

# **Who Controls the Learning? Examining the Impact of an Autodidactic Framework in a Grade 12 Girls' Atmospheric Science Class**

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## **Abstract**

A 21st-century education must move beyond a student acquiring a body of knowledge presented through direct instruction. To find workforce success, students must become adept problem solvers, and, as such, they need to develop the capacity to independently direct their own learning. (Association for Supervision and Curriculum Development, 2022). Future employees will need to be project managers, expected to solve problems they have never seen before. They will not be asked to read a textbook chapter, then answer a series of questions. In my experience as a high school science teacher, students often struggle when they are first introduced to self-directed learning. In this action research project, I investigated if a self-directed learning framework would assist students in strengthening their autonomy through autodidactic experiences. The project was conducted over an eight-week period with students in my senior elective, Atmospheric Science. For the unit, "Introduction to Weather Forecasting," students were given a learning pathway that outlined all topics they needed to master, along with a set of learning activities to be completed to support the learning. A "Wakelet" playlist with multimodal resources allowed students to develop their knowledge and understanding; students demonstrating mastery by completing activities that used real-time weather data. As a summative assessment, students synthesized their knowledge by researching and producing a short, video weather forecast for a selected city. In my mixed-methods research design, I implemented a self-directed learning assessment and metacognitive awareness inventory. Student reflections, classroom observations, focus groups, and contemporaneous

comments also helped me understand changes in learning patterns. Data analysis suggested that students ended up in two camps: those with a fixed mindset who struggled with self-directed learning and those with a growth mindset who excelled with project planning. My results suggested that self-directed learning experiences must be carefully balanced with the students' desire for collaborative work during learning. Furthermore, there must be an ongoing conversation between teacher and student about how students might understand their learning personas and thereby build agency in all types of learning.

### **Glossary**

**Asynchronous Learning:** An educational framework that allows students to learn on their own schedule, within a certain timeframe.

**Fixed Mindset:** As defined by Carol Dweck (2017), students with a fixed mindset believe their intelligence is static, leading to a desire to “look smart.” As a result, these students tend to avoid challenges and give up easily, confirming a deterministic view of the world.

**Growth Mindset:** As defined by Carol Dweck (2017), students with a growth mindset believe that intelligence can be developed, leading to a desire to learn. As a result, these students tend to embrace challenges and persist in the face of setbacks, giving them a greater sense of free will.

**Self-Directed Learning:** An educational framework in which students set clear goals for their learning, shape their learning journey in line with goals and plans, monitor their own learning process, and evaluate and reflect on the outcomes of their own learning. Students take the initiative to learn.

**Metacognition:** Thinking about one's thinking; a critical awareness of one's thinking and learning and of oneself as a thinker or learner. Awareness of one's metacognition allows one to transfer or adapt their learning to new contexts and tasks.

## **Who Controls the Learning? Examining the Impact of an Autodidactic Framework in a Grade 12 Girls' Atmospheric Science Class**

The COVID-19 pandemic required teachers to experiment with new approaches to teaching and learning in fundamentally new settings. Phrases like “asynchronous learning” entered our vocabulary, and, as teachers, we believed that the teacher and student did not need to be in the same space at the same time for learning to occur. It became apparent, however, that many students did not have the necessary skills to manage their asynchronous learning and, therefore, equated that phrase to “free period.”

The Global Action Research Collaborative (GARC) on Girls' Education offered me the opportunity to explore student readiness for self-directed learning with students in my senior elective, Atmospheric Science. In Fall 2022, I posed the following research question: How does a self-directed learning (SDL) framework strengthen a Grade 12 girl's autonomy and independence in the Atmospheric Science classroom?

The action research framework, as outlined by Mertler (2020), provided a “systematic inquiry ... for the purpose of gathering information about ... how students learn” (p. 5). Atmospheric Science is a project-based, activity-based course. After teaching the class for almost twenty years, I made the assumption that seniors could identify how they learn best and had the necessary time management and project management skills to plan and reflect on their learning. With the pandemic demanding a balance between asynchronous and synchronous learning, I was challenged by several questions. How could I help students develop their self-directed learning skills? How could I measure student development of these skills? and, How could I evaluate student understanding and mastery of course content?

## Literature Review

In response to the COVID-19 pandemic, many schools closed, some were reimaged, and almost all became dependent on “the role of the individual learner through online computer lessons” (Roberson, 2021). Because the transition to remote learning happened so quickly, teachers expected students to immediately demonstrate the necessary skills to be successful, independent learners. These skills include “a preference for learning modality [reflective of a learner’s metacognitive ability], an ability to participate in self-guided learning, and an ability to work collaboratively with peers in completing projects” (McCormack et al., 2010, p. 363). Karatas and Arpaci (2021) argue that self-directed learning skills, metacognitive awareness, and 21st-century skills and competencies “positively predict prospective readiness” (p. 1) for teachers – and, by extension, students – for online learning.

The skills that make for a successful e-learner are similar in scope to the 21st-century skills we promote in our classrooms on a regular basis. Schleicher (2011) separates these 21st-century skills into *ways of thinking* (critical thinking, creativity, problem-solving, and decision making) and *ways of working* (communication and collaboration). Furthermore, these 21st-century skills are similar in scope to the distinct elements of talents (DELTAs) described by McKinsey (2022), a mix of skills and attitudes that define success in the future world of work. These DELTAs fall under four main categories: cognitive, interpersonal, self-leadership, and digital. In the 2022 survey, adult respondents tended to be strongest in self-leadership skills and relatively weakest in digital skills. As noted by Yudrugal and Dmir (2017), students need to develop their skills and knowledge in parallel with appropriate affective characteristics, such as attitude and motivation, to be successful learners. Teaching and learning may be reimaged so that students build, develop, and strengthen their independent learning skills across all learning environments.

To be a successful independent learner, students need a clear pathway to mastery, moving from a beginning learner to an emerging expert (Lench et al., 2015). In terms of my project, this

pathway began with student metacognitive awareness, or a student's ability to understand "how they learn." Carey (2015) suggests:

You can teach facts and concepts all you want. What's most important in the end is how students think about that material, how they organize it mentally, and [how they] use it to make judgments about what's important and what's less so. (p. 16)

Students, however, rarely take the time to consider, or are rarely asked about, their own metacognitive awareness. A student's metacognition includes how they plan their learning process, how they evaluate that process, and how they conduct an adequate self-assessment (Achben, 2020). Students need to focus on *how* they engage with their learning, not necessarily *how much* they engage (Song, 2021).

Metacognitive awareness is strongly connected to problem-solving ability, comprehension, and memory (Song, 2021). However, Song further notes that asking students to evaluate their metacognitive ability, either through think-aloud protocols (for example, Raven's Progressive Matrices) or retrospective questionnaires (for example, Metacognitive Awareness Inventory) may introduce an unwanted bias. Students with a higher level of metacognitive awareness often have higher levels of achievement, and, as a result, are better able to regulate their own learning. Lower performing students tend to overestimate their own performance (called the *Dunning-Kruger effect* – Dunning, 2011); they have weaker insights and are often less aware of their own thought processes. Pennycook et al. (2017) suggest that a student's metacognitive awareness improves when learning environments are supported with digital tools.

The next step for a student on their pathway to mastery focuses on self-directed learning. Roberson (2020) defines self-directed learning as a learning environment where "management of the learning process is clearly in the hands of the student" (p. 1012) Self-directed learning is intentional, active learning which promotes "independence and accountability, conversations and collaborations, and nurtures metacognitive thinking" (Platt et al., 2014, p. 490).

Zach et al. (2018) note that self-directed learning is the most efficient method of acquiring new knowledge as students are “more active and participatory, more responsible and accountable for their own learning activities” (p. 61). We need to remember that most students are emerging self-directed learners. By using a variety of instructional tools, strategies, and modalities, in conjunction with regular student planning, students will progressively move toward a deeper understanding of the material and, ultimately, to greater independence in the learning process. As a result, students will eventually adopt, use, and apply appropriate learning habits of mind they find useful to them (Zach et al., 2018).

Self-directed learning is more than just “planning one’s learning.” BEST (Best for the Future, 2021) describes five key dimensions of self-directed learning: goal setting and planning, engaging and managing, monitoring and adapting, initiative and ownership, and self-awareness. If these dimensions are viewed on a continuum from emerging learner to expert learner, then a learner’s self-awareness should generally decrease (as they become more understanding of their metacognitive awareness), while their monitoring and adapting as well as their engagement and management should generally increase (as they become better able to apply their metacognitive understanding to varied learning scenarios).

The end of the pathway is the demonstration of mastery. In a mastery learning classroom, students have “the opportunity to establish a level of performance that all students must master before moving on to the next unit” (Slavin, 1987, p 300). Students work at their own pace and formative assessments are used to monitor progress by both student and teacher. Should mastery not be demonstrated, a student may use multimodal resources, found on a content playlist, for example, in conjunction with other learning activities, to mend learning problems that the assessments have identified.

Suandi et al. (2018) note that mastery learning, in comparison with convention instruction, may be a better instructional strategy for achieving competence. However, a student’s point of

entry in mastery learning is determined by their cognitive entry behavior (CEB). Also known as pre-learning (or the experiences a student brings to any learning scenario), CEBs are behaviors that are a combination of a student's interest in, attitude towards, academic self-concept. Academic self-concept, defined as a learner's perception about their academic achievements, is strongly correlated with their academic self-efficacy, a student's "solid and sincere beliefs about whether they will be able to fulfill a given academic task successfully at a predetermined level or not" (Caliskan, 2014, p. 1817). A student's academic self-concept and self-efficacy are influenced by their understanding of how they learn, their metacognitive awareness. This pathway to mastery is not linear but iterative. Each success in mastery learning informs a student's metacognitive awareness, slightly or significantly altering "how they learn" in the next pathway to mastery.

An apparent conflict arises, though, centered on "how girls learn." The 21<sup>st</sup> century high school experience tends to favor "a more independent, autonomous learning style that makes [students] more assertive information seekers and shapes how they approach learning in the classroom" (Jaleel & Anuroofa, 2017, p. 1849). However, research literature on engaging girls in STEM fields shows "girls prefer to work when they are able to work in collaboration with each other" (Ching et al., 2002, p.168). Furthermore, female students report "having a better experience when working *with* other students and are more likely to finish an assignment as well as persist in a STEM course when working collaboratively" (Cphoon, 2008, p. 208). Herein lies the challenge: how do we build self-directed learning experiences for girls while also addressing the needs of girls to work collaboratively?

Students are constructing their own knowledge by following this single pathway to mastery. Education constructivist theory argues that "students are active creators of their own knowledge, using active learning techniques such as experiments and real-world problem solving to create more knowledge, reflect on it, talk about what they are doing, and how their understanding is

changing” (Cano-Fullido, 2015, p. 66). By constructing their own knowledge, students develop one of the most important skills for success in the future world of work.

### **Research Context**

Marymount School of New York is an independent, Catholic day school located on the Upper East Side of Manhattan. We seek to “educate young women who continue to question, risk, and grow – young women who care, serve, and lead – young women prepared to challenge, shape, and change the world.” Marymount was founded in 1926 and is a member of the Religious of the Sacred Heart of Mary (RSHM) Network of Schools, a family of twenty-one schools in nine countries.

My research was undertaken with students in the senior elective, Atmospheric Science. The project took place at the start of the academic year in September. Data were collected in early September, throughout the eight-week project, and at project completion in early November. Data were also collected at the end of the semester in December. Out of the eleven students in the class, I had only taught one previously, so I had no preconceived notions about their learning styles or academic abilities.

Participation in the action research project was optional; however, all eleven students in the pass agreed to participate. Students and their parents/guardians were required to sign a media release form.

Data were collected in multimodal forms. To maintain the integrity of the data, all written responses (surveys, reflections, assessment instruments) were scanned and stored on a secure server. Video content was downloaded and stored a secure server. Each student had a shared GARC folder in our school’s Google Workspace, where they saved their assignments, weekly reflections, and weekly work plans. “Formative” was used as an assessment platform form and “Flip” was used for end of project video reflections. “Typeform” was used to create and share digital surveys and reflections.

## The Action

My action spanned nine interconnected lessons focusing on weather forecasting with my class of eleven Atmospheric Science students. The essential learning objective focused on how to access and analyze real-time weather data to produce a short video weather forecast for a selected city. At the beginning of the unit, students were given a self-directed learning framework as shown in Table 1.

**Table 1**

### *Self-Directed Learning Framework*

1. <b>REVIEW</b> the essential questions, Wakelet, and class notes provided.
2. <b>STOP.</b> Do you have any questions? Something you don't understand? Ask a peer or ask me.
3. <b>MURAL.</b> Move your learning progress bar over.
4. <b>COMPLETE</b> the application activity. If you have any questions during the activity, ask a peer or ask me.
5. <b>MOVE</b> your application activity to your shared folder.
6. <b>MURAL.</b> Move your learning progress bar over.
7. <b>COMPLETE</b> the Formative. Achieve the minimum score of 90%.
8. <b>REVIEW and REASSESS</b> if your Formative score is less than 90%.
9. <b>RETAKE</b> the Formative.
10. <b>MURAL.</b> Move your learning progress bar over to show completion of an activity

An outline of the learning pathway and the learning activities is shown in Appendix 1.

### **Data Collection**

Mertler (2020) suggests that the deliberate use of a variety of tools and methods to collect data is an appropriate method to triangulate any research findings. I used a mixed-methods approach to maintain the credibility and trustworthiness of my data. I regularly collected quantitative and qualitative data during the project, including:

#### **Quantitative Data**

- Pre- and post-project self-directed learning survey (SDLS) responses
- Pre- and post-project metacognitive awareness inventory (MAI) responses

#### **Qualitative Data**

- Pre-project student interview transcripts
- Post-project student video reflections
- Weekly student learning plans and reflections
- Post-project written reflection
- End of semester student reflections

At the beginning of the project, I asked students to complete two surveys:

**The Metacognitive Awareness Inventory (MAI)** allows students to reflect on “the strategies and conditions that work best for them while they are learning ... [and] ... [their] knowledge about the implementation strategies and the ability to monitor the effectiveness of their strategies” (Schraw & Dennison, 1994, p. 461). This inventory (see Appendix 2) uses a scoring rubric (see Appendix 3) to evaluate student knowledge and regulation about their metacognition. The rubrics and associated scores were not shared with the students.

**The Self-Directed Learning Survey (SDLS)**, based on the BEST Self-Directed Toolkit Rubric (2020), “set a benchmark for students’ pathways to becoming self-directed and self-determined learners” (p. 3). by asking them to evaluate their own self-awareness, communication, decision

making & problem solving, support, and monitoring and adapting skills. The survey is shown in Appendix 4. The survey uses a Likert scale to measure specific learning traits. Scores in each category were not shared with the students. Students completed the MAI and SDLS post-project and were then provided with individual reports summarizing their survey results to see “how their approach to learning had changed.”

Each student had a learning journal, created as a Google Slideshow. On Monday of each week, students would set their goals for the week (see Fig. 1), and then, at the end of the week, would reflect on their progress (see Fig. 2).

**Figure 1**

*Weekly Goal Setting Template*

<b>Week 1: Goal Setting</b>		
<b>Where am I going this week?</b> List the tasks and activities you wish to complete.	<b>How will I get there?</b> Describe your in-class and out-of-class plan.	<b>What will success look like?</b>

**Figure 2**

*Weekly Reflection Template*

<b>Week 1: Reflection</b>		
<b>Did you accomplish your goals this week?</b> List the tasks and activities you completed.	<b>Did you manage your time effectively?</b> Did you accomplish all you set out to this week?	<b>What changes will you make for the following week?</b>

I reviewed the students' learning plans and reflections with them on a regular basis. I also filmed several classes and used those videos to generate field observation notes.

In a separate reflection document, students responded to prompts related to "how you learn and your ability to engage in self-directed learning." Students responded to specific questions related to their learning, as shown in Table 2.

**Table 2**

*Student Success and Challenge Questions*

<b>Successes</b>	<b>Challenges</b>
1. How do you believe you learn best? 2. Where do you believe you were successful? 3. What did you employ that led to success?	1. Where do you believe you were not successful? 2. Why do you believe you weren't successful? 3. How might your learning have been structured differently?

Furthermore, using Flip, students recorded extemporaneous reflections at the end of the semester, where they talked about what worked and what did not. This strategy allowed every voice to be heard, not just the students selected for the initial interviews.

In mid-January, I administered **Dweck Mindset Instrument (DMI)** (P'Pool, 2014) to research a connection between students' metacognitive awareness, their perceived mindset, and their ability to engage in self-directed learning.

**Data Analysis**

After collecting my data, I used the following approaches to analyze my data (see Table 3).

**Table 3**

*Data Analysis Approaches*

<b>Qualitative Data</b>
1. Used Sonix.ai to transcribe initial student video interviews and Flip video reflections. 2. Used qualitative data analysis (using nVivo) to reduce the volume of data and to organize my data around major themes.

<b>Quantitative data</b>
<ol style="list-style-type: none"><li>1. Compared average Likert-scale scores on SDLS pre- and post-project.</li><li>2. Categorized and evaluated MAI responses.</li><li>3. Compared MAI responses pre- and post-project.</li><li>4. Evaluated DMI responses.</li></ol>



As a result of my analysis, I developed a substantially complete learning profile for each student participating in the project.

### **Discussion of Findings**

The goal of my action research project was to explore if students, based on a self-assessment of their metacognitive and self-direction abilities, could direct their own learning in a Grade 12 Atmospheric Science class. All eleven students demonstrated a strong metacognitive awareness, and they were able to identify their strengths and weaknesses as self-directed learners. The results may be clustered around four specific themes.

#### **Students Need Guidelines and Experience With Self-Directed Learning**

An analysis of the results of the BEST (Building Essential Skills Today) Self-Direction Rubric (implemented pre- and post-project) indicated student improvement in the following areas.

- I can evaluate how I have expanded my strengths by setting learning goals.
- I can adopt strategies when accessing more complex information.
- I can follow a process to select reliable resources based on task requirements.
- I can seek help when gaps in my progress are identified.
- I can use established benchmarks to monitor quality.

Student confidence in self-directed learning attributes decreased in the following areas.

- I can analyze my ability to adapt or expand my strengths and interests to successfully complete a new task.
- I can choose a new learning opportunity from options provided.
- I can seek input to help me analyze content or context of learning tasks.
- I can set personally meaningful project-based goals.

Statistically significant data are included in Appendix 6. Six of the eleven students thought they could direct their own learning, but when faced with the challenge of SDL, they felt they did not have the skill set to be successful.

The ability to successfully engage in SDL and reflect on their learning was evident in the project reflections, end-of-semester feedback, and SDL survey responses. Six students thoughtfully used the learning pathway graphic, learning objectives, and activity guidelines to plan their work and reflect on their learning. Five students would not, could not, or refused to use the framework provided.

Student B, for example, ranked herself as above average (4 or 5 out of 5 on the SDL Likert scale). In her pre-project interview, she stated, “the class is appealing to me due to the content; the class description matched my preferred learning style.” My field notes and classroom observations bore this out. Student B knew how to design, regulate, and complete her learning. In her semester reflection, Student B stated, “the learning pathway provided was very helpful because I got to see all that I had to do in one place,” and “I thought the learning was structured really well; we were given multiple supports during our learning.” Student D, however, ranked herself as average or below average (SDL Likert scores less than 3) in several categories, including taking responsibility for her own learning, analyzing project-specific expectations, and independently seeking input on learning goals. My field notes and classroom observations suggest that this student struggled throughout the project. In her project and semester reflections, she wrote, “I feel like I got very confused when I did

work on my own. I also don't like how we must use special platforms and websites for certain things." Student D further added, "I think I poorly divided my assignments and time each week."

Student G struggled to master challenging concepts and submit her work in a timely manner in her junior year science class. However, Student G quickly acclimated to the SDL learning environment. In her pre-project interview, she stated, "I find written, assignment-based projects more of a struggle than creative, self-expressive work. Self-expression is an important factor in me staying motivated." My field notes and observations support this. Student G set an effective learning plan for herself, worked diligently in class, and was often the first student to submit an activity for review. Moreover, her final project, in which she produced a short video weather forecast, demonstrated mastery and was highly creative.

### **Students Have a Good Sense of Who They Are as Learners**

An analysis of the results of the Metacognitive Awareness Inventory (MAI) suggested that students were very much aware of their knowledge about cognition ("knowing how I learn") and regulation about cognition ("how I plan, monitor, regulate, and evaluate my learning"). Student knowledge about cognition and regulation of learning was unchanged pre- and post-project. That is not to say that students could effectively plan their learning. Students who ranked, on average, lower scores on regulation of cognition, struggled mightily with SDL. In her reflection, Student E stated, "I have bad time management skills. Always have. Always will." Student F further added, "Self-directed learning just reinforced my bad study skills." These were the same students who did not adapt their learning protocols to the framework given, and in several instances, these students completed most of the project in the final weekend.

### **The Social Aspect of Learning Cannot be Ignored**

There may have been an expectation on my part that students would actively and naturally collaborate with each other; that students would be up and about in class, seeking input and guidance from their peers. My video recordings of class and the associated field notes suggest

otherwise. Students worked quietly and independently on their learning activities, seeking assistance from their small peer group when they had a question. Most students were actively engaged in their work; however, the classroom lacked any enthusiasm for learning. During one-on-one check-ins, students stated that they thought SDL meant truly working independently.

Student I commented, "I missed working with my friends in class. One month of self-directed learning was a lot. I wish there were more points where we could come together, share, and work together." Student D noted at parent-teacher conferences, "I work best when I'm in a group. I am able to bounce ideas off my friends and bring my own ideas." Students also missed the opportunity to dissect complex ideas as a class. Student K noted, "I really liked it when Mr. Walters went over confusing things as a class, so I think doing that every class would have been helpful."

### **The Conversation Between a Student and Teacher About How the Student Learns Best is a Critical Aspect of Learning**

Students had the opportunity to regularly reflect on their learning. Students rarely mentioned their assignment grades. The universal theme: we want our teachers to talk to us about how we learn. Student G, in her pre-project video, stated, "Thanks for taking the time to ask how I learn," while Student I added,

Even though I didn't like SDL, I appreciate the fact you listened to our feedback and changed our class. Having mini projects now instead of a month-long project works to my advantage. When projects are super long, I can sometimes lose focus. Maybe a week-long project might have been better.

Student K adapted well to SDL, commenting,

The Wakelets, learning pathway, and notes helped me understand the information from a variety of sources and then test my understanding with the Formatives. It allowed me to have some say in the videos (sources) I picked, which allowed me to (better) engage in my learning.

Student K also added, “Mr. Walters was really good at checking in with us, but going over confusing things once a week would have been helpful so that everyone would feel confident asking questions.”

### **Conclusions**

Even with an appropriate framework, not all students will be successful in self-directed learning; therefore, additional support is needed to strengthen a student’s sense of autonomy and independence with their learning.

Based on their responses to the SDLS and MAI, all eleven students were confident in their learning personas. They knew their strengths and weaknesses as learners, and they knew “how they learned best.” There were subtle shifts in the class averages for each instrument but none that were statistically significant. The five students who identified as self-directed learners, maintained that identity throughout the project. Based on their DMI responses, these students also possessed a growth mindset and were more confident in exploring new ideas and concepts on their own. Six students struggled with self-directed learning; a struggle that was reflected in their SDLS and MAI profiles. Based on their DMI responses, these students, except for one, possessed a fixed mindset, and their reflections suggested that they preferred more teacher-led, direct instruction to support their learning. In general, a student who identified as a self-directed learner, ranked themselves higher in the categories of planning, comprehension monitoring, and information management strategies.

My project did highlight several issues in the student-teacher relationship. Because the project started on the third day of class, my only knowledge of the students as learners came from their pre-course and pre-project surveys. I did not have time to “get to know them as learners.” This was borne out in the student reflections. Even though I scheduled regular check-ins, group checkpoints during the project would have helped build a community of learners. Evans (2022) identifies four components of an effective student learning environment: “social-based learning,

untethered learning, contextualized learning, and self-directed learning” (p. 22). Student feedback suggests that a better alignment of these four components would have provided a more positive learning experience for all students.

Even with the best teacher-developed framework, student input on their learning pathway, which is unique for every student, is essential to mastery and to a successful learning experience. While my project did not strengthen a student’s sense of autonomy in the classroom, it did highlight the need for ongoing, constructive dialogue between teacher and student and the need to differentiate and redesign instruction based on these student personas. It is all about the user experience!

### **Reflection**

A night-time drive on Topanga Canyon Boulevard in northwestern Los Angeles, which connects the San Fernando Valley to the Pacific Coast Highway, can be challenging. The road is windy and continually doubles back on itself. One wrong turn of the wheel and you can go off a cliff. That description applies to my journey as part of the Global Action Research Collaborative (GARC).

When I started my project, I had a vision that all would go “perfectly.” My self-directed framework would guide my students along the golden road to mastery. They would enthusiastically plan their work for the week, engage in their learning both independently and collaboratively, and regularly reflect on their learning. Instead, our car broke down on the golden road. Because I did not successfully contextualize their learning in a way that was meaningful for the students, some of them disengaged from the learning process, seeing their journey as a series of stops to be completed. There was more than one time that I felt I was close to driving off a cliff.

In hindsight, I would have approached this project differently, keeping the user experience in mind. While I reviewed all the learning activities in advance, I should have given a time frame for completion for each. Because students did not know the requirements for each activity, they could not effectively plan their learning for the week. I should have also explained to the students how

each activity connected to the unit's enduring understanding. They needed to know *why* they were completing the activity. That said, once a student decided that their preferred learning style did not align with the self-directed learning process, there was nothing I could do make that alignment happen.

Inquiry-based and hands-on activities should have also been included, as opposed to having students solely complete data analysis activities. The students needed to discuss, debate, and collaborate on what they were learning. While they were encouraged to work with their peers, students worked quietly in silos with little social interaction. Students equated self-directed with working alone and were reluctant to collaborate with their peers.

The apparent conflict between self-directed learning and socially connected learning needs to be resolved. Over the summer, I plan on redesigning this unit to add intentional touchpoints for collaboration, group sharing, and group feedback. I am also going to develop a self-paced course on Canvas that will give teachers a framework for developing self-directed learning experiences for their own classrooms.

There are many people to thank. First, Natalie Demers got me on the road in the first place, and I am glad she did. I would not have made it to the end of the road if it were not for my research advisor, Debbie Hill. Her patience, insights, and faith kept me on the road the entire time. My research group was a source of true inspiration. Thanks to my critical friend and our Upper School Division Head, Sabra McKenzie-Hamilton, for her support and to my Head of School, Concepcion Alvar, for her encouragement. Finally, I must thank the students in my Atmospheric Science class for their patience, feedback, and honesty.

When it comes to Topanga Canyon Boulevard, where there's a Will, there's a way.

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# Appendices

## Appendix 1

### Learning Pathway and Learning Activities



## Appendix 2

### Metacognitive Awareness Inventory (MAI)

#### Metacognitive Awareness Inventory (MAI)

Think of yourself as a **learner**. Read each statement carefully. Consider if the statement is true or false as it generally applies to you when you are in the role of a learner (student, attending classes, university etc.) Check (✓) True or False as appropriate. When finished all statements, apply your responses to the Scoring Guide.

	True	False
1. I ask myself periodically if I am meeting my goals.		
2. I consider several alternatives to a problem before I answer.		
3. I try to use strategies that have worked in the past.		
4. I pace myself while learning in order to have enough time.		
5. I understand my intellectual strengths and weaknesses.		
6. I think about what I really need to learn before I begin a task.		
7. I know how well I did once I finish a test.		
8. I set specific goals before I begin a task.		
9. I slow down when I encounter important information.		
10. I know what kind of information is most important to learn.		
11. I ask myself if I have considered all options when solving a problem.		
12. I am good at organizing information.		
13. I consciously focus my attention on important information.		
14. I have a specific purpose for each strategy I use.		
15. I learn best when I know something about the topic.		
16. I know what the teacher expects me to learn.		
17. I am good at remembering information.		
18. I use different learning strategies depending on the situation.		
19. I ask myself if there was an easier way to do things after I finish a task.		
20. I have control over how well I learn.		
21. I periodically review to help me understand important relationships.		
22. I ask myself questions about the material before I begin.		
23. I think of several ways to solve a problem and choose the best one.		
24. I summarize what I've learned after I finish.		

	True	False
25. I ask others for help when I don't understand something.		
26. I can motivate myself to learn when I need to.		
27. I am aware of what strategies I use when I study.		
28. I find myself analyzing the usefulness of strategies while I study.		
29. I use my intellectual strengths to compensate for my weaknesses.		
30. I focus on the meaning and significance of new information.		
31. I create my own examples to make information more meaningful.		
32. I am a good judge of how well I understand something.		
33. I find myself using helpful learning strategies automatically.		
34. I find myself pausing regularly to check my comprehension.		
35. I know when each strategy I use will be most effective.		
36. I ask myself how well I accomplish my goals once I'm finished.		
37. I draw pictures or diagrams to help me understand while learning.		
38. I ask myself if I have considered all options after I solve a problem.		
39. I try to translate new information into my own words.		
40. I change strategies when I fail to understand.		
41. I use the organizational structure of the text to help me learn.		
42. I read instructions carefully before I begin a task.		
43. I ask myself if what I'm reading is related to what I already know.		
44. I reevaluate my assumptions when I get confused.		
45. I organize my time to best accomplish my goals.		
46. I learn more when I am interested in the topic.		
47. I try to break studying down into smaller steps.		
48. I focus on overall meaning rather than specifics.		
49. I ask myself questions about how well I am doing while I am learning something new.		
50. I ask myself if I learned as much as I could have once I finish a task.		
51. I stop and go back over new information that is not clear.		
52. I stop and reread when I get confused.		

This survey and scoring guide are attributed to Schraw, G. & Dennison, R.S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, 19, 460-475.

## Appendix 3

### Metacognitive Awareness Inventory Rubric (MAI)

<b>Metacognitive Awareness Inventory (MAI) Scoring Guide</b>					
<p><b>Directions</b> For each <b>True</b>, give yourself <b>1 point</b> in the Score column. For each <b>False</b>, give yourself <b>0 points</b> in the Score column. <b>Total</b> the score of each category and place in box. <b>Read</b> the descriptions relating to each section.</p>					
<b>KNOWLEDGE ABOUT COGNITION</b>					
<p><b>DECLARATIVE KNOWLEDGE</b></p> <ul style="list-style-type: none"> <li>• The factual knowledge the learner needs before being able to process or use critical thinking related to the topic</li> <li>• Knowledge about <i>what</i> or <i>that</i></li> <li>• Knowledge of one's skills, intellectual resources, and abilities as a learner</li> <li>• Students can obtain knowledge through presentations, demonstrations, discussions</li> </ul>	<p><b>DECLARATIVE KNOWLEDGE</b></p> <p>5. I understand my intellectual strengths and weaknesses.</p> <p>10. I know what kind of information is most important to learn.</p> <p>12. I am good at organizing information.</p> <p>16. I know what the teacher expects me to learn.</p> <p>17. I am good at remembering information.</p> <p>20. I have control over how well I learn.</p> <p>32. I am a good judge of how well I understand something.</p> <p>46. I learn more when I am interested in the topic.</p>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: right;">TOTAL</td> <td style="text-align: center;">8</td> </tr> </table>	TOTAL	8
TOTAL	8				
<p><b>PROCEDURAL KNOWLEDGE</b></p> <ul style="list-style-type: none"> <li>• The application of knowledge for the purposes of completing a procedure or process</li> <li>• Knowledge about <i>how</i> to implement learning procedures (e.g., strategies)</li> <li>• Requires students know the process as well as when to apply process in various situations</li> <li>• Students can obtain knowledge through discovery, cooperative learning, and problem solving</li> </ul>	<p>15. I learn best when I know something about the topic.</p> <p>18. I use different learning strategies depending on the situation.</p> <p>26. I can motivate myself to learn when I need to.</p> <p>29. I use my intellectual strengths to compensate for my weaknesses.</p> <p>35. I know when each strategy I use will be most effective.</p>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: right;">TOTAL</td> <td style="text-align: center;">4</td> </tr> </table>	TOTAL	4
TOTAL	4				
<p><b>CONDITIONAL KNOWLEDGE</b></p> <ul style="list-style-type: none"> <li>• The determination under what circumstances specific processes or skills should transfer</li> <li>• Knowledge about when and <i>why</i> to use learning procedures</li> <li>• Application of declarative and procedural knowledge with certain conditions presented</li> <li>• Students can obtain knowledge through simulation</li> </ul>	<p>14. I have a specific purpose for each strategy I use.</p> <p>27. I am aware of what strategies I use when I study.</p> <p>33. I find myself using helpful learning strategies automatically.</p>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: right;">TOTAL</td> <td style="text-align: center;">5</td> </tr> </table>	TOTAL	5
TOTAL	5				
<p>This survey and scoring guide are attributed to Schraw, G. &amp; Dennison, R.S. (1994). Assessing metacognitive awareness. <i>Contemporary Educational Psychology</i>, 19, 460-475.</p>					
<b>REGULATION OF COGNITION</b>					
<p><b>PLANNING</b></p> <ul style="list-style-type: none"> <li>• Planning, goal setting, and allocating resources prior to learning</li> </ul> <p><b>INFORMATION MANAGEMENT STRATEGIES</b></p> <ul style="list-style-type: none"> <li>• Skills and strategy sequences used to process information more efficiently (e.g., organizing, elaborating, summarizing, selective focusing)</li> </ul> <p><b>COMPREHENSION MONITORING</b></p> <ul style="list-style-type: none"> <li>• Assessment of one's learning or strategy use</li> </ul> <p><b>DEBUGGING STRATEGIES</b></p> <ul style="list-style-type: none"> <li>• Strategies to correct comprehension and performance errors</li> </ul> <p><b>EVALUATION</b></p> <ul style="list-style-type: none"> <li>• Analysis of performance and strategy effectiveness after a learning episode</li> </ul>	<p>4. I pace myself while learning in order to have enough time.</p> <p>6. I think about what I really need to learn before I begin a task.</p> <p>8. I set specific goals before I begin a task.</p> <p>22. I ask myself questions about the material before I begin.</p> <p>23. I think of several ways to solve a problem and choose the best one.</p> <p>42. I read instructions carefully before I begin a task.</p> <p>45. I organize my time to best accomplish my goals.</p>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: right;">TOTAL</td> <td style="text-align: center;">7</td> </tr> </table>	TOTAL	7
TOTAL	7				
<p>9. I slow down when I encounter important information.</p> <p>13. I consciously focus my attention on important information.</p> <p>30. I focus on the meaning and significance of new information.</p> <p>31. I create my own examples to make information more meaningful.</p> <p>37. I draw pictures or diagrams to help me understand while learning.</p> <p>39. I try to translate new information into my own words.</p> <p>41. I use the organizational structure of the text to help me learn.</p> <p>43. I ask myself if what I'm reading is related to what I already know.</p> <p>47. I try to break studying down into smaller steps.</p> <p>48. I focus on overall meaning rather than specifics.</p>	<p>1. I ask myself periodically if I am meeting my goals.</p> <p>2. I consider several alternatives to a problem before I answer.</p> <p>11. I ask myself if I have considered all options when solving a problem.</p> <p>21. I periodically review to help me understand important relationships.</p> <p>28. I find myself analyzing the usefulness of strategies while I study.</p> <p>34. I find myself pausing regularly to check my comprehension.</p> <p>49. I ask myself questions about how well I am doing while learning something new.</p>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: right;">TOTAL</td> <td style="text-align: center;">10</td> </tr> </table>	TOTAL	10
TOTAL	10				
<p>25. I ask others for help when I don't understand something.</p> <p>40. I change strategies when I fail to understand.</p> <p>44. I re-evaluate my assumptions when I get confused.</p> <p>51. I stop and go back over new information that is not clear.</p> <p>52. I stop and reread when I get confused.</p>	<p>7. I know how well I did once I finish a test.</p> <p>19. I ask myself if there was an easier way to do things after I finish a task.</p> <p>24. I summarize what I've learned after I finish.</p> <p>36. I ask myself how well I accomplish my goals once I'm finished.</p> <p>38. I ask myself if I have considered all options after I solve a problem.</p> <p>50. I ask myself if I learned as much as I could have once I finish a task.</p>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: right;">TOTAL</td> <td style="text-align: center;">7</td> </tr> </table>	TOTAL	7
TOTAL	7				
<p>3. I try to use strategies that have worked in the past.</p>	<p>15. I learn best when I know something about the topic.</p>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: right;">TOTAL</td> <td style="text-align: center;">5</td> </tr> </table>	TOTAL	5
TOTAL	5				
<p>This survey and scoring guide are attributed to Schraw, G. &amp; Dennison, R.S. (1994). Assessing metacognitive awareness. <i>Contemporary Educational Psychology</i>, 19, 460-475.</p>					

### Permission statement

This survey and scoring guide are attributed to Schraw, G. & Dennison, R.S. (1994).

Assessing metacognitive awareness. *Contemporary Educational Psychology*, 19, 460-










475.


# Appendix 4

## Self-Directed Learning Survey (SDLS)

grades  
9-12

### BEST Self-Direction Rubric

	 <b>Self-Awareness</b> <small>Reflecting on past experiences to evaluate one's own strengths, limitations, motivation, interests, and aspirations within different learning contexts.</small>	 <b>Initiative &amp; Ownership</b> <small>Taking responsibility for learning, finding purposeful driving questions, shaping opportunities to fit personal interests and learning style, and seeking input from others.</small>	 <b>Goal Setting &amp; Planning</b> <small>Developing long-term goals, establishing meaningful learning targets, identifying effective strategies, and planning out steps.</small>	 <b>Engaging &amp; Managing</b> <small>Seeking out relevant resources and information to support learning goals and refining strategies. Maintaining effective pace, reaching short-term benchmarks and long-term goals.</small>	 <b>Monitoring &amp; Adapting</b> <small>Evaluating progress, adapting strategies, seizing failure in order to grow from mistakes, and attributing success to effort and motivation.</small>
 <b>Emerging</b>	<b>I can...</b> Analyze how my interests have sometimes been in conflict with expectations of others and generate ways I might overcome this in the future.	<b>I can...</b> Choose a new learning opportunity from options provided and explain how it reflects personal curiosity or interests.	<b>I can...</b> Set a project-based goal modeled after examples provided and use familiar strategies to develop steps and strategies to accomplish it.	<b>I can...</b> Follow a process provided to select reliable resources based on task requirements or suggested criteria.	<b>I can...</b> Begin a course of action, seeking help when gaps in my progress, understanding, or work quality are identified by me or others.
 <b>Developing</b>	<b>I can...</b> Explain how my strengths or strategies used successfully in the past can be applied in a new learning situation.	<b>I can...</b> Collaborate with others to share control of shaping the direction of a new learning task while pursuing my interests or learning goals.	<b>I can...</b> Analyze project-specific expectations, identifying resources needed, strategies suited to completing the tasks, and steps to complete the project.	<b>I can...</b> Adapt strategies for my approach, with help as needed, when accessing more complex information or resources.	<b>I can...</b> Use established benchmarks or feedback to monitor quality or progress, consider alternative approaches, and revise my plan, as needed.
 <b>Applying</b>	<b>I can...</b> Analyze my ability to adapt or expand my strengths and interests to successfully complete a new task or project.	<b>I can...</b> Take responsibility for my own learning by establishing driving questions to guide my own learning process.	<b>I can...</b> Set a personally meaningful project-based goal, with steps to complete the plan and possible challenges along the way with alternative strategies or resources needed to complete the project.	<b>I can...</b> Anticipate complexities of task completion and schedules, and explain how I adjusted my pace appropriately to meet agreed-upon deadlines.	<b>I can...</b> Evaluate my progress and work quality, citing examples of successful strategies used and analyzing the effectiveness of changes made to complete a multistep task or project.
 <b>Extending</b>	<b>I can...</b> Cite examples from my work to evaluate how I have expanded my strengths and interests by setting learning goals beyond assigned tasks.	<b>I can...</b> Seek input to help me analyze the content and context of learning tasks in order to reshape, extend, or enhance my own learning.	<b>I can...</b> Independently seek input on a project-based learning goal and plan that pushes my learning beyond the task, and use feedback to improve the plan.	<b>I can...</b> Provide examples of how I set and maintained a high standard of work quality and how I plan to improve my process in the future.	<b>I can...</b> Analyze my learning by citing examples of how I met or exceeded project goals, transformed mistakes into new learning, and enhanced my personal growth.



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## Appendix 5

### Self-Directed Learning Survey Statistically Significant Results

Criteria	Pre-Project	Post-Project
<b>Zones of Improvement</b>		
"I can cite examples from my work to evaluate how I have expanded my strengths by setting learning goals.	3.778	4.222
"I can adopt strategies for my approach, with help as needed, when accessing more complex information or resources."	3.889	4.556
"I can follow a process provided to select reliable resources based on task requirements or suggested criteria."	4.444	4.667
"I can begin a course of action, seeking help when gaps in my progress, understanding or work quality are identified by me or others."	4.111	4.444
"I can use established benchmarks or feedback to monitor quality or progress, consider alternative approaches, and revise my plan."	3.889	4.111
<b>Zones of Non-Improvement</b>		

<p>“I can analyze my ability to adapt or expand my strengths and interests to successfully complete a new task or project.”</p>	<p>4.444</p>	<p>3.889</p>
<p>“I can choose a new learning opportunity from options provided and explain how it reflects personal curiosity or interests.”</p>	<p>4.778</p>	<p>4.222</p>
<p>“I can seek input to help me analyze the content or context of learning tasks to reshape, extend, or enhance my own learning.”</p>	<p>4.333</p>	<p>3.889</p>
<p>“I can set a personally meaningful project-based goal, with steps to complete the plan and possible challenges along the way with alternative strategies or resources needed to complete the project.”</p>	<p>4.444</p>	<p>3.778</p>