Getting Agile at School

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Abstract Teachers at an international boarding school began experimenting with Scrum as a way to structure self-regulated learning in the context of a class taught in 2013–2014. In the 4 academic years since then, teachers have developed Kanban boards as individual, group, and classroom-wide organizational structures and trialed a number of concepts familiar to practitioners of Scrum, e.g., sprints, burndown charts, and retrospectives. Working with the support of the school's professional development department, teachers engaged, in their particular classroom contexts, with action research cycles of planning, doing, reflecting, and redoing until arriving, at least for the time being, at ten practices of an Agile mindset for teaching and learning. Each of these will be familiar to educators. The thinking is that small adjustments in multiple practices are not only manageable for teachers, but also more likely to shift educational practice away from the tendency to rely heavily on carrot-and-stick traditions. Informing our practice in school with insights from the Agile revolution in industry is a way of suggesting that many of our current educational practices are in need of an update. Further, incremental change, shared by many, can be a powerful tool to create learning that organizations can be proud of.

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1 Introduction

1.1 The Agile Mindset

A group of teachers at the Leysin American School have been leveraging the school's professional development program to experiment with different approaches to teaching and learning. What began as a remedy to a struggling project-based curriculum in a class taught in 2013–2014 has grown, often through an approach of ready, fire, aim (e.g., Fullan, 2011), into a cultural shift at the school. By the 2017–2018 school year, several of our teachers were pulling Agile into education, of course with different levels of understanding and differing results. We felt the time had come to make a clearer statement of what we meant when speaking about having an Agile mindset, with the dual goal of creating a shared vision and a professional development process that would help us continue to focus on the type of learning environment we are trying to create.

While Agile in education is relatively new, Agile itself is no longer new at all. Practitioners in fields where Agile grew up speak of "modern Agile" (TechBeacon) and a "post-Agile environment" (Cockburn, 2017). As we travel our own implementation path now in education, those of us pulling Agile into our practice can benefit greatly from their experience. A signatory of the original manifesto, Alistair Cockburn, reminds us with the Heart of Agile (Cockburn, 2014) that, at its core, Agile is a way for teams to get things done. In education, we have plenty of teams (classes, student groups within classes) that are required to get an awful lot done (learning). Cockburn has boiled Agile down to this: collaborate, deliver, reflect, and improve. Simple enough to remember, but deep enough to drive a lot of work and potentially a lot of change. Take the notion of collaboration. Yes, as educators we often create activities for students in pairs or groups. But there are also plenty of admonitions to do one's own work, use of grading curves that pit students against each other, classes taught behind closed doors, and a lack of collaboration between the school and students concerning what is even worth learning in the first place.

As newcomers to Agile, our practices may not be as honed as the Heart of Agile, but we believe that our practices have Agile at their heart. We illustrate them here through a number of experiences in and out of the classroom, real stories that deepen our understanding and let us share our efforts for consideration in your context. Taken together, the vignettes create a sense of the culture that our version of Agile in education can create. Ultimately, our goal is a shift in culture, from an emphasis on teaching, for example, to an emphasis on learning. From an emphasis on teacher as knower to teacher as learner. From an emphasis on satisfying what the teacher, the curriculum, and the school want to satisfying yourself, as the student, as a self-regulated learner.

Agile for us is a mindset. We have no prescription, no method, and no program, though we continue to benefit by learning about prescriptive methods like eduScrum (Delhij, van Solingen, & Wijnands, 2015) and Scrum@Schools ("Manifesto for agile education," 2015). We learn from the ongoing conversations of why we as a group

of learners (and here we include students and teachers) prefer this over that. (See the Agile manifesto, Beck et al., 2001; the Agile in Education Compass, Robbins, 2016; and the Manifesto for Agile Learning, Scrum@Schools, 2015 for examples of right-shifting thinking.) For example, we prefer a culture that favors student self-regulation over teacher control. We do not claim that student self-regulation is always required, nor do we villainize teacher control. But we strive toward student self-regulation when it is practicable. And maybe sometimes even when it is not.

1.2 The Core of Agile in Education

These are our values, the core of the mindset we are working toward

- EXPLORATION—Exploration and play over tests and perfection;
- GROWTH—Growth and rework over assessment reports without corresponding mechanisms to improve identified weaknesses;
- SELF-REGULATION—Student-driven reflection and improvement over teacher directives; and
- LIFE WORTHY LEARNING—Learning that supports additional learning over detailed course content.

In a quick sentence, we might describe our efforts this way:

As we strive to understand learning and its outcomes better, we look for student and teacher growth through self-regulated, collaborative exploration and play.

1.3 Our Context

We are pulling Agile into education at the Leysin American School in the Swiss Alps. We are a boarding school with 320 students from approximately 50 countries, in grades 7 through 12. The school is structured in three grade bands: grades 7 and 8, grades 9 and 10, and grades 11 and 12. We write here mostly about the middle school, grades 7 and 8, where the curriculum is most flexible. This is practical for a number of reasons:

- the recent creation of the new middle school signaled to everyone that changes were coming, helping us to manage expectations;
- we opened the new school with only 18 students, or about 5% of the whole school population; and
- in the American education system, grades up through grade 8 are not included on high school transcripts.

These conditions point to a key enabler for us as we pull Agile into education. We have an environment in which we can fail safely (Elia, Lockard, & Ackerbauer, 2017), simply because we do not draw too much scrutiny.

More than a year before we started planning the middle school, and before we started framing our understanding in terms of Agile, we were experimenting with what we felt were common sense notions of working together as students and teachers. When we implemented eduScrum (Delhij et al., 2015) in one class, the conversation continued, but with the addition of terminology familiar to agilists. Along the way we began internalizing an understanding of agility with the help of John Miller's Agile Classrooms (Agile Classrooms, 2018), among others. By the time we started middle school planning, it was clear that the Agile Mindset would inform our teaching methodology. Through a combination of planning, modeling, observing, talking, and writing we have settled on—now in our second year of the middle school—ten interrelated practices. They are:

- EXPLORATION—Exploration over fixed content
- GROWTH MINDSET—Growth over stasis
- TRUST—Self-regulation over teacher control
- TRANSPARENCY—Visibility over obscurity
- ADAPTABILITY—Flexibility over rigidity
- SMALLIFY—Quick, workable iterations and feedback over big plans
- VALUE—Valuable learning over convenient assessments
- COLLABORATION—Working together over competing against
- REDO—Reflection and progress over right and done
- UPLIFT—Problems as opportunity over problems as problems.

It is during the academic exploration classes of the middle school, classes that are only 4–6 weeks long, where Agile practices tend to flourish. There are a few other promising areas, notably the year-long course Physical Education and Health, and some non-course examples, like our faculty process for reflecting on courses during curriculum review and the professional development we engage in to support ongoing implementation. In all cases, the interest and commitment of the individual teacher or teachers is key.

Below we illustrate the ten actionable practices with vignettes from our own experience. At the end of each vignette we have provided some cross-references with other Agile practices that also apply. You be the judge if the overlap suggests we should combine some of our practices. You might also like to wonder, as you read, which practices we may be missing.

The short classes the vignettes refer to are

- DIY Language, in which students construct a new language as an introduction to the study of linguistics;
- Ideal School, in which students design a school and present it in a poster session during an annual school conference;
- Introduction to Engineering, in which students create and pitch designs they create themselves;
- Project Innovate, in which students select a project of personal interest; and
- Robot Gardeners, in which students use Arduino to build gardens in terrariums that can thrive without human attention.

The full-year class in the vignettes is:

- Physical Education and Health.

We hope that sharing our stories helps bring alive the cultural shift we are trying to grow.

2 Ten Actionable Practices

2.1 Exploration

> I believe that every human being with a physically normal brain can learn a great deal and can be surprisingly intellectual (Asimov, 1980, p. 19).

Do-It-Yourself Language is a backdoor into the study of linguistics. In groups of eight, students write a dictionary and build a set of grammar rules until they have enough language to put together a skit, which they perform for the class and others as the final project. Our first language was called Blasa, from the root "bla," which you might guess the students took from the English bla-bla-bla. We have also created Yeuropan and Chuankglish.

This type of project-based learning turns the traditional curriculum inside out. Instead of following a list of topics that we have determined before the class begins, we treat the linguistic topics that arise at the moment they arise. We know we will have good conversations. We just do not know what they are going to be about. When you are exploring you expect to be discovering things.

For example, the students are generally inclined to follow their native language when creating a new system, say, pronouns. English speakers may initially want to replace I, you, he, she, it, we, you all, and they (let alone my, mine, myself …) with a different word for each pronoun. Referring them to Mandarin provides a logic that is much easier to learn—and therefore a better choice when building an easy language from scratch. The Mandarin pronoun system is so elegant that the conversation arises: are Mandarin speakers more logical in general because their language is more logical? Voilà, we're discussing Sapir-Whorf and one of the more common questions in sociolinguistics: does language affect thought?

When the students build a number system, they find out that some systems are quite logical (Japanese, Korean, Finnish) and others, well, you have probably heard of how French say 95 (four-twenty-fifteen) and you can ask a Dane why they count as they do. So are speakers of languages with regular number systems better at math? Researchers have studied this. So, students, what did those researchers find … and if you are interested, why not look into it further?

Students get to choose what parts of language they think they need to create, how that part of language is going to work (grammar) and sound (vocabulary), how it is represented (letters, characters, other?) and so on. Exploration breeds motivation. Learning something just at the point where it has captivated one's attention is key.

It makes us wonder … are there other courses that we could be renaming—and re-teaching—as DIY Something-or-Other?

See also TRUST and UPLIFT.

Students in Physical Education and Health choose topics, within teacher prescribed parameters. Incorporating student choice allows them to explore topics in which they are interested. The basic steps used in Physical Education and Health are

- Give the students parameters. Too much choice, i.e., broad or unclear parameters, can lead to paralysis and little or no exploration. For example, allow students to select from racket sports or sports that involve using a ball.
- Allow students to identify what they want to learn within the broad topic. What do they want to know? What puzzles them? What can they go over again if they feel less confident than others? Make these questions the goals for the unit and keep them visible in the room to refer to later. Students can add to them as they like.
- Revisit the goals from time to time. Are students actually focused on them? Are they finding answers? How do they rate their progress? And can they add or take out goals as the unit progresses? Sure!

See also TRANSPARENCY and ADAPTABILITY.

2.2 Growth Mindset

When you get to the top of a mountain, keep climbing (Kerouac, 1958).

Each year, our research center selects a number of faculty members to be Resident Scholars. These teachers commit themselves to a year-long investigation of their choosing. We support them with a small stipend and possible assistance to present their work at a conference or other professional development event.

A few years ago, a math teacher combined her resident scholarship with a graduate course, setting up a grading system in her algebra class closely aligned to standards based grading, as contrasted with what our entire school was doing at the time, a traditional American 90% A, 80% B style of grading. Drawing on work by O'Connor (2011), she transformed grading in her math class, published her work in our research center's publication, Spotlight (Gorasia, 2015), and then unfortunately accepted a position elsewhere. Her work is still very alive at our school, however, as it was her model we adopted when creating the middle school.

Key to our middle school grading system is the notion of "not yet." On any assignment, project, or test, a student receives a 4 (you know this so well you could teach it), a 3 (you know this well enough to move on), or a 2 (you do not know this yet). After demonstrating sufficient effort to learn the material, students may reassess to bring a 2 up to a 3 or 4.

While not all teachers immediately adopted the system and we continue to discuss exactly how it should be implemented, we are seeing certain effects. The summary here is that we're supporting a growth mindset over a fixed mindset (Dweck, 2016).

The interesting supporting evidence is that students are never "let off the hook" by simply receiving a bad grade and moving on. Instead, they must learn the material. Further, teachers have an incentive to make good use of formative assessments to see if students are ready for a summative assessment, since teachers know that assessing for a grade before students understand the material leads to review and redo for some students while others are ready to move on. This puts pressure on the curriculum to adapt, expanding or contracting according to how much time students need to get to a 3 or a 4.

Further still, we as teachers often bemoan the resistance students have to risk taking, yet some of our most common grading systems reinforce their aversion. If the result of taking a risk is a low grade, figured in an overall average, for evermore on the transcript, why take the risk? Assessment can easily hinder a growth mindset. We think we're getting around that, as many schools have done before us, by re-examining the method by which we assign grades to student learning.

See REDO and ADAPTABILITY.

2.3 Trust

> My appeal is to observation — observation that each of you must make by [yourself].—Charles Sanders Peirce (Turrisi, 2007, p. 140)

We want to place lots of trust in our middle school students to further their ability to self-regulate. So, we experimented with a new way for the middle school director to observe classes; namely, by asking the teacher not to be present. Certainly then the students will have room to demonstrate the degree to which they are self-regulating! The director takes notes on how well the students carry on without the teacher, then talks through the notes with the teacher when the lesson is over.

After 5–6 weeks of experimenting with Agile practices, the Physical Education and Health teacher invited the director to observe a teacherless lesson on badminton. She was naturally a bit nervous about how it would go. Would students use the tools they had and plan a lesson that demonstrated good learning? Might it be a complete 90-min fail?

The tools students had practiced with and that were available during the observation were

- A visual task board (e.g., a Kanban board);
- A reflection sheet for planning future lessons;
- Paper stars with questions that allowed each student to check for understanding and earn points;
- A folder about badminton that included ideas, links, and drills to help if students were stuck;
- Assigned roles for various parts of the lesson; and
- Previous teacherless moments—on several occasions, the teacher had practiced handing over control to students to observe and debrief the dynamic of the class.

Table 1 Notes from a teacherless observation

Time	Student actions as described by the observer Individual students are referred to by first initial
08.11	All set up. R asks J to tell everyone what they are going to be doing. R moves a sticky into the DOING column. They start an exercise
08.15	First exercise ends. J leads stretching. R updates Kanban board, moving the first exercise to DONE and the next activity to DOING
08.16	J writes on the board. Everyone else gathers around. They are figuring out a tournament structure. Nobody tries to talk to me, to ask me what to do, to wonder if I'm in charge
08.18	V fills in who will play whom. A is a little aloof. V coaxes everyone to come start. The first players take the court
The students play the tournament …	
08.41	Tournament over. J always wins, says V. J borrows my computer and starts video. One of the students updates the Kanban board
08.46	J says "let's practice" and everyone goes back on the courts. There's a mix of practicing what was on the video and maybe just playing for fun. The students finish practicing and set up another tournament
08.52	All students take to the courts. I'm impressed by the quick transition times. The equipment got set up quickly, the time to switch from practice to tournament and the other transitions are all pretty quick
08.53	Tournament 2 is underway. 4 players, 2 scorekeepers, and A sitting on the bouldering pad in the corner
The tournament finishes …	
09.08	Students pull questions (on stars) and ask each other randomly. All participate except A. He is holding a question, but not asking or answering
09.10	Now A asks J a question. Perhaps he is just more patient than everyone. Students continue to ask each other questions and fill in points on the board for each other
9.12	C says something in Chinese to J. B says "English please." C switches and explains with gestures, in English
09.13	Nice laughter, explanation, self-organizing pairs. W spells the words "drop shot" for J
09.14	Students determine they have more time and W and V set up new tournament. R and J clean up the star questions and the students start to play
	End of observation

The results were much better than she had hoped. The students were able to set up, lead, and organize themselves, practicing badminton skills that they had previously highlighted for practice and improvement. In Table 1, snippets from the observation notes tell the story of how this particular lesson unfolded.

It takes a good degree of trust to turn the class over to students, whether for ten minutes of small group work time or a 90-min PE class. What if they waste the time? What if they get off-task? We counter by asking when students are going to learn to self-regulate if they do not practice doing self-regulation, which will necessarily

include off-task time. In a very real sense, what we see in a teacherless observation is student learning, not teacher teaching. Or to dig a bit deeper, we see in the student self-organization the fruits of the teaching that lead up to the self-regulation observed in this lesson.

See also GROWTH MINDSET and TRANSPARENCY.

2.4 Transparency

> Honesty and transparency make you vulnerable. Be honest and transparent anyway (Keith, 2002).

A few years ago, John Miller trained us in the use of his Learning Canvas. Last year, Willy Wijnands of eduScrum trained us using his Flap. Internally we have been calling it a Kanban board, though it might be a Scrum board. The names don't matter so much—but the visibility that a Kanban board supplies, whatever one chooses to call it, does.

A simple three-column Do, Doing, Done display is an easy and practical first step toward shifting the culture to a more visible workflow. We used it for planning the middle school (in Trello) and during the first year in the daily homeroom (on a poster). Most middle school teachers transferred the homeroom example to their classrooms, gradually customizing to create their own versions. Some teachers used labeled magnets on the whiteboard, some used laminated cards. Other classes began using smaller Kanban boards for small groups or individuals, usually inside a standard manila folder. Students working on individual or group projects (e.g., coding, touch typing, Ideal School) set the Kanboard board next to them so that they—and the teacher—could quickly monitor progress.

It is a small thing, but we have found that transparency tends to create good, and often unexpected, developments. For example, the teacherless observation described in TRUST above is a direct result of the Kanban board in an English class. The director filled in for the English teacher one afternoon. Her directions stated that the students would start the lesson with a stand up at the Kanban board. It felt so promising that the director told the students to go ahead and run the whole class while he watched. The teacherless observation was born. Other teachers, trying to keep track of individual progress in loosely structured classes, took pictures of individual or small group Kanban boards at the beginning of the class to make sure that students made progress by the end of class. While perhaps diverging a bit from our TRUST practice, it is a pragmatic option that wasn't available before Kanban boards. Finally, use of Kanban boards has begun extending beyond the classroom, to student planning in the resident halls, to faculty professional development sessions, and to the dean of students and admissions offices (which now use Trello).

It's a simple tool, yet it seems to be a reliable driver of the cultural shift we believe we have started.

See also COLLABORATION.

2.5 *Adaptability*

> The acquisition of knowledge (i.e. the process) is more important than soon outdated content (Quinton, 2010, in Weichart, 2013, p. 43).

In our work with whole school curriculum, we recently solved one of those problems that seems easy on the surface but somehow manages to get everyone stuck, repeatedly, until it does not seem there is a way to get unstuck. A few of us are calling our adopted approach "lean curriculum." Here's why: More often than not, in what Sutherland (2014) refers to, albeit in other contexts, as a "tall stack of futility" (p. 11), curriculum is presented as a pre-established plan for the entire academic year, usually in every subject, for every class, and in great quantity. And then instruction starts. But as Apple and Jungck (1991, in Fullan & Hargreaves, 1996) point out, "dumping curriculum packages on teachers … tends to make them deskilled and dependent" (pp. 101–102).

Our lean curriculum places an emphasis on the ongoing, never-ending process of comparing the curriculum plan with what is actually being taught. The two naturally diverge; that is not a problem, it is an expectation. Teachers take the curriculum for a guide and then do their thing, teaching to their strengths, expanding where there is interest, cutting short where there is none, slowing or speeding the pace to make content and available time come out even, and so on. They are, in short, "responding to change over following a plan" (Beck et al., 2001).

Our process requires a lean curriculum, literally four pages for a class for the academic year, which is made available for comments to all faculty members of the school. Every teacher and staff member can leave suggestions for any course. Then, at a minimum, once a semester all the members of the academic department resolve the comments on the curriculum document, in an effort to resolve the divergence between the curriculum plan and what is taught:

1. Is what the teacher taught more on target (in respect to student interest, preparation for future courses, parent expectations, etc.) than what the curriculum suggested? Then change the curriculum to match what is taught.
2. Is what the curriculum suggested more on target than what the teacher taught? Then reinforce with the teacher what needs to be taught, why this is so, and provide assistance if something is blocking that teacher from teaching the agreed-upon curriculum.

There may be a comparison here between project planning using a Gantt chart, for example, and the cyclic iterations of agile acting and planning. We are aiming for the latter.

The lean curriculum is nimble and allows ongoing review in the short periods of time available to teachers. And there may be other benefits. Bankston (2017) describes a vocational school in Rotterdam that encourages a 70–30 split of planned and unplanned curriculum so that there is room in the backlog—the collection of possible lessons—for professors to introduce material based on student interest, student need in a particular year, and so on. In other words, while we may as curriculum

writers and administrators feel we have done a good job if we have each day planned, in detail, perhaps we should be intentionally making sure that three out of ten days (in the Rotterdam example) are not planned, at least not until they need to be planned. Slack time may in fact be a necessary enabling factor for many of our actionable practices. Exploration and play may thrive better in unstructured time. Further, as a general warning familiar to the Agile community: beware of the big plan!

See also TRUST, VALUE, and SMALLIFY.

2.6 Smallify

> Agile methods derive much of their agility by relying on the tacit knowledge embodied in the team, rather than writing the knowledge down in plans (Boehm, 2002, p. 66).

Staff turnover is a constant confounding variable when implementing change. International schools can be particularly good at turning over staff, to a large degree because international teachers are a self-selected group who love to travel. For this reason no one was surprised when, already in our second year, two teachers new to the middle school and to the Agile Mindset joined the team. During orientation week they asked: "When is the training for Agile?" We fumbled around for an answer, saying that we would get to it later or something equally unsatisfactory. But in reality, that is exactly what we are doing. We train as the year unfolds, in our classes, and through our conversations as topics arise. In education this could be referred to as classroom-embedded and ongoing—two hallmarks of solid professional development. And each interaction is short. We might ask: Did you see what just happened? The students directed the next move because you made the process transparent. Or: What do you think if we do this during the next activity—how might it lead to students asking deeper questions?

The same is true for our students, too. We will always be faced with continuous implementation of the Agile Mindset in our middle school because we will always be working with students new to our school. We will never be able to "train" them in agility during the orientation week. We will do it along the way, modeling teaching and learning that deliberately creates short feedback cycles, celebrates little bets, and provides multiple opportunities to fail safely, because any individual fail is small enough to climb over, or climb up on, to reach higher.

See also VALUE and UPLIFT.

2.7 Value

> Very few schools teach students how to create knowledge … Instead, students are taught that knowledge is static and complete, and they become experts at consuming knowledge rather than producing knowledge.—Keith Sawyer (Sims, 2011, p. 160).

For 4–6 weeks each year, we ask students to come to a class called Project Innovate, in which they must create the curriculum. "What would you enjoy working on?" we ask them. "What do you want to learn?" And then we have to trust that, confronted with this golden opportunity, they can handle it. Often they cannot, particularly at first.

It would be hard to assess in this class. Students are being given the chance to choose something to learn, pursue it, go deep, share it with others … and they may fail. We have seen students wander from project to project. We have seen many students pick something far too complex, at least initially. We have seen others stick with a project and create an excellent end product, while others do two or three reasonable projects, and still others flounder. We believe the experience is important—a gut check of sorts that allows the students to experience firsthand how self-regulated they are, or aren't, at this stage in their schooling. It also affords the opportunity for those who can't—at least those who can't *yet*—to observe those who can, without a penalty.

Now, what if we were to assess them? Could we allow casting about, floundering, and, well, failure? We might be accused of wasting valuable school time during Project Innovate, throwing away those 15 class meetings, or 15 h, for some students. On the other hand, what if those 15 h demonstrate to the students who need to learn it most, both intellectually and emotionally, that they are going to need much more practice learning how to self-regulate? That it is not easy? That there is a gap to cross between where they are now and where they will need to be in order to self-regulate well?

See also TRUST and GROWTH.

At the end of our Introduction to Engineering course, we set up a role play, complete with a small story, as context. Students must introduce the company they have created in pairs or threesomes, along with their company website and their company product, to students, teachers, and administrators at the end of the course. Everyone in the audience is given play money and turned into angel investors, who are looking for excellent products they can invest in. But that's at the very end of the class. What leads up to the demo day is also important.

As part of the curriculum, students must add to their project at least one feature suggested by another group of students (see COLLABORATION below). This gives the students practice sharing and getting ideas from each other throughout the class. Then at the beginning of the last week of class there is a practice presentation, to get ready for the final presentation to teachers and administrators playing the role of angel investors. The lead times gives students time to adapt and redo their demos based on peer feedback. Inspired by each other, most of the student groups improved their presentations and most were inspired to update their web pages as well. None of this was required by the teacher, but students realized the value of their peers' ideas and were self-motivated to spend additional time in order to make their presentations and web pages significantly better.

See also TRUST and COLLABORATION.

2.8 Collaboration

> Coming together is a beginning; keeping together is progress; working together is success.—Henry Ford (Collins, 2007, p. 8)

Setting up work in a scrum-like fashion ensures a certain amount of collaboration among our students, as well as some of the pain that comes as groups of people, particularly groups of 13-year olds, figure out how to team up and work well together. The Introduction to Engineering class required students, in pairs or threesomes, to develop a product and share their work online at GitHub. The teacher was consistently firm with students that, when they were stuck, they needed to (1) consult a friend, (2) search online, and only then (3) ask the teacher. The class Kanban board had a column for Stuck (between Doing and Done) with exactly those three levels. At first students did what their prior schooling has trained them to do. They got stuck and shot their hands into the air while simultaneously calling "teacher!" Their expressions were fairly incredulous when the teacher declined to answer questions that students had not first tried to answer themselves. It certainly did create collaboration, however, and a sense that expertise in class wasn't only embodied in the teacher.

As the class worked toward final presentations, one acceptance criterion for the project was that every group had to credit at least one person from another group for assistance along the way. Just the opposite of a classroom worried about cheating, this classroom was all about sharing to learn. The teacher strives to make the assignments too hard for one individual student but doable by four-fifths of the students, given that they are helping each other.

Over the course of our first year, student presentations gained an important role in the cycle of a project or a course. At the end of the first semester, with no final tests to fill the last days before the holiday, teachers chose instead to help students showcase their learning for the semester. Teachers and students collaborated across classes to develop student displays of work, complete with demos, recordings, and other exhibits of their work. On exam day morning the students prepared the room and their presentations, so that on exam day afternoon they could present their learning to the rest of us. It was successful enough that during Family Week, when parents visit the boarding school classes during the winter term, the students chose to put on a similar exhibition for the visiting parents. Together we had created a culture of collaboration. In good positive feedback loop style, other classes, like DIY Language, came to rely on collaborative final projects instead of exams. We didn't know it would happen from the start, but the Agile Mindset of classes like Introduction to Engineering has turned some interesting possibilities into reality.

See also VALUE and COLLABORATION.

2.9 Redo

> Iff ure maeking misteaks iht meenz ure owt thair dewing sumthing. - Kneal Gaemin (Sigmon, 2015)

We challenged students to create a climate controlled "robot gardener" that would use microcontrollers (brains), sensors (light, temperature, and soil moisture), and actuators (LED lights, fans, and water pumps) to keep plants healthy over the holiday break, when the students are on vacation. Robotic design projects are a nice fit for employing the Agile Mindset since they can be broken down into small systems, there are many chances for iterations along the way, and the ultimate answer is unknown. There are lots of different ways to build a robot that can keep plants alive.

Building a robot gardener is a large enough project that smallifying (Sims, 2011) is quite important. Early on we ask students to think about the completed project as a series of features. Once they have identified and made a preliminary design of the different features working together, we ask them to choose one feature, for example light control, to start with, build, and test. Students need to figure out how to build the feature and how to write a program that does what it needs to do. In order to scaffold this process for beginners, we provide a circuit diagram and some sample code. Once they have the feature working, we ask students to change the code to reflect a specific set of plant needs. With each subsequent feature (temperature control and eventually moisture control), we offer less scaffolding, but they follow the same engineering and design cycle.

Once students feel confident about their small feature ability to work, we "break" it. We do this in different ways, depending on the student's level of understanding. For beginners, we may simply move the sensor to a different pin or change the code so that it looks for the sensor at a different pin. For more advanced students, we experiment with different versions of sensors and actuators or different ways of integrating the feature into the larger project. The idea is to highlight the "bugs" of the design and get kids thinking.

We test for understanding by having students fix the break in a novel way. If we change the pin position, we require students to change the code to allow for the new pin position—not just move the connection back to where it was. If students choose to use one sensor or component over another or decide to change the way the features work together in the final project, they need to explain why. They do this by showing and explaining their work to student colleagues and the teachers.

We learned that students learn best by making mistakes. For example, if a student does not wire a pump to fail in the off position, a failure (say a loose wire) can cause their robot gardener pumps to water continuously, flooding the plant (which is not good for plant health!) and causing a watery mess. They do not learn this concept as dramatically when working with the light and the temperature features, which can also fail unsafely, but the same principle of learning from mistakes applies. In addition, we learned that the process of purposely trying to break the project and creating fixes to these bugs has not only generated "aha" moments, but it is also a very fast way to know if students "get it."

In any case, the formative assessment in Robot Gardeners is real and generally pretty obvious—things either work or they do not. Students learn quickly what they need to redo and they learn that redoing needs to repeat itself until the problem is solved. As Sims (2011) puts it, students are learning the art, like entrepreneurs, of "failing forward" (p. 53). Merely redoing is not enough. A redone connection to the water pump that still fills the classroom floor with water again the next day is definitely not done. You have to fail into success.

See also SMALLIFY and EXPLORATION.

2.10 Uplift

Make people awesome (Industrial Logic, 2016).

Uplifting creates safety, in the context of an engineering mindset, when students feel safe to choose their own direction, designs, and peers to work with and when students are accepting of mistakes and missteps along the way. Here are two experiences that describe what we mean.

A group of three boys was designing a self-powered car. Their goal was to make it move two meters without a shove. They were using plastic soda bottles for the chassis, a motor hooked to a fan, and plastic bottle lids for wheels. One day they were arguing loudly. The teacher joined their group and together they looked at the drawing of their design and their task distribution. The teacher asked what each student was responsible to build. They each stated their role. Then the teacher asked why they were arguing. They explained that their parts did not integrate and each student wanted the other students to change their design. The teacher asked why they were not building from the design sketch. It turns out they had rushed the design (because they did not realize its importance), so their sketch was vague and they did not agree on the specifics. So of course, the parts they designed were not fitting together.

Before discussing what it would take to agree on a design, the teacher backed up and facilitated a discussion about how they could work together. After a good 15 min of discussion they were able to talk about making a new design.

By the end of the unit they had built a car that worked and was voted by their peers as the most successful project. When the group cited one thing they had learned (the review was deliberately vague, but the teacher was expecting a technical answer), the group said that the most important thing they learned was how to work together. The teacher reported afterward that he was sure if he had punished them for arguing and disrupting the class, they never would have learned this lifeworthy (Perkins, 2016) lesson.

In another group, one of the more focused students was taking a very long break. (Students were allowed to choose themselves when they took a break and for how long.) When the teacher asked him if he was ready to get back to work, the student said he was stuck and did not know what to do. So the teacher engaged him in conversation.

The student explained that he was building a rubber band car but that it would only travel about 20 cm. He had demoed the car and found that the rubber band, which he had glued to the car, was actually making it stop. After some experimentation together, they decided he needed to cut off the rubber band. He reused the place where it had been glued by converting it into a hook. He was unstuck and able to get back to work. It took him awhile to feel it was safe to ask for help, and it took him awhile to feel comfortable about making mistakes. But after that experience he was much more exploratory and interested.

Like the arguing boys from the other group, turning this boy's overly long break into a discipline issue would not have accomplished much at all, while exploring the problem in a friendly way—without giving him the answer—uplifted him and built his confidence.

See also EXPLORATION, REDO, and TRUST.

3 Conclusion

Conclusion is a misnomer. Continuation is more accurate. The worth of the Agile mindset as a thinking and working culture lies in its application. Similarly, its application is what continues to create the mindset. Explore, adapt, redo, grow … we recognize change as normal and healthy.

We hesitate to say that any particular actionable practice is more important than another. They are all, in fact, important and they are all interdependent. And of course there may be more actionable practices that we have missed here, practices that we will discover as we continue creating a shift in culture. We wonder about SLACK, for example. Should unplanned space in learning be emphasized more? What about CHOICE? Are either of these implied in our existing practices, and is merely being implied good enough? We expect to find out over time, depending of course on how our Agile mindset and culture move forward.

Among our existing actionable practices, we do feel that EXPLORATION is really only possible if time is made available to do it (there is the notion of SLACK again) and if our learning environment is truly infused with TRUST and a commitment to UPLIFT. Without these, any practice of Agile in education might give unintentional rise to stress, since the necessary conditions to support exploration, with all its quirky twists and turns, successes and failures, may be registered by students, teachers, and administrators as mistakes or wasted time instead of positive learning experiences. Working on just one or two of these practices should be beneficial, as each individual practice contains some element of good educational practice. But the ideal is to work on many of them, over time, exploring the manners in which they reinforce each other and to witness how that transforms teaching and learning in the classroom and beyond.

Recently we have begun training using the actionable practices we have outlined, collecting stories in the form of these short vignettes as the teachers reflect on the teaching and learning experiences they are creating in their own contexts. We ask

teachers to focus on two actionable practices at a time, while being mindful of their interconnectedness. A teacher, for example, might choose to focus on ADAPTABILITY and UPLIFT, because she has identified the former as difficult and the latter as a practice she excels at. She can both address a weakness and strengthen an asset. Over time strengths and weaknesses will shift and new actionable practices will be identified for improvement, allowing teachers to choose how to adapt and grow as they add self-regulation to their teaching style. In doing so, the teachers are practicing what we are asking students to do, and the students have multiple good models to learn from. The stories of Agile practices that we collect along the way, provided by teachers right from their classroom experience, will inform teaching and learning and the future iterations of our Agile culture.

We are not concluding, we are just beginning.

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