

Students were asked to use a simulator and to calculate parameters in order to contrast the results. Later in the semester, they were asked to analyze a circuit and to assemble and test it. There was a substantial contrast in their engagement (Table 1); the depth they researched about peripheral topics; and the amount of hours they spent working on it. The instructor's interpretation of this was that instead of finding the “right” answer, they spent their time investigating, exploring and deriving deeper questions. This result further attended to students' perception of their own abilities.

For the second research question, students showed an increase of self efficacy (Table 6) when building circuits and interpreting results from their experiments. The first sessions and online one-on-one consultations were all reporting anxiety about whether they would be able to finish their circuits or if they could solve problems alone. Through the different activities several teams expressed confidence and were able to combine circuits to understand how they work.

This finding is also reflected by the pre and post assessments (Table 8) responses on how comfortable they would approach building circuits when answering questions regarding physical tools such as soldering and connecting circuits in a breadboard. This positive student perspective supported their further beliefs on how the Kits could enhance their questioning skills.

The focus of the third research question found that one hundred percent of the students responded affirmatively (Appendix) to the Kits are Effective Online for helping them to become better researchers. Students detailed their perceptions of improved research with comments such as “by taking a careful look at the mechanisms

behind the components, I developed a deeper understanding of some important science theories; without reading the corresponding data sheet and analyzing all of the pins, I can not finish my project; and when the program does not work with the circuit, it propels me to do research about it to find out where it was not done correctly and enables me to get to know about the related knowledge more effectively.”

The fourth part of this study found that when comparing the 2018 editions of the same course (Cossovich, 2020), where studio work and F2F classes were offered to support projects, the projects created online using Home Kits did not have any appreciable difference from F2F projects. In Project Based Learning courses, it is common to discuss among faculty about the “cookie cutters” when referring to how much freedom to give students but also how students can create a quality project that can be designed, developed and presented in a short period of time. This term can also be used in a negative sense, where students will not have the chance to create, explore and make mistakes with such a strict level of guidance from the instructors. When we introduced the idea of having remote instruction and students using kits, the question of whether we would be able to let them create their own projects, and have agency over their results or we need to use a “cookie cutter” was raised. Overall, the instructor found a satisfactory dynamic between an open-ended and “cookie cutter” experience, which resulted in students engaging in meaningful discussions and demonstrating a great diversity of projects (Tables 2 and 3) during their presentations. It appeared that students were able to balance the openness with quality and time, which are key attributes for online learning.

Our fifth question addressed a major challenge for learning online, the concept of self-regulated learning. Our results (Table 7) showed that students believe that the Kits kept them engaged in recurring offline activities, supported by their statements, “I can dig deeper into my interests; besides the projects I need to do, I can also try some interesting circuits, such as light control; there are always some ways to improve the circuit with these components; I will continue discovering the feasible ways to improve the project; and with the advice of my professor, I am curious to explore the potential of all the material in my Kits.” This data also seems to keep students' attitude and desire to make progress, which was especially important during less than ideal health challenges around the world.

The sixth research item was to ascertain if the Kits could assist with student motivation, which was especially key, in the absence of traditional F2F motivators. Students recognize (Appendix) that the Kits are effective online for motivation and enhancing their dispositions to continue their efforts, which was supported as they use adjectives to describe their feelings about the Kits as “Fantastic, Inspiring, Useful, Fascinating, Exciting, Challenging, and Useful.” Students responding with positive dispositions help them connect to their intrinsic motivation, that helped them persevere during times of feeling alone. This was also showed in the project they showed during Midterms and Finals (Tables 4 & 5)

In addition, through reviewing the student data, we arose at several additional inquiries worth discussing.

- How does this online, at Home Kit approach compare to F2F?
  - Key differences between the two approaches include a technical aspect given that some activities and exercises were not possible to carry because they require more complex tools (such as oscilloscopes, regulated power supplies, frequency generator, etc) or materials (equipment to manipulate high voltage, high power dissipators, PCB milling CNC, etc).
  - Students suggested several advantages, which included the ability to have their own electronic workbench at home and work in flexible times when compared to the laboratory work at the studio.
- Could the Kits be part of an ongoing regular lab offered online?
  - The instructor expects to teach this course in an online format simultaneously with an offline version, both groups of students working with the same Kits. The COVID-19 emergency actually informed the instructor about different ways the experiments could be designed to be carried out by the students independently. The expectations of using the kits both for online and offline activities are that it could be possible to allocate more resources to share the finding of the experiments, discuss possible implementations and give space to answer questions from the students. Instead of the traditional setup where the instructor spends a significant portion of the allocated time for laboratory work giving instructions and supervising closely how to carry out the activities, this time could be used to reflect on the learning.

The quality of the student artifact was higher overall (accounting [not controlling] student prior knowledge, data collected and observed indicates that this a typical class with respect to GPA, background, experience, etc.). We believe this has happened for the following reasons:

1. The class was one of the few opportunities during the semester for the students to carry on their own project, pursuing their interests in the Project Based Learning modality. Other classes were proctoring exams remotely or assigning extra writing exercises to complement the lack of face to face activities.
2. The challenge of being part of developing a new teaching methodology together with the instructor for a course that was integrating disciplines was a motivation factor for students to work longer and research more.
3. The Kits gave a sense of agency and ownership over the way they approached practicing when compared to utilizing materials already existent in the studio inventory of the University.
4. The activities in class required students to collaborate between each other in rotating groups as well as to work with partners, giving a sense of community belonging and accountability in front of the other participants.

Based on the class's experience, the instructor has observed that the lack of integration between different communication tools was far from ideal. For example, when he started using Discord learning management system for a planned asynchronous task for groups of three students, they could not talk among each other unless they were already "friends" with each other. That single technological inability was a distraction from the class. Even simple tasks for a F2F class session like using a soldering iron or measuring current have become technical challenges that need very careful planning.

However, the instructor believes this will not be a hindrance for online learning and remote communications. Every week, students are surveyed about their class experience and suggestions. Some of them have been volunteering to help on the technical challenges the class faces, creating a real learning community. Thanks to students' recommendations, the instructor is made real time, continual adjustments and improving the class by trying new technology and pedagogy to make the online sessions more engaging.

#### Limitations of Study

The variables for this study are numerous due to the rapid migration of courses online; the students physical location; and subsequent wide differences in internet connections and several of the students (n=3) reported during office hours that the overload work they had given the circumstances was influencing their lack of attention and difficulties to concentrate in class. As an example, two of them reported sleeping less than five hours average during the midterm exam week. Great influence of last week mixed mode tryout (n=6) was reported in the last class feedback form, where several of the remote students (n=5) mentioned that remote learning did not work well for them, while for them as in other weeks. The situation of having students in the classroom with physical manipulatives and others simultaneously having online instruction proved to be another challenge in the last two weeks of classes.

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#### Appendix. Course Student Perception Data

1. **Please Share How the Home Lab Kits are Supporting the Online Lectures?**
  - The Kits help me better understand the theories learned during class by allowing hands on learning.
  - The Kits we have at home give us actual experience in operating soldering, building circuits, etc.
  - The Kits are really helpful. But it is a little hard to figure it out by ourselves at home.
  - The Kits include most of the materials we need for class. Great help!
  - Practice makes perfect. The Kit allowed me to do a lot of real-world experiments, thus discovering more details of digital circuits that any simulations couldn't show.
  - The Kit definitely helps me understand the theoretical concept we have learnt during the class time.
  - The Kit is very useful and provides many materials needed with clear information.
  - The Kit helps me understand more about the concepts mentioned in class.
  - While it is certainly helpful and seems robust, it is hard to understand what every function does when I lack the knowledge in the real world as well (new to the subject).
  
2. **Please Share How the Home Lab Kits are Supporting the Online Readings?**
  - The Kits and the readings are two distinct factors supporting my online learning. (3)
  - The Kits allow us to turn the theory in the readings to an actual project or a little gadget in real life.
  - The Kits provide a kind of practical application of the Online Readings.
  - The Kits enable me to know the information in the readings in a more concrete way.
  - The Kits allow me to build real stuff based on the theory in the readings.
  
3. **Are the Home Lab Kits increasing your self-confidence for the topics learned? If so, please share how.**
  - Yes (6)
  - Yes. By getting my hands dirty, I could have a better understanding of the theories learned in class.
  - I think seeing my own circuit works definitely increases my confidence in the electric knowledge that I learned.
  - Of course, yes. It is even not possible to learn without the help of experiments.
  - Yes! Getting a hand on the Kit components makes me feel confident about building any circuit.
  - I'd like to say no and yes. No. Because I used to believe that the digital circuit is entirely discrete and easy to design. However, after I conducted many experiments using the Kit, I realized that there are lots of analog factors I should consider when creating a digital circuit. Yes. Because after using the Kit, I learned way more about the digital circuit, and now I'm more confident about what I've learned.
  - Of course. When I complete the construction of my own circuit and see it can successfully run, I definitely get a sense of achievement.



- Yes. Being able to make the digital circuit into a real one helps to learn more about the circuit knowledge and bring attention to many details that are hard to notice through digital simulations.
  - Yes. I am able to explore all the related stuff by myself and play with it.
4. **Are the Home Lab Kits helping you to become a better researcher? If so, please share how.**
- Yes (6)
  - Yes, by taking a careful look at the mechanisms behind the components, I developed a deeper understanding of some important science theories.
  - Yes, by delving more into all the details and unexpected problems.
  - Yes. For example, as for the NE555 and the 9013 transistors, without reading the corresponding data sheet and analyzing all of the pins, I can not finish my project.
  - Yes. When something goes wrong or do not work with the circuit, it propels me to do research about it to find out where it was not done correctly and enables me to get to know about the related knowledge more effectively.
  - Yes. With the raw material, I can explore more than what the professor asks and do my own modifications.
5. **Do you believe the Home Lab Kits are helping you create more meaningful projects?**
- Yes (6)
  - Yes. It is giving me flexibility in what to build.
  - The kits give me more options when building projects, and I can buy the parts I need online to make my project finished.
  - Yes, it provides many possibilities for us to discover what we can make out of the materials at hand.
  - Yes, using the kit we create something in real-world.
  - Yes, it provides me the basic support to discover the world of electronic circuits.
  - Yes, the kits bring certain inspiring possibilities.
  - Yes, it provides me with more possibilities when designing my own project.
6. **Do the Home Lab Kits help motivate you to continue your efforts?**
- Yes (4)
  - Yes. I can dig deeper into my interests.
  - Yes. Besides the projects I need to do, I can also try some interesting circuits, such as light control.
  - Yes, there are always some ways to improve the circuit with these components.
  - Just so-so.
  - Yes, with the help of the Kit, I will continue discovering the feasible ways to improve the project.
  - It depends? Sometimes after too many failed attempts, it gets a bit tiring and overwhelming.
  - Yes. With the advice of my professor, I am curious to explore the potential of all the material in my Kits.
7. **What is one word that describes how you feel about the Home Lab Kits?**
- Fantastic
  - A little **tricky** but generally **fine**
  - Inspiring
  - Useful, but the quality really needs some improvement
  - Fascinating
  - Exciting but sometimes also challenging
  - Challenging
  - Useful
8. **Overall, what is contributing to your learning in this online class?**
- My interaction with professor and fellow after class.
  - Building interesting projects with my classmates.
  - Group discussion.
  - Self-learning.
  - The anti-pressure ability.
  - Certain extent of self exploration.
  - Self-learning and discussion with classmates and professor.



9. **What is one concrete action which the instructor can do now to improve online learning?**
- I think learning online is harder than learning in face to face. Hope professor can adjust the grading policy. (2)
  - I think it is hard to say immediate actions right now, but I definitely think the learning process is building itself step by step.
  - Being more specific on the overall requirements and what is expected from our work.
  - Holding more office hours to improve the interaction procedure.
  - Explaining some theories and requirements as well as guidelines more clearly.
  - Have more breaks.