Faculty feedback on hub-based approach to national dissemination of low-cost desktop learning modules

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Work in progress (WIP): Faculty feedback on hub-based approach to national dissemination of low-cost desktop learning modules

Abstract

Low Cost Desktop Learning Modules (LC-DLMs) are hands-on modules that are used in traditional lectures, in order for students to observe the concepts they are learning in class. These modules have been developed, tested, and optimized over the past several years. The newest iterations of these miniature experiments and accompanying materials are being spread to about 50 institutions nationwide over the course of five years. To accomplish widespread distribution and implementation, we are using a hub and spoke dissemination model, where hub coordinators were trained in the use and implementation of LC-DLMs at an initial workshop at Washington State University. The coordinators then assist in training local "spoke" participants at a workshop held at the coordinator's home institution. We gauge the effectiveness of local workshops on both local and widespread implementation as well as student performance via faculty surveys.

The initial workshop for hub coordinators was held in Spring 2019, and the first spoke workshop for participants was held at the University of Central Oklahoma in Fall 2019. Feedback from the hub coordinator workshop was used to make changes to the spoke workshop. Key feedback included an appreciation for the brief lesson on educational psychology, since very few engineering faculty have been exposed to the theory behind hands-on activities in the classroom, as well as suggestions on how to improve the hands-on activities during the workshop.

We modified the workshop agenda for our South Central Hub workshop in Fall Semester 2019 and received generally positive feedback from faculty. Of the ten responses, 100% indicated that the overall experience of the workshop was "good" or "excellent" with only 4 critical yet constructive responses to individual questions. Key feedback included practicing the implementation from a faculty perspective instead of from a student perspective, and desire for additional time spent on the educational psychology background. In addition, the workshop spurred some participants to request additional modules after seeing ease of use, and other participants inquired about letting other faculty at their home institution use the LC-DLMs in the classroom. This feedback will be used to improve future spoke workshops in the coming years, including two serving the South Central Region, one in the Northeast, and one in the West.

Keywords: active learning, hands-on activities, dissemination

Introduction:

Studies have shown that students participating in engaged, active learning demonstrate larger increases in cognitive performance than students participating in traditional inactive learning [1-3]. While all types of active learning show greater improvements compared to passive learning, interactive engagement, where students are interacting with each other or technology shows the largest learning gains [1]. Our hands-on team-based learning is inherently interactive, due to students working within groups, and we hypothesize that this pedagogy will also demonstrate larger learning gains compared to traditional lectures or students working on the DLMs by themselves.

Often, engineering students do not get to interact with technology or do experiments related to concepts they are learning until their junior or senior year in a specific laboratory environment. These later interventions do not help their understanding when they are initially taught these concepts. To address this, miniaturized hands-on modules have been developed to compel student engagement in sophomore and junior level engineering classes, specifically within the heat transfer and fluid mechanics classroom context. These highly visual low-cost desktop learning modules (LC-DLMs) have been shown to improve student understanding compared to passive lectures, especially at higher Bloom's levels such as evaluation and creation [4-5].

Even with significant data to support the fact that active learning leads to more cognitive gains compared to traditional lecture-based teaching, there are still perceived barriers to implementation [6]. Faculty often indicate worry about additional preparation time needed and an inability to get through the syllabus material in regards to adding active learning to their classroom. When considering hands-on activities that require additional hardware and/or preparation, there are even more barriers to implementation, including financial cost and ease of use.

The low-cost desktop learning modules address, in part, each of these barriers:

- Preparation time: worksheets have been developed to accompany the modules, so faculty simply need to look over the pre-developed worksheet and bring the hardware and accompanying worksheet to class.
- Syllabus material: DLMs address core concepts in fundamental classes and can be used in lieu of or in addition to traditional lecture.
- Financial cost: Each DLM kit which contains two modules (heat transfer or fluid mechanics) is comparable to the price of a textbook ($125-$150).
- Ease of use: students can set up and tear down the modules in the classroom, requiring little oversight from the faculty.

Because of these considerations, we want to propagate the use of DLMs across the United States at a diverse set of institutions and collect additional data regarding the effectiveness of the modules under different implementation conditions. To disseminate this pedagogy, we have developed a regional hub-and-spoke adoption procedure, which is outlined below.

Procedure:

This national dissemination effort is scheduled to take place over five years. We started with a subset of participants (fifteen spoke institutions and five hub institutions) in 2019 and will continue to add approximately five to ten more every year until 2023. This gradual roll-out was planned at a rate commensurate with our ability to manufacture the DLMs, address any lingering issues with the modules, and refine ancillary materials in the first year with a small number of participants (<15), while still expanding DLM usage.

Faculty were recruited from several types of higher-education institutions, including Research One, primarily undergraduate institutions (PUI's), historically black colleges and universities (HBCU's), Hispanic serving institutions (HSI's) and one two-year institution. We collect the same types of data from each school, specifically quantitative data in the form of pre- and posttests, as well as motivational surveys. This diverse set of participants will allow us to compare the effect of DLMs within different implementation scenarios we think important to

contrast, e.g., small vs. large class size, lab vs. classroom, hands-on vs lecture-based implementations, the type of institution, and student demographics, while controlling many variables such as using the same DLMs, pre- and posttests, classroom timing, and instructor training.

To ensure important variables were appropriately controlled, we set up workshops to train participants on proper implementation and to explain our motivation behind the large-scale project and their role in it. The workshops are supported by a robust website that contains all accompanying material including worksheets, instructions, assembly videos, frequently asked questions, a frequently asked questions hotline, and real-time help during implementation.

Planning

Most participants, approximately 50, were recruited in the spring and summer of 2018, approximately one year before the workshops began occurring. Participants were recruited via a number of sources, including the ASEE ChED Summer School, personal networks, and secondhand suggestions. After faculty agreed to participate in this project and their home IRB offices gave approval, they were assigned to hubs based on their geographic location. A schematic of these hubs can be seen in Figure 1 below.

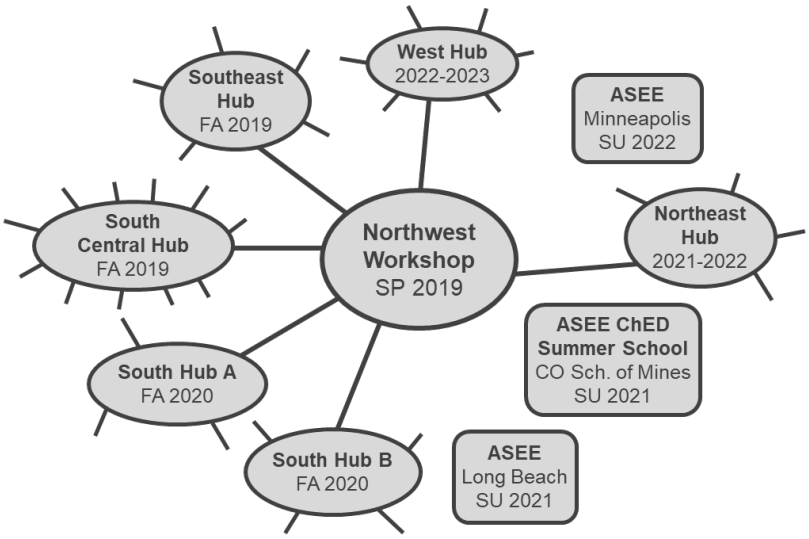

Figure 1: Representative schematic of the national hub and spoke model, where hubs are labeled and each spoke represents a different participant. The dates of the Northeast Hub and West Hub will be determined in the fall of 2020 and 2021, respectively.

We strove to ensure that no more than a half-day of travel to or from the workshop was required for any participant, which is often a barrier that prevents faculty from participating in projects that require training. However, some faculty elected to attend workshops at geographically different hubs due to factors outside of their control, including weather, curriculum considerations, etc.

Workshop planning took place over the course of a year, starting with confirmation of IRB approval from each participating institution. The workshop date was set approximately nine months in advance, keeping in mind academic schedules, major conferences, and travel convenience. Six months before the workshop, any necessary modifications were made to the workshop materials. This includes materials ancillary to the DLMs themselves, specifically the worksheets and learning objectives for each module, workshop topics, and workshop schedule. Three to four months before the workshop participants were contacted to confirm that they still wish to participate in the project. If the original participant was no longer teaching fluid mechanics or heat transfer, the two topics specifically addressed by our current DLMs, we asked that they suggest a replacement from their institution. During this initial communication, we also gathered information about their implementation

plans, including which class they are teaching, how many DLMs they need, and when they plan on using them in the classroom. Once all attendees were confirmed, we finalized the workshop agenda and all workshop materials. During and after the workshop, attendees were able to access all workshop materials, including presentations and handouts.

This timeline is currently being used to plan workshops for Fall 2020 and will be used for all future workshop planning. This ensures timely communication and uniform workshops, sans improvements made each year. Any changes made to DLM materials, such as worksheets or training videos, will be clearly communicated to prior hubs at the beginning of the academic year.

Hub coordinator training:

The first workshop held in Spring 2019 was attended by hub coordinators and Northwest participants, all of whom were familiar with the DLMs before attending the workshop. The day-long workshop served to teach them about the larger scope of this project and allow them additional practice with the DLMs. In addition, they were informed about the background and history of the DLMs, given an overview of educational psychology and the motivation for the project, and shown technical data from DLMs that typically agrees to within 10% of those predicted by industrial correlations. This workshop differs from the future workshops due to the participants' familiarity with the DLMs, which "spoke" participants will not have seen before.

Spoke workshops:

The South Central Hub and Southeast Hub workshops for spoke participants were scheduled to be held in September 2019. Due to Hurricane Dorian, the Southeast Hub was cancelled and attendees were given the option of attending the South Central Hub workshop, receiving one-on-one training, or attending a future workshop at a South Hub. Tropical Storm Imelda caused travel delays for some attendees at the South Central Hub workshop, although the majority of participants (nine of thirteen) were able attend. One additional faculty who expressed interest in the DLMs but is not a formal participant in the project was invited to attend for a total of ten spoke participants. One hub coordinator and five members of the main research team were also present to facilitate the day-long workshop.

Many topics overlapped between the first hub-coordinator workshop and the spoke-focused workshop, especially the DLM history, technical data, and introduction to educational psychology. However, significantly more time was spent working hands-on (four hours vs. two hours) with the DLMs since these participants did not have the same prior use experience as the hub coordinators.

Two South Hub workshops have been scheduled for September and October 2020, and workshop materials will be updated in the coming months as per the timeline outlined above.

Workshop feedback results:

The first step in gauging the effectiveness of the local workshops is to get direct feedback from faculty attendees. We gathered both formal and informal feedback during the South Central Hub workshop. This not only informed changes to future workshops, but also impacted interactions we have with implementers throughout the year. Sample questions are below in Table 1.

Table 1: Sample questions from the faculty workshop survey.

Please indicate your level of knowledge and skill with the topics below:

Rate your knowledge of:	NOW					BEFORE THE WORKSHOP				
	Low 1	2	Average 3	4	High 5	Low 1	2	Average 3	4	High 5
EDUC-ATE vision for transformational change in teaching approaches	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Evidence-based theories of learning and instruction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
How to harness the visual impact of the LC-DLMs to enhance student understanding	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

To what extent were the following features incorporated into the workshop you just completed?

	Not at All 1	A very Little 2	A small amount 3	Somewhat 4	Quite a Bit 5	A Lot 6	Very Much 7
The workshop included presentation of new material that I had not seen before.	☐	☐	☐	☐	☐	☐	☐
Workshop material was presented in an interesting, engaging way.	☐	☐	☐	☐	☐	☐	☐

Please indicate the quality of the following aspects of the workshop:

	Excellent - 4	Good - 3	Fair - 2	Poor - 1	N/A
Information usefulness	☐	☐	☐	☐	☐
For the workshop overall: Presenters' knowledge	☐	☐	☐	☐	☐

Faculty were asked to self-report their knowledge and skill with DLM topics on a Likert-scale of 1 to 5, where 1 is low knowledge and 5 is high, after the workshop and compare it to what they knew retrospectively before the-workshop. Topics included the overall dissemination project, learning theories, and implementation practices. We saw significant increases in self-reported knowledge ($p<0.01$) for all topics, indicating that faculty feel that they are gaining something from the workshop.

The lowest increase in knowledge from before-to-after the workshop was on the topic of evidence-based theories of learning and instruction. Five participants indicated a higher-than average level (>3) before the workshop and indicated no increased knowledge of the topic. The other faculty who had an average or lower (≤3) level of knowledge about learning theories before the workshop indicated that they knew more after the workshop was completed.

In addition to asking about knowledge gained, we also asked questions about the workshop content. Participants were asked to rate the extent that certain features, including new material, engaging presentations, and useful ideas, were incorporated into the workshop on a Likert scale of 1 (Not at all) to 7 (Very much). We saw that the average responses were all above 5 (Quite a bit), indicating that faculty found that we generally incorporated engaging, novel features into the workshop. However, a few features had some individual responses that were at level 4 (Somewhat) or below which we want to address for future workshops.

The three faculty who responded with a 4 or lower for "presentation of new material" are a subset of the five faculty who indicated a high level of knowledge of learning theories. We had

set aside significant time to introduce educational psychology based on feedback from the hub coordinator workshop, where participants indicated that was the most useful information they received. For future workshops, we will poll faculty participants about their knowledge of these topics when we confirm their attendance and modify the workshop topics based on these responses. We anticipate that by modifying the workshop based on their self-reported knowledge, we can improve the score on new material.

The other three questions that had low-to-average responses (≤4) were related to using the DLMs and workshop material after leaving the workshop. Faculty were appreciative of the hands-on use of DLMs during the workshop, but expressed apprehension about using them with students in a typical class period of 50 minutes. To address this with participants after the workshop, we provided extensive support during the semester to address any concerns they had. Specifically, some faculty took advantage of a one-on-one pre-implementation meeting with members of the research team to go over their implementation procedure. This is a concern we are working to address in future workshops so that participants can leave feeling very confident that they can use DLMs in the classroom without additional support.

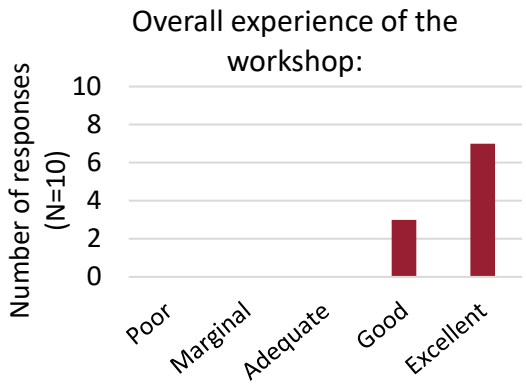

Figure 2: Responses from workshop participants regarding the overall experience of the workshop.

Overall, faculty participants had a good or excellent experience at the workshop, shown in Figure 2. Multiple participants mentioned that using the hands-on DLMs was a highlight of the workshop and that the activities helped break up the other sessions. Three faculty requested additional modules immediately following the workshop after seeing how straightforward the DLMs were to set up and use. Many constructive comments were also given, many of which are addressed above. Others, such as comments about logistical and communication issues, will be fixed in future workshops.

Current and future outlooks:

We have gathered one semester of quantitative and motivational data for DLM implementation from South Central Hub and Southeast Hub participants. We are continuing to work with the participants as they complete a second semester of data collection and make adjustments to their implementation. This data will be used in conjunction with the faculty feedback to demonstrate the effectiveness of the workshops in DLM implementation and student performance. In addition, we are providing support in the form of collaborative feedback to faculty who wish to make significant modifications to DLM implementation.

Planning for year 3 workshops at South Hubs A and B is underway, and modifications to the workshop agenda will be made based on the feedback from the South Central Hub participants. Our goal is to increase all individual responses to above average for the year 3 workshops. We also hypothesize that year 2 participants will need significantly less support as they enter their second year of implementation, which will allow us to focus on new participants.

Year 4 and 5 workshops are tentatively scheduled for 2021 and 2022. Because the DLM manufacturing is ahead of schedule and year 2 implementations are going as expected, they could take place earlier. We also will have shorter trainings at the ASEE ChED summer school and 2021 and 2022 ASEE Annual Meeting conferences for additional faculty who are interested.

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