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Elementary Science Essential Elements Curriculum Map & Progress Monitoring with Evidence-based Teaching Strategies

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Abstract

Little research has explored the field of science instruction tailored to students with significant disabilities. However, research studies have begun to emerge that suggest, with specific instructional strategies, these students can be successful in learning science curriculum. This project evaluated literature to find evidence-based instructional strategies for teaching science to students with significant cognitive disabilities. Six strategies were consistently found across multiple studies. The six strategies include (1) time delay, (2) systematic instruction, (3) multiple exemplar training, (4) task analysis, (5) graphic organizers, and (6) guided inquiry-based learning. These strategies were shared with a team of nine special education teachers who provide instruction based on the Essential Elements for their students with significant cognitive disabilities. A collaboration meeting was conducted monthly during Professional Learning Community (PLC) meetings. Ultimately, the objectives of this project were to improve data collection, enhance collaboration, and refine instruction on the relatively new science Essential Elements.

State Science Standards Essential Elements

State science expectations for all students in Utah are mandated in the Common Core State Standards. For students whose disability significantly impacts intellectual functioning and adaptive behavior, instruction is provided using the Essential Elements. Students are given the opportunity to learn "content linked to the Utah Core Standards through the support of Utah's Alternate Achievement Standards, the Essential Elements, [as determined] by the IEP team." (USBE). Each element was designed with an initial, precursor, and target linkage level that progressively increase in difficulty, and are tied to a Common Core state standard. "Alternate achievement standards are specific statements of the content, skills, and grade-level-specific expectations for students with significant cognitive disabilities that are aligned to the Utah Core Standards but have been reduced in depth, breadth, and complexity." (USBE, 2024) Essential Elements provide guidance for special education teachers on what content to cover. The list of Science Essential Elements for elementary school grades (3-5) contains nine total standards in the areas of physical, life, Earth and space sciences. The Essential Elements provide a broad beginning of what content to cover, but the need is critical for special education teachers to implement evidence-based teaching strategies in teaching that content. Additionally, under the Endrew F case, "To meet its substantive obligation under the IDEA, a school must offer an IEP reasonably calculated to enable a child to make progress appropriate in light of the child's circumstances" (*Endrew F. v. Douglas County School District*, 2017, p. 15) teaches are required to progress monitor to track the achievements of each student and evaluate the success of instructional methods.

Need For a Curriculum Map & Progress Monitoring System

I helped develop a curriculum map which included the science Essential Elements for grades 3-6 for one academic year. Along with the map, I created a digital progress monitoring system for teachers to track students' achievement in science. Our special education team, consisting of 9 special education teachers, teacher leaders, and others collaborated monthly on students' progress. To further enhance this collaboration, review of current research detailing instructional strategies was discussed. A presentation of these strategies and helpful hints for implementing them was reviewed and discussed and is now on the team website for further reference. This collaboration was documented, to preserve teachers' insights. I gathered assessment pieces from our curriculum into one document to facilitate data collection on students' science scores. I supplemented assessments with my own created exam when the curriculum lacked necessary material.

Literature Review

A literature review was conducted using Utah State's online library using the search engine Academic Search Ultimate, which contains a multidisciplinary collection of sources. The following search terms were applied: science education, science teaching, science learning, instructional strategies, best practices, disability, disabled, impaired, elementary school, grade school, primary school.

This search yielded 66 results and 25 studies were considered applicable. These 25 studies were analyzed closely. The following criteria were used to analyze each study. The article must include strategies for teaching science to students with disabilities from kindergarten to sixth grade. Articles that evaluated a specific curriculum were considered solely by analyzing instructional strategies embedded within the curriculum which could be applicable with science instruction.

Through this research it became apparent that the study of special education science is somewhat sparse, with the historical focus on vocabulary, life skills, safety, and cooking. (Knight et al., 2020). With the advent of Essential Elements for science, the depth of content is improving and the requirement to include science in grade-level testing has increased rigor. However, the critical question remains of how to successfully implement instruction in this challenging field for students with significant cognitive disabilities. In a review of studies conducted by Knight, he laments the lack of science practices taught in special education. Instead, the focus has been on teaching content such as life skills and safety. (Knight et al., 2020).

Despite these obstacles, there is promising research detailing effective teaching strategies for science instruction in special education. During research, several strategies were repeatedly cited as successful research-based methods. The six strategies include (1) time delay, (2) systematic instruction, (3) multiple exemplar training, (4) task analysis, (5) graphic organizers, and (6) guided inquiry-based learning. A record of collaboration on progress monitoring and experience using these specific strategies was kept. Courtade, Spooner, and Browder conducted a literature review of science instruction methods for students with significant cognitive disabilities. Their review verified the issue of limited science content taught to students with disabilities. However, they discovered eleven studies that implemented interventions with promising results. (Courtade, 2007). The six specific strategies discussed were present in several research studies.

Time Delay and Systematic Instruction

Time delay is a teaching strategy that embeds instruction to systematically present material to students (Jimenez et al., 2012). A teacher will present a concept, illicit a response, and immediately provide the correct answer. This prevents the student from guessing or becoming confused by incorrect responses. This is known as the zero second time delay round. Next, the process is repeated with a few seconds between the question being asked and a correct response provided. Students can respond correctly within the few seconds or receive an error correction for incorrect answers. Alternatively, they may not respond in time and are then provided a correct answer by the teacher. This prevents students from becoming frustrated, sitting for long periods unable to answer (Knight et al., 2020) In their study Jimenez et. al used time delay along with graphic organizers, including a KWHL chart (what we know, want to know, how to find out, what was learned), to successfully train five special education students to achieve mastery of science content and vocabulary. They did this by embedding time delay procedures with trained peer mentors as mediators. The students participated in inquiry-based lessons with their KWHL charts; and peer buddies trained in time delay procedures to facilitate. (Jimenez et al., 2012) All students demonstrated increased correct responses across all units. Three students required additional instruction from the special education teacher to reach mastery. Four other studies also demonstrated positive effects during science instruction when time delay was implemented. (Collins et al., 2011; Jimenez et al., 2012; Knight et al., 2018; Riggs et al., 2013; Smith et al., 2013).

Systematic instruction is an evidence-based behavioral analysis teaching method that can be applied very broadly, from science or other academics to functional skills. It has been proven over the span of years to be an effective practice for students with disabilities. Systematic instruction considers a lesson in its entirety, along with preceding lessons and those that will follow. With this large scope, lessons are then designed analyzing the objectives of the lesson. Systematic instruction makes use of targeted interventions such as prompt fading, errorless learning, and time delay. Data collection is prepared in advance to accompany the lesson. After the lesson is implemented, analysis of the data is undergone to determine its effectiveness and adjust for future lessons (Greene & Bethune, 2021). Special education teachers often excel at using systematic instruction in reading. Greene and Bethune (2021) investigated the potential of applying systematic instruction to science.

They discussed the problem of the historical lack of science instruction for students with significant cognitive disabilities. (Greene and Bethune, 2019) They investigated the potential of applying systematic instruction during group science lessons. Systematic instruction is a research-based strategy but had not been verified in group settings teaching science to students with IQ levels below 70. Greene and Bethune taught three elementary school aged students with intellectual disabilities (ID) and autism spectrum disorder (ASD) science lessons using systematic instruction, including time delay. They used a multiple baseline design across units with replication for each student. The dependent variable consisted of small group instruction on five vocabulary words, five definitions, and three concepts for each unit and assessed by daily probes. Researchers sought to answer the question whether group instruction would be an effective method to teach science content and examined the social validity of this type of intervention. These were taught with errorless correction and time delay. This involves immediately modeling the correct answer and intervening with prompting, to prevent the student from selecting an incorrect answer. Each student received instruction and then observed instruction in random order. After the instruction students engaged in an activity that reinforced the concepts learned. Daily probes were conducted, not immediately after instruction. The method of the study was multiple baselines with concurrent replication for all students. Results demonstrated a gradually increasing trend in accuracy of responses across all units for all three students. Staff indicated positive social validity for this type of instruction. Opinions of staff about the practice were favorable. A limitation is the necessity of moving on to a new unit due to time constraints and the group setting, when doing so was not ideal for all members of the group.

Task Analysis

One component of systematic instruction is task analysis. (Spooner et al., 2011) Task analytic instruction is a process where a difficult skill is broken down into small manageable steps. Students are taught a chain of step-by-step instructions to finish a large task (Knight et al. 2020). Students with disabilities benefit from instruction that has broken large concepts into increments that can be taught directly. Task analysis focuses on sequencing a large idea one piece at a time in a sequential process. In another study Knight reviewed literature examining task analysis as a mode of instruction (Knight et al. 2020). They found that six methodologically sound studies found positive outcomes when using task analytic instruction.

Multiple Exemplar Training with KWHL Chart

Multiple exemplar training is a practice used in applied behavior analysis. It involves teaching a new concept by using a variety of examples with the goal of generalization. (Jimenez et al., 2009) The teacher will demonstrate a new idea using several related objects or images. For example, a student can be shown a new vocabulary word with a clip art image, a real-life image, and a concrete object. Doing so assists students with disabilities to generalize knowledge. This can be pertinent in science instruction. Multiple exemplar training has been used effectively to teach daily living skills, vocational skills, communication, appropriate behavior, and academic skills. (Rozenblat et al., 2019). (Noell et al., 2019)

Graphic organizers can improve student outcomes. A KWHL chart is a graphic organizer with the "headings of "*K*" standing for "What do you *K*now?" "*W*" standing for "What do you *W*ant to know?" "*H*" meaning "*H*ow will you find out?" and an "L" prompting the question

“What did you *L*earn?” (Knight, et al., 2020, p. 337). This chart gives students visual accommodations to assist them in organizing their information and following the steps to solving a science experiment.

Guided Inquiry Based Learning

A final instructional strategy, suggested in several studies, is inquiry-based learning with guidance or accommodations (Miller, 2012). This is a hands-on approach to science that is focused on activities that are directed by the student (Lee et al., 2015). National Science standards describe it as a process where questions are posed, then answered by the student through scientific experimentation. (Knight et al., 2020). A daunting hindrance to providing inquiry-based instruction to students with significant cognitive disabilities is their lack of background knowledge. This presents an imposing challenge for students with special needs during inquiry-based lessons.

Courtade, Jimenez and Browder examined the ability of three middle school students with intellectual disabilities to participate in inquiry-based learning with supports. Supports included multiple exemplar training, time delay, a KWHL chart, and a 15-step task analysis. The dependent variables were the task analysis, a KWHL chart notebook, and analysis of inquiry-based tasks. (Courtade et.al, 2007). A multiple probe design was used across two science units with replication for each participant and probes during maintenance. All three students achieved mastery levels of science content, with large improvement from baseline levels. There were some unexplained generalizations across topics that raised questions about the complete validity of the intervention. This could be due to the nature of the inquiry-based learning. Students showed surprising ability to generalize to new materials as well as problem solve using their

KWHL tools without additional instruction. All students improved dramatically from baseline to intervention with the use of the KWHL charts.

Knight, Spooner, Browder, and Smith also examined the effectiveness of systematic instruction to teach science to students with disabilities. Their article discusses the challenges of using inquiry-based instruction for students with disabilities were discussed. Discrimination training, as part of systematic instruction has been effective in teaching vocabulary to students with disabilities. Researchers examined whether students with autism could learn science descriptors through this method. The methods used were a multiple probe across behaviors with replication for each student. Three elementary age students with autism participated in the study. Data was taken for baseline, response, and maintenance sessions. The dependent variable was the number of accurate responses. The independent variable was the systematic instruction, which uses the model- lead- test method to teach new descriptors. Additionally, the students participated with their same age peers in an inquiry experiment for each unit. During the experiment they were assessed on their maintenance of the science descriptors. All three students met their goal and demonstrated high levels of maintenance of the science terms. They all generalized to new objects and new settings. However, generalization from objects to pictures was not as successful. Another limitation of this study is the difficulty of physically manipulating objects for discrete trial. This would be especially difficult to replicate in the general education classrooms. Findings of the benefits of systematic instruction to teach science descriptors are useful for educators. The model -lead -test method is a simple skill to acquire and implement.

Knight et al further examined systematic instruction in science in a 2013 study (Knight, 2013). This study highlights the challenges of students with autism in accessing the general education curriculum for science. Barriers include the vast amount of vocabulary acquisition necessary. Three middles school students with autism were provided graphic organizers and were taught in the resource room. The independent variable was systematic instruction. The dependent variable was the number of correct tasks completed in a task analysis. A multiple probe across students was used. Results showed a functional relationship between intervention and increased accuracy scores. Students were all able to master the steps of the task analysis. Explicit teaching of the graphic organizer was shown to be an effective accommodation. One aspect that was useful for students was the implementation of visuals. A limitation of the study arises from the use of a package of systematic instruction practices. Thus, it is difficult to isolate the effectiveness of any one piece of the intervention or its effectiveness when separated from other components of systematic instruction. Because students were instructed outside of the general education classroom it is unknown how well this intervention would transfer to a general education setting. Despite limitations this study is part of an important emerging body of work dedicated to providing students with disabilities the opportunities and skills needed to learn science content.

Another obstacle to inquiry-based learning is the heavy load placed on the working memory. Lee and So (2015) contemplated this phenomenon in their study. They explain the need for special education teachers to be flexible, creative, and intentional in easing the load on their students' working memories. While large challenges exist, there is good news. Teachers of students with significant cognitive disabilities can successfully utilize research-based strategies.

Conclusion

The field of special education strives to help students reach their educational capabilities by providing accommodations and support they need. The combination of a curriculum map, progress monitoring and evidence-based teaching strategies offer unprecedented opportunities for students with disabilities to succeed. While students with disabilities may require more time or accommodations and modifications, new possibilities unfolding. Even daunting inquiry-based science activities have been made accessible to students with cognitive disabilities by providing necessary adaptations (Jimenez et al. 2009). Special education teachers in the elementary school setting will have the tools and plan to accommodate each unique student's learning and identify gaps in their progress.

Curriculum Report and Progress Monitoring

State science expectations for all students in Utah are mandated in the Common Core State Standards. Students are given the opportunity to learn "content linked to the Utah Core Standards through the support of Utah's Alternate Achievement Standards, the Essential Elements, [as determined] by the IEP team." (USBE). For students where the disability significantly impacts intellectual functioning and adaptive behavior specialized instruction is provided using the Essential Elements as their standard. Each element was designed with an initial, precursor, and target linkage level that progressively increase in difficulty and are tied to a Common Core state standard. "Alternate achievement standards are specific statements of the content, skills, and grade-level-specific expectations for students with significant cognitive disabilities that are aligned to the Utah Core Standards but have been reduced in depth, breadth, and complexity." (USBE, 2024) Essential Elements provide guidance for special education teachers on what content to cover. The list of Essential Element science standards for elementary school grades (3-5) contains nine standards in the areas of physical science, life science, and Earth and space science. While this provides a broad beginning, the need is critical for special education teachers to implement evidence-based teaching strategies. Additionally, progress monitoring is essential to track the achievements of each student and evaluate the success of instructional methods (Kingston, 2016).

I created a progress monitoring tool that covered each science Essential Element for grades 3-5. (See Figure 1) The progress monitoring tool is digital and was made accessible to our special education team of teachers- kindergarten through sixth grades. This tool is accompanied by a sequential map of when to cover each science Essential Element throughout the year. This ensured teachers covered the same material simultaneously. Thus, collaboration focused on the effectiveness of instruction for each Essential Element. Student progress was tracked, and analysis made to enhance future teaching. As a team, the 9 special education teachers in our school gather every Friday for Professional Learning Community (PLC) meeting. During these meetings we collaborate, review data, problem solve, set goals, and encourage each other. This year one Friday per month was dedicated to science progress monitoring. Teachers shared what went well and sought advice on concerns.

A total of four teachers kept record of fourteen students in third to fifth grades. As this was an extra assignment on top of already heavy caseloads, not all teachers participated, and data from kindergarten to second grades and sixth grade were kept separately, as they are taught on different Essential Elements. Figures 2-5 show the results of the progress monitoring. This record will be kept and used in future years to allow us a longer view of students' growth. It will also provide awareness to future teachers at what level students have received previous instruction.

Assessments were conducted with each student individually. For each Essential Element, they were given a pre-test on Monday, then received instruction during the week. On Friday each student was given an individual post- test. Most exam questions contained three pictures. The student was asked a question and then touched the correct picture answer. A few of the more advanced standards had assessment questions written at a more challenging level including text only, or text and picture. As an example of how assessments were conducted, Essential Element SCI.EE.5.LS2-1 states that a student should be able to “create a model that shows the movement of matter (e.g., plant growth, eating, composting) through living things.” For a student to meet the initial level of this Element, they would need to identify common human foods (and non-food items). A test question was asked, “which one is not food?” The student had three picture options including a carrot, an apple, and a jacket. If they selected the jacket, the item was marked correct. The precursor level for this Essential Element states that a student should be able to “identify a model that shows the movement of matter from plants to animals (e.g., food chain/food web).” To demonstrate mastery of this level the student would select from three different visuals of food chains. Options included a food chain diagram beginning with the sun, then an arrow pointing to grass, then an herbivore. Other options contain the same pictures in different sequences. The student was required to select the food chain that was in the correct sequence. The target level for this Element requires a student to create the model of the food chain themselves. To do this they were given separate pictures of the sun, grass, and an herbivore. To demonstrate mastery the student was required to assemble the pictures in the correct sequence.

As Figure 1 depicts our initial Essential Element covered understanding a daily routine. At this time in the school year students were instructed on learning the school routines. Our first data point was collected September 15, 2023. Students’ ability levels were divided by the initial, precursor, and target levels of each Essential Element. If the student achieved the initial level their color was red, precursor was yellow, and target was green. One third grade student improved from initial to precursor levels after science instruction in the month of September. Two fourth grade students moved from initial to target levels. Five fourth and fifth grade students moved from precursor to target levels. The other five students maintained their level during pre and posttests. This is good information for us to continue working on this skill in future years.

October's Essential element covered how people can protect the environment. Our third graders all maintained initial levels. Fourth grade showed more improvement with four students moving up a level, one maintaining and one dropping a level. Two fifth grade students progressed from precursor to target levels and one maintained at precursor levels.

Figure 1

		SCI.EE.5.ESS1-2 Represent and interpret data on a picture, line, or bar graph to show seasonal patterns in the length of daylight hours			SCI.EE.5.ESS2-1 Develop a model showing how water (hydrosphere) affects the living things (biosphere) found in a region.			SCI.EE.5.ESS3-1 Use information to describe how people can help protect the Earth's resources and how that affects the environment.		
		Initial Precursor	Order events in a daily routine, including sunrise and sunset.		**Initial Precursor**	Anticipate routine (e.g., clothes to wear, activities to do) to follow when it is raining.		**Initial Precursor**	Identify one way to protect a resource of Earth (e.g., put paper in the recycling bin to save trees, recycle cans to save metal, turn off appliances to save energy).	
		Precursor	Recognize patterns about length of daylight hours over time (e.g., week to week, month to month).		**Precursor**	Recognize how water (hydrosphere) affects people in a region (e.g., floods, droughts, mudslide, tourism, and recreation).		**Precursor**	Compare two methods (e.g., reusable water bottles vs. recycling disposable bottles, shutting off lights, using both sides of paper) people can use to help protect Earth's resources.	
		Target	Represent and interpret data on a picture, line, or bar graph to show seasonal patterns in the length of daylight hours.		**Target**	Develop a model showing how water (hydrosphere) affects the living things (biosphere) found in a region.		**Target**	Use information to describe how people can help protect Earth's resources and how that affects the environment.	
Teacher	**Student**	Aug 25	Sept 1	Sept 8	Sept 15	Sept 22	Sept 29	Oct 6	Oct 13	Oct 18
A	3-1					18%	30%	20%		17%
B	3-2									
B	3-3									
C	4-1	multiple surgeries								
C	4-2									
A	4-3	out of country 1 month					43%	50%		46%
A	4-4					27%	U	U		25%
A	4-5					73%	82%	31%		57%
A	4-6	hospitalized 2 weeks				64%	91%	71%		57%
B	4-7									
D	4-8									
C	5-1									
C	5-2									
C	5-3									

Figure two displays Essential Elements SCI.EE.5.PS2-1 and SCI.EE.5.LS1-1, needs of plants and gravity. In November two third graders remained at initial levels. One was unavailable, signified by the letter U. (This means the student was present, but due to health, behavior, or anxiety could not participate that day). Two fourth grade students moved from initial to precursor levels. One maintained initial level and a final fourth grade student dropped from target to precursor level. Two fifth graders-maintained target levels. One dropped from precursor to initial.

In January one third grade student went from unavailable to target level. Three fourth graders reached target level and two reached precursor level. Two fifth graders reached target level and one reached precursor level.

Figure 2

		SCI.EE.5.LS1-1 Provide evidence that plants need air and water to grow.			SCI.EE.5.PS2-1 Demonstrate that the gravitational force exerted by Earth on objects is directed down.		
		Initial Precursor	Distinguish things that grow from things that don't grow (but some things grow slower than others).		**Initial Precursor**	Recognize the direction an object will go when dropped (recognition should be after the action).	
		Precursor	Provide evidence that plants grow (e.g., increase in weight, size, or number of stems, leaves, roots).		**Precursor**	Predict the direction an object will go when dropped (not to be misconstrued as an object moving forward/backward or staying still).	
		Target	Provide evidence that plants need air and water (but not soil) to grow.		**Target**	Demonstrate that the gravitational force exerted by Earth on objects is directed down.	
Teacher	**Student**	Nov 3	Nov 10	Nov 17	Jan 5	Jan 12	Jan 19
A	3-1	U		33%	U		71%
B	3-2						
B	3-3						
C	4-1						
C	4-2						
A	4-3	A		50%	29%		43%
A	4-4	17%		33%	U		U
A	4-5	A		67%	43%		86%
A	4-6	83%		67%	57%		57%
B	4-7						
D	4-8						
C	5-1						
C	5-2						
C	5-3						

Figure three represents Essential Elements SCI.EE.5.PS1-2 and SCI.EE.5.PS1-3. These were taught during February and March. In February one third grader maintained precursor levels, the teacher of the other two third graders was unable to test that element. Two fourth graders maintained initial levels. One dropped from precursor to initial and another maintained precursor levels. One fourth grader was absent that month. Fifth grade had two students progress from precursor to target levels.

In February one third grader maintained initial levels. Three fourth graders reached target levels. One remained at initial levels. One fourth grader tested at precursor level but was absent for the posttest. Fifth grade had one student on target and two on precursor levels.

Figure 3

		SCI.EE.5.PS1-2 Measure and compare weights of substances before and after heating, cooling, or mixing substances to show that weight of matter is conserved.			SCI.EE.5.PS1-3 Make observations and measurements to identify materials based on their properties (e.g., weight, shape, texture, buoyancy, color, or magnetism).		
		Initial Precursor	Recognize the change in state from liquid to solid or from solid to liquid of the same material.		Initial Precursor	Match materials with similar physical properties (e.g., shape, texture, weight)	
		Precursor	Compare the weight of an object before and after it changes from a liquid to a solid and from a solid to a liquid.		Precursor	Classify materials by physical properties (e.g., weight, shape, texture, buoyancy, color, or response to magnetic force).	
		Target	Measure and compare weights of substances before and after heating, cooling, or mixing substances to show that weight of matter is conserved.		Target	Make observations and measurements to identify materials (e.g., glass, wood, metal) based on their properties (e.g., weight, shape, texture, buoyancy, color, or response to magnetic force).	
Teacher	Student	Feb 2	Feb9	Feb 16	Feb 23	Mar 1	Mar 8
		40%		50%	0		
A	3-1						
B	3-2						
B	3-3						
C	4-1						
C	4-2						
A	4-3	30%		30%	50%	A	A
A	4-4	40%		33%			
A	4-5	59%					
A	4-6	A	A	A			
B	4-7						
D	4-8						
C	5-1						
C	5-2						
C	5-3						

As Figure four illustrates, end of year DLM testing began in March, making it necessary to move elements SCI.EE.5.LS2-1and SCI.EE.5.PS3-1 to April and May. In summary, a review of the yearlong progress monitoring tool indicated that 54% of students remained on the same level from pre-test to post test, despite instruction. Thirty percent of students moved up one level after instruction. Eight percent of students improved two levels from pre-test to post test. Results also showed that 8% of students dropped one level in their pre-test to post test scores.

Figure 4

SCI.EE.5.LS2-1 Create a model that shows the movement of matter (e.g., plant growth, eating, composting) through living things.			SCI.EE.5.PS3-1 Create a model to describe that energy in animals' food was once energy from the Sun.		
Initial Precursor	Identify common human foods (and non-food items).		**Initial Precursor**	Identify simple models (e.g., concrete pictures or tactile displays) that show that plants need sunlight to grow.	
Precursor	Identify a model that shows the movement of matter from plants to animals (e.g., food chain/food web)		**Precursor**	Use models (e.g., visual/tactile displays) to describe that plants capture energy from sunlight.	
Target	Create a model that shows the movement of matter (e.g., plant growth, eating, composting) through living things.		**Target**	Create a model (e.g., visual/tactile display) to describe that energy in animals' food was once energy from the Sun.	
Mar 15	Mar 22	Mar 29	Apr 12	Apr 19	Apr 26
DLM testing					
A					
DLM testing					
DLM testing					
DLM testing					

Collaboration Report

In the elementary school setting teachers meet as a grade level to monitor progress and collaborate to improve student outcomes. Elements of this have been missing in our special education team meetings for a variety of reasons. The largest barrier is that our significant special needs students each have unique needs and IEP goals they are working on. This presents challenges on progress monitoring. However, as each students' goals are tied to the state Essential Elements, there is a common standard to reach for. With the progress monitoring tool, I created, and the science Essential Elements broken down into the most basic levels, teacher collaboration can be more effective. There is value to incorporating progress monitoring into our PLC team meetings. In John Hattie's research, measuring performance indicators in education, he created a visual that rates the average effect size of specific items. (Donohoo et al, 2018) One year's worth of growth on the scale is labeled at .4. It is surprising to view the level of impact collective teacher efficacy has. It was given a 1.57, higher than classroom management, feedback, and teacher clarity. This provides a solid reason for prioritizing collaboration.

In August 2023, I shared the digital progress monitoring tool with the science essential elements with all our special education teachers. Then, we held a collaboration meeting about once per month from October to April (see Figure 5).

Figure 5

Sept **9/12/23**	**Oct**	**Nov**	**Jan**	**Feb**	**April**
Introduced Data collections system. Demonstrated where and how to use it.	Strategy: Multiple Exemplar Training	Strategy: Time Delay Errorless learning Error correction Systematic Instruction		**Strategy:** KWHL Chart Graphic Organizer	Guided Inquiry Based Learning Task Analytic Instruction
Attendance: 8 Special Education Teachers grades K-6 Team Leader Facilitator- (with 20 years' experience as a general education teacher					
Science Unit SCI.EE.5.LS1-1 Provide evidence that plants need air and water to grow.	SCI.EE.5. ESS1-2 Represent and interpret data on a picture, line, or bar graph to show seasonal patterns in the length of daylight hours.	SCI.EE.5.PS2-1 Demonstrate that the gravitational force exerted by Earth on objects is directed down	SCI.EE.5.LS2-1 Create a model that shows the movement of matter (e.g., plant growth, eating, composting) through living things.	SCI.EE.5.LS1-1 Provide evidence that plants need air and water to grow.	SCI.EE.5. ESS1-2 Represent and interpret data on a picture, line, or bar graph to show seasonal patterns in the length of daylight hours.

Our school received five new special education teachers this year, with four remaining from previous years. We also had a new superintendent hired, who emphasized the importance of using our PLC time wisely. Our original meeting dates and time frames were rearranged several times. Due to this and the need of new teachers to receive basic instruction, our time to cover in depth science strategies was somewhat limited. During two of our collaboration sessions, we combined the discussion to cover two strategies or more. A review of current research detailing instructional strategies was discussed, along with an example of that strategy in our curricula. I created a slideshow presentation listing each strategy and an example of its use (see Appendix A). This slideshow was added to our special education team website for future reference. It also served as a springboard to our discussions during collaboration. Additionally, I sought advice from our facilitator, who taught in the general education setting for 20 years, and she added the strength of her experience and perspective. A record of this collaboration was kept preserving these insights. Questions asked to each PLC member included: What is your experience implementing this science instructional strategy? What went well? What would you like to improve? Did you locate any resources that were useful in teaching this specific Essential Element?

October's discussion centered on multiple exemplar training. A slide was presented detailing multiple pictures of bears, as part of a vocabulary lesson, including clipart animated and photographs. One teacher noted that she enjoys bringing in tactile items for students to touch, such as a teddy bear or piece of fur. This helped her students make further connections to the term. Another teacher takes a screenshot of a google images page, which was a fast method of finding multiple exemplars. This practice is used only for student info, taking care to not publish this outside of copyright practices.

Novembers’ strategy focused on systematic instruction (i.e., time delay and error correction). A presentation on the needs of plants was shown from our curriculum. This facilitates new teachers’ becoming more familiar with materials already in our possession. Our team leader emphasized the benefits of error correction and time delay in keeping a brisk pace to maintain student attention. Another teacher noticed the benefit of increased clarity for her students. Our LEA representative felt that the strategy of error correction would be very useful for multilingual students in the general education setting. This was a further benefit to our students, most of whom receive language services and have high needs in this area.

In February 2024, we discussed KWHL charts. One of our teachers, a former high school teacher indicated that she noticed students who were given access to materials, and those who were not. Some students arrived with little knowledge in how to observe or use science materials. They seemed to think science was strange or magical. Other students clearly had exposure to the scientific process, and it was much easier for them to learn new skills. Our coach and special education teacher with 16 years’ experience recommended never assuming that this is too difficult for our students. They may need lots of repetition and practice, but when given the opportunity to use KWHL charts multiple times, they will build skills to understand it. She emphasized the need to use the same format in our lessons. For example, if the same KWHL chart is used every week, the students will not need to comprehend a new worksheet design every time. Another teacher has had great experiences using our curriculum News 2 You. The materials are already created there, with the same format as a KWHL chart for weekly science lessons. When students repeatedly work on this process it becomes familiar to them.

From this experience, I gained a greater appreciation of the power of collaboration. The creativity of special educators in finding ways to help their students enjoy science was inspiring.

It was beneficial for new teachers to learn research-based teaching strategies. Shared experiences of seasoned teachers and direction on where to find resources were also appreciated by new teachers. The design of the Essential Elements allows for organized growth and establishes a common ground for collaboration. Our progress monitoring tool will continue to be used in future years. This year was its maiden voyage. It was not perfect but established a strong foundation to continue joint progress monitoring next year and beyond. It's potential to track student progress across multiple years will also be valuable. This will help teachers pinpoint their students' present levels of achievement in science and plan for areas that need continued instruction. Next steps in areas for improvement include creating or locating assessments that align more closely with each initial, precursor, and target levels of all Essential Elements. Lessons learned from timing will also be implemented next year. Assessments will be scheduled outside of end of year testing windows, for example. Future research could be conducted on progress monitoring within special education and science instruction for students with significant cognitive disabilities. This is an exciting, growing field with high potential for improving students' well-being.

References

Bell, R. L., Mulvey, B. K., & Maeng, J. L. (2016). Outcomes of nature of science instruction along a context continuum: preservice secondary science teachers' conceptions and instructional intentions. International Journal of Science Education, 38(3), 493–520. https://doi-org.dist.lib.usu.edu/10.1080/09500693.2016.1151960

Cook, Bryan G., and Samuel L. Odom. (2013). Evidence-Based Practices and Implementation Science in Special Education." *Exceptional Children*, vol. 79, no. 3, pp. 135–144., https://doi.org/10.1177/001440291307900201.

Cook, B. G., Buysse, V., Klingner, J., Landrum, T. J., McWilliam, R. A., Tankersley, M., & Test, D. W. (2015). CEC's Standards for Classifying the Evidence Base of Practices in Special Education. *Remedial & Special Education*, *36*(4), 220–234. https://doi-org.dist.lib.usu.edu/10.1177/0741932514557271

Collins, L. W., & Fulton, L. (2017). Promising Practices for Supporting Students with Disabilities through Writing in Science. *Teaching Exceptional Children*, *49*(3), 194–203. https://doi-org.dist.lib.usu.edu/10.1177/0040059916670629

Courtade, G. R., Spooner, F., & Browder, D. M. (2007). Review of Studies with Students with Significant Cognitive Disabilities Which Link to Science Standards. *Research & Practice for Persons with Severe Disabilities*, *32*(1), 43–49. https://doi-org.dist.lib.usu.edu/10.2511/rpsd.32.1.43

Donohoo, J. Hattie, J. & Eells, R. (2018) The Power of Collective Efficacy. *Educational Leadership,* 75 (6), 40-44.

Greene, A., & Bethune, K. S. (2021). The effects of systematic instruction in a group format to teach science to students with autism and intellectual disability. *Journal of Behavioral Education*, *30*(1), 62-79.

Holcomb, Edie L. (2009). *Asking the Right Questions: Tools for Collaboration and School Change.* Corwin Press.

Jimenez, B. A., Browder, D. M., & Courtade, G. R. (2009). An exploratory study of self-directed science concept learning by students with moderate intellectual disabilities. *Research & Practice for Persons with Severe Disabilities*, *34*(2), 33–46. https://doi-org.dist.lib.usu.edu/10.2511/rpsd.34.2.33

Jimenez, B. A., Browder, D. M., Spooner, F., & Dibiase, W. (2012). Inclusive inquiry science using peer-mediated embedded instruction for students with moderate intellectual disability. *Exceptional Children*, *78*(3), 301–317. https://doi-org.dist.lib.usu.edu/10.1177/001440291207800030

Kim, W., & Linan-Thompson, S. (2013). The Effects of Self-Regulation on Science Vocabulary Acquisition of English Language Learners with Learning Difficulties. *Remedial & Special Education*, *34*(4), 225–236. https://doi-org.dist.lib.usu.edu/10.1177/0741932513476956

Kingston, N. M., Karvonen, M., Bechard, S., & Erickson, K. A. (2016). The philosophical underpinnings and key features of the Dynamic Learning Maps Alternate Assessment. *Teachers College Record*, *118*(14), 1-30.

Knight, V. F., Wood, L., McKissick, B. R., & Kuntz, E. M. (2020). Teaching Science Content and Practices to Students with Intellectual Disability and Autism. *Remedial & Special Education*, *41*(6), 327–340. https://doi-org.dist.lib.usu.edu/10.1177/0741932519843998

Knight, V. F., Collins, B., Spriggs, A. D., Sartini, E., & MacDonald, M. J. (2018). Scripted and Unscripted Science Lessons for Children with Autism and Intellectual Disability. *Journal* *of Autism & Developmental Disorders*, *48*(7), 2542–2557. https://doi-org.dist.lib.usu.edu/10.1007/s10803-018-3514-0

Knight, V., Smith, B., Spooner, F., & Browder, D. (2012). Using explicit instruction to teach science descriptors to students with autism spectrum disorder. *Journal of Autism & Developmental Disorders*, *42*(3), 378–389. https://doi-org.dist.lib.usu.edu/10.1007/s10803-011-1258-1

Knight, V. F., Spooner, F., Browder, D. M., Smith, B. R., & Wood, C. L. (2013). Using systematic instruction and graphic organizers to teach science concepts to students with autism spectrum disorders and intellectual disability. Focus on Autism & Other Developmental Disabilities, 28(2), 115–126. https://doi-org.dist.lib.usu.edu/10.1177/1088357612475301

Lee, T. T. H., & So, W. W. M. (2015). Inquiry learning in a special education setting: managing the cognitive loads of intellectually disabled students. *European Journal of Special Needs Education*, *30*(2), 156–172. https://doi-org.dist.lib.usu.edu/10.1080/08856257.2014.986907

Mason, L. H., & Hedin, L. R. (2011). Reading Science Text: Challenges for Students with Learning Disabilities and Considerations for Teachers. *Learning Disabilities Research & Practice (Wiley-Blackwell)*, *26*(4), 214–222. https://doi-org.dist.lib.usu.edu/10.1111/j.1540-5826.2011.00342.x

McGinnis, J. R. (2013). Teaching Science to Learners with Special Needs. *Theory Into Practice*, *52*(1), 43–50. https://doi-org.dist.lib.usu.edu/10.1080/07351690.2013.743776

Miller, B. (2012). Ensuring Meaningful Access to the Science Curriculum for Students with Significant Cognitive Disabilities. *Teaching Exceptional Children*, *44*(6), 16–25. https://doi-org.dist.lib.usu.edu/10.1177/004005991204400602

Noell, G. H., Donaldson, J. M., Gansle, K. A., Bradley, R. L., Goodwin, A. K., Larson, E., Richard, P. R., Upright, J. J., Lark, C. R., Moore, K. L., & Bordelon, A. E. (2019).

Developing helping behavior in young children through multiple exemplar training. *Behavioral Development*, *24*(1), 6–17. https://doi-org.dist.lib.usu.edu/10.1037/bdb0000083

Ramanathan, G., Carter, D., & Wenner, J. (2022). A Framework for Scientific Inquiry in Preschool. *Early Childhood Education Journal*, *50*(7), 1263–1277. https://doi-org.dist.lib.usu.edu/10.1007/s10643-021-01259-1

Rozenblat, E., Reeve, K. F., Townsend, D. B., Reeve, S. A., & DeBar, R. M. (2019). Teaching joint attention skills to adolescents and young adults with autism using multiple exemplars and script-fading procedures. *Behavioral Interventions*, *34*(4), 504–524. https://doi-org.dist.lib.usu.edu/10.1002/bin.1682

Rye, J. A., Selmer, S. J., Pennington, S., Vanhorn, L., Fox, S., & Kane, S. (2012). Elementary School Garden Programs Enhance Science Education for All Learners. *Teaching Exceptional Children*, *44*(6), 58–65. https://doi-org.dist.lib.usu.edu/10.1177/004005991204400606

Schauble, L., Glaser, R., Duschl, R. A., Schulze, S., & John, J. (1995). Students' Understanding of the Objectives and Procedures of Experimentation in the Science Classroom. *Journal of the Learning Sciences*, *4*(2), 131. https://doi-org.dist.lib.usu.edu/10.1207/s15327809jls0402_1

Simpkins, P. M., Mastropieri, M. A., & Scruggs, T. E. (2009). Differentiated Curriculum Enhancements in Inclusive Fifth-Grade Science Classes. Remedial & Special Education, 30(5), 300–308. https://doi-org.dist.lib.usu.edu/10.1177/0741932508321011

Spooner, F., Knight, V., Browder, D., Jimenez, B., & DiBiase, W. (2011). Evaluating Evidence-Based Practice in Teaching Science Content to Students with Severe Developmental

Disabilities. *Research & Practice for Persons with Severe Disabilities*, *36*(1/2), 62–72. https://doi-org.dist.lib.usu.edu/10.2511/rpsd.36.1-2.62

Therrien, W. J., Taylor, J. C., Watt, S., & Kaldenberg, E. R. (2014). Science Instruction for Students with Emotional and Behavioral Disorders. *Remedial & Special Education*, *35*(1), 15–27. https://doi-org.dist.lib.usu.edu/10.1177/0741932513503557

Villanueva, M. G., & Hand, B. (2011). Science for All: Engaging Students with Special Needs in and About Science. *Learning Disabilities Research & Practice (Wiley-Blackwell)*, *26*(4), 233–240. https://doi-org.dist.lib.usu.edu/10.1111/j.1540-5826.2011.00344.x

Utah State Board of Education: Special Education Services. (2024, January). *Utah Participation and Accommodations Policy 2023-2024*, www.schools.utah.gov/specialeducation/_specialeducation/_accessibilityaccommodationsassessment/_accommodations/UtahParticipationAccommodationsPolicy.pdf.