Innovations in Science Map, Assessment & Report Technologies

I-SMART

Goal 3: Teacher Dashboard Design

February 12, 2020

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Introduction

In this report, we will describe the operations and activities of Goal 3, in which we designed and developed a dashboard that supports teachers' effective interpretation of—and planning based upon—student performance on science assessments. This effort consisted of researching and designing the user experience, interaction, and interface for the dashboard through an iterative co-design process consisting of an initial needs assessment followed by an alternating series of co-design sessions with a cadre of educators and rapid prototype development. This procedure resulted in a fully-fledged prototype of a score-reporting dashboard for Innovations in Science Map, Assessment, and Report Technologies (I-SMART) that is ready for development.

Dynamic Learning Maps Terminology

Appendix A defines key terminology central to the Dynamic Learning Maps® (DLM®) and I-SMART projects.

Part 1: Needs Assessment

Overview

To determine teachers' needs for the I-SMART testlet score-reporting dashboard, we conducted four focus groups in the summer and fall of 2017 with educators experienced in teaching and assessing students with significant cognitive disabilities. Focus groups were 90 minutes long and were conducted remotely through video-conferencing software. Educators who participated outside the scope of their usual job requirements were paid a stipend of $50.

Participants

All focus group participants hailed from an I-SMART partner state. Focus Group 1 consisted of four teachers from New York. Focus Group 2 consisted of five teachers from Oklahoma and Maryland. Focus Groups 3 and 4 both consisted of six teachers from Maryland, Missouri, New Jersey, and Oklahoma. The participants differed in their experience teaching special education students, depth of science background, and familiarity with the DLM alternate assessment. Most were classroom teachers.

Focus Groups 1 and 2

We began the needs assessment process by conducting two focus groups in June 2017. Offering two sessions allowed us to keep the size of the groups manageable and accommodate the educators' schedules.

Protocol

The focus groups adhered to the following protocol. A brief explanation of the study and the purpose for the focus group was followed by participant and researcher introductions. Participants were given an orientation of DLM and I-SMART projects, and were shown current score report examples (see Appendix B). This was followed by a "cold" requirements gathering—in which we sought not to contaminate participants' preconceived thoughts and ideas with our own—including a discussion of the information, features, and supports teachers need. Next, we introduced the concept of a dashboard and shared several examples of existing dashboards used for educational purposes. This exercise was interactive and encouraged spontaneous questions, feedback, suggestions, and discussion. Finally, we had participants share parting thoughts, ideas, and impressions. Focus groups were recorded using the video-conferencing software to facilitate post hoc analysis.

Analysis

Analysis consisted of reviewing focus group notes and recordings and then coding comments according to three categories: (1) what teachers need, (2) what teachers currently do and believe, and (3) what teachers think about dashboards. The level of teachers' agreement with each others' comments was also determined.

Findings

Findings from Focus Groups 1 and 2 are summarized here according to the three aforementioned categories. Asterisks indicate ideas that were strongly articulated in both focus groups.

What Teachers Need

- Teachers need to know what their students have already **mastered**, at a fine-grained level.
- Teachers need to know how their students can **express their knowledge** on assessments, particularly what accommodations would be beneficial.
- Teachers crave **explicit connections between standards and instructional practices**, such as including example problems and/or lesson ideas with each standard. Many teachers report confusion about the meaning of the standards and believe this is a widespread issue among teachers of students with significant cognitive disabilities.*

What Teachers Currently Do and Believe

- Teachers do not have one reliable and centralized way to **track information** about their students' assessment needs/previous mastery, so they draw upon a number of sources, including parents, communications with previous teachers, other students, trial and error, form/procedures such as IEPs, and other assessments.
- Teachers find the **IEP to be moderately helpful** for making decisions about instruction and assessment, but IEPs can be hard to absorb, vary in quality, and provide more information about instructional goals than about the teaching/assessment procedures that allow teachers to achieve those goals.
- Teachers leverage information from **ELA and mathematics assessments** for science instruction because they are both very relevant to science.*
- Many teachers **create their own centralized place** to store information about teaching/assessments/students' characteristics in the form of binders/folders, and use these to communicate with other teachers/parents.*
- Teachers find **DLM reports to be of limited value for informing instruction** because they are hard to understand and do not provide actionable information.*
- Teachers are interested in tracking **noncognitive factors**, such as the context of assessment (e.g., distractions, student sickness, medication levels), but are concerned about the **additional burden** that tracking these factors may impose.*

Teachers' Thoughts on Dashboards

- Dashboards should provide **clear learning objectives** that are explicitly linked to standards/goals.
- Dashboards should clearly identify **what has been mastered and what has not been mastered**, providing teachers with information that helps them identify knowledge gaps and allows them to make decisions about what needs to be taught next.
- Dashboards need to be **easy to understand** and simply designed, so that teachers and other stakeholders (parents, possibly students) can interpret the information quickly without additional time burden.
- Teachers are **lukewarm** about the idea of both **longitudinal and aggregated data**. Concerns about longitudinal data come from the infrequent nature of science testing (not

enough data/unclear what the scale would be) and because some students may show limited progress across years (discouraging for students, parents, and teachers).

- Teachers want to **share information with parents** but are **cautious** about it because of concern that parents may misinterpret information without guidance.
- **Dichotomous mastery indicators may not be useful** for this population because students often take a very long time to master a single skill/concept. Sliding scales of mastery may be better.*

Focus Groups 3 and 4

We continued the needs assessment process with two additional focus groups in November 2017. None of the educators present in these focus groups participated in the earlier focus groups. The intention of this round of focus groups was to obtain additional information on teachers' needs. In addition, a preliminary prototype was shared, and we solicited feedback from teachers on the initial design direction.

Protocol

Focus Groups 3 and 4 were conducted according to a protocol similar to the one used for Focus Groups 1 and 2. One significant deviation was the refinement of the cold requirements gathering; in this iteration, we asked teachers what student information would be most salient for their purposes. Further, we added a question geared toward learning about educators' current workflows. In place of existing dashboard samples, we shared our initial dashboard prototype. Educators discussed how they imagined using it and shared their impressions. Finally, during the wrap-up, we asked teachers to evaluate the merits of using DLM assessment results for summative versus formative purposes. Focus Groups 3 and 4 were recorded to facilitate post hoc analysis.

Analysis

Similar to the first pair of focus groups, analysis consisted of reviewing notes and recordings and then coding comments according to three categories: (1) what teachers need, (2) what teachers currently do and believe, and (3) what teachers think about the preliminary dashboard designs. The only change from the first focus groups was that the third category focused on impressions of our initial dashboard designs, rather than dashboards as a whole. The level of teachers' agreement with each others' comments, including those from the first focus groups, was also determined.

Findings

Findings from Focus Groups 3 and 4 are summarized here according to the three aforementioned categories. Asterisks indicate ideas that reinforce what was learned during Focus Groups 1 and 2.

What Teachers Need

- Teachers need to know **what students already know**. This includes content that students have already mastered and what skills students have (reading, writing, etc.).*
- Teachers need to know **how students can best express their knowledge**. This includes knowing if and how students can communicate (symbolic, eye gaze, etc.), what technology can help support them, and what type of environment is productive for each student.*
- Teachers need more support to understand the **meaning of standards and how to relate instructional experiences to DLM testlet selection/performance**. Current language used in the presentation of standards is hard for teachers to understand, seems unrelated to their day-to-day experience in the classroom, and is insufficiently

scaffolded. Specifically, some teachers reported that the materials, vocabulary, and types of items used in DLM assessments made it challenging for them to evaluate what students actually know and can do.*

- Teachers need to know their students' **levels of cognitive disability** and **what behaviors might interfere** with their ability to learn and express what they know.
- Teachers need to know what **types of experiences are meaningful** to students.
- Teachers need to know what **students', parents', and other stakeholders' goals are for the students' progress**, especially in science, in which goals are not set in the IEP.
- Teachers expressed **frustration at the differences in instruction and assessment—** materials, vocabulary, and types of items used on DLM assessments can feel very different and removed from what students are doing day to day in the classroom. This creates a situation in which teachers believe students are unable to demonstrate what they actually know.

What Teachers Currently Do and Believe

- Teachers **rely on observation and trial and error to learn what students know, need, and can do,** as opposed to having well-established sources to learn about their students. Additional sources include forms and documents such as IEPs and conversations with previous teachers/schools.*
- Teachers often **create their own solutions to track and communicate information about students**, such as making binders or folders for each student.*
- IEPs can be a very helpful resource for teachers, but the **IEPs teachers receive for students can vary in quality and may require reorganization** by the teachers to improve utility. Also, IEPs do not specifically address science goals or needs.*
- Many teachers **use some data tracking procedures**, such as applied behavioral analysis, and some online systems, such as Rethink, to support their students' learning, assessment, IEP creation, and goal-setting.

Teachers' Thoughts on the Preliminary Dashboard Design

The following findings were generated on sharing the initial dashboard prototype with participants of Focus Groups 3 and 4.

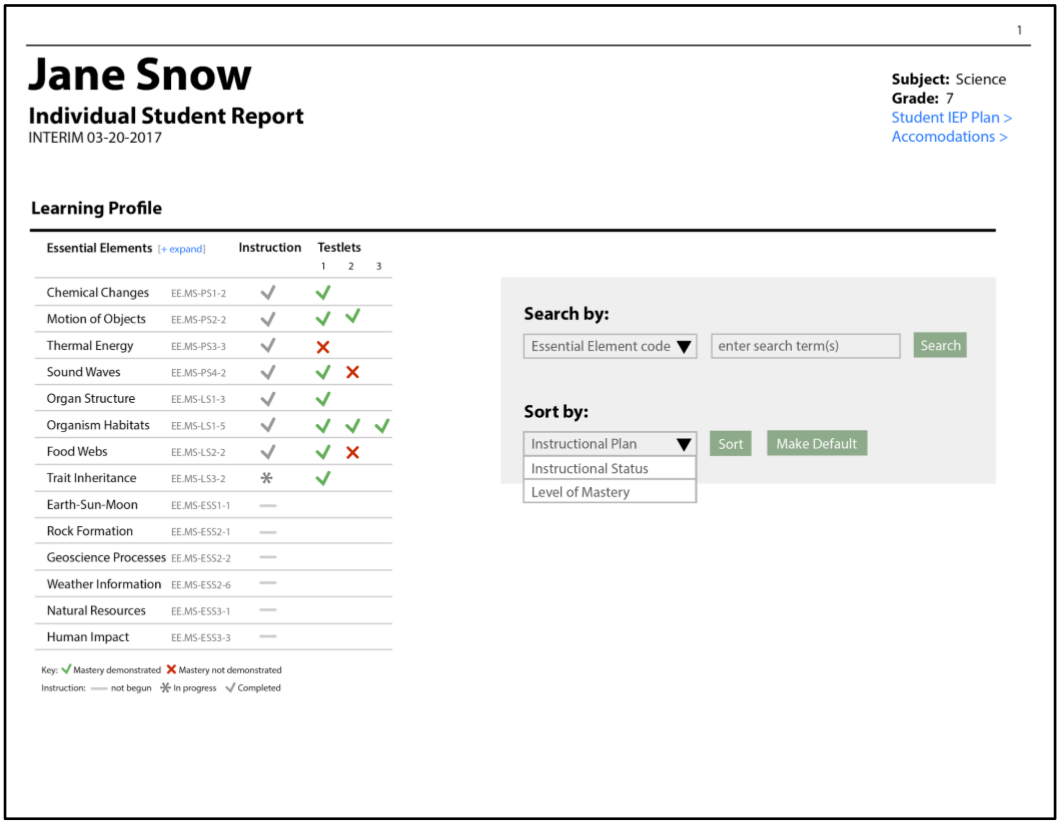
Individual Student Report: Learning Profile

Description

The Learning Profile page (Figure 1) allows teachers to view a snapshot of a single student's progress at a macro level. A complete listing of Essential Elements (EEs) is displayed; for each EE, the student's status of instruction is indicated as "not begun," "in progress," or "completed." EEs can be sorted by status of instruction, EE code, level of mastery, and chronological order. For the EEs for which testlets have been administered, the testlet results are indicated with a green checkmark or a red "X" to signify mastery has or has not been demonstrated, respectively.

Figure 1

Learning Profile: Initial Design



Findings

Teachers appreciated the clarity of the learning profile. Multiple teachers across both Focus Groups 3 and 4 indicated that they would likely use this screen for their instructional planning.

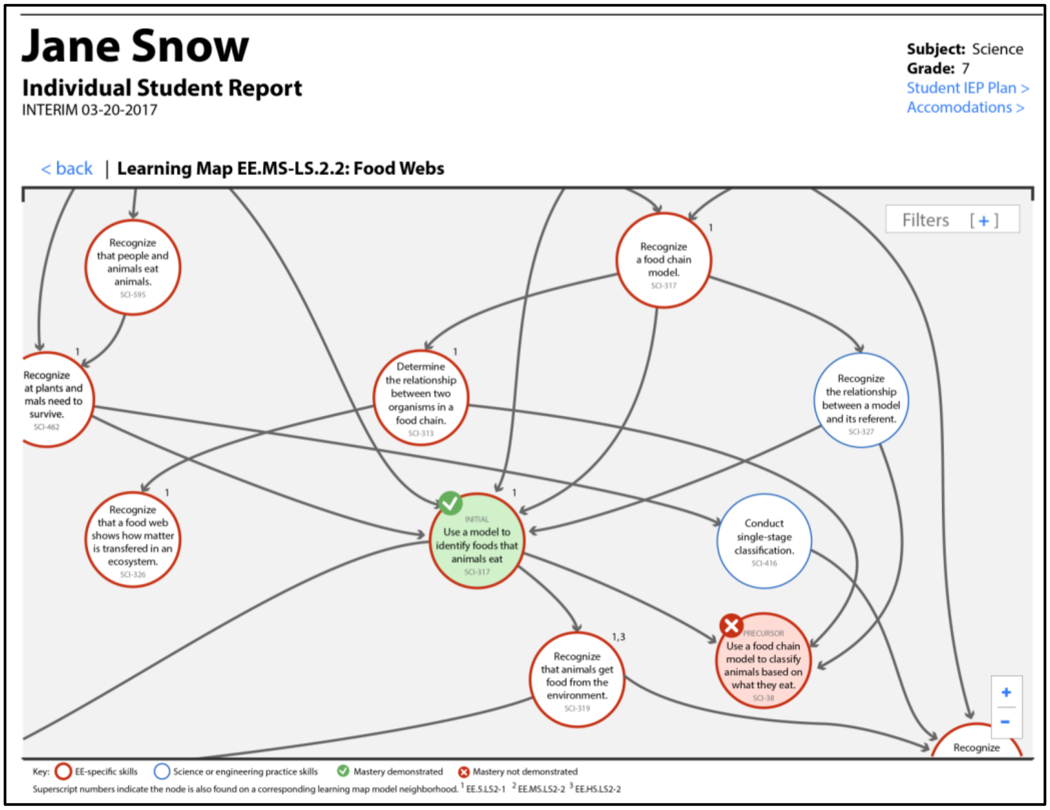
Individual Student Report: Learning Map

Description

The Learning Map interface (Figure 2) provides teachers with an interactive, navigable diagrammatic representation of one EE neighborhood. Teachers can zoom in and pan around the map to view by section or zoom out to view its entirety. It displays the interconnectivity of the nodes that make up each EE. For testlets that have been administered, the student's results are indicated on the node.

Figure 2

Learning Map: Initial Design



Findings

Focus Group 3 participants, who had somewhat less experience with the DLM project overall, found the map view to be overwhelming and not immediately useful. One teacher said, “When you’re looking at [the map], where is the beginning versus the end? Or there isn’t a beginning? I’m just looking at this and thinking where do you even start looking?” Most teachers in this group agreed that the map view was confusing and that they would prefer not to use it.

Focus Group 4, consisting of a number of teachers who had written DLM items and had a higher level of DLM expertise, expressed a very positive opinion of the map view. One teacher said, “I love the map, and I love that you can zoom in and out on it. I think that would be very informative… looking for patterns of mastery, looking for areas in which the student is benefitting from a certain type of instruction. I like this ability to view it that way, and I think it’s good for conceptually organizing instruction as well.” This suggested that the learning map might be hard for teachers to understand and utilize at first, but with additional gained expertise and explicit scaffolding, it could become a valuable resource.

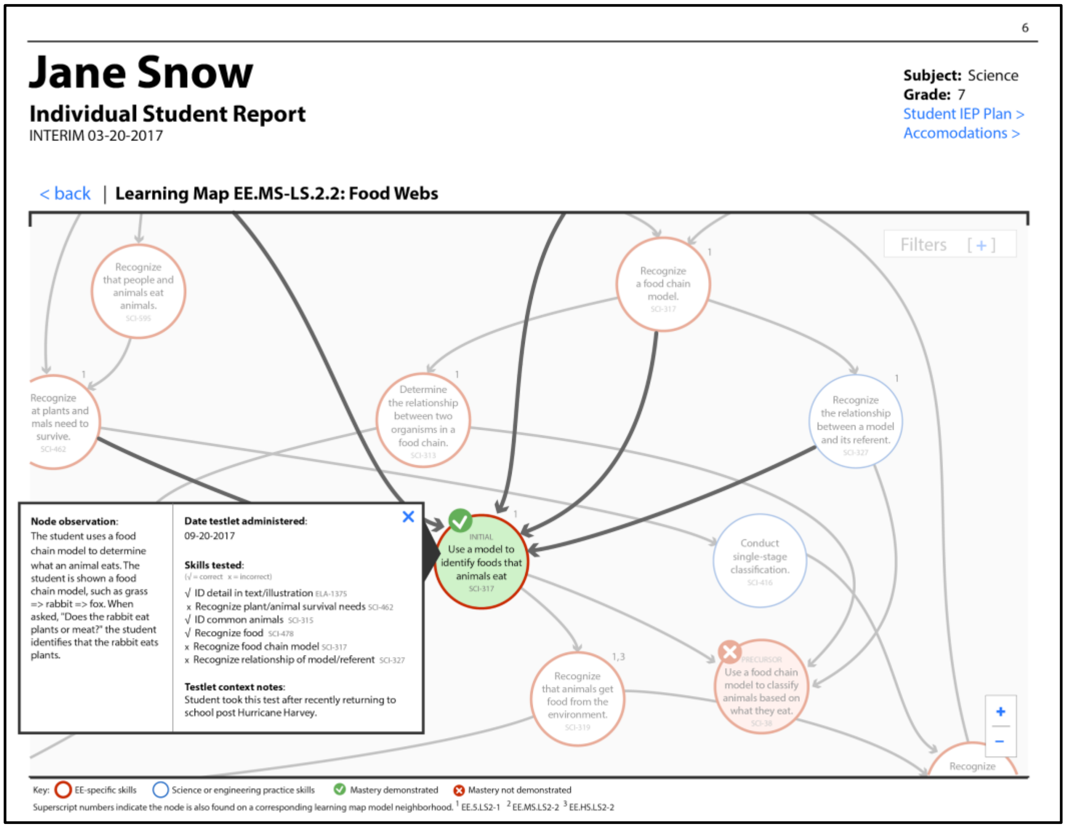
Individual Student Report: Expanded Node Card

Description

The Expanded Node Card (Figure 3) is accessed from the Learning Map by clicking on a node contained within a testlet. The pop-up window contains details regarding the administration of the testlet, such as the date it was given and testlet context notes the teacher can record. The skills tested within the active node and the student's results are displayed in list form. In addition, the node observation is provided, supplying further curricular context to the educator.

Figure 3

Learning Map: Initial Design



Findings

Teachers liked the node observation information and the list of skills that were addressed through the tested node.

None of the teachers from either focus group considered the testlet context notes section to be useful. While context information in general was considered important, lack of specific processes for considering this information makes it difficult to consider this information when analyzing student performance and making instructional decisions. In addition, students in this population are allowed to take tests when it is most optimal for them, and they are allowed to restart a test if necessary, decreasing the potential effect of considering contextual information.

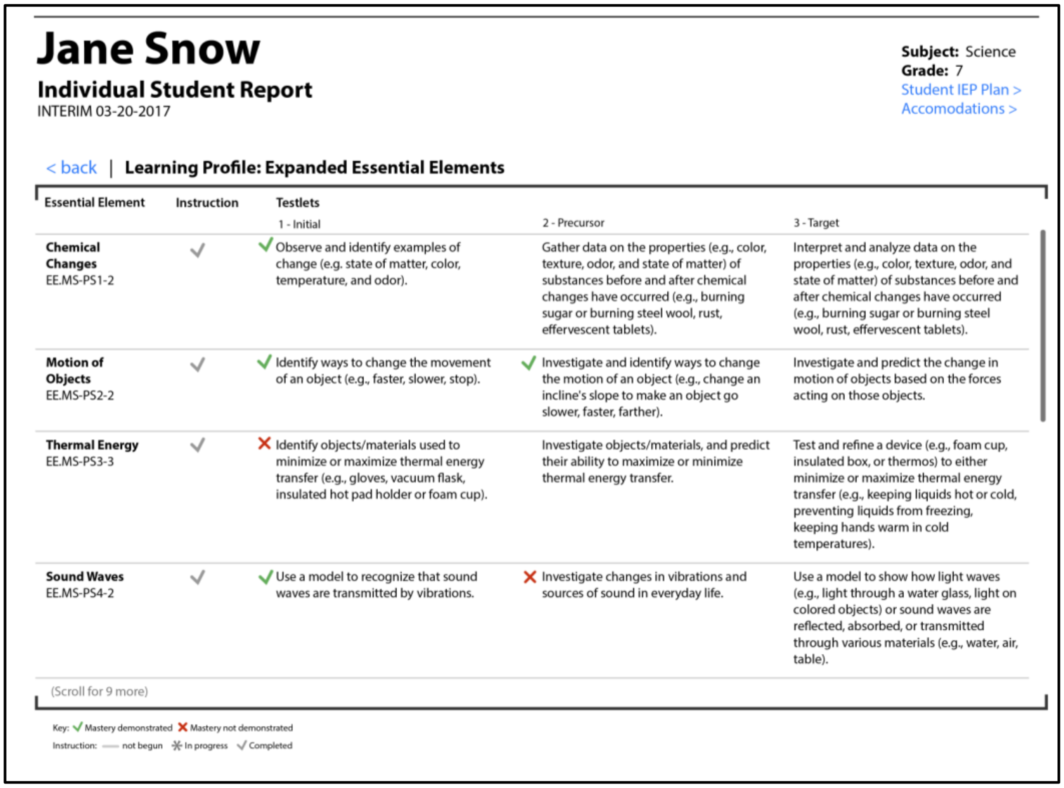
Individual Student Report: Expanded Essential Element List

Description

The Essential Element List (Figure 4) provides a tabular view of EEs and a summary of the content tested at each linkage level. When expanded, a user can view the nodes and node observations contained in each testlet.

Figure 4

Expanded Essential Element List: Initial Design



Jane Snow

Individual Student Report

INTERIM 03-20-2017

Subject: Science
Grade: 7
Student IEP Plan >
Accomodations >

< back | **Learning Profile: Expanded Essential Elements**

Essential Element	Instruction	Testlets 1 - Initial	2 - Precursor	3 - Target
Chemical Changes EE.MS-PS1-2	✓	✓ Observe and identify examples of change (e.g. state of matter, color, temperature, and odor).	Gather data on the properties (e.g., color, texture, odor, and state of matter) of substances before and after chemical changes have occurred (e.g., burning sugar or burning steel wool, rust, effervescent tablets).	Interpret and analyze data on the properties (e.g., color, texture, odor, and state of matter) of substances before and after chemical changes have occurred (e.g., burning sugar or burning steel wool, rust, effervescent tablets).
Motion of Objects EE.MS-PS2-2	✓	✓ Identify ways to change the movement of an object (e.g., faster, slower, stop).	✓ Investigate and identify ways to change the motion of an object (e.g., change an incline's slope to make an object go slower, faster, farther).	Investigate and predict the change in motion of objects based on the forces acting on those objects.
Thermal Energy EE.MS-PS3-3	✓	✗ Identify objects/materials used to minimize or maximize thermal energy transfer (e.g., gloves, vacuum flask, insulated hot pad holder or foam cup).	Investigate objects/materials, and predict their ability to maximize or minimize thermal energy transfer.	Test and refine a device (e.g., foam cup, insulated box, or thermos) to either minimize or maximize thermal energy transfer (e.g., keeping liquids hot or cold, preventing liquids from freezing, keeping hands warm in cold temperatures).
Sound Waves EE.MS-PS4-2	✓	✓ Use a model to recognize that sound waves are transmitted by vibrations.	✗ Investigate changes in vibrations and sources of sound in everyday life.	Use a model to show how light waves (e.g., light through a water glass, light on colored objects) or sound waves are reflected, absorbed, or transmitted through various materials (e.g., water, air, table).

(Scroll for 9 more)

Key: ✓ Mastery demonstrated ✗ Mastery not demonstrated
Instruction: — not begun ✳ In progress ✓ Completed

Findings

Teachers from Focus Group 3—particularly those who found the map view overwhelming—responded positively to the expanded view of the Essential Elements List. They felt more confident using this view because it provided a clearer sense of students' instructional path as determined by the testlets and linkage levels.

Future Feature Development. Based on the feedback received through the four focus groups, we compiled a list of requested additional features to inform the next iteration of the dashboard prototype.

- Aggregated data view
  - In Focus Groups 3 and 4, teachers expressed a desire for aggregated views of students so that they could see what the class as a whole had mastered or was struggling with. This was contrary to our findings from Focus Groups 1 and 2, in which teachers said that they did not think an aggregated view would be useful.

    - Teachers stated that an aggregated view of performance would increase their ability to plan for the class as a whole.
    - One teacher suggested seeing the percentage of students in the class who had mastered each node within an EE would be helpful. This could be displayed within the expanded node card.
- More resources and scaffolding for teaching and assessing students
    - Teachers from all focus groups spoke of their challenges understanding assessment literacy-related concepts, choosing tests and items that best fit their students, and relating test questions to what happens in the classroom.
    - Teachers would like to see sample items that represent what they might encounter for each node. Teachers cited a strong disconnect between their instruction and what students experience on the tests.
    - Language used to describe linkage levels could use more scaffolding or be written more simply. Teachers struggled to make meaning from the formal language used and to translate that to their classroom practice.
    - Teachers wished for instructional activities to be included as part of the EE information.
- Multiple pathways to viewing student results
    - Teachers suggested that the detailed student results available in the Learning Map view should be made available elsewhere within the tool, such as within the Essential Element List.

Follow-up Questions. Teachers asked several questions that referred to the nature of the dashboard's integration with the testing platform. The following is a list of their questions.

1. How are IEPs connected to the system (e.g., can they access and comment on IEPs from within the dashboard)?
2. What does "instruction completed" mean? Are there accompanying lesson plans?
3. How would the dashboard be integrated seamlessly into existing operational assessment programs?

Summary

The needs assessment process provided us with a collection of insights and evidence reflecting the needs and wants of educators who will be using the I-SMART score-reporting dashboard. The most salient findings of the needs assessment were:

1. Teachers need to know what students have and have not mastered.
2. Teachers need support in understanding the standards on which students are being evaluated.
3. Teachers wanted dashboards with clear overviews of each student's progress.
4. Teachers had mixed reactions to the Learning Map view; some thought it would be useful for instructional decision making, and others found it overwhelmingly hard to use.

Our synthesis of these data informed the prioritization of new feature development for the second iteration of the dashboard design.

Part 2: Co-Design of Dashboard Prototype

Overview

Upon the conclusion of the needs assessment, we convened a cadre of educators to co-design the ensuing prototypes iteratively and collaboratively with our design team. Their participation allowed us to collect practitioner feedback and recommendations at each stage of the dashboard design process and respond to their guidance and concerns through rapid prototyping and retesting. This report describes the cadre organization, participants, and the structure of the cadre meetings. In addition, it showcases examples of the cadre's effect on the evolution of the dashboard design.

Cadre Organization

Cadre participation consisted of four sets of virtual meetings, each 90 minutes in length and roughly 1 month apart (late February, late March, early May, and early June of 2017). To allow for flexibility in scheduling and to avoid the sessions being too large, individual meetings consisted of one to five cadre members with two to four I-SMART team designers and researchers, with most or all of the cadre members participating each month. We compensated cadre members with $50 per session, with a $50 bonus for attending all four sessions, for a possible total compensation of $250 per member.

Cadre Participants

The design cadre consisted of 11 educators from the I-SMART partner states. We primarily recruited cadre members from the pool of teachers who had previously participated in one of the needs assessment focus groups, while we recruited others from the pool who had previously expressed interest but did not participate. One participant was recruited through a personal connection with a cadre member.

We administered a survey to the cadre members to collect information about their demographics and teaching experience. Of the 11 cadre members, we had representation from four of the five partner states: four were from Oklahoma, three from Missouri, two from Maryland, and two from New Jersey. Seven identified their primary role as a classroom teacher, with two serving as district staff, and one each reporting as a curriculum/program coordinator and a program specialist. Appendix C contains additional information about the cadre teachers.

Cadre Meetings

The following section describes the structure of the four cadre meetings, including the agenda and purpose of the meetings.

Cadre Meetings 1–3

Standard Procedures

The first three cadre meetings maintained a similar structure and agenda. The meetings began by reviewing the most recent dashboard prototype as a group, followed by participants responding to the following questions in an open discussion format:

1. ***When*** would I use it?
2. ***How*** would I use it?
3. Which features would I find ***useful/less useful***?
4. Would this ***change the way I teach*** my students? (Consider all students and settings in which you teach science.)

Participants were given the opportunity to ask questions, provide feedback, and suggest changes.

Divergent Procedures

During Cadre Meeting 1, participants received an introduction to the project and a brief overview of the DLM terminology and current reporting practices. Next, the I-SMART team gave a brief summary of findings from the needs assessment.

During Cadre Meeting 2, participants engaged in a visual design exercise to help determine a direction for the look and feel of the dashboard interface.

Cadre Meeting 4

Procedure

The purpose of the fourth and final cadre meeting was to conduct a usability activity and to elicit feedback about the cadre process. The usability test consisted of a series of 13 scavenger hunt–style items that tested usability and data interpretability of the dashboard interface. Next, the members were asked to provide feedback about their experience in the cadre, including their thoughts about participating in the co-design process, their opinion of the video-conferencing format, and whether they found the cadre experience to be beneficial for their teaching practice.

Participant Experiences

In addition to the discussion during Cadre Meeting 4, participants also had the opportunity to provide feedback about their experience via an anonymous survey. Nine of the 11 members responded to the survey.

The discussion and the survey both showed that teachers reported feeling positive about their experiences participating in the co-design process. For example, all of the respondents agreed or strongly agreed that their feedback on the prototype was acted on, and eight of the nine agreed or strongly agreed that they personally benefited from participating in the cadre (one respondent was neutral).

General Education Focus Group

Participants

Because the I-SMART project includes students without significant cognitive disabilities who perform significantly below grade level in science, an additional focus group with two middle school, general education science teachers was conducted in late May 2017. Both teachers worked in a suburban district in Massachusetts as middle school science teachers, one in Grade 6 and one in Grade 8. Note that they did not complete the full demographic survey, so their information is not included in Appendix C. These teachers were compensated with a $50 Amazon gift card. (Note: Massachusetts is not an I-SMART partner state, nor do they use DLM alternate assessments.)

Procedure

This focus group followed a similar format to the cadre meetings; it lasted 90 minutes and was conducted virtually via video-conferencing software.

The meeting began with a brief introduction to DLM and the I-SMART projects, followed by a needs assessment. The participants were asked what types of information they have or need to have about their students' performance, with particular emphasis on students with disabilities in their classrooms.

Next, we demonstrated the clickable dashboard prototype and discussed if, how, and why they may use it in their classroom.

Findings

In general, the two general education teachers responded positively to the dashboard prototype. They were especially positive about the ability to view performance for the whole class at once on the Class Overview and the Learning Map view. They saw potential for using this tool formatively—not only for their students with disabilities, but also for their general education students who may struggle with concepts in science. They both thought instructional tools designed for students with disabilities were typically helpful for all students. They indicated the dashboard would allow them to conduct formative evaluations that may inform their instructional decisions. However, they did note that not being able to see the questions on testlets after students completed them would be a substantial drawback for them.

Part 3: Summary of Design Iterations

The cadre members' questions, suggestions, and feedback drove each iteration of the dashboard design. Leveraging the thoughtful input of end users was integral to the co-design process we engaged in, directly informing our progress and guiding our decisions to include, rework, or eliminate specific features and functions. This section illustrates the evolution of four main functional areas in the score-reporting dashboard: the Student Report and Map Preview (later referred to as the Student Overview), the Class Overview, the Essential Element List, and the Learning Map.

Student Report and Map Preview

The initial goal of the Individual Student Report was to provide users with a broad overview of a single student's performance. The data allowed teachers to identify and understand a student's achievement across all EEs in aggregate. The cadre indicated early on that this level of detail would be appropriate as a starting point, provided that additional detail and specificity would be available elsewhere in the dashboard. They agreed that the glanceable icons effectively provided a simple indication of student mastery and instructional status. They appreciated the clarity of the information displayed and reported that the initial layout seemed familiar and straightforward. Some mentioned the design appeared similar to other gradebook applications they had used previously.

As the design evolved, the Student Report also became a gateway to the Learning Map. A map preview was incorporated to expand and collapse on interaction with a specific EE. Initially, this preview featured a small section of the EE neighborhood map with visual indications of student mastery by node, as shown in Figure 5a. The cadre thought this preview lacked context and required more orientation within the larger map to be helpful. In subsequent design iterations, we displayed only the nodes assessed within testlets with some additional key nodes that connected linkage levels together, as shown in Figures 5b and 5c. The cadre responded positively to this revision but noted that the addition of nodes outside testlets was not necessary at the preview stage. They preferred only seeing nodes included within testlets. That update, along with the decision to include direct and indirect pathways between nodes, was introduced in later iterations, as shown in Figure 5e.

The addition of the Class Overview to the dashboard (see Figures 6a–6c) compelled the determination to shift the Student Report from the tabular layout to the card layout introduced in Version 4 (see Figure 5d). We ventured to clearly differentiate each space and support teachers in easily discerning the individual from class views. Cadre members confirmed the updated layout was easily interpretable and appreciated that the cards helped visually distinguish each EE and the data provided within. This revision yielded increased consistency among the dashboard's spaces. Providing users with a recognizable hub of links to the Learning Map and Essential Element List views improved navigation throughout the tool.

Figure 5a

Individual Student Report: Version 1

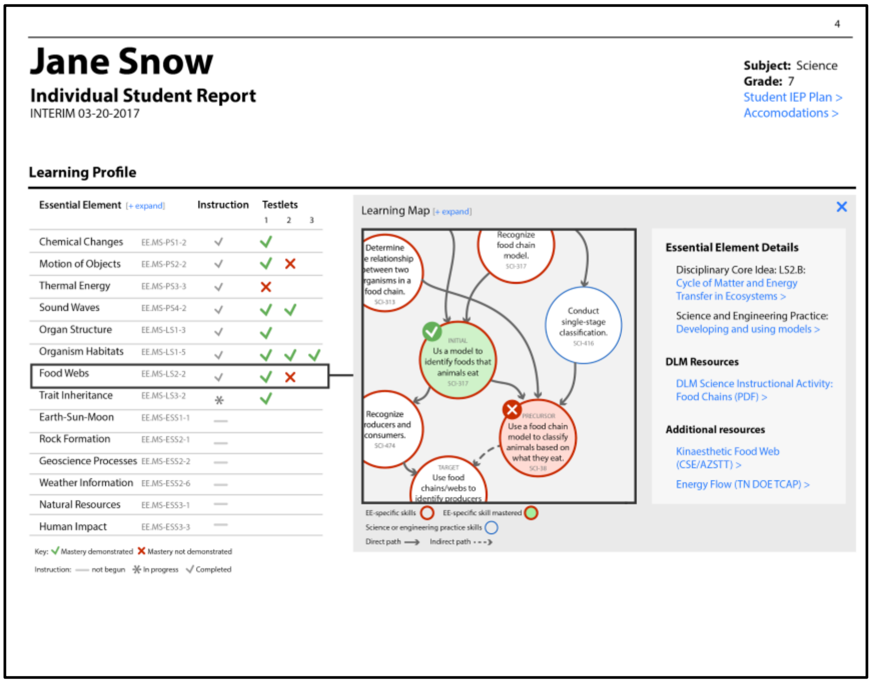


Figure 5b

Individual Student Report: Version 2

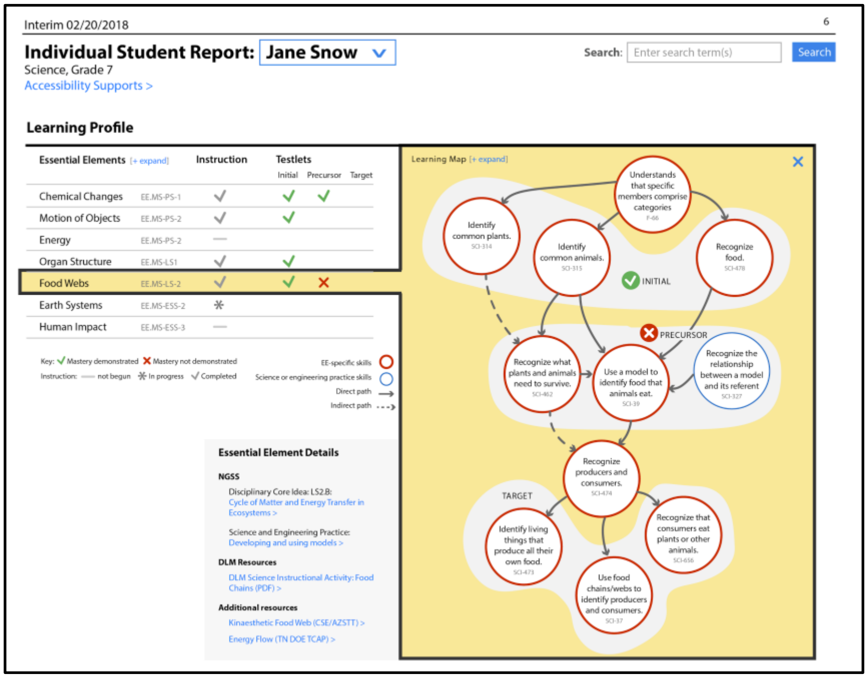


Figure 5c

Individual Student Report: Version 3

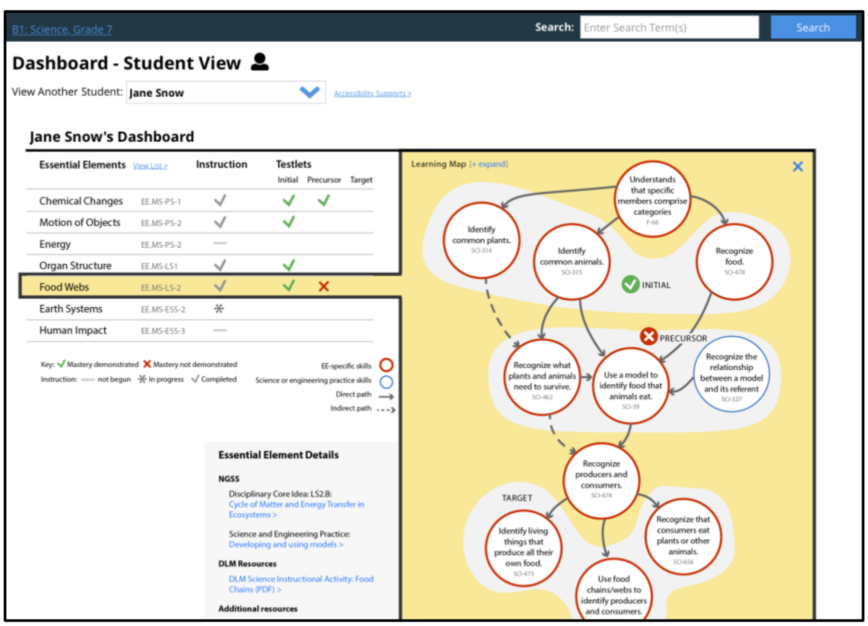


Figure 5d

Individual Student Report: Version 4

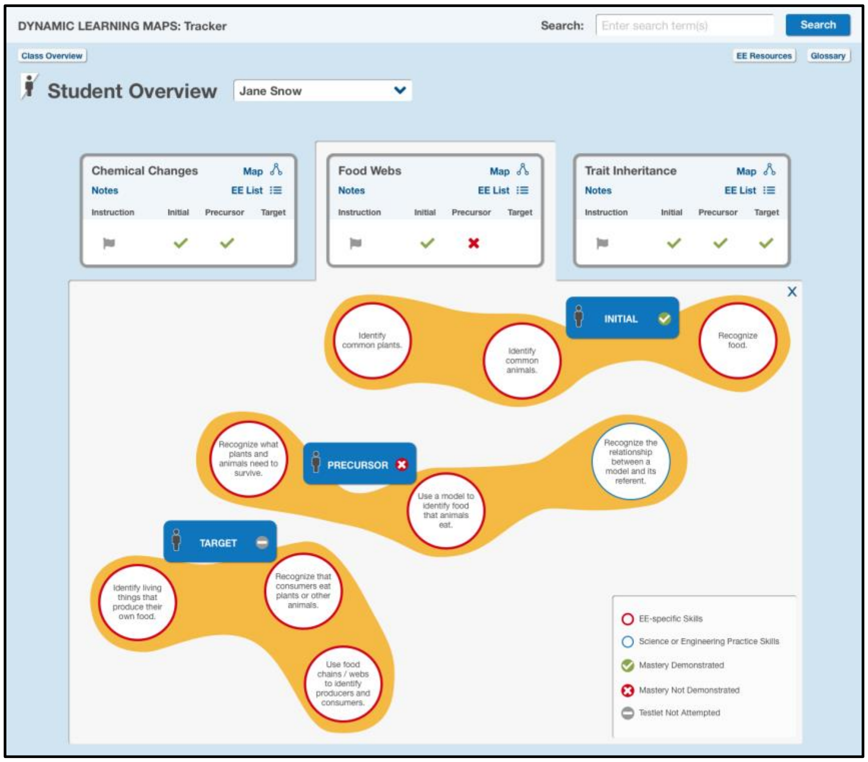
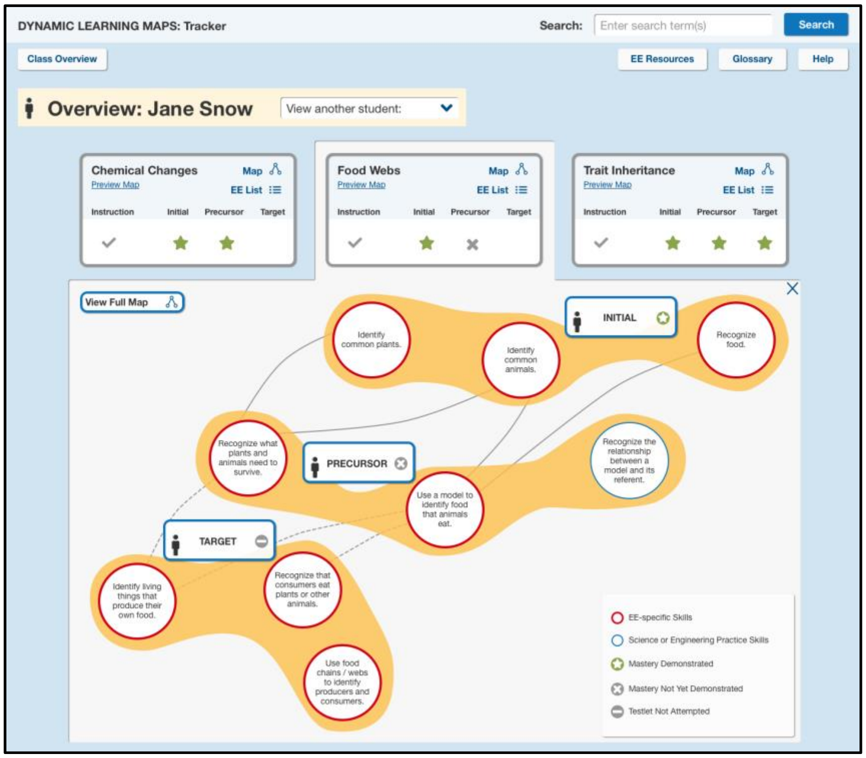


Figure 5e

Individual Student Report: Version 5



Class Overview

In discussions beginning with the needs assessment, teachers were enthusiastic to see an overview of their whole class—akin to the information displayed in the Student Report. We grappled with the implications of introducing this view, given the primary users of I-SMART are teachers of students with significant cognitive disabilities, and their students— even when grouped as a class—may be receiving instruction individually and moving at different paces through the curriculum. We probed the impetus for the request and discussed the desired outcome of this addition for the teachers in favor. We determined that while only a subset of teachers would benefit from this view, many deemed essential the ability to see student progress in toto. Some suggested the need for this information as a planning tool. Cadre members appealed for the ability to input instructional status by student rather than by class, so the dashboard would support variability and they could track a student's progress alongside their peers.

Some cadre members discussed their interest in using the Class Overview to spot patterns among student performance, such as when multiple students all struggled with one concept. Teachers mentioned that this information would be difficult to glean from the individual Student Reports and that seeing the class results as a whole would save them time. Some envisioned this view would influence their planning and instructional decision-making, for example, by highlighting when several students may benefit from additional coverage of a concept.

Cadre members advocated for the same level of simplicity they appreciated in the Student Report while also articulating considerable data needs. We began by creating a parallel page to the Student Report, including instructional status and student performance information, but omitting the map preview, as shown in Figure 6a. This decision was corroborated by the cadre members, who felt that a separate map view showing combined performance would be preferable by allowing them to focus on the "big picture" at this stage.

The iconography used in the Class Overview was tested and revised; changes implemented here cascaded through the interface. We determined it was most effective to utilize a unique symbol for each denotation on the overview, to improve scannability and accessibility (decreasing reliance on color alone to signify meaning), as shown in Figure 6c. We also made the proactive decision to remove the red "X" from the design system, acknowledging that it can have negative connotations for students and parents.

The Class Overview became the landing page for the dashboard, as cadre members described it as a "place to start" and a "jumping off point." Its development provided the tool with a home base that fulfilled the need for a navigational fulcrum.

Figure 6a

Class Overview: Version 1

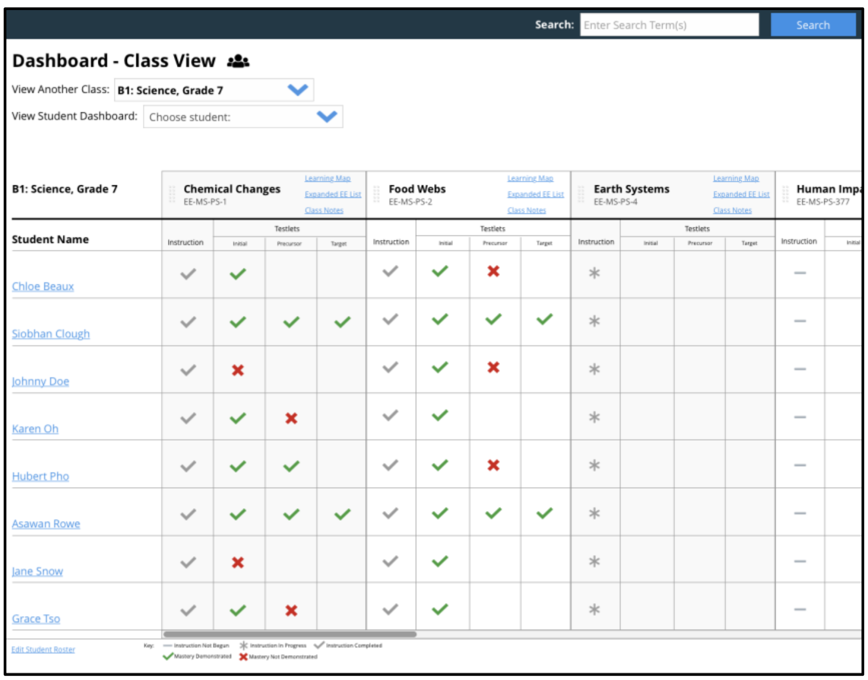


Figure 6b

Class Overview: Version 2

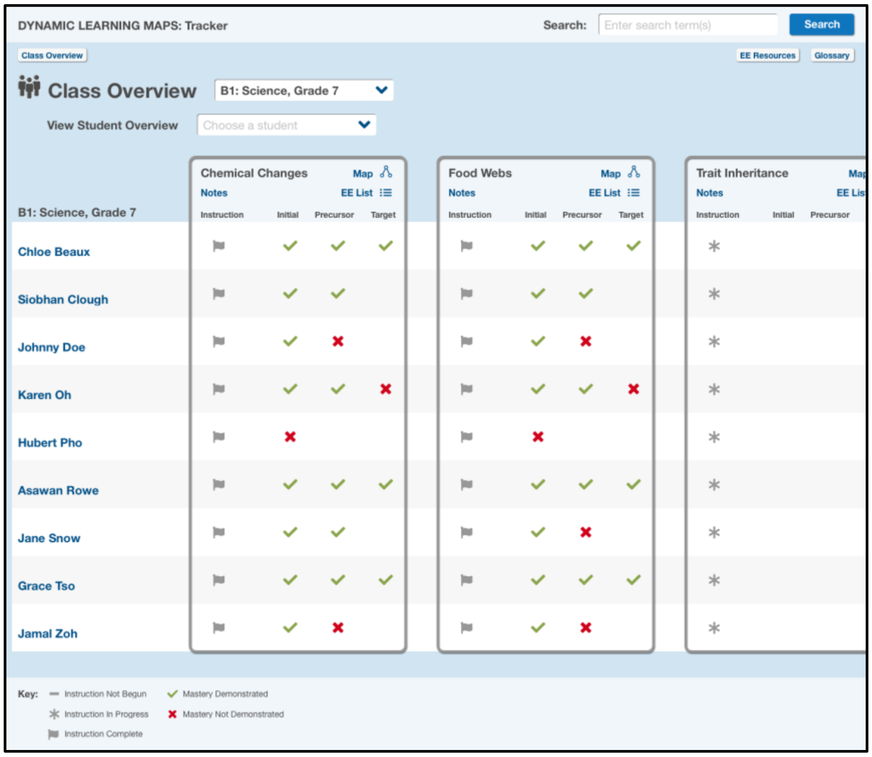
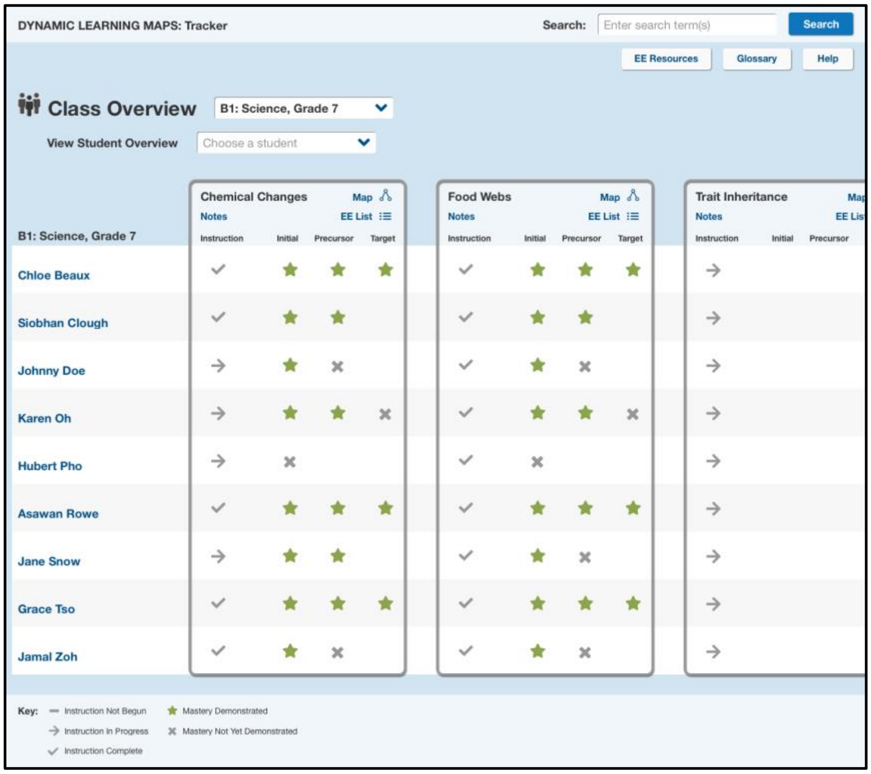


Figure 6c

Class Overview: Version 3



Essential Element List

The sentiment that the Essential Element List (Figure 7a) should become a prominent, multifunctional space within the dashboard emerged from the needs assessment and was reinforced by many cadre members. This viewpoint was predominantly voiced by those who had little to no prior experience navigating the Learning Maps, though there was consensus among all members that it would be a valuable addition to the tool. Teachers appreciated that the Essential Element List gave them “a starting point” to access the content. We saw merit in providing an alternative mechanism to display map data—accommodating the variability of our users’ needs and preferences.

Initially, the Essential Element List delivered a linear view of the nodes and node observations included within testlets at each linkage level. However, the student data shown were limited to mastery demonstrated at the testlet level, not the node level. Cadre members thought that the addition of node-level results would improve the utility of the Essential Element List. In the second version of the design, we incorporated indicators to show student results by individual node, as well as the number of items tested within each node, as shown in Figure 7b. Teachers affirmed that this degree of granularity was appropriate. They noted that this page would be particularly useful to save, print, and share with colleagues and parents.

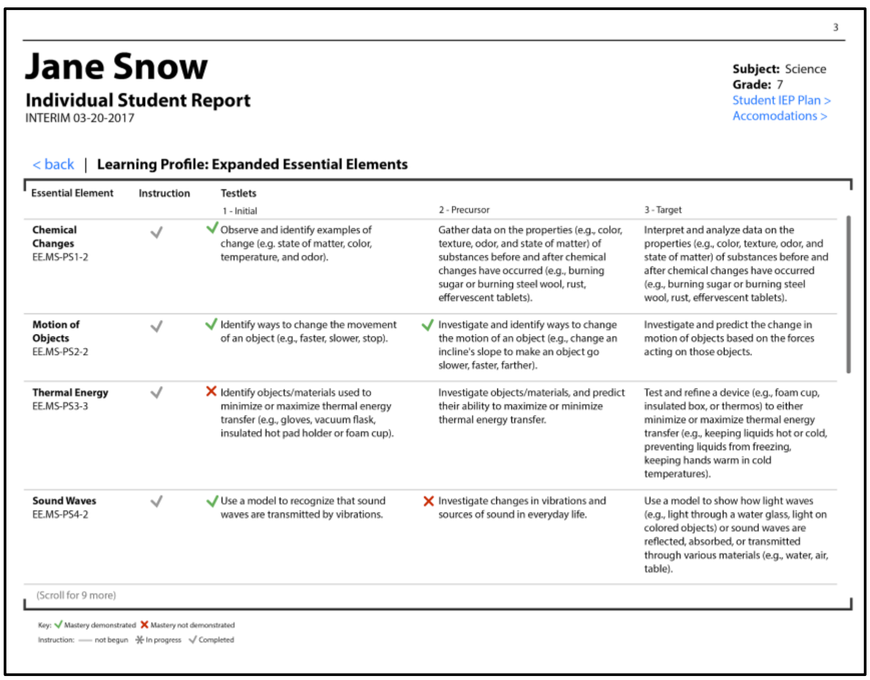
Subsequent iterations of the Essential Element List (Figures 7c–7e) featured the ability to expand and collapse the node observations because teachers noted that they only needed this information occasionally. Developing a show/hide function helped decrease complexity on the page and highlight salient information for users.

Upon the development of the Class Overview view, cadre members advocated for a commensurate version of the Essential Element List by class. Teachers described the divergent objectives at hand when reviewing Essential Element List data through the lens of one student's performance against reviewing those of a whole class. The divergence in intended usages drove the decision to feature aggregated student results by class on a separate page.

Throughout the development of this page, we considered the consequences of omitting the untested nodes in the Essential Element List view. Our cadre members expressed that their priority would be viewing the content of tested nodes paired with student results. With that recognition, we weighed the relative value of displaying the entirety of node content present on an EE neighborhood map versus only tested nodes. We concluded that the linearity of the Essential Element List format could not effectively support the interconnectivity that the map offers, and to promote users building familiarity and comfort with the map view, we limited the node data on the Essential Element List to tested nodes exclusively.

Figure 7a

Essential Element List: Version 1



3

Jane Snow

Individual Student Report
INTERIM 03-20-2017

Subject: Science
Grade: 7
Student IEP Plan >
Accomodations >

< back | **Learning Profile: Expanded Essential Elements**

Essential Element	Instruction	Testlets: 1 - Initial	2 - Precursor	3 - Target
Chemical Changes EE.MS-PS1-2	✓	✓ Observe and identify examples of change (e.g. state of matter, color, temperature, and odor).	Gather data on the properties (e.g., color, texture, odor, and state of matter) of substances before and after chemical changes have occurred (e.g., burning sugar or burning steel wool, rust, effervescent tablets).	Interpret and analyze data on the properties (e.g., color, texture, odor, and state of matter) of substances before and after chemical changes have occurred (e.g., burning sugar or burning steel wool, rust, effervescent tablets).
Motion of Objects EE.MS-PS2-2	✓	✓ Identify ways to change the movement of an object (e.g., faster, slower, stop).	✓ Investigate and identify ways to change the motion of an object (e.g., change an incline's slope to make an object go slower, faster, farther).	Investigate and predict the change in motion of objects based on the forces acting on those objects.
Thermal Energy EE.MS-PS3-3	✓	✗ Identify objects/materials used to minimize or maximize thermal energy transfer (e.g., gloves, vacuum flask, insulated hot pad holder or foam cup).	Investigate objects/materials, and predict their ability to maximize or minimize thermal energy transfer.	Test and refine a device (e.g., foam cup, insulated box, or thermos) to either minimize or maximize thermal energy transfer (e.g., keeping liquids hot or cold, preventing liquids from freezing, keeping hands warm in cold temperatures).
Sound Waves EE.MS-PS4-2	✓	✓ Use a model to recognize that sound waves are transmitted by vibrations.	✗ Investigate changes in vibrations and sources of sound in everyday life.	Use a model to show how light waves (e.g., light through a water glass, light on colored objects) or sound waves are reflected, absorbed, or transmitted through various materials (e.g., water, air, table).

(Scroll for 9 more)

Key: ✓ Mastery demonstrated ✗ Mastery not demonstrated
Instruction: — not begun ✳ In progress ✓ Completed

Figure 7b

Essential Element List (Expanded): Version 2

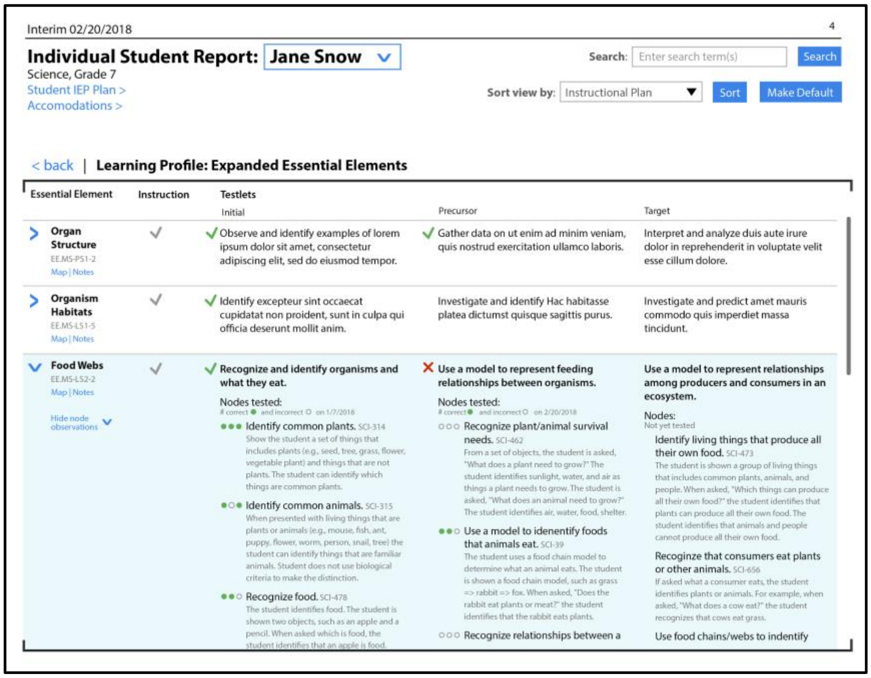


Figure 7c

Essential Element List (Expanded) Student View and Class View: Version 3

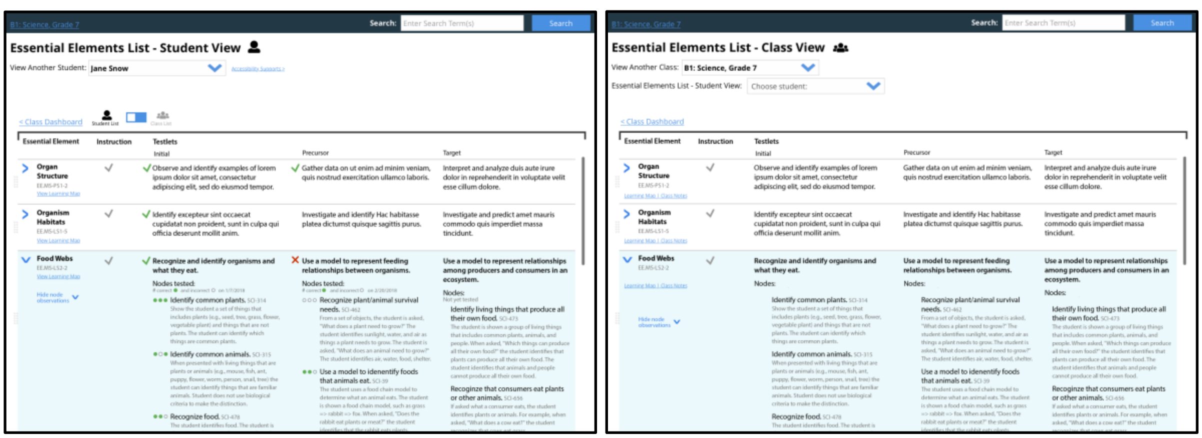


Figure 7d

Essential Element List (Expanded) Student View and Class View: Version 4

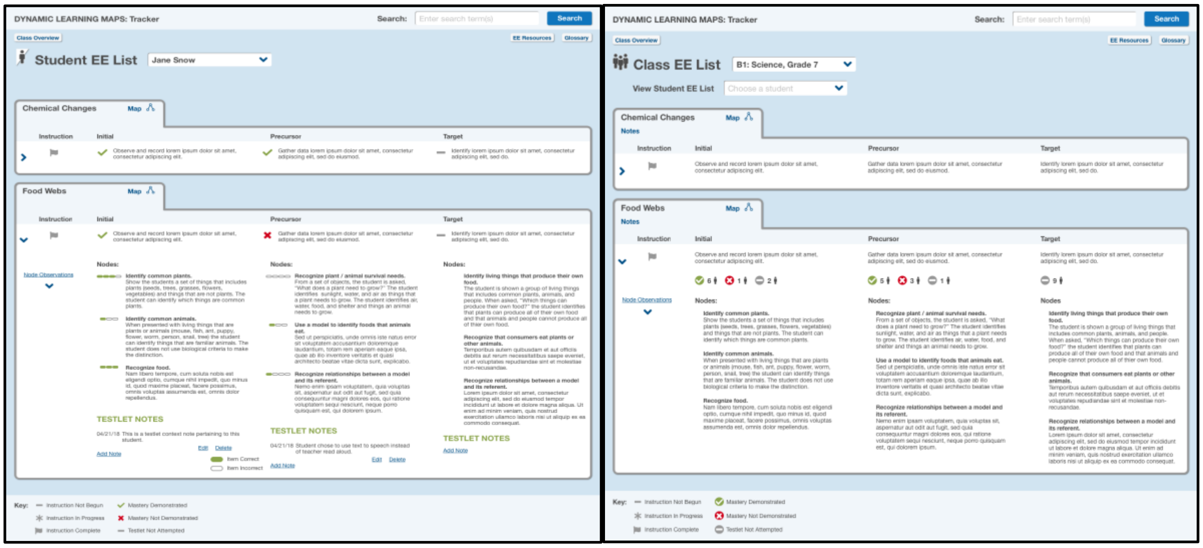
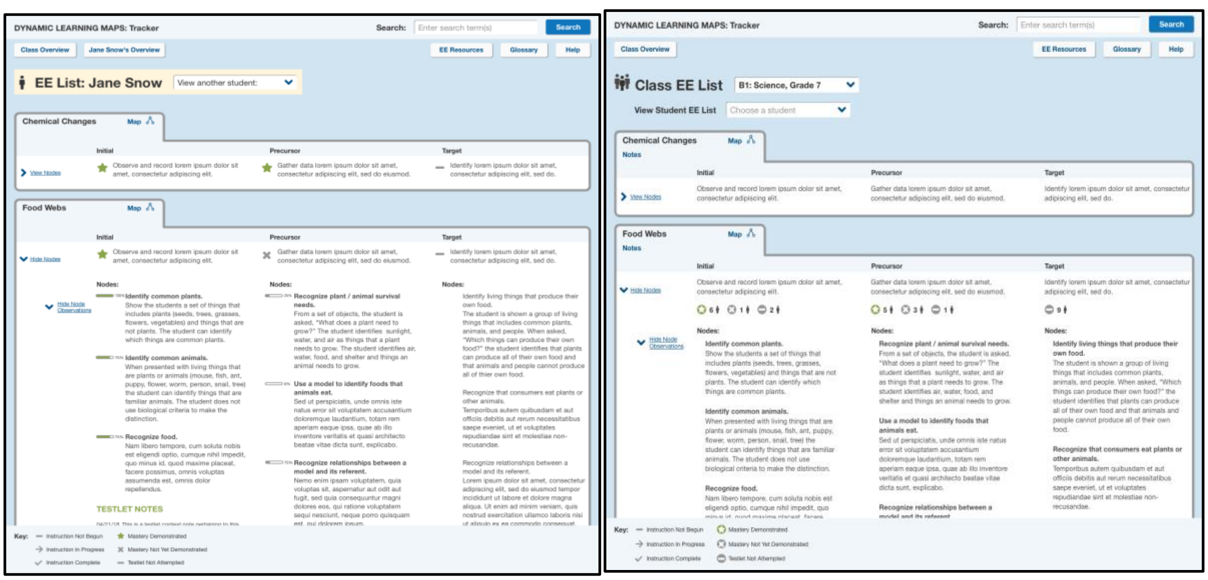


Figure 7e

Essential Element List (Expanded) Student View and Class View: Version 5



Learning Map

The findings of the needs assessment indicated that designing the Learning Map (Figures 8a–8e) to be a constructive and functional aspect of the dashboard could prove to present a considerable design challenge to our team. The reactions of the first cadre meeting participants fortified that belief. Teachers expressed confusion about how to use the map, noting that it "didn't feel user-friendly" and "seemed messy." It is important to note that the map models themselves were not originally conceived with teachers' use in mind, but rather as a tool for test construction. It was clear that teachers would require additional support and scaffolding to make the map feel less intimidating at the start and ultimately become useful to their practices. One cadre member concisely summarized the goal of our ensuing Learning Map design iterations, stating, "the information in the map is good, but it needs to be a readable, usable format."

To help clarify the purpose of the Learning Map for users, the second version included a highlight around the nodes tested at each linkage level, as shown in Figure 8b. This update was intended to orient teachers to the map's scope and sweep, giving them a visual indication that students would traverse the map from top to bottom as conceptual complexity increased. Some teachers remonstrated with the idea that no predetermined route through the map was prescribed; however, others enjoyed the notion that they had autonomy and control over the pathways and corresponding content they chose to cover with their students, with the caveat that they received specificity about the content to be tested so they could ensure it would be addressed.

Gaining familiarity with the map no doubt ameliorated user attitudes toward it, as evidenced by the cadre's evolving opinions of its utility. Participants perceived the map's interactivity, such as the node observation pop-ups triggered upon clicking each node, as convenient and intuitive. They requested the addition of detailed score reports within the map so they could directly connect student performance with the content being assessed. Later versions introduced a score report pop-up for each linkage level within the map, as shown in Figure 8c. Teachers responded positively to this addition, noting that it supplied more insights at the node level than the Student Report and Class Overview were designed to give, such as how many items were tested per node and how many of those a student demonstrated mastery of.

The addition of a Learning Map viewable by class for each EE neighborhood—analogous to the class version of the Essential Element List—was welcomed by the cadre, who overwhelmingly expressed the need for parallel student and class views of each space within the dashboard. We endeavored to make visually distinct the student and class Learning Maps to aid navigation and clarity within the interface. The inclusion of enhanced connectivity among the spaces also supported users with wayfinding.

Figure 8a

Learning Map: Version 1

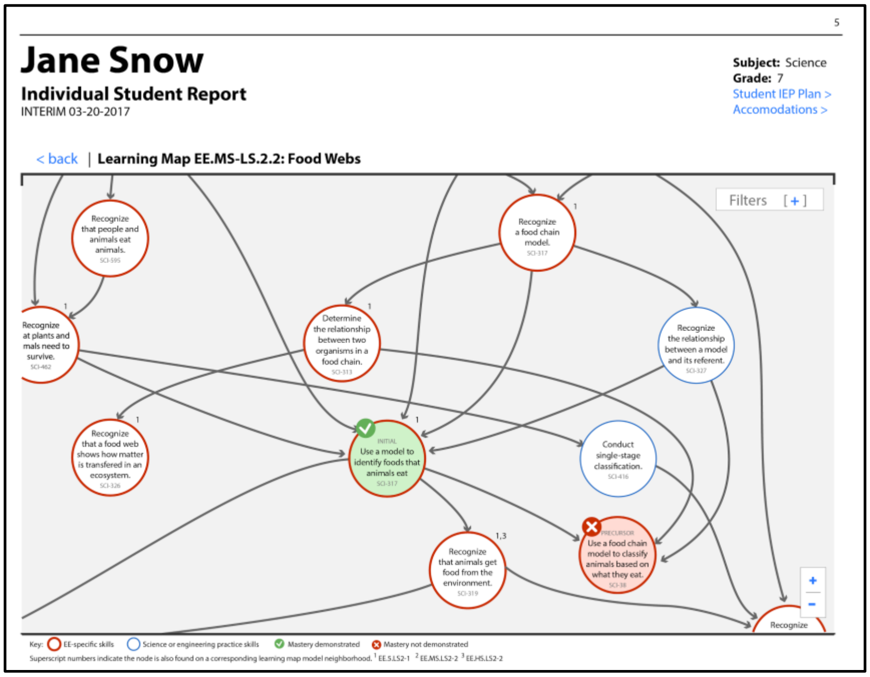


Figure 8b

Learning Map: Version 2

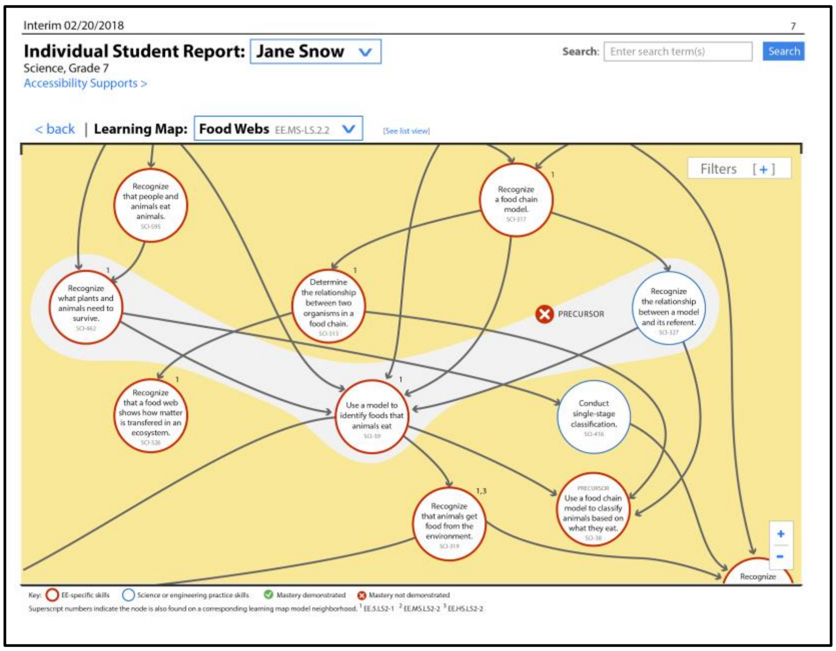


Figure 8c

Learning Map: Version 3

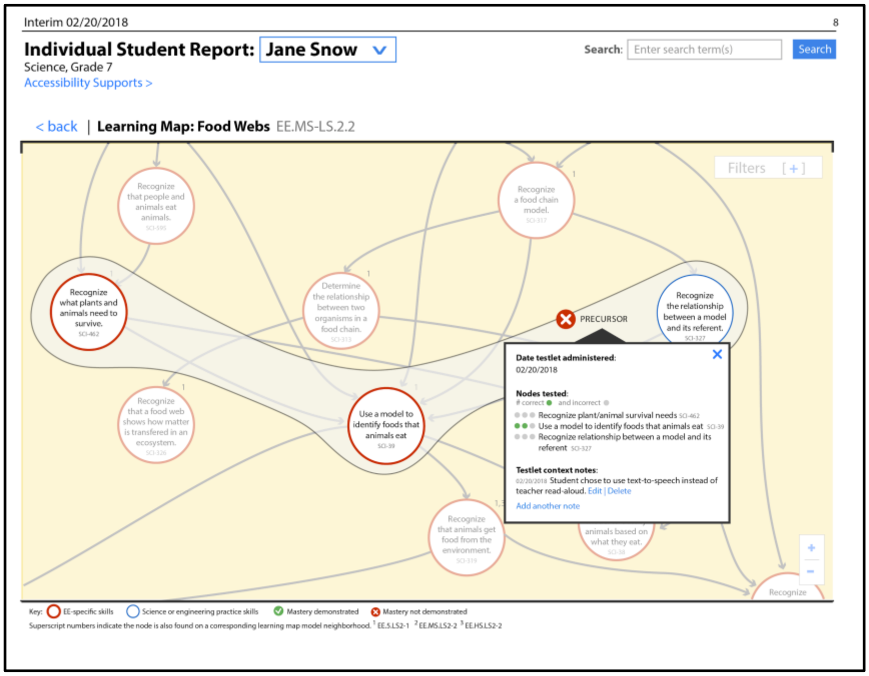


Figure 8d

Learning Map Student View and Class View: Version 4

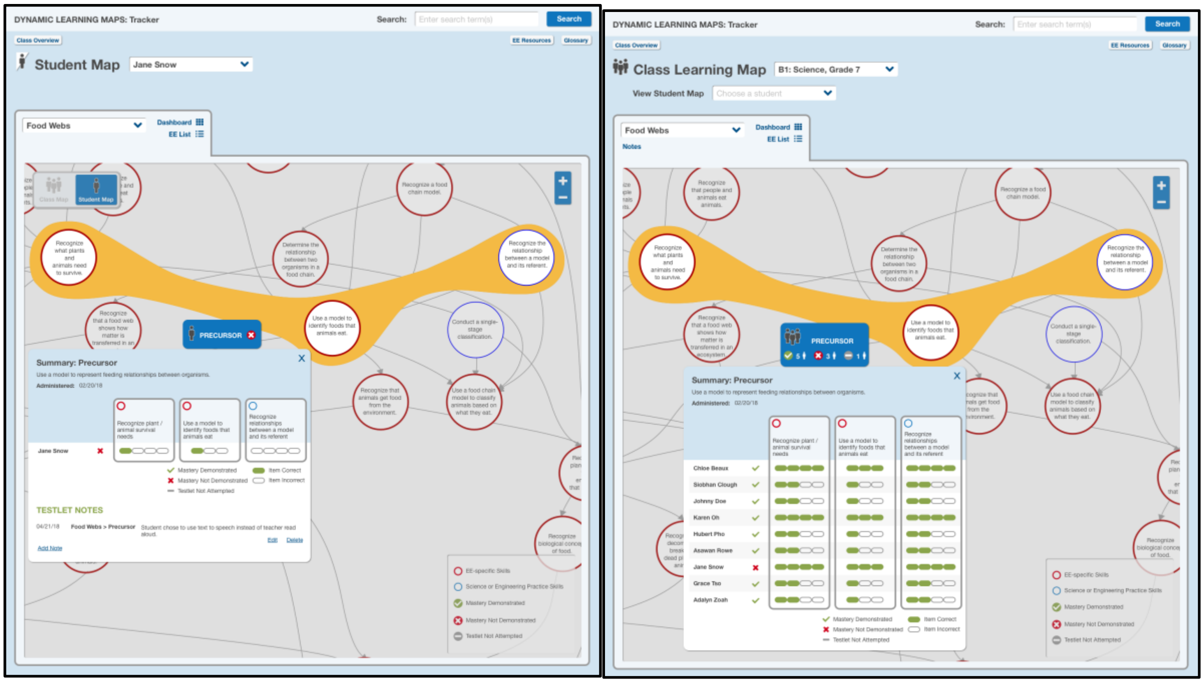
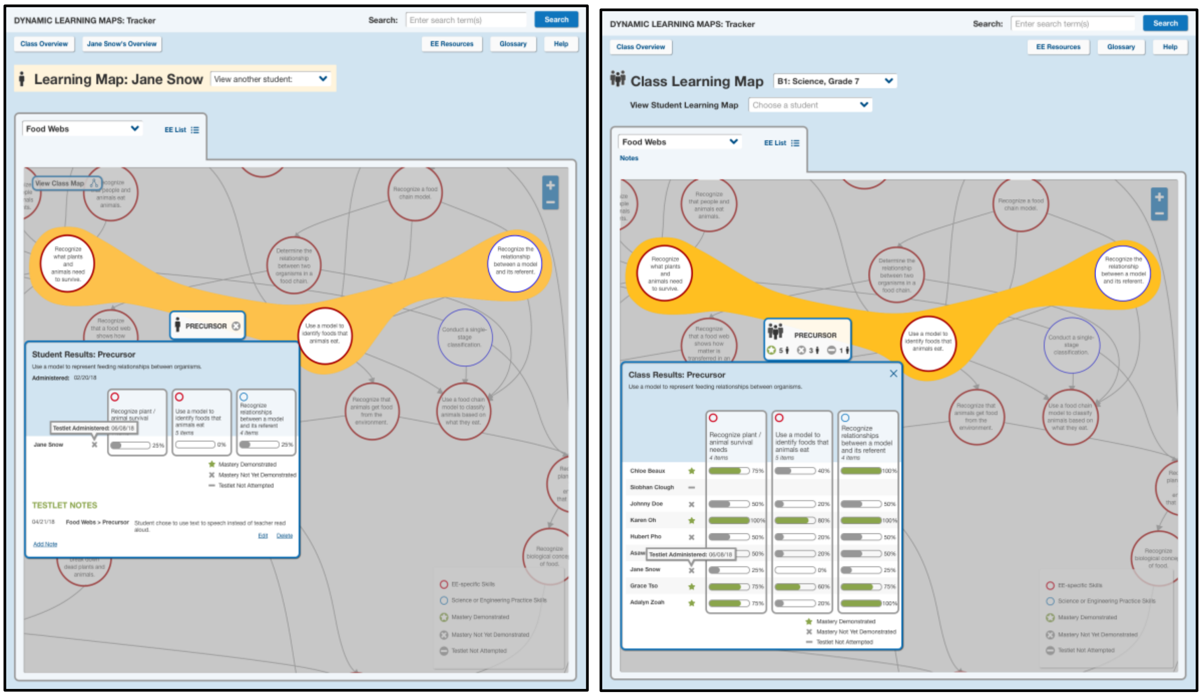


Figure 8e

Learning Map: Version 5



Part 4: Next Steps

Beginning in winter 2019–2020, a usability and utility study will be conducted with teachers using a fully functional prototype of the teacher dashboard. This study will leverage cognitive labs with teachers to gain deep understandings of how well the new design features are likely to support effective data-driven decision making based on student testlet results. Teachers will be provided access to mock data that are based on actual student data collected during early pilot studies. One of the central questions this study will answer is whether teachers indeed find the Learning Map views intuitive and useful for understanding student progress and for instructional planning.

Appendix A: DLM Terminology (Glossary)

The following terminology is central to the DLM and I-SMART projects.

Essential Element

Essential Elements (EE) are grade-level–specific expectations about what students with the most significant cognitive disabilities should know and be able to do. Essential Elements are related to college- and career-readiness standards for students in the general population.

Linkage Levels

Linkage levels are small collections of nodes that are measured at different levels of complexity. Target levels are most closely aligned with the Essential Element. Precursor and Initial linkage levels are connected to the Essential Element at a reduced level of complexity.

Node Observations

Node observations describe the student behaviors that can provide evidence in evaluating their knowledge, skills, and understandings aligned with a given node.

Nodes

Nodes are points in a learning map model that represent individual concepts and skills.

Testlets

Testlets are short groups of computer-delivered items that share a context and engagement activity and can be dynamically routed based on difficulty level required by a student.

Appendix B: Current Score Report Examples

Performance Profile Report

REPORT DATE: 03-20-2017
SUBJECT: Science
GRADE: 5

Individual Student Year-End Report
Performance Profile 2016-17

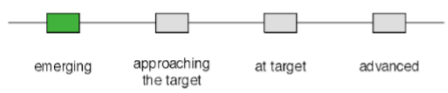
DYNAMIC® LEARNING MAPS

NAME: Student DLM
DISTRICT: DLM District
SCHOOL: DLM School

DISTRICT ID: DLM District ID
STATE: DLM State

Overall Results

Elementary science allows students to show their achievement in 27 skills related to 9 Essential Elements. Student has mastered 7 of those 27 skills during the 2016-17 school year. Overall, Student's mastery of Science fell into the first of four performance categories: **emerging**. The specific skills Student has and has not mastered can be found in Student's Learning Profile.



EMERGING:	The student demonstrates **emerging** understanding of and ability to apply content knowledge and skills represented by the Essential Elements.
APPROACHING THE TARGET:	The student's understanding of and ability to apply targeted content knowledge and skills represented by the Essential Elements is **approaching the target**.
AT TARGET:	The student's understanding of and ability to apply content knowledge and skills represented by the Essential Elements is **at target**.
ADVANCED:	The student demonstrates **advanced** understanding of and ability to apply targeted content knowledge and skills represented by the Essential Elements.

A student who achieves at the **emerging** performance level typically can recognize changes in state of matter, match properties, observe the effects of gravity, distinguish living from non-living things, identify human needs, order daily events, and anticipate routines.

In physical science, the student can

- recognize melting and freezing
- match materials with similar physical properties
- recognize the direction objects go when dropped
- identify models that show plants need sunlight to grow

In life science, the student can

Page 1 of 2

Learning Profile Report

REPORT DATE: 03-20-2017
SUBJECT: Science
GRADE: 5

Individual Student Year-End Report
Performance Profile 2016-17

DYNAMIC® LEARNING MAPS

NAME: Student DLM
DISTRICT: DLM District
SCHOOL: DLM School

DISTRICT ID: DLM District ID
STATE: DLM State

Performance Profile, continued

- distinguish things that grow from things that do not grow
- identify common human foods

In earth and space science, the student can

- order events in daily routines, including sunrise and sunset
- identify routines to follow when it is raining

Domain

Earth & Space Science — 22% — *Mastered 2 of 9 skills*

Life Science — 50% — *Mastered 3 of 6 skills*

Physical Science — 17% — *Mastered 2 of 12 skills*

More information about Student's performance on each of the Essential Elements that make up the Domains is located in the Learning Profile.

Page 2 of 2

REPORT DATE: 03-20-2017
SUBJECT: Science
GRADE: 5

Individual Student Year-End Report
Learning Profile 2016-17

DYNAMIC® LEARNING MAPS

NAME: Student DLM
DISTRICT: DLM District
SCHOOL: DLM School

DISTRICT ID: DLM District ID
STATE: DLM State

Essential Element	Level Mastery 1	2	3 (Target)
SCI.5.PS.2.1	Recognize the direction objects go when dropped	Predict the direction objects go when dropped	Demonstrate that gravity is directed down
SCI.5.PS.3.1	Identify models that show plants need sunlight to grow	Model plants capturing energy from sunlight	Model energy in food coming from the Sun

Levels mastered this year | No evidence of mastery on this Essential Element | Essential Element not tested

Page 2 of 2

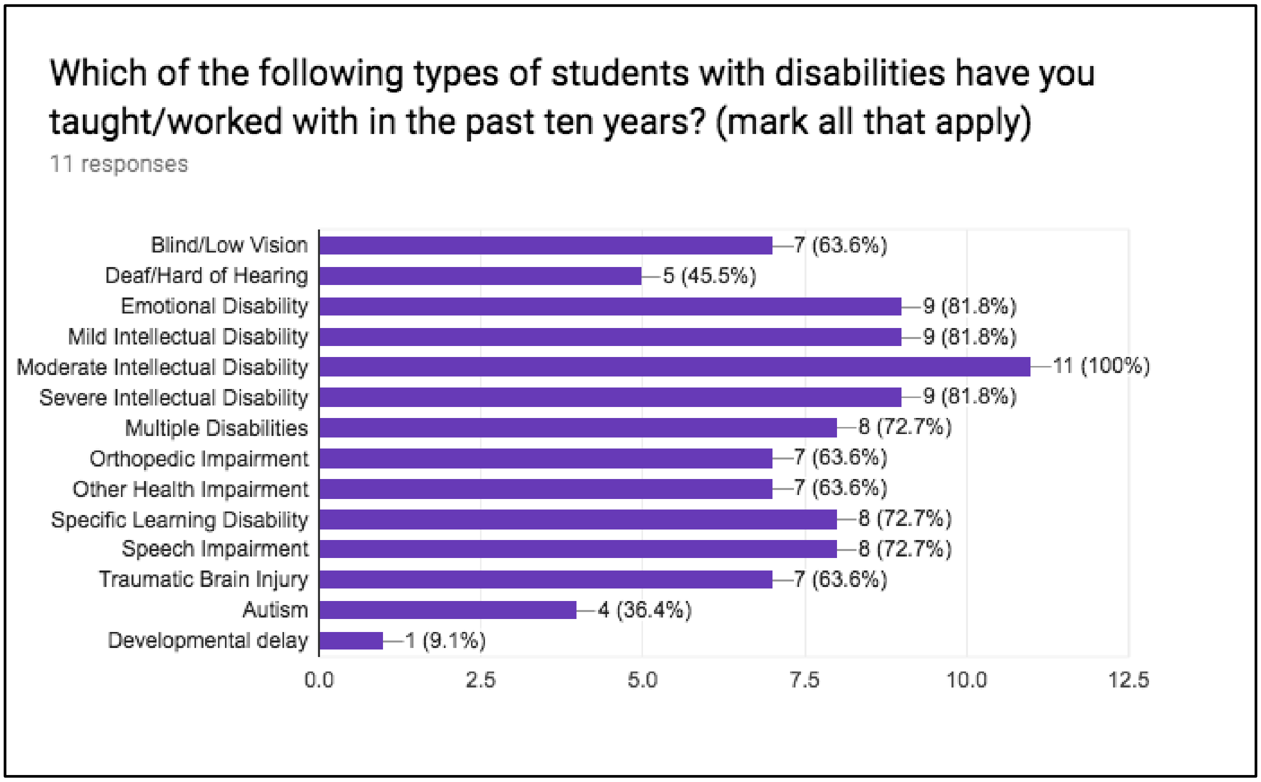
Appendix C: Cadre Member Information

Types of Students Cadre Members Have Served

Cadre members have worked with students with a wide range of disabilities (Figure 9).

Figure 9

Number of Cadre Members Who Have Worked With Students from Each Disability Type



Populations Served

Nine of the respondents do at least some of their work with students with significant cognitive disabilities, with six reporting their current experience working with students with other types of disabilities. One participant worked primarily with teachers and administrators in a district office.

Cadre Members' Years of Experience

Table 1 shows the years of experience of cadre members in some education settings. There is a wide range of an overall number of years of teaching experience, from 3 to 5 years to 25 to 30 years. Cadre members have worked throughout K-12, in a range of classroom types.

Table 1

Number of Cadre Members by Education Setting and Years of Experience

Education setting	Years of experience (*n*)								
	None	<2	3–5	5–10	10–15	15–20	20–25	25–30	>30
Total teaching	0	0	1	2	2	2	2	2	0
Science	0	0	6	0	2	1	2	0	0
Students with significant cognitive disabilities	0	0	1	3	2	1	3	1	0
Students with other disabilities	1	1	2	2	3	0	1	1	0
General education	7	3	1	0	0	0	0	0	0
Self-contained	1	1	2	2	3	0	1	1	0
Resource room	5	2	2	2	0	0	0	0	0
Inclusive classroom	6	1	2	1	0	1	0	0	0
Grade									
K–2	6	1	1	1	1	0	0	1	0
3–5	5	1	2	1	1	0	0	1	0
6–8	4	1	2	1	0	1	1	1	0
9–12	5	0	3	0	0	1	1	1	0

DLM Experience

The cadre has substantial experience with DLM alternate assessments; eight members (72.7%) have implemented DLM assessments in ELA and mathematics, five (45.5%) in science, and seven (63.6%) have participated in DLM item writing or map review.

Next Generation Science Standards Experience

Two cadre members (18.2%) have only heard of the standards, five (45.5%) have read them but do not fully understand them, two (18.2%) understand them somewhat, two (18.2%) understand them well, and none consider themselves a Next Generation Science Standards expert.

Alternate Assessments Based on Alternate Achievement Standards Experience

Four (36.4%) cadre members have 11 or more years of experience administering Alternate Assessments Based on Alternate Achievement Standards, five (45.5%) have 6–10 years of experience, and two (18.2%) have 1–5 years of experience.

Population Density of Cadre's Districts

Five (54.5%) of the cadre members work in a suburban district, three (27.3%) in an urban district, and two (18.2%) in a rural district.