5E-SESE Phase 1 Research Report

Lindsay Ruhter
Rebecca Swinburne Romine
Meagan Karvonen
Sarah Koebley

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5E-SESE Phase 1 Research Report

The purpose of phase 1 research was to gather preliminary evidence of usability and expected feasibility of the 5E-SESE PD system. Research questions included:

1. To what extent do participants complete the online course components?
2. How do participants perceive the usability and likely feasibility of the 5E-SESE system? What changes do they recommend?

Phase 1 research was based on the version of the PD system that included (1) seven modules (1 course overview, 3 fundamental modules, 3 modules each based on one Essential Element (EE) in grades 3-5), (2) a self-assessment for selecting EE modules, and (3) an assignment for individualized lesson plan development which was completed at the end of the selected EE module.

Participants

Six districts from six states agreed to participate in this phase. Within those districts, all teachers who were responsible for providing science instruction to students with SCD in grades 3-5 were recruited to participate. There were no teacher- or student-level exclusion criteria. To ensure a wide range of perspectives at an early stage of the project and to account for teachers distributing themselves across available EE modules, the target sample size was 18 teachers. Seventeen teachers from six states (one district per state) consented to participate, with a range of 1 to 7 teachers per district (see Table 1). Although not originally planned, we included two non-special educators who were based in participating districts and were involved in science instruction for students with SCD. The majority of participants had 1-5 years of experience teaching science to students with significant cognitive disabilities and most reported receiving no professional development in the past year on science instruction for students with significant cognitive disabilities.

Table 1

Participant Characteristics (n = 17)

Characteristic	n
State	
Iowa	7
Wisconsin	4
Oklahoma	3
Missouri	1
Kansas	1
West Virginia	1
Role	
Special Educator	15
General Educator	1
Consultant	1
Years of Experience teaching science to students with SCD	
>1 year	1
1-5 years	10
6-10 years	5
11+ years	1
Hours of PD on science instruction for students with SCD	
None	13
1-5 hours	3
6-10 hours	1

Measures

Background Survey

We used a brief teacher background survey to collect information on teachers' characteristics and recent professional learning experiences. Topics included years of teaching experience, student population, science professional development activities in the past year, degrees or licensure in science or science education, and size of case load.

Course Logs

Course logs are generated on demand in the online course platform. Logs provide information about real-time usability without resource-intensive data collection such as direct observation studies. The course log contains a time stamp each time an element is selected (e.g.,

course module homepage, lesson pages, checks for understanding). Each participant's actions were compared against a checklist of the intended sequence of activities. The checklist was developed based on module design and participant instructions for completing the sequence of steps. Evaluating course logs with the checklist yielded the sequence of steps that were completed in what order, per participant.

Usability Survey

The usability survey included items that measured content usability and course configuration usability. Content usability covered modules and activities and were measured using items from two existing instruments. First, we used items used to evaluate current DLM professional development modules to gather feedback on each module. These 4 items, rated on a 4-point scale (strongly disagree to strongly agree), follow the phases of Guskey's (2002) model and ask respondents to evaluate the importance of the content, whether the program gave them new ideas, whether it was worth their time and effort, and whether they intended to apply what they learned. Based on more than 78,000 modules completed, there is evidence of consistency of module evaluations (correlation of mean response ratings across modules = 0.96). For the EE-specific modules we also developed new items to gather feedback on the extent to which each section of the module accomplished its learning objective. We also asked participants to give open-ended feedback on each module.

The second part of the content usability measure used items from the Attitudes Toward Web-Based Professional Development survey (AWPD; Kao, Tsai, & Shih, 2014), specifically the Perceived Usefulness (PU) and Perceived Ease of Use (PEU) scales. Each scale has four items that are answered on a Likert-type scale (strongly disagree to strongly agree). Previous researchers (Kao et al., 2014; Kao & Tsai, 2009) documented strong internal consistency for both scales (α = .87 to .92 across studies) and construct-related evidence, in that PU and PEU

items loaded on different factors. Items were modified slightly to reflect 5E-SESE system goals and to drop the neutral point so items were answered on 4-point scales. Scale scores are calculated as means of the item responses, with values ranging from 1 to 4 where 4 indicates strong agreement. Internal consistency was reasonably strong in our study given the sample size (α_{PU} = .881, α_{PEU} = .789). One open-ended item gave participants the opportunity to provide general feedback on the overall system.

Usability of course configuration (i.e., overall online course design) were evaluated using the System Usability Scale (SUS), developed by Brooke (1996) and modified slightly by Bangor et al. (2008). The SUS consists of 10 items with 5-point response scales. Response values are summed to create an overall usability score ranging from 1 to 5. Bangor et al. (2008) described the use of SUS across more than 200 studies and various technology applications and reported evidence of a single usability factor and internal consistency of 0.91 across items. Internal consistency in our study was α_{SUS} = .833. The usability survey concluded with three open-ended items where participants may provide additional feedback and recommendations for improvement of each component (platform, modules, lesson plan activity).

Focus Group Protocol

The primary purposes of the focus group were to determine participants' acceptance of the overall 5E-SESE PD system, identify potential usability barriers, evaluate the likely feasibility of future implementation, and solicit suggestions for improvement. Additional details and specific probes around navigation, visual design, interactivity, and content/resources were included in the semi-structured interview protocol (Zaharias, 2009).

Procedures

Teachers were recruited from participating sites in late August and early September 2019. Teachers completed the background survey and informed consent. After consent, teachers were

given course accounts, instructions for accessing and completing the modules and activity, and a recommended timeline for completion. The implementation phase lasted eight weeks (September-November 2019).

Participants were instructed to complete a course orientation module, three fundamental modules, a self-assessment tool to guide EE module selection, and one EE-specific module. During the intervention, the project coordinator monitored participants' course progression every Monday morning. After two weeks, the project coordinator reached out to any participant who had not yet logged into the 5E-SESE system. After three and five weeks, a recommended pacing guide was sent to participants who were behind the recommended schedule. All participants were given a two-week and one-week reminder to complete the course.

After the intervention, researchers exported course logs. One researcher analyzed the course log data statistically to determine completed steps and completion sequence per participant. In addition, time spent in each lesson within each course was recorded. The post-course survey and focus-group invitations were sent to all participants two days after the intervention was completed. Reminders were emailed to survey non-respondents both one week and two days before the deadline.

The focus groups were conducted 2-3 weeks following the close of the survey. We recruited all 15 teachers who completed the requirements of the intervention to reach the target of 8 participants. Eight teachers volunteered, but two were unable to attend due to scheduling constraints. The six participants included five teachers who completed all five required modules and one teacher who completed three of the five required modules. Due to participant schedules, we conducted one focus group interview with four participants and two individual interviews.

All were conducted using a virtual conferencing platform with video. The co-PI facilitated all interviews. Audio files were exported and transcribed for analysis.

Teachers who participated in the intervention received a $50 gift card.

Data Analysis

The research question on course completion was addressed by calculating descriptive statistics on information extracted from the course logs. For the research question on usability, we calculated item-level frequency distributions and measures of central tendency and variability for the PU, PEU, and SUS scales. Transcripts and notes from each of the focus groups were parsed for key information, combined and then coded using iterative cycles of review to organize feedback into categories.

Results

To what extent do participants complete the online course components?

Participants were expected to complete the following activities in order:

1. Course overview module
2. Fundamental module #1: Overview of DLM Essential Elements (EEs)
3. Fundamental module #2: The 5E Model
4. Fundamental module #3: Universal Design for Learning
5. EE self-selection tool
6. One of three EE modules based on their choice after using the EE self-selection tool: Earth Science (ES), Physical Science (PS), or Life Science (LS).

Of the invited participants, 15 began the course, and 13 completed the overview and three Fundamental Modules, as well as at least one of the EE Modules. In other words, 13 of 15 participants completed the minimum course requirements. Of these, one individual completed all three EE modules, and five participants started but did not complete at least one additional EE

module beyond the minimum expectation. One participant skipped a fundamental module and one participant began the course but stopped partway through the third fundamental module. Life Science and Earth and Space Science were the most frequently chosen EE modules. The median course completion time was 4 hours and 34 minutes. Module completion patterns for each participant are summarized in Table 2.

Table 2

Course Completion by Participant

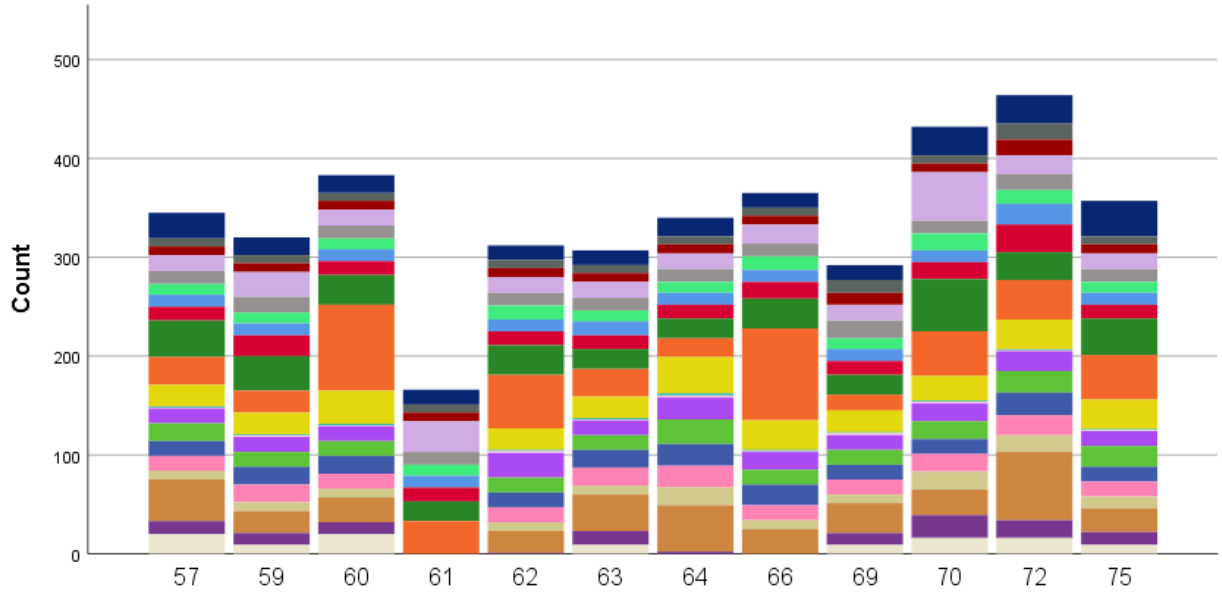
Participant	Overview	DLM EE	5E Model	UDL	ES	PS	LS	Foundation + Topic	Time hr:mn
57	Y	Y	Y	Y			Y	Y	3:35
59	Y	Y	Y	Y	Y	Y	Y	Y	3:43
60	Y	Y	Y	Y			Y	Y	4:34
61	Y	Y	Y	Y	Y	Partial	Partial	Y	6:51
62	Y	Y	Y		Y	Partial	Partial		8:24
63	Y	Y	Y	Y		Partial	Y	Y	5:18
64	Y	Y	Y	Y		Y	Partial	Y	7:57
65	Y	Y	Y	Partial					2:09
66	Y	Y	Y	Y	Y	Partial	Partial	Y	7:34
68	Y	Y	Y	Y	Y			Y	5:42
69	Y	Y	Y	Y			Y	Y	8:16
70	Y	Y	Y	Y			Y	Y	3:38
71	Y	Y	Y	Y	Y			Y	3:45
72	Y	Y	Y	Y			Y	Y	2:22
75	Y	Y	Y	Y			Y	Y	2:41
Total	15	15	15	13	6	2	8	13	

Participants spent the most time in the EE modules. Since only one participant went beyond the intended intervention requirements and completed all of the EE modules, it is difficult to compare their lengths. But Physical Science, the least often selected module, appears to be the most time consuming at approximately 50 minutes. Both Earth Science and Life Science took about 40 minutes for most participants. Participants broke the course up into between 5 and 23 sessions. These sessions ranged from less than a minute in length, to about 2 hours.

Within EE modules, participants spent varying amounts of time on each lesson. Some sections took roughly the same number of minutes across participants (e.g., A Tale of Two Lessons, Science & Engineering Practices). There was more variability across participants in the number of minutes spent on Common Misconceptions (orange in Figure 1, forest green in Figure 2) and Knowing your Students (yellow in Figure 1, orange in Figure 2) sections.

Figure 1

Participant time per lesson in minutes, Life Science module

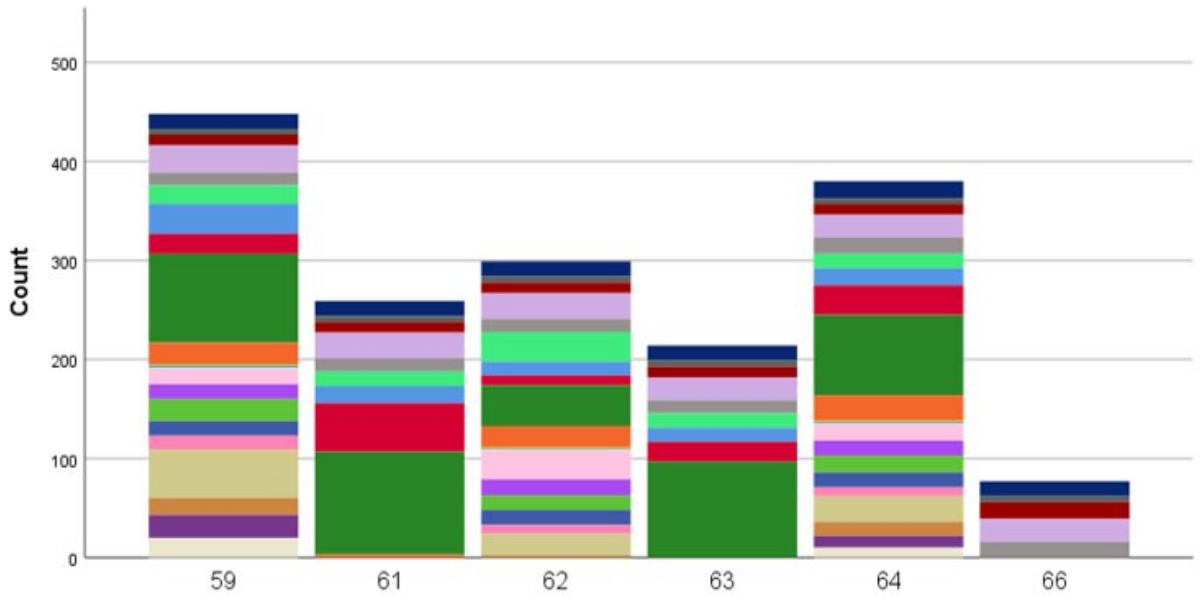


Note: Color location within each bar does not indicate order of lessons. Colors represent lessons topics (e.g., orange = Misconceptions, yellow = Knowing your Students)

There was some evidence that the Misconceptions section was more time consuming than other sections for some participants, particularly in the Physical Science Module (see dark green shading in Figure 2).

Figure 2

Participant time per lesson in minutes, Physical Science module



Note: Color location within each bar does not indicate order of lessons. Colors represent lessons topics (e.g., orange = Knowing Your Students, dark green = Misconceptions)

Participants varied somewhat in the order in which they attempted the modules, but within modules, proceeded through in the intended order, occasionally revisiting earlier topics but not skipping around. Twelve (12) of 13 course completers went through the modules in the anticipated order. See Appendix B for figures illustrating variations in how participants navigated across sessions within the course.

In this study we provided participants with an Essential Element module selection tool to help them self-assess which of the three available EEs might be the best fit for them. Participants rated the three EEs on a variety of factors that might influence their choice, including some level of existing familiarity with the topic, a strong need to know more about an unfamiliar topic, and

curricular priorities in the school. The tool was to be completed after the fundamental modules. Ten participants started using the tool and six completed it. Of those who did use the tool, three took only the recommended module, two took the recommended module plus one more, three took a module other than the one recommended, and two did not get a clear recommendation because their responses showed more than one potential match. Course non-completers were distributed across all of these conditions.

How do participants perceive the usability and likely feasibility of the 5E-SESE system? What changes do they recommend?

A total of 13 of the 15 participants completed the usability survey. See Appendix A for item-level frequency distributions. In general, the responses indicated that the participants felt positively about the course content but felt less positively about the online platform.

Positive responses were most frequent for items dealing with course content, particularly for the EE modules. Participants agreed or strongly agreed with items related to science content and lesson planning. All respondents agreed or strongly agreed that they intended to apply what they learned in the EE module to their instruction. Participants were less likely to agree that they intended to apply concepts from the fundamental modules, which were intended to lay groundwork and thus not be as directly applicable to instruction. In response to open-ended questions participants requested additional examples, especially for working with students with the most significant needs, and a more streamlined platform. Overall evaluation of content usability of the course based on Perceived Usefulness (PU) and Perceived Ease of Use (PEU) 4-point scales was moderate (M_{PU} = 2.38, SD_{PU} = .79; M_{PEU} = 2.42, SD_{PEU} = .58).

Participants perceived the online system as moderately useful (M_{SUS} = 2.82, SD_{SUS} = .53 on a 5-point scale). Open-ended survey feedback included a request for a more streamlined

platform. Moreover, many participants reported the EE course selection tool was not at all or only somewhat useful in assisting them in choosing which EE module to complete.

Additional feedback came from the focus groups. Findings are organized into categories including interactivity, science content and module engagement, population knowledge, user accessibility, navigation, and coaching model feedback.

Interactivity

Participants reacted positively to many features included in the 5E-SESE system for the purpose of interactivity: lesson plan examples, longer videos (for explaining science content), simulations, websites, quick-writes, and posing of questions to consider as they worked through the modules. While some participants noted that having assessment questions was helpful to allow them to review, some quiz questions were too simple (answers were too obvious) while other questions were so complex that it took too long to get the right answer. (Several participants noted that it took 10 – 15 tries on some of the more involved questions and that it was hard to select a response from such a long list of options for answers.)

The short videos (simulations of lessons created for 5E) seemed to some participants to be truncated to some participants and noted the need for a smoother exit and entry in those specific videos. Users noted that the "self-pacing" aspect of the modules was attractive to allow for teachers to go through the material at their own rate and at a different pace from others. In one school, where multiple teachers participated, the group mentioned that it would have useful for them to be able to work together on the modules and to have conversations about them.

There was concern expressed by one participant as to the time required to take the modules as she unsure that teachers would spend the time needed. Other participants noted that large blocks of text should be broken up using either visuals or "quick checks," and they expressed concern that the "wordiness" might lead users to just click through in order to

complete modules. Questions posed as merely "think about this" were confusing to some when they were expecting to have to write an answer at some point in the future, and they requested clearer direction for the user. Participants wanted incorrect answers color-coded and with links included so that learners could return to sections that needed to be reviewed.

Science Content and Module Engagement

As noted in the previous section, participants were very positive about the use and choice of video material. They liked the ability to go back and re-watch the videos after learning the science content they were focused on and using the key questions posed at the beginning of each module. Special education teachers appreciated the opportunity to learn science content as they have had little to no coursework in these areas. They appreciated the resources offered and the ability to "dig where… interested." One user stated that the module helped her to think differently about science while others noted the usefulness of the ideas presented as they look for resources to adapt lessons for increased accessibility (including a look at student misconceptions). The lesson plan template was helpful in guiding their thinking during instructional planning. While one user noted the usefulness of the 5E model, another participant stated that she had initially confused "5E" and "EEs."

One science content teacher noted the use of "weight" instead of "mass" in the physical science module and requested the correct science terminology be used there. Another user did not consider the content in that module to be engaging enough for users to do the work required to complete the module.

Population Knowledge

Users liked how the modules helped them to think about engaging this population of students in a different way, specifically by paying attention to the "Engage" stage of 5E. They were positive about the possibilities of applying what they had learned to create better science

lessons in the future. The videos of actual students and teachers were received very positively and users asked for more videos, as well as more examples of how to adapt lessons for emergent communicators or "initial level" students. With one group, we presented the idea of using "routines" to assist teachers in how to adapt lessons using the Science and Engineering Practices and the Cross-cutting Concepts (like the routines being developed for English language arts in Erickson's Project Core at UNC-CH). The response was very favorable in that teachers expressed that more of these types of supports were needed.

User Accessibility

Participants provided feedback on several aspects of the course with regard to accessibility. They suggested that audio clip transcripts should contain the actual transcript, not just a synopsis; that complicated graphics or pages with a lot of information to process needed additional audio instruction to assist learners in understanding how and where to start with that information; and that each page needs a "read aloud" function for learners who might have visual impairments. They also noted that rearranging font size to "average" resulted in content not fitting properly on the page.

Navigation

Every group and participant indicated that there was a significant amount of confusion and frustration regarding how to navigate the system. There were too many buttons to click, the buttons were not labeled in a clear way, it was not clear to the users where to start, and users were not sure when they had completed sections or modules. Users often were unsure that they were in "the right place" – the system did not allow for ease in moving back and forth in the lessons (to "explore first"), which many indicated was "the way that they learn." They wanted flexibility in being able to look ahead (scan), to see a visual of the course itself and where they were located in it (their progress), as well as the ability to go back and review previous content

or assessment responses. The course configuration in Phase 1 did not allow users to look ahead, has a limited visual of the course (with no "progress bar"), and required re-doing each assessment question in each section in order to look back or review previous content. They wanted to be able to go back through assessments to see what answers were missed and why – this course configuration had very limited capability to do so. Finally, one user who clicked "Review" thought she was going to see a quick review page, but instead was taken back to the beginning of the module. Transparency, user expectations, simplicity, and consistency as to system architecture were needed to improve on the construct of system navigation.

Coaching Model Feedback

Participants were asked to react to the idea of the added virtual coaching component for Phase 2. Respondents were positive about the idea, stating that this would have helped them to check to see if they were implementing lessons the correct way and that they would learn a lot from a mentor/coach. They liked the idea of completing a full lesson, trying it out, and having something in the future that they can use again in their classrooms. Participants expressed the need for science content knowledge support from a coach more than population knowledge; the exception would be for new teachers who are still learning how to teach and adapt lessons for the population of students with significant cognitive disabilities.

Some sites experienced issues with firewalls in their district blocking access for weeks at a time; they expressed that a coach could have helped troubleshoot these types of issues as well as issues with navigation within the 5E system. They appreciated the weekly emails from 5E staff (the "nudges") and saw that this type of more personal support in a future iteration would be valuable.

Conclusion

The purpose of the Phase 1 Usability study was to examine the usability and feasibility of the 5E-SESE PD system. Results indicated that participants reacted positively overall to the module content and the feasibility of the 5E-SESE PD system in developing teacher capacity for science instruction. Most participants completed the intended sequence of lessons and activities within the modules, though some attempted and completed modules in a different order then intended. Some participants reported difficulty and confusion in navigating the modules. Participants reacted positively to videos and simulations within modules, though some requested more examples of adapting content for students. Overall, participants reported the modules helped them think differently about science instruction for students with significant cognitive disabilities, and they were excited about the addition of the virtual coaching component in Phase 2 to support teacher learning.

Considerations for Phase 2 include improving and streamlining system navigation features (e.g., reducing the number of clicks required to advance through modules), and including additional examples of science instruction for students with varying support needs. In addition, the design team developed more teaching scenarios to mirror the process of lesson planning. The design team developed a revised prototype to share with the Project Advisory Committee in May 2020 to solicit feedback.

Appendix A: Survey Item-Level Frequencies

Table A.1. Frequency Distributions for Module Evaluation Items

Module/Question	Strongly Disagree	Disagree	Agree	Strongly Agree
Overview				
This module was important in assisting me as a learner in the 5E-SESE system.	2	1	7	3
By the end of the module, I knew what to expect in the rest of the course.		2	9	2
By the end of the module, I knew how to navigate the online system.		1	8	4
DLM Essential Elements				
This module addressed content that is important for my work with students with significant cognitive disabilities.	2		8	3
This module presented me with new ideas to improve my work with students with significant cognitive disabilities.		4	4	5
Completing this module was worth my time and effort.		2	7	4
The 5E Model				
This module addressed content that is important for my work with students with significant cognitive disabilities.		1	6	6
This module presented me with new ideas to improve my work with students with significant cognitive disabilities.		2	7	4
Completing this module was worth my time and effort.		3	7	3
Universal Design for Learning				
This module addressed content that is important for my work with students with significant cognitive disabilities.	1		6	6
This module presented me with new ideas to improve my work with students with significant cognitive disabilities.		2	5	6
Completing this module was worth my time and effort.	1	1	8	3
EE Modules				
The Introduction section (prompts and a short video about real world science content) generated interest for me to continue learning.	2		7	4
The Teaching Life/Physical/Earth Science (‘A Tale of Two Lessons’) section helped me to connect my		3	8	2

Module/Question	Strongly Disagree	Disagree	Agree	Strongly Agree
prior ideas about teaching to the learning outcomes of the module.				
The Science Content in Three Dimensions (DCI, SEP and CCC examples) section helped me to increase my own science content knowledge for the Essential Element I chose.			10	3
The Choosing Your Own Lesson Focus section helped me to identify learning goals that are appropriate for student learning characteristics and the module's Essential Element.		1	7	5
The Choosing a Phenomenon section helped me to identify phenomena that illustrate the science Essential Element concepts, can be explored using the Science and Engineering Practice, and are appropriately complex.		1	11	1
The Identifying Misconceptions section helped me to understand common misconceptions in order to describe instructional strategies which resolve those misconceptions.		2	7	4
The UDL: Knowing your Students section helped me to identify strategies for removing sensory, mobility, communication, and cognitive barriers for students with significant cognitive disabilities.	2	1	7	3
The 5E Lesson Plan Structure "What the Teacher Does/What the Student Does" section helped me to identify key 5E model student and teacher behaviors.		2	7	4
The Planning a 5E Lesson section helped me to use the knowledge gained in the previous sections in order to develop a 5E lesson plan for the module's science Essential Element.			11	2
The Reflection and Next Steps section helped me to connect concepts learned throughout the module.			9	4
The resources connected from within this module to sources external to the course (videos, readings, computer simulations, additional webpages, etc.) were helpful to me as a learner.		1	9	3
This module addressed content that is important for my work with students with significant cognitive disabilities.	2		6	5
This module presented me with new ideas to improve my work with students with significant cognitive disabilities.		3	6	4

Module/Question	Strongly Disagree	Disagree	Agree	Strongly Agree
This module increased my knowledge of science content in a way that will improve my science teaching for students with significant cognitive disabilities.		1	10	2
Completing this module was worth my time and effort.		1	7	5
I intend to apply what I learned in this module to my professional practice.			9	4

Table A.2. Frequency Distributions for Usability Scale Items

Scale	Strongly Disagree	Disagree	Agree	Strongly Agree
Subjective Usability				
1. I would like to use the 5E-SESE system frequently.	2	2	5	4
2. I found the 5E-SESE system unnecessarily complex.	1	7	5	
3. I thought the 5E-SESE system was easy to use.		4	6	3
4. I think I would need the support of a person with technical knowledge to be able to use the 5E-SESE system.	2	7	2	2
5. I found that the various functions of the 5E-SESE system were well integrated.			11	2
6. I thought that there was too much inconsistency in this system.	1	9	2	1
7. I would imagine that most people would learn to use the 5E-SESE system very quickly.	2	3	5	3
8. I found the 5E-SESE system very awkward to use.	2	7	4	
9. I needed to learn a lot of things before I could start using the 5E-SESE system.	3	5	2	3
Perceived Use				
1. The 5E-SESE System will help teachers to make their instruction more interesting	6		7	
2. The 5E-SESE System will help to increase teachers' ability to design science instruction.	2	2	9	
3. The 5E-SESE System will effectively enhance teachers' learning.	3		10	
4. The 5E-SESE System will improve teachers' professional knowledge.	4		9	
Perceived Ease of Use				
1. It will be easy for teachers to use the 5E-SESE System.	1	3	9	
2. It will be convenient for teachers to receive training on-the-job by using the 5E-SESE System.	1	5	7	
3. The content of the 5E-SESE System will be clear and easy to access for learning.	4	4	5	
4. Learning using the 5E-SESE System will be flexible.	2	2	9	

Appendix B: Examples of Progression through 5E-SESE Course

These figures illustrate how individuals progressed through the course. Each figure is a different participant and the x-axis represents consecutive sessions (log-ins) to the course.

- Figure B.1 shows the intended pattern of course progression through modules for someone who chose the life science module.
- Figure B.2 shows the pattern for a participant who generally went through the required modules as intended but who also took two additional EE modules and reviewed sections of previous modules at various times later in the course.

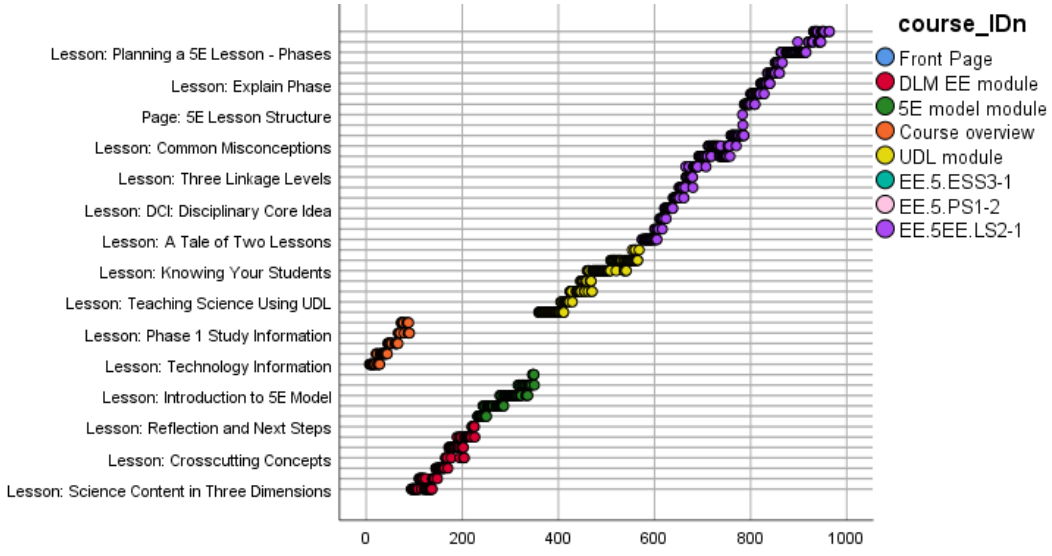


Figure B.1. Progress through lessons over consecutive sessions, Participant 57

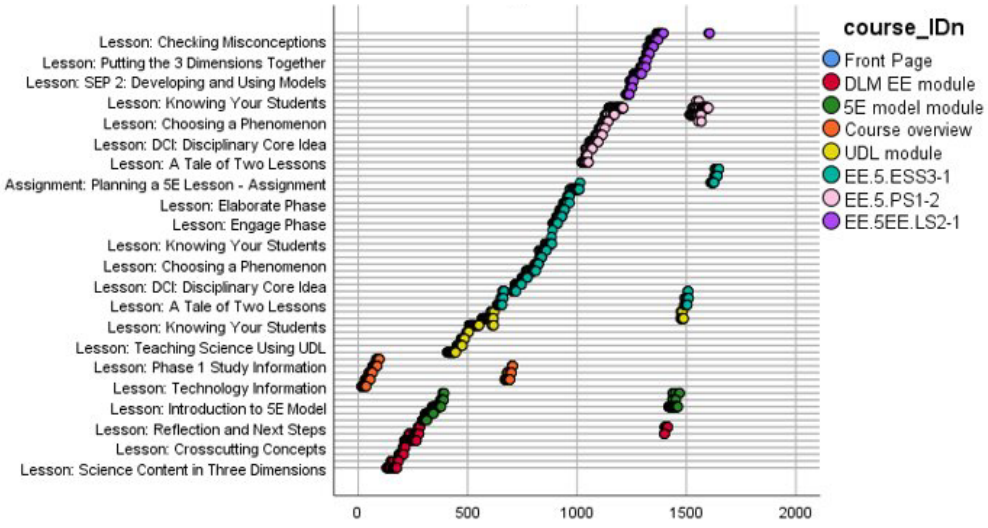


Figure B.1. Progress through lessons over consecutive sessions, Participant 61

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