Inflection Point

> *"The real problem of intellectual education is the transformation of more or less casual curiosity and sporadic suggestion into attitudes of alert, cautious, and thorough inquiry."*
>
> —John Dewey

Background:

Traditional American education is largely dominated by *content*. It is content that is taught in the classrooms, and content mastery that is judged by standardized tests; most student work revolves around integrating, manipulating, or regurgitating specific information. If you ask a typical middle schooler what she learned at school today, you're likely to hear something like:

> *"Well, in math, we learned the quadratic equation. In social studies, we talked about the Great Depression and the dust bowl. Science class was all about light and radiation—like, x-rays and radio waves and the spectrum and stuff—and in English, we did another couple of pages of Romeo and Juliet."*

Similarly, if you ask her what she *did*—what activities she took part in, and what work she produced—you will get answers along the lines of:

> *"We did some worksheets in math, like drawing the graphs and stuff. There were questions on the reading in social studies, and we started doing research for our essays. Mr. Benson had us do a neat experiment with prisms, and then we did some problems calculating wavelengths. And we read aloud in English, and discussed the feud between the Capulets and the Montagues, and how it motivates different characters' actions."*

Most of the content here is arbitrary in the sense that it is not strictly necessary for growth and development nor likely to be particularly relevant in the life of any given student. Replace the quadratic equation with Euclidean geometry, the Great Depression with the Great War, the electromagnetic spectrum with plate tectonics, and *Romeo and Juliet* with *The Great Gatsby*, and you are unlikely to hear an outcry from parents and teachers. Similarly, most specific activities—projects, papers, labs, discussions—are interchangeable; comparably excellent teachers in different states, different districts, or even different wings of the same school often give their students wildly different assignments yet produce similarly competent graduates.

The obvious conclusion is that (barring subjects with progressive hierarchies of knowledge, like mathematics) the choice of content is largely irrelevant. As a sixth grader, I studied *The Lion, the Witch, and the Wardrobe* and learned about the governments of twentieth-century Europe. As a sixth grade teacher, I watched my colleagues teach *Tuck Everlasting* and the history of ancient Greece and Rome. I would be highly skeptical of any claim that either curriculum was fundamentally "better" than the other. Education, at its core, is about *processes*, and the content is simply the vehicle by which the processes are learned and practiced. Students need to learn to read and write, to reason and argue, to plan and produce, to critique and reflect; years later, it will matter little what shape or color of whetstone they used to sharpen their mental knives.

Recent developments in American education reflect a cautious embrace of this fundamental premise. The growing popularity of experiential and project-based learning; the increased focus on literacy and analysis; the shift away from set algorithms to fluid, experimental problem solving; all of

these are signs that we are learning to pay more attention to the *how* and the *why* instead of spending all of our time on the *what.*

However, there is still an unspoken assumption that students will simply "get" it on their own—that by posing interesting problems and rewarding mental flexibility, we've done all we should. *Instruction in thinking itself* remains largely absent from the classroom, relegated to brief interludes on "problem solving strategies" and post-project reflections. Rare is the middle or high school teacher who has the time and resources to make metacognition or the study of justified truth the core focus of a lesson, let alone a whole unit—there's simply too much content to check off the list.

Yet there is much to be gained from explicit instruction in logic, rationality, and self-awareness. In a fast-paced and ever-changing world, there are few content domains that are as valuable as the more general skills of quickly identifying and defining problems, discriminating between relevant and irrelevant information/valid and invalid inferences, recognizing (and correcting) biases and gaps in knowledge, and coordinating with others to devise and execute plans that have high probabilities of success. These are skills that take time and nurture to develop, which is all the more reason why the seeds should be planted early and watered well. Much research indicates that these metacognitive skills cannot reliably be taught before the age of ten or eleven, but that same research also shows that an early start makes a tremendous difference:

> *"Seventh graders turned out to be the group most affected by experimental condition. Without explanation or feedback [regarding concepts of logic and rationality], their performance was highly variable, with some reasoning at the level of fourth graders and others at the level of the best college students. With explanation or feedback, however, seventh-grade performance improved to the level of the college students."*
>
> —David Moshman

This is the rationale behind Inflection Point. We want the next generation to be able to think clearly, and reason formally; to categorize, prioritize, and optimize. To recognize wrongness and replace it with rightness (or at least with well-defined uncertainty); to balance head with heart, bringing both to bear on questions and problems that matter. To search for what would prove their beliefs wrong rather than what would prove them right, and to begin the long, hard process of getting to know their own minds from the inside out. Most importantly, we want them to see their own mental development as a process that increases their ability to affect the world, and to take ownership of that process as soon as they are capable of doing so.

But a lot of them won't get there on their own, and that's where we (hope to) come in. Inflection Point is a layered, immersive, two-week introduction to the concepts of logic, epistemology (seeking truth), and metacognition—essentially, a safari through the jungle of human thought. Drawing on the fields of project-based learning, decision theory, economics, and heuristics and biases, we've constructed a hands-on curriculum that takes the tools of mature critical thinking and makes them relevant and accessible to the middle grades age group. Students divide their time between lateral thinking puzzles, TED-ish lectures, design challenges, guided discussions, group problem-solving, and open-ended cognitive competitions, with an hour and a half of parkour instruction each afternoon. The idea is to move rationality out of the abstract and into the mud, where kids can practice using it to tackle every kind of obstacle.

Camp goals:

- Challenge kids who are rarely challenged
- Make cognition an immersive experience (food for thought in every direction)
- Provide a thorough grounding in the basics of logic, epistemology, and metacognition
- Teach proto versions of "rationality techniques"
- Increase the range and complexity of situations to which kids are capable of applying deliberate, reasoned inquiry
- Instill (or reinforce) a sense of *intellectual morality*
    - Growth mindset
    - Strong preference for truth over falsehood
    - Heroic responsibility

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Identifying questions and problems worth considering (subset: recognizing confusion)
- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Effectively recruiting and coordinating with others
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)
- Generating simple tests (understanding scientific method)
- Seeing or devising solutions (including unorthodox ones)
- Making defensible decisions (and rejecting unsound ones)
- Making intelligent plans (and identifying bad ones)
- Making coherent arguments (and recognizing incoherent ones)

Influences/research:

- Tversky and Kahneman (heuristics and biases)
- David Moshman (adolescent development)
- Deanna Kuhn (education)
- Mihaly Csikszentmihalyi (psychology of motivation)
- Eliezer Yudkowsky (rationality and epistemology)
- The Center for Applied Rationality (epistemology and applied psychology)
- *Labyrinths of Reason*, by William Poundstone (rationality and epistemology)
- *Ender's Game*, by Orson Scott Card (strategy and moral development)
- *Mister Fred*, by Jill Pinkwater (education)

Is this really developmentally appropriate for middle schoolers?

It truly does depend on the individual. The Inflection Point curriculum was written by an experienced middle grades educator* in accordance with research-based best practices and developmental psychology, and each activity has been improved with feedback from actual participants and parents. However, it's deliberately designed to push the boundaries of what ten- to fourteen-year-olds are capable of. Our most successful students tend to be those who are voracious learners, self-motivated workers, and optimistic thinkers (with raw intelligence being a distant fourth). **It's a course for turbocharging the underchallenged, not for inspiring the disinterested or "turning around" kids who are already struggling.**

**Take a look inside our curriculum director's sixth grade classroom*

Why not elementary or high school students?

Inflection Point's unique approach is designed to capitalize on the in-between-ness of middle school aged thinkers, who are often underserved and pigeonholed as "too old for the fun stuff" and "too young for the hard stuff." These are children whose brains are just entering more mature stages of development, and who will benefit the most from some well-planted and well-watered seeds of critical thinking. Our goal was to create an experience that could bridge the gap between broad-spectrum elementary programs like AltSchool (San Francisco), and specialized programs for older kids like SPARC (Berkeley), or High Tech High (San Diego). It's meant to be an introduction, a primer—a well-timed dose of Serious Fun.

What exactly do the students do? What are some of the activities?

Spoiler alert! Many of the puzzles and challenges that students face *absolutely require* the absence of any foreknowledge. Mazes aren't hard once you've seen the solution, and mysteries are boring if you already know who the murderer is. Similarly, we are very serious about keeping the details of our challenges under wraps, so as not to undercut the power of the experience. However, you can view a sample activity here, and parents who are willing to sign a non-disclosure agreement are welcome to view the entire curriculum in detail.

Recurring "classes" within the camp (topics touched on every day, or just about):

- **Rediscovering Civilization**—*Faced with challenges requiring group cooperation, our heroes must invent ways of working effectively together.*
- **Calibrating Confidence**—*Surrounded by misinformation, our heroes must learn to carefully evaluate the limits of what they can claim to know with certainty.*
- **Red Herrings and Ugly Ducklings**—*When reality makes no sense, our heroes will have to learn to separate that which matters from that which does not.*
- **Under the Hood**—*To maximize their chances of victory, our heroes must learn about their own strengths and weaknesses, and how to build upon the former while overcoming the latter.*
- **Mission Impossible**—*When there is no conceivable way to win, our heroes will simply have to make one up anyway.*
- **I Do All My Own Stunts**—*Having worn out their brains, our heroes will take to the playground, learning to jump, bound, vault, and climb under the supervision of an experienced parkour instructor.*

----------End of public section----------

Camp Culture:

As any experienced educator (or attentive student or parent) can attest, the *atmosphere* of the learning environment is critical to the overall experience. A classroom's culture is the sum of many things, foremost among them teacher attitudes, behavioral norms and consequences, and the allocation of time, resources, and incentives. There are many different kinds of excellent academic atmospheres, but few are achieved by accident; most are the result of careful planning and deliberate maintenance.

By its very nature, the Inflection Point experience is meant to be alien and disruptive. Students are being asked to loosen their preconceptions, strain for new perspectives, and undertake modes of thought that—for many of them—will be entirely novel. Therefore, it follows that the camp would both tend to have, and benefit substantially from, an atmosphere that is substantially unlike that of the classrooms they are accustomed to.

In particular, there are three sociological pitfalls into which many teachers lead their classes, which Inflection Point seeks to preempt:

- The implicit treatment of knowledge as cheap and worthless (since it is everywhere and adults are shoving it down the kids' throats)
- The abandonment of academic effort as the primary method of rebellion (since they can make you go, but they can't make you learn)
- The conflation of the moral axis with the competence axis (since most rewards are tied to academic achievement, but most punishments are tied to violations of behavioral norms, and lack of academic achievement correlates strongly with behavioral issues)

Inflection Point's particular solution to these problems, and to the broader question of academic atmosphere, is something we've dubbed "antagonistic learning." Inspired by authority figures both real and fictional, and tested/refined in a sixth grade project-based charter school classroom, antagonistic learning is a reframing of the classic teacher-student relationship. Instead of presenting as a guide or mentor, the teacher sets himself or herself up as a *nemesis*—a miserly hoarder of information, a trickster, an Unreliable Narrator whose role in the classroom is primarily that of an obstacle to be overcome and an opponent to be beaten. Learning becomes a game, with students on one side and teacher on the other, a game in which the teacher dares the students not to participate instead of commanding them to do so by fiat.

Click here for a narrative example set in a fictional seventh grade English classroom.

Of course, this is largely just a skin on top of the usual attention, care, and accommodation that any truly effective teacher must offer. Antagonistic learning dominates interactions at the *group* level, but one-on-one interactions between student and teacher remain nurturing, encouraging, and positive. The key is to strike a balance: challenging, but not taunting; skeptical, but not dismissive; cryptic, but not incomprehensible. At all times, the effective antagonistic teacher is a locked door behind which lies valuable information—once the students find the key, the door swings open without resistance.

Other elements of antagonistic learning and the unique Inflection Point camp culture:

- **The question limit**—Students begin the camp with a limit of one question per lesson/activity. That limit can rise or fall, depending on factors like the difficulty of the challenge, the amount of effort the student puts forward, or the quality of questions the student has previously asked. *Purposes: encourage careful thinking, conserve time, foster creativity, foster collaboration (as students pool their questions to gather more complex information).*
- **No repeats**—The teacher never says the same thing twice, unless a student uses up their question or some other resource to procure a repeat. *Purposes: encourage self-regulation and attention, encourage group cohesion as students rely on each other for information, avoid offering implicit reinforcement of ignoring-teacher behavior.*
- **The Daily Lie**—At least one important thing that the teacher says each day will be an intentional lie (this is a norm that will be explained to the students on day one). Not a subtly misleading statement; not a plausible omission or half-truth, but an outright, complete-opposite-of-the-truth bald-faced lie. *Purposes: provide a "fair" channel by which misinformation can be introduced to make games and challenges more complex, encourage critical thinking and conscious weighing of the statements of authority figures, give students an outlet for excess attention/mental energy.*
- **The Opportunity Cost table**—A large table, just outside of the Inflection Point classroom, containing (among other things) LEGOs, juggling balls, books, snacks, and arts-and-crafts supplies. After the introduction to the camp, students will be free to leave the classroom at any time, if the value of a given activity falls below the allure of the Opportunity Cost table. *Purposes: self-regulation, cost sensitivity, building an atmosphere of trust and cooperation, encouraging student responsibility and agency, something to do during break times, and a place to hide clues.*
- **The Calibration Board**—A data-gathering space for tracking student confidence and how accurately it reflects reality. Throughout the camp, each student will register various predictions six different levels of certainty, and keep track of how well they do in each level. When they're 90% sure, are they actually right nine times out of ten? *Purposes: showcase the power of data, encourage thinking in numbers, calibrate students' confidence levels, promote caution and metacognition.*
- **Costs, not Consequences**—Instead of the traditional warn-then-punish model, camp teachers use an economic model for regulating behavior. Good behavior (silent and attentive during lectures, respectful to other students, on-task and in-bounds) is clearly defined, and exemptions are *purchased* at preset costs. For example, if a student wishes to talk when silence is expected, he or she is free to do so, but it will cost them game points, earned rewards, social time during lunch or breaks, or other, depending on the nature of the current activity. *Purposes: encourage self-regulation, encourage weighing of opposing values, remove emotion and moral judgment from consequential interactions.*
- **Hints, Clues, and Side Quests**—One of the defining characteristics of Inflection Point is its *immersive* nature. Few students will be 100% engaged 100% of the time; attention *always* wanders at some point. Additionally, few activities will fully challenge every single student. In recognition of this, we have littered the curriculum and the classroom with hints, clues, and side quests. Wandering eyes will often fall on tantalizing information; students crawling under desks or peering into cabinets will discover hidden notes or strange objects, and

pointers pointing to pointers eventually lead to mysteries above and beyond the main goals and lessons. *Purposes: keep distracted students engaged on some level, encourage curiosity and exploration, provide an outlet for underengaged students, provide a challenge for competitive students, provide advantages for the motivated and ready help for the demoralized, and cultivate an air of omniscience and mystique on the part of the teachers.*

- **Utilons**—One of the major side quests, the Game of Impending Doom, offers students 100 utilons (points) apiece. The value and utility of these utilons is governed by rules which are never explained, but which may be discovered; students can trade and spend utilons to accomplish tasks within the camp, and can accrue further utilons for insight, effort, creativity, or other reasons related to learning goals. *Purposes: provide a unit of exchange that can be used as the basis of a fiat token economy, provide extrinsic motivation, create another mystery for attentive students to unlock.*
- **It Goes Without Saying**—The traditional strategy of absorbing some media and then analyzing it, discussing it, or working with it is powerful and good, but it brings with it negative associations as well ("Yeah, but I had to read it for *school*"). There is a series of ten videos, each touching on the common theme of expanding one's awareness of one's place in the universe, that students watch during lunch, with no strings attached. The hope is that the "moral education" that comes from learning about (for example) the Hubble Ultra Deep Field images will not need annotation.

Contents:

Day 1

Try being a little less sure…

The overarching theme of day one is *constructive confusion.* By far, humans in general and middle schoolers in particular vastly overestimate their knowledge and competence, and getting people to admit that on a conscious level is not the same as getting them to believe it on a wordless, emotional level. In one way or another, each activity on day one is intended to unbalance and undermine, forcing students to ask the question *why do I believe what I believe?*

● RC: Arch Allies (progress in the face of uncertainty)	9:00 - 10:10
● Lecture/discussion: Camp goals, methods, and norms	10:10 - 10:40
● MI: The Game of Impending Doom	10:40 - 10:45
● Break	10:45 - 10:55
● UtH: Cogito Ergo Dico (non-conformity training)	10:55 - 11:45
● Lunch + video	11:45 - 12:15
● CC/RHUD: Optical non-illusions (intro to calibrating confidence)	12:15 - 1:15
● IDAMOS: Introduction to Parkour (drops, jumps, rolls, step vaults)	1:15 - 2:45
● Snack and RHUD: Interlude (recap and land plot problem)	2:45 - 3:10
● MI: Paper Beats Cinderblock	3:10 - 4:50

Arch Allies

Progress in the face of uncertainty.

Description:

Students enter the Inflection Point classroom to find a large wooden board, upon which are stacked fourteen large, irregular wooden blocks (roughly microwave-sized). There is a clock on the wall counting down from one hour, a teacher with tape over his mouth and a sign that says THINK, and no other obvious instructions, hints, or clues. Without guidance or help, they must assemble the blocks into an 8' freestanding catenary arch (Rediscovering Civilization, Mission Impossible). **Ideal solution: build the arch flat on the board, and then tip the board upward until it takes its own weight.**

Goals:

- Establish the atmosphere of *antagonistic learning*
- Gather starting-point data on student personality traits
- Generate the reference class of "maze problems" (problems which are difficult to solve, but whose solution is obviously correct once reached)
- Begin building positive associations with the clicker

Student skills:

- Identifying questions and problems worth considering (subset: recognizing confusion)
- Effectively recruiting and coordinating with others
- Generating simple tests (understanding scientific method)
- Seeing or devising solutions (including unorthodox ones)
- Making intelligent plans (and identifying bad ones)
- Making coherent arguments (and recognizing incoherent ones)

Materials:

- The Arch (14 pc.)
- Lifting board
- Cameras? (for analysis afterward)
- Dog clicker (1)
- THINK sign (1)
- Check-in medium (post-its, whiteboard, markers, terminal, etc.)

Timeline:

- 0:00 - 0:05 *Confusion*—Students enter room, evaluate situation, react
- 0:05 - 0:10 *Mobilization*—Students begin work in earnest
- 0:10 - 1:10 *Experimentation*—Students eventually reach a solution
  Pause clock for check-ins @ 0:20 and 0:40 ("How do you feel?")
- 1:10 - 1:40 *Debrief*—Discussion of method and meaning

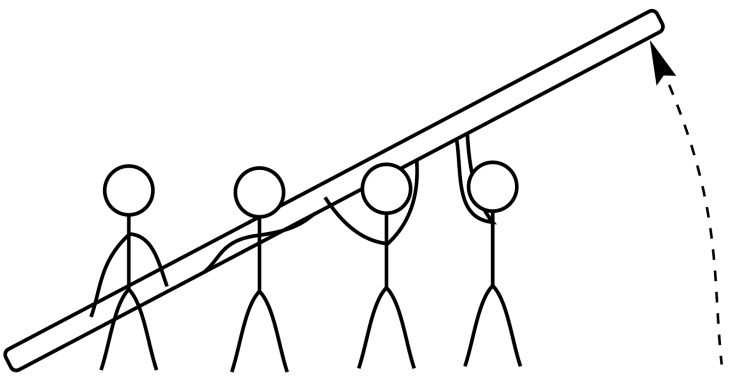
Instruction and Differentiation:

"None," in quotes. During the activity, the teacher or teachers are constantly monitoring the students for both physical and emotional safety. They have three methods of communication:

- Body language—simple gestures may be used to discourage unwanted behavior, e.g. aggression, defeatism, or disengaged wandering.
- Raising the THINK sign—this is done whenever students ask a question, or whenever a particular action or proposition needs to be discouraged (connotation: "think further.")
- Clicking—throughout the camp, dog clickers will be strongly associated with positive reinforcement and feedback. This will begin from minute one; whenever a teacher overhears a good suggestion or sees a positive action, he or she will immediately *click* with the clicker hidden in his or her pocket.
- Personality/socialization assessments (both teacher- and self-):
    - Rationality axes
        - "Rational" vs. reflexive (S2-dominant vs. S1-dominant)
        - Intuitive vs. methodical (quick-thinking vs. slow-thinking)
        - Confirming vs. falsifying (seeking affirmation vs. seeking contradiction)
        - Theory-based vs. trial-based (frontloaded thinking vs. backloaded)
        - Cognitive vs. metacognitive (playing by the rules vs. testing them)
    - Personal axes
        - Engaged vs. disengaged ("This is cool" vs. "This is dumb")
        - Pessimism vs. optimism ("This is too hard" vs. "We can do this")
        - Constructive vs. destructive (ordered/goal-oriented vs. playful/careless)
    - Interpersonal axes
        - Communicative vs. quiet (cooperative vs. independent)
        - Supportive vs. confrontational (tribe-esteem vs. self-esteem)
        - Leadership vs. followership

Hints and Cheats:

- There is a smaller version of the catenary arch on the Opportunity Cost table outside of the Inflection Point classroom.
- There are several subtle notes hidden around the room, each leading to different information. Among these is a diagram detailing how to use the lifting board.



Side Quest Tie-Ins:

- Notes:
    - One note highlights the doubling of the ERS, for the Game of Impending Doom
    - One note contains the phrase “The odd one out is heavier,” which is a helpful hint for the Keep the Change activity on day three
    - One note provides the URL for the Oracle
- The arch is marked with lettering in the Novan phonetic cipher, which students must later crack. When the arch is assembled, the lettering spells out “Stop the doubling,” which is a reference to the Game of Impending Doom.

Discussion and Debrief:

- Initial check-in: student self-report (“How do you feel?”)
- Self-analysis: what went wrong? What went right? How would you approach a similar problem in the future? What advice would you give to yourself one hour ago?
- Why *this* problem?
    - Real problems are often inscrutable; no one points them out
    - Solutions are often obvious in hindsight (beware hindsight bias)
    - Understanding the goal does not make executing it easy
- Segue into camp goals, methods, and norms
    - Name games/introductions (hook, line, and sinker?)
    - Primary goal: think more clearly (become less wrong)
        - Why? To win! At what? Everything!
    - Clarify supporting goals
        - Accurate self-assessment of confidence
        - Accurate/intelligently approximate integration of evidence (Bayes)
        - Preference for truth over falsehood (Tarski/Gendlin)
        - Familiarity with complete mental toolkit (Kahneman/Gendlin)
        - Growth mindset
        - Preference for meaningful pursuits/heroic responsibility
    - Clarify methods
        - Challenges, puzzles, lectures, games, discussions
        - Data (self-report, confidence, bets/predictions)
        - Behavioral standards (expectations and consequences)
        - Commitment to “play along”
- Introduce The Game of Impending Doom
- Break (10min)

Cogito Ergo Dico

Non-conformity training

Description:

Students open their dropboxes to find two small slips of paper. The first is a three-digit multiplication problem (e.g. 773 x 819), with room to do scratch work. The second is a simple, obviously true statement (such as “two plus two is four”).

The activity begins with the first card; the teacher asks each student to solve the problem on the card, in silence. However, nine out of ten cards have the following instruction: **PRETEND YOU ARE SOLVING THIS PROBLEM, AND THEN GIVE 743087 AS YOUR ANSWER (THIS IS WRONG, BUT PLAY ALONG).** Of the remaining two cards, one has the problem without extra instructions, and the other has a different problem (e.g. 713 x 879).

After a minute or two, the teacher begins to go around the room, calling on students to share their answers. Once ten or so students have given the deliberately wrong answer, the student with the main problem (but not the extra instructions) is called on. If all goes according to plan, that student “folds” and conforms to the group’s answer. If not, the teacher frowns, shrugs, and proceeds through six or seven other confederates before calling on the student with the other problem. Again, hopefully the student conforms; then the remaining students are called on.

Immediately after, the teacher launches into a discussion of the phenomenon of conformity, referencing relevant examples from psych and highlighting the pressure felt by the two students (or, alternately, congratulating those two students on their unusual confidence). The entire scheme is exposed, and the next part of the lesson explained.

For part two, each student comes to the front of the room with his or her obviously true statement. Their task is to confidently state their truth, and then defend it against the doubts, contradictions, and mockery of the others for 30 seconds (teachers monitor mockery carefully to ensure that it stays within emotionally safe bounds, but reinforce clever arguments or points against the true statement). **However, the last student to go is a confederate, and has a “truth” that is, in fact, false, though it appears defensible at first.** That student stands, defends his or her truth, and sits, after which the teacher reveals to the rest of the class that it was a lie all along. Another discussion follows.

Goals:

- Build up social reinforcement for standing one’s ground, even in the face of opposition
- Undermine student certainty, laying the groundwork for later lessons on evaluating and assembling *relevant supporting evidence*
- Continue the development of the atmosphere of *antagonistic learning*—the teacher is an Unreliable Narrator, and is not to be trusted

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)

Materials:

- Dropboxes (20)
- Dry erase board/projector (for math answer and notes on conformity)
- Index cards
    - 18 confederate math cards (773 x 819 = 743087)
    - 1 non-confederate math card with main problem (773 x 819 = ?)
    - 1 non-confederate math card with different problem (713 x 879 = ?)
    - 19 obvious truth cards
        - "The sky is blue."
        - "One plus two is three."
        - "Down is *that* way."
        - "My name is _____."
        - "Today is Monday."
        - "We're in California."
        - "Most dogs have four legs."
        - "This sentence is in English."
        - "Summer comes after spring."
        - "A second is shorter than a minute."
        - "I am wearing clothes."
        - "Nobody in this room has green skin."
        - "I am standing in a classroom."
        - "The capital of the US is Washington DC."
        - "The Earth is in orbit around the sun."
        - "Everyone here is over two feet tall."
        - "Left is the opposite of right."
        - "Everything in this room is made of atoms."
        - "The first letter of the alphabet is A."
    - 1 non-obvious falsehood card
        - "There is no gravity in space."

Timeline:

- 0:00 - 0:05 Introduction/explanation and first problem solving
- 0:05 - 0:10 Conformity experiment
- 0:10 - 0:20 Conformity discussion
- 0:20 - 0:35 Non-conformity practice
- 0:35 - 0:50 Non-conformity discussion

Instruction and Differentiation:

During this activity, there is little direct instruction. Teachers should strictly enforce silence and honesty during the math portion, to ensure that the students are not giving away "the twist." When explaining and opening up for discussion, particular care should be taken to positively reinforce the emotional safety of the students who found themselves in the hot seat, and to reward their participation.

Hints and Cheats:

N/A (few degrees of student freedom)

Side Quest Tie-Ins:

- The correct answer to the multiplication problem (633087) is a passcode that may be entered into the Oracle, to receive a clue to the Novan phonetic cipher.
- One of the obviously true statements factors in to some other side quest (TBD)

Discussion and Debrief:

- What is conformity? (discuss research, solicit examples from group)
- Why is conformity good? How has it helped us, as a species?
- When is conformity bad? How do you distinguish when it's appropriate to go against the majority opinion?
- What is the value of input from others? How weak or strong is the evidence provided by an individual? A group? What strengthens or weakens that evidence?
- What is *knowledge?* (JTB)
- Introduce the Daily Lie
- Break (10min)

Optical Non-Illusions

Introduction to calibrating confidence

Description:

Students open their dropboxes to find worksheets, on which are printed five simple questions and five familiar, common optical illusions, with questions attached (e.g. “Which line is longer, A or B?”). They are asked to mark their answers on their sheet, along with their confidence level (multiple choice) for each answer. When they are finished, they come up to the Calibration Board to duplicate their confidence data.

Confidence levels:

- “Just guessing.” (50%, or “I expect to be wrong half the time.”)
- “Makes sense.” (75%, or “I expect to be wrong only 1 out of 4 times.”)
- “Pretty sure.” (87.5%, or “I expect to be wrong only 1 out of 8 times.”)
- “Very confident.” (93.75%, or “I expect to be wrong only 1 out of 16 times.”)
- “I’d bet my shorts.” (96.875%, or “I expect to be wrong only 1 out of 32 times.”)
- “Certain.” (100%, or “It’s not possible for me to be wrong.”)

The teacher reviews the answers with the class. All five of the optical illusions are, in fact, *actually* as they appear (e.g. a line with arrows pointing inward appears longer than a line of identical length with arrows pointing outward, but in this case the former is *actually longer* than the latter). Confidence results are recorded, and the teacher introduces the general concept of calibrated confidence. The teacher asks for a prediction with confidence attached, based on evidence thus far, both about the images and about how the camp is progressing overall: will the next image shown be an optical illusion, or will it merely *appear* to be an optical illusion?

Five more illusions are shown, one after another. For each, students record their confidence in their answers to the associated questions. The first: an actual illusion. The second: an actual illusion. The third: an actual illusion. The fourth: an actual illusion. The fifth: an actual illusion. The teacher asks for a prediction with confidence attached: will the next image shown be an optical illusion, or will it merely *appear* to be an optical illusion? The next image shown is neither an actual illusion nor a meta-illusion; both predictions are false, and students come up to publish their data (each student has seventeen points of data so far).

Next, the teacher presents the 3-6-9 problem for the group to solve:

- “You are presented with the numbers 3, 6, and 9, in that order. These numbers follow a specific rule, and your task is to state the rule. You will only get one guess, but you may first gather data by proposing other sets of three numbers to see if they fit the rule. So, for example, you might ask ‘1, 2, 3?’ to which your teacher would either answer ‘Yes, that set follows the rule,’ or ‘No, that set does not follow the rule.’”

As each question is asked, students record their predictions with confidence attached, using a grid on the back side of the worksheet. Each student gets up to one guess at the pattern solution, and the rest of the class also records predictions and confidences for the accuracy of those guesses.

The game proceeds until the correct answer is discovered. The teacher initiates a discussion regarding confidence levels.

Next, the students pull the next sheet from their dropboxes. There are four different versions:

- A question asking whether intelligence leads to happiness, a paragraph supporting the claim that getting your license **earlier** makes you a safer driver, and a question asking whether hybrid cars actually lead to reduced gas consumption.
- A question asking whether intelligence leads to happiness, a paragraph supporting the claim that getting your license **later** makes you a safer driver, and a question asking whether hybrid cars actually lead to reduced gas consumption.
- A question asking whether getting your license earlier makes you a safer driver, a paragraph supporting the claim that intelligence leads to **happiness**, and a question asking whether hybrid cars actually lead to reduced gas consumption.
- A question asking whether getting your license earlier makes you a safer driver, a paragraph supporting the claim that intelligence leads to **unhappiness**, and a question asking whether hybrid cars actually lead to reduced gas consumption.

At the bottom of the paper, students provide an answer to the first question, with confidence attached. Then they read the paragraph, and afterward state how confident they are in the conclusion, as well as predicting how likely they *would have been* to reach that answer. Finally, they provide an answer to the final question, again with confidence attached. Analysis of these various answers usually illustrates *hindsight* and *confirmation biases.*

Goals:

- Introduce the concept of calibrated confidence
- Encourage students to attach numbers to their predictions, and to track those numbers as a route toward making better predictions
- Introduce the dangers of hindsight bias and confirmation bias
- Introduce the concept of *seeking falsification*

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)
- Making coherent arguments (and recognizing incoherent ones)

Materials:

- Optical illusion worksheet with prediction confidence chart on back (20)
- Hindsight bias worksheet (20)
- Confidence Board

Timeline:

- 0:00 - 0:05 Individual work with illusion worksheet
- 0:05 - 0:15 Debrief/discuss initial illusions, define calibrated confidence
- 0:15 - 0:25 Next five illusions (with predictions), and final image
- 0:25 - 0:40 3-6-9 game
- 0:40 - 0:45 Individual work with hindsight bias worksheet
- 0:45 - 1:00 Discussion of hindsight and confirmation biases

Instruction and Differentiation:

No special considerations

Hints and Cheats:

N/A (few degrees of student freedom)

Side Quest Tie-Ins:

- Information hidden in first five questions on illusion sheet (TBD)
- The final, non-illusion image from the first part of the lesson is a drawing of columns holding up a platform, which is the crucial insight for Paper Beats Cinderblock.

Discussion and Debrief:

- Calibrated confidence
    - Briefly introduce System 1 and System 2 (to be fleshed out later)
    - Introduce concept of bits of information (that 50% to 60% is a smaller jump than 85% to 95%)
- 3-6-9
    - Introduce concept of *seeking falsification* rather than *seeking confirmation.* Talk about the Venn diagram conception, and how what matters is the information on the edges.
- Hindsight bias
    - Tie hindsight bias back to the arch—how easy did it feel at the time? How easy would it have been if you'd *known* it was an arch? Did having "all the clues right there in front of you" make any difference in the difficulty?
    - Point out the dangers of allowing hindsight bias to devalue scientific method and thereby slow scientific progress
- Tarski/Gendlin: I wish to believe the truth
- Break (10min)

IDAMOS Day 1

Drops, jumps, rolls, step vaults

Description:

Students change shoes/clothes if necessary, and assemble in lines. The teacher gives a brief introduction to parkour, including behavioral expectations, and leads the group in some basic warmup exercises. Following these, the students then engage in the following introductory parkour activities:

- Drops (from a ~30" height down to a ~10" constrained landing), practicing safe "cannonball" landing form and quiet landings
- Upward jumps (from a ~10" starting point up to a height of ~30"), practicing arm swing, knee/ankle alignment, posterior chain recruitment, and quiet landings
- Broad jumps (at ~30", across a gap of ~5'), practicing midair tuck, 45° angle trajectory, and quiet landings
- Strides (static-one-land and static-one-two-land)
- Introductory rolling techniques (backwards, forwards, walking, and with small drops)
- Step vaults and speed vaults (over ~30" obstacle)
- Tic tacs (45° angle to precision)
- Arm jumps (from a ~30" height to a ~5' height at a distance of ~6')

Goals:

- Provide an outlet for pent-up energy
- Introduce students to the philosophy of parkour (efficiency & growth mindset); highlight obstacle coursing as metaphor for rationality
- Begin the process of building physical confidence and competence

Materials:

Note: this list is changeable depending on timing/funding. Equipment is nice, but parkour can be done outdoors at no cost.

- Six Twix
- Six Turtles
- Three Goldiboxen
- Porto-wall

Timeline:

- 0:00 - 0:15 Intro & warmup
- 0:15 - 0:25 Drops, jumps, strides
- 0:25 - 0:45 Rolls
- 0:45 - 1:00 Game (Raptor tag) & break
- 1:00 - 1:15 Stations (step vault, tic tac, arm jump)
- 1:15 - 1:30 Free training and debrief

Interlude

The Land Plot Problem

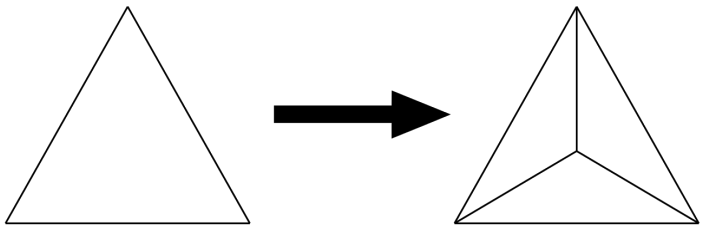
By this point, students have covered multiple topics, and are both tired and flushed with endorphins from parkour practice. Prior to starting the next activity, it makes sense to have a brief snack time and a quick re-focusing discussion. **During this discussion, each student must balance a beanbag on one of his or her feet. This is cover for other strange actions (such as the straws in this activity) which will have actual meaning; it's important to normalize such things so that students start to pay them less attention.**

- What we've done so far
  - Built the Arch
  - Practiced non-conformity
  - Calibrated confidence
  - Begun learning parkour
- What have you learned? Phrase that knowledge as advice to future you.
- Reminder: do not fall prey to hindsight bias (have sympathy for your confusion; problems are difficult and answers are often hard to see even if you have all the pieces)

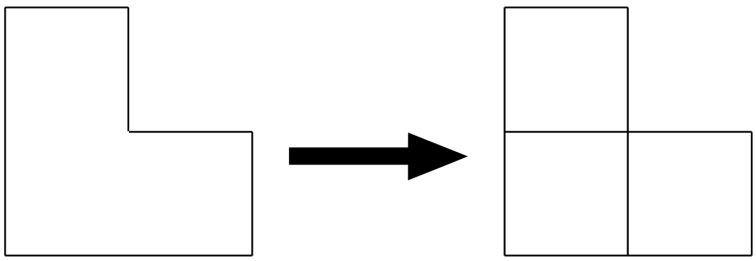
Problem:

You are a county official in a region with many strangely shaped properties. It's your job to help people when they sell their land, or pass it on to their children, etc.

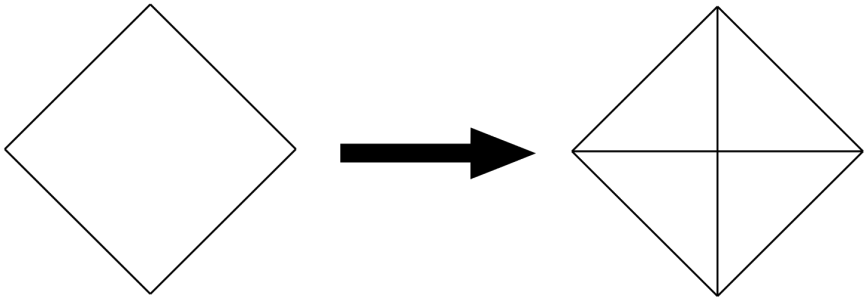
- Mrs. Anders approaches you. She has three children, and wants each of them to receive an equal share when she dies—same size, same shape. She shows you the map of her property, which you quickly and easily divide into three identical parcels:



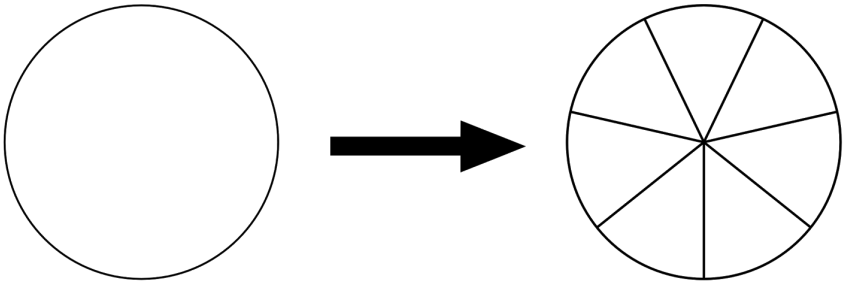
- Next you are approached by Mr. Baker, who also has three children. His property is L-shaped, and again you find it quite easy to divide:



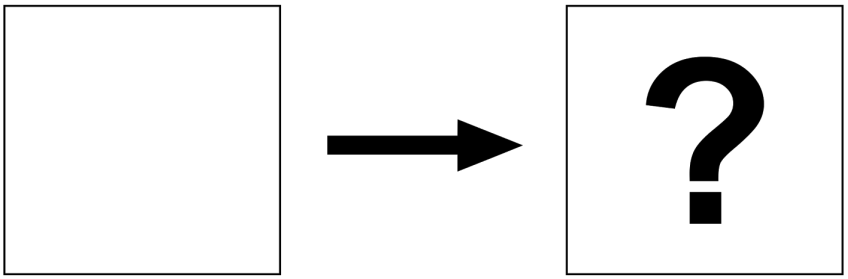
- Mrs. Cartwright is next. She has four children who will inherit a diamond-shaped property. You quickly sketch the following solution:



- After Mrs. Cartwright, you are visited by Mr. Durden. He has *seven* children who will each inherit a share of his circular property. You have to pull out your protractor, but you still find yourself reaching the solution quite quickly:



- Lastly comes Mrs. Evans. She owns a square property, which she wants divided into five equal shares for her five daughters. What is your solution?



Paper Beats Cinderblock

The Paper Box Problem

Description:

Students receive five 3” x 5” index cards, twelve inches of Scotch tape, and access to rulers, pencils, and scissors. They are tasked with building a paper box to exact dimensions (3” x 3” x ¾”, with tolerance of $^{1}/_{16}$”) that will hold up a stack of cinderblocks. For each cinderblock over the minimum, they will receive a tangible reward (dollars, utilons, candy, clues for other quests).

Goals:

- Establishing the habit of focused grit (Get. It. Done. Now.)
- Reward critical thinking (there is one key insight that makes success possible, and it can be made intuitively or through any number of cheap experiments)
- Engage kinesthetic and visual learners; give students a change of pace
- Establish firm standards for following directions (no extra tape; boxes offsize not graded)
- Provide students with a cool experience and a product/souvenir to take with them

Student skills:

- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Generating simple tests (understanding scientific method)
- Seeing or devising solutions (including unorthodox ones)
- Making intelligent plans (and identifying bad ones)

Materials:

- Index cards (5x/person; 100 total)
- Tape (12”/person, 20’ total)
- Scissors (10)
- Rulers (10)
- Pencils (20)
- Cinderblocks (flat pavers; 20)
- Example box

Timeline:

- 0:00 - 0:05 Demonstration and explanation
- 0:05 - 1:10 Work time
- 1:10 - 1:40 Crush time

Instruction and Differentiation:

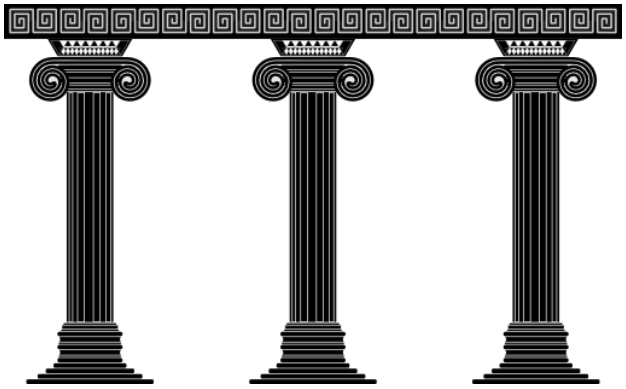
During the introduction, teachers take particular care to be very clear about what constitutes success (first, that the box must be made only with the allowed materials and be of the correct

dimensions, and second, that it must retain its shape while cinderblocks are stacked on top of it in the testing area). They remind students to be careful with their measuring and cutting, as they will not be given additional materials in the event of a mistake.

When moving around the room, the teachers use clickers to indicate approval of student suggestions or actions. Otherwise, their feedback is limited to Socratic interrogation.

Hints and Cheats:

- The final image from the first part of Optical Non-illusions is a drawing of columns holding up a platform, priming the most efficient solution:



- The technical criteria for success allow for the placement of other objects in the testing area. The obvious candidates are other boxes, but the rolls of Scotch tape also happen to be of exactly the right height—four of them placed around a student's box while that box is being tested will significantly increase its ability to survive.

Side Quest Tie-Ins:

- Clues provided as rewards (TBD)
- Four of the index cards (scattered golden-ticket style around the room) have been written on in Sharpie: [1 = ↑], [2 = →], [3 = ~ next], and [4 = double next]. These are clues for the Complex Coordination game to come near the end of week 1.

Discussion and Debrief:

- Primary brainstorming and cheap experiments
    - What do you do when faced with an impossible problem and limited time?
- Maximizing resources and looking for cheats
    - Could this problem have been solved with only two index cards?
- "Just because it's hard doesn't mean it's complicated."
- "Just because it's simple doesn't mean it's easy."

Day 2

On being a program that wrote itself, running on a computer made of meat.

Having begun to delineate the boundaries of responsible confidence on day one, day two will be concerned primarily with developing self-awareness and a rough understanding of the internal workings of the human brain. The day will begin with a confusion recap, and then proceed through a set of activities and challenges that are all about learning the ins and outs of System 1 and System 2.

● RHUD: Prelude (hot plate experiment)	9:00 - 9:25
● RC: Floating Pipe	9:25 - 9:45
● UtH: The Monkey and the Robot (System 1 and System 2)	9:45 - 10:50
● Break	10:50 - 11:00
● RHUD: Resistance is Rational (social gaming)	11:00 - 11:45
● Lunch + video	11:45 - 12:15
● UtH: It's Not What It Looks Like (representativeness heuristic)	12:15 - 1:10
● IDAMOS: Fear is the Mind-Killer (S1 and S2 responses to danger)	1:10 - 2:40
● Snack and CC: Interlude (the map, the territory, and the stars above)	2:40 - 3:00
● UtH: Invisibility Cloaks (the Dunning Kruger effect)	3:00 - 4:00
● RHUD: The "Ratio" Part of Rationality (Bayes' Theorem)	4:00 - 5:00

Prelude

The Hot Plate Problem

Description:

Students enter the Inflection Point classroom to find a large, ceramic plate sitting in front of a heater that is turned on. Instructions on the board encourage them to touch the plate and make observations. The students quickly discover that the side of the plate *closest* to the heater is quite cold, while the side of the plate *farthest* from the heater is unusually warm.

Students are then asked to have a seat and to write down up to three hypotheses that would explain the phenomenon, assigning confidence to each. The first three minutes of this brainstorming is done in silence; during the last two, students may collaborate. A discussion follows in which the students share their ideas without critical commentary from the teacher. Afterward, students re-check the plate (discovering that the temperatures have begun to neutralize/reverse), and the true explanation is given.

Goals/Discussion:

- Teachable moment on *noticing confusion* (when to bring deliberate mental effort to bear)
- Continued calibration of confidence
- Occam's razor (absent reasons to prefer a complex explanation, simpler is better)

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Identifying questions and problems worth considering (subset: recognizing confusion)
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)
- Making coherent arguments (and recognizing incoherent ones)

Materials:

- Heater
- Ceramic plate
- Paper & pencils (20)

Floating Pipe

Problems with Coordination

Description:

Students line up in two shoulder-to-shoulder lines just a couple of feet apart from one another, facing inward. Each student clasps his or her hands together, extending both index fingers forward at roughly chest height; the lines are staggered so that all of the index fingers line up side by side in a single central row. The teacher slides a long PVC pipe, capped at both ends (the "helium stick") across the central space so that it is resting evenly on every student's fingers. Students must work cooperatively to lower the stick to the ground while individually maintaining contact with the stick at all times.

Goals:

- Generate the reference class of "coordination problems" (problems which are easy to comprehend and solve in theory, but where conflicts of incentives make progress difficult)
- Establish a baseline for the group's ability to work intelligently together
    - Do they choose leadership? Agree on communication norms?
    - Do they brainstorm intelligently? Are all voices heard?
    - Do all individuals coordinate and support a central strategy?
    - Are there unhelpful levels of stress/accusation/blame/antagonism?

Student skills:

- Identifying questions and problems worth considering (subset: recognizing confusion)
- Effectively recruiting and coordinating with others
- Making intelligent plans (and identifying bad ones)
- Making coherent arguments (and recognizing incoherent ones)

Materials:

- One PVC pipe (~20')

Instruction and Differentiation:

During this challenge, the teachers subtly encourage discord and defection so as to make the experience last longer and produce more frustration. The simplest way to do this is by rigidly and enthusiastically enforcing the rule that all students must keep their fingers in contact with the stick at all times—repeated reminders and sharp warnings will keep every student exerting upward pressure, to the detriment of the lowering goal. As always, care is taken to ensure that emotional safety is maintained, but in many ways frustration is the *point* of this activity—the students need to be sufficiently dissatisfied with the experience that they feel intrinsic motivation to fix the way the group works together.

Discussion and Debrief:

- Introduce the *tragedy of the commons*, including real-world examples
- Solicit ideas for the next coordination problem—what will they do differently?
- Highlight the difference between top-down approaches (rules) and bottom-up approaches (altering incentives). Which would have been more effective in this case?

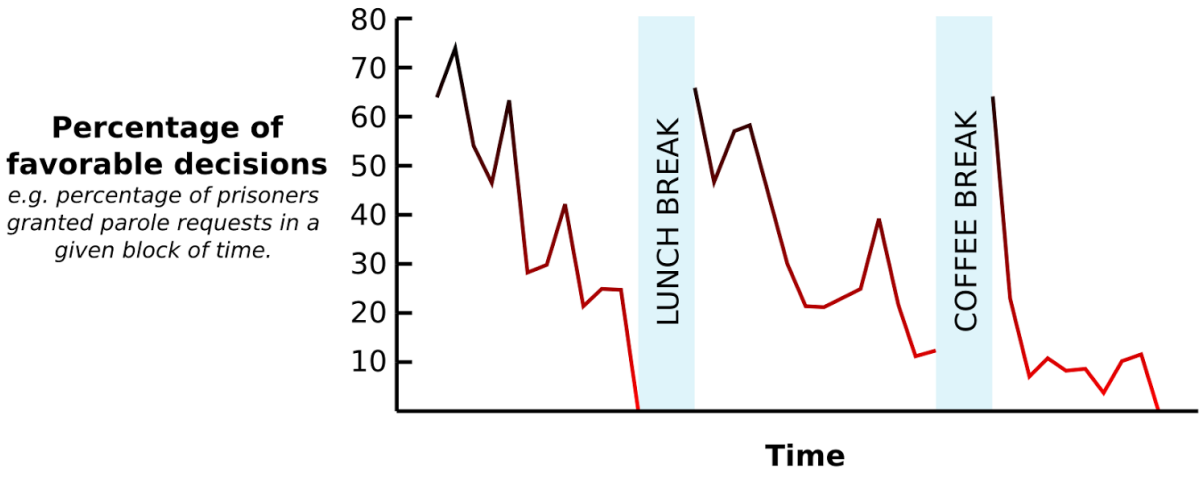
The Monkey and the Robot

System 1 and System 2

Description:

Students open their dropboxes to find a wrapped plastic straw and a card with instructions to either hold that straw horizontally in their teeth (forcing a smile) or pointing straight ahead in their lips (forcing a frown). Once everyone is in position, students watch this three minute video. Then, still holding the straws, each student rates how funny the video was on a scale from 1 to 5 (5 being the funniest).

Next, students look at the following graph, while the teacher quickly collects and collates the student data:



Source

Students discuss the graph and its implications. In particular, the teacher tries to solicit a sense of shock, perturbation, or moral outrage—a general recognition that the example has far-reaching implications. Next, the teacher poses the question: how important do you think this type of effect is in *your* life?

After initial student responses, the collated ratings of the video are presented as an average, usually somewhere between 3 and 4. Then the data is divided into two distinct averages based on straw position, usually creating a gap of between .5 and 1 points. These results are also discussed, and then System 1 and System 2 are described in detail, including the strengths and weaknesses of each.

Next, students are presented with the following logical problem: which of these four cards (which have a letter on one side and a number on the other) must be flipped to prove or disprove the hypothesis “All even-numbered cards have a vowel on the back”?

E	2	7	K

Teachers solicit individual responses from all students (no group discussion), and then offer the following statement: “Okay, so, don’t take this as evidence one way or the other, because I would have said this regardless of whether you were right or wrong. This is just the point at which I offer this information, no matter what, understand? So, if I were to tell you that the vast majority of people—like 70-90%—get this problem wrong, would that make you want to reconsider your answer?”

After this statement, students are allowed to openly discuss the problem for 2-3 minutes. Then the teachers switch gears, providing an alternate problem: “Some local police walk into a bar and see the following people. What kinds of checks do they need to do, to make sure that everybody’s following the laws about who can drink alcohol?”

Ella, who the cops know is 25, is drinking an unknown beverage.	Mark, whose age the cops don’t know, is drinking a glass of beer.	Meredith, whose age the cops don’t know, is drinking water.	Ortíz, who the cops know is 19, is drinking an unknown beverage.

A final discussion follows, in which the correct answers are NOT confirmed unless some student pays for them somehow (using up a question, spending utilons), the logical equivalency of the two problems is established (including a reference to the general case $A \rightarrow B = \sim B \rightarrow \sim A$), and the power of context is highlighted (System 1 made the second version of the problem trivial, but both System 1 and System 2 had trouble with the first version).

Goals:

- Create a *System 1* belief in/understanding of, the effects and importance of System 1
- Highlight the difference between “Spock rationality” and “human rationality”
- Prime students to begin querying System 1 and System 2 separately

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)

Materials:

- Wrapped straws (20)
- Instructions for straws (20)
- Data-gathering method (cards, app)
- Data-sharing method (projector, whiteboard)
- Wason 4-card problem cards (two sets)

Timeline:

- 0:00 - 0:07 Straws, video, data collection
- 0:07 - 0:15 Discussion of judicial results graph
- 0:15 - 0:25 Discussion of straw results
- 0:25 - 0:45 Introduction of System 1 and System 2
- 0:45 - 1:05 Wason 4-card problem (two versions) and debrief

Instruction and Differentiation:

No special considerations

Hints and Cheats:

N/A

Side Quest Tie-Ins:

- There is a Symbolic Logic side quest in the form of an introductory tutorial, worth utilons

Discussion and Debrief:

- System 1 (the monkey) is
    - Nonverbal and holistic
    - Quick, effortless, and automatic
    - Tied to emotion, belief, and habit
    - The source of ideas and reactions

    - Always running
    - Good for:
        - Snap sensory judgments (e.g. near vs. far, orienting to loud sounds)
        - Snap emotional judgments (e.g. facial expressions, body language)
        - Completing familiar structures (e.g. “sharp as a …” or “2 + 2 = ?”)
        - Carrying out routine tasks (e.g. biking, eating, teacher on Indoboard)
        - Generating emotional narratives and emotional direction
- System 2 (the robot) is
    - Verbal and analytical
    - Slow, effortful, and attention-intensive
    - Tied to critical thinking and sense of self
    - The censor of ideas and reactions
    - Usually on standby and capable of burnout/overload
    - Good for
        - Tasks requiring sustained focus (e.g. multiplication, word search)
        - Learning new or complex skills
        - Integrating new evidence or making reasoned judgments
        - Creating and evaluating plans
- The Map and the Territory
    - System 1 is the navigator, looking at the map and yelling out what it sees there
    - System 2 is looking at the real world, and sometimes has to convince System 1 that the map is incorrect and needs updating
- Neither system is superior; both are critical
- Neither system is perfect; both have flaws
    - Discuss metaphor of monkey and robot, along with other metaphors (caveman and philosopher, horde of kindergarteners)
- Successful rationality requires practice at leveraging the strengths of each and learning how to integrate them so they can work well together
    - Do not attempt to fight System 1 with System 2.
- Can you think of weaknesses of each system?
- Wason card problem
    - Number-letter version
        - Introduce formal logic
    - Drinking alcohol version
        - Introduce “cheater detection”

Resistance is Rational

Integrating information from System 1 and System 2

Description:

Students are arranged in three groups of six (two volunteers will be excluded and set on another mission TBD), with each group at its own table. Within each group, two students are secretly and randomly assigned to be spies (and each made aware of the other's identity), while the remaining four are assigned to be members of the resistance.

Students practice "going out on a mission" by each placing either a black (cooperate) card or a red (sabotage) card into a hat. Cards are placed face-down and shuffled before being revealed; a single red card is enough to cause a mission to fail.

Gameplay requires five rounds. One student is the "leader," and proposes a subset of students to go on the mission (possibly including him/herself). The rest of the group discusses and votes on the proposal. If the proposal passes, that subset of students puts cards into the hat (resistance always put in black cards; spies generally put in red cards, but may choose to put in black for tactical reasons). If the proposal fails, the next student to the left becomes the leader, and proposes a new team.

The first mission requires a team of two. The second, third, and fourth missions require teams of three. The fifth and final mission requires a team of four. If the spies manage to sabotage three missions, the resistance loses; if the resistance manages three sucesses, the spies lose.

Goals:

- Give students practice distinguishing System 1 feedback (he's acting suspicious!) from System 2 feedback (integrating evidence from multiple missions)
- Make critical thinking fun and competitive

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Effectively recruiting and coordinating with others
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)
- Generating simple tests (understanding scientific method)
- Making intelligent plans (and identifying bad ones)
- Making coherent arguments (and recognizing incoherent ones)

Materials:

- Deck of playing cards (1)

Timeline:

- 0:00 - 0:05 Explanation/introduction
- 0:05 - 0:15 Game 1
- 0:15 - 0:30 Game 2
- 0:30 - 0:40 Game 3
- 0:40 - 0:45 Debrief

Instruction and Differentiation:

No special accommodations

Hints and Cheats:

N/A

Side Quest Tie-Ins:

- Two kids off on a side quest (TBD)
- Each team that defeats the spies and successfully completes three resistance missions will receive a clue drawn from a hat. The first clue will be useful for solving the Novan phonetic cipher. The second will provide information on the Game of Impending Doom. The third will be an Oracle key that can help the students escape the Locked Room.

Discussion and Debrief:

- What strategies were effective? What strategies led you into a trap?
- Did you get valuable information from both systems? Which was more reliable for you?

It's Not What It Looks Like

Understanding the representativeness heuristic

Description:

The teachers produce a large bag, filled with approximately 150 golf balls (70% orange, 30% green, well-mixed). Without looking, one of them pulls fifteen balls out of the bag, one at a time, recording the results on the board. They should look something like: OGOGO OOOGG OOGOO. Then the balls are replaced and the bag is mixed/shaken.

Students use Scratchpost to log their prediction for the next fifteen balls (with a reminder that order does matter). Each student also registers their confidence that their prediction will contain eight or more correct guesses. Once all of the predictions are visible, students make an additional bet (with confidence) regarding which of their peers' predictions will be the most accurate.

The teachers then reveal the "house bet," which is OOOOO OOOOO OOOOO. Hopefully, at this point, some number of students will groan, and the remainder will recognize that they are confused. The teachers will ask the class generally to decide which is more likely for the *very first ball* to come out of the bag: orange, or green? Then the ball is pulled, and the result recorded. The question is repeated: which is more likely for the *very next ball?* That should be sufficient to hammer home the point, but an additional repeat may be necessary.

The rest of the fifteen balls are then pulled from the bag, and predictions assessed. A discussion follows, introducing the *representativeness heuristic* as a plausible culprit for why most students did not make the mental leap to the statistically optimal prediction.

Next, students are presented with the following version of Tversky and Kahneman's *Alice* problem (conjunction fallacy):

> *Marcus is a ninth grader and the middle of three siblings, with an older sister (17) and a younger brother (12). His father is an environmental engineer and his mother is a defense attorney, and their house is in a wealthy part of town. Marcus is generally quiet and shy, with only a few friends, though they are very close. He has maintained straight A's in school since kindergarten, and his favorite elective is Technology.*
>
> *Based on the description above, please rank the following predictions about Marcus's extracurricular activities from most likely to least likely:*
>
> - *Marcus is a volunteer at Big Brothers Big Sisters, working with disadvantaged youth*
> - *Marcus is a part-time employee at Subway*
> - *Marcus is a kicker for his high school football team*
> - *Marcus is an avid video gamer and a part-time employee at Subway*
> - *Marcus is an actor in a local youth theater troupe*
> - *Marcus is a Science Olympiad and a kicker for his high school football team*
> - *Marcus is working with an after-school tutor to improve his Spanish*

In reviewing student responses, teachers touch briefly on the *conjunction fallacy*, but only to the degree necessary to demonstrate that representativeness has caused a logical error.

Finally, students are presented with the following description:

> *Alia is a skilled and competitive tennis player. She won four out of the last five championships she competed in, with the following scores in her final matches:*
>
> *2-0 (against Liz)*
> *2-1 (against Heather)*
> *2-1 (against Yuki)*
> *1-2 (against Heather)*
> *2-0 (against Yuki)*
>
> *Her next match is against Heather. Please rank the following outcomes from most likely to least likely:*
>
> - *Alia will win the match*
> - *Alia will lose the first set*
> - *Alia will lose the first set but win the match*
> - *Alia will win the first set but lose the match*

With any luck, by this point students will identify the risk of falling into a representativeness trap, and correctly rank Alia [winning the match] over the more specific [losing the first set but winning the match]. A final debrief follows.

Goals:

- Continue to emphasize the myriad ways in which humans are vulnerable to mistakes
- Establish the general concept of a *heuristic* as a decision-making shortcut, and a *bias* as a persistent, reproducible error in judgment as a result of a flaw in System 1 or System 2
- Introduce *representativeness* as a System 1 heuristic of value, but with known bugs

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)

Materials:

- Bag of golfballs (96 orange, 41 green)
- Scratchpost and devices that can access it (laptops or phones)
- Projector

Timeline:

- 0:00 - 0:07 Initial drawing of golf balls; prediction and confidence recording
- 0:07 - 0:15 House bet, secondary drawing of golf balls, discussion of statistics
- 0:15 - 0:25 Introduction of the *representativeness heuristic*
- 0:25 - 0:40 Alice problem, representativeness cont'd (social judgments)
- 0:40 - 0:55 Zebras before horses, Bayesian reasoning

Instruction and Differentiation:

No special considerations

Hints and Cheats:

N/A

Side Quest Tie-Ins:

- Students who predict OOOOO OOOOO OOOOO will receive an Oracle key useful in a later mission or side quest (TBD)

Discussion and Debrief:

- Teachers take care to underline, in the conclusion of the golf ball debrief, that while the act of making a bet forces a *commitment to predicting orange,* the true answer is that "There is a 70% chance that the next ball will be orange, and a 30% chance that it will be green," and there is nothing further to be said.

IDAMOS Day 2

Fear is the Mind-Killer

Description:

Students change shoes/clothes if necessary, and assemble in lines. The teacher gives a brief reminder of the rules and concepts covered the day before, and leads the group in some basic warmup exercises, including rolling practice. Following these, the students then engage in the following parkour activities:

- Strides (static-one-land and static-one-two-land)
- Step vaults and speed vaults (over ~30” obstacle)
- Tic tacs (45° angle to precision)
- Arm jumps (from a ~30” height to a ~5’ height at a distance of ~6’)
- Rail dismounts/safe bails (from a ~30” rail)
- Cranes/one foot landings (at a ~30” height)
- Rail precisions (specifically set so as to be scary, but doable)
- Running jumps (specifically set so as to be scary, but doable)

Goals:

- Provide an outlet for pent-up energy
- Highlight the visceral difference between System 2 confidence and System 1 confidence, and introduce the idea that System 1 treats negative and positive evidence differently (e.g. a single mistake—even by someone else!—can create a long-lasting fear, while a string of successes can still fail to produce confidence)
- Continue the process of building physical confidence and competence

Materials:

Note: this list is changeable depending on timing/funding. Equipment is nice, but parkour can be done outdoors at no cost.

- Two Twix
- Two Turtles
- Two Goldiboxen
- Porto-wall
- Two porto-rails

Timeline:

- 0:00 - 0:20 Intro & warmup + rolls
- 0:20 - 0:45 Stations (strides, step vault, tic tac, arm jump)
- 0:45 - 1:00 Game (Octopus) & break
- 1:00 - 1:10 Stations (safety/prep)
- 1:10 - 1:30 Stations (fear) and debrief

Interlude

The Map, the Territory, and the Stars Above

As on day one, the period after the parkour session is the perfect time for a snack, a quick recap, and a self-contained mini-lesson.

- What we've done today
    - Faced confusion (hot plate)
    - Faced coordination problems (floating pipe)
    - Learned about System 1 and System 2
    - Learned about representativeness, and the concept of heuristics and biases
    - Faced our fears (or listened to them!) in parkour
- What did we do yesterday?
- What are some takeaways or rules about clear thinking so far?
    - Rule #1: "I could be wrong."
    - Rule #2: "So could you."
    - Rule #3: "The critical step in correcting an error is noticing it in the first place."
    - Rule #4: "Just because it's simple doesn't mean it's easy; just because it's hard doesn't mean it's complex."

Lecture:

Okay. So, before we move on to the next challenge, I'd like to take a few minutes to back up and talk about the larger mission, here.

We've spent a lot of time over the past two days learning how to update our picture of reality—how to shrink the gap between what we believe and what's actually true. In large part, we've been talking about the relationship between the *map* and the *territory*. The world is a certain way, and the picture of it we have in our heads can be complete or incomplete, correct or incorrect, detailed or vague. Some parts of your map are almost totally trustworthy, like your ability to detect emotion in someone's facial expression, or your answer to questions like two plus two. Other parts of your map are a bit sketchier, or even totally empty—for instance, the interactions between quarks are terribly important in any deep understanding of reality, but I'd bet my shorts that none of you have a good model of those yet.

So let's be systematic for a moment (draws on board, or points to poster or projected image). We have a map, and we have a territory, and they don't line up perfectly. At this point, what things can happen?

(Student fumbling; likely answers include things like "You'll get lost" or "You'll make mistakes.")

Okay, true, but I'm more interested in what you *do* about it. Like, what's *next?*

(...)

Okay. So, the first and most common response is that you just don't even notice. This is what we've been trying to fix with all our practice in *noticing confusion.* There are millions of people out there who don't even pay attention to conflicting information. They just brush right on past without ever realizing that there's something wrong with their model of the world. I'm going to call this *sleepwalking.*

We all agree that this is bad, right? Okay, good—just checking. Don't forget—*you and I do this too, all the time, which is why we've got to keep practicing.*

The second kind of response, which is also depressingly common, is a shrug. There's a certain sort of person who just doesn't care that their model is wrong. They either figure it would be too difficult to find out the truth, or they don't think there *is* a truth to be discovered, or they don't think that the truth is particularly important or relevant—there are lots of reasons that people have, and all of them make me sad. This is also the category where you get things like Holocaust deniers and anti-evolution creationists—people who ignore overwhelming evidence because they've got too much invested in their map. They don't *want* to admit that it's wrong, because for one reason or another, that would *hurt.*

Just another check—also bad, right? Anybody disagree? ...good. Notice that here I'm using social pressure and conformity to make sure that you all stay in line. If anybody secretly thinks that I'm wrong, now would be a good time to be brave and use your anti-conformity training to speak up. ...no? Okay. I don't have a good name for that second category yet, so I'm just going to call it *la la la not listening.*

There's a third category which we call *rationality*. It's summed up by the Litanies of Tarski and Gendlin, which we've touched on briefly already—*if the sky is blue, I wish to believe that the sky is blue. If the sky is not blue, I wish to believe that the sky is not blue. If my beliefs are false, I wish to stop believing them. Even if the truth is painful—what is true is already so, and owning up to it doesn't make it worse, and refusing to believe it doesn't make it go away.* Basically, a person who calls herself a rationalist is on the lookout for mismatches between the map and the territory, and makes a deliberate effort to keep the map up-to-date with the latest information. This is the home of true science, where Newton's theories went right out the window as soon as Einstein's proved more accurate.

All of *you* are here because you want to be rationalists, or because your parents want you to, or because you wandered in here by mistake and have been too embarrassed to say anything.

But there's one more possible response to a mismatch between map and territory. Do any of you see it?

(...)

So, we've got *don't notice it*, *notice it but don't do anything,* and *change the map to match the territory.* What else is—yes, exactly. *Change the territory to match the map.*

This is *applied* science. This is medicine. This is literature, and architecture, and philanthropy, and humanitarian aid. This is invention, and progress, and creativity. It's Galileo and Columbus and Jackson Pollock and Bill Gates and Neil Armstrong and Martin Luther King, Jr.

It's also war, and destruction, and genocide. Hitler and Al Qaeda and the Westboro Baptist Church.

This is the realm of the word *should.* This is where we believe in our map so strongly that we'd rather remake the world than settle for mere reality. Where we're willing to dedicate our whole lives to a cause, because that's the way the world *ought* to look. These are the people who eradicated smallpox, which used to kill four million people a year *every year*. These are the people who took us to the moon. These are the people who decided that slavery shouldn't be a thing, and who are currently fighting for clean energy and marriage equality and two hundred year lifespans and missions to Mars.

I'm going to call this category *heroic responsibility.* That's a pretty grand title, but it fits. Because you don't reshape the world by being ordinary. You don't make it into the history books by trying a *little.* Most people, they hear that heart disease is responsible for over 25% of all deaths, and they *don't* become cardiovascular researchers. Most people, they hear that we might have colonies on Mars in the next couple of decades, and they say *Oh, great, I'm glad other people are working on that,* and they go on about their business. It takes an unusual sort of person to step up and *actually make things happen.* You have to feel *responsible*, have to look at the world and realize that *your individual efforts can actually make a difference.*

That's what I'm really after, here. If all I manage to do is turn you into rationalists, then I've basically failed, because the world doesn't need more smart people who sit in their living rooms. It needs more smart people who aren't willing to leave it up to chance. Who aren't going to wait for someone else to solve the problems.

In 1956, basically nobody in America cared about space. In 1957, Russia launched Sputnik, and suddenly we decided to care. Suddenly, millions of middle schoolers and high schoolers had teachers and parents telling them, *listen, kid, it's time for you to start studying math and science, because ten years from now, we need you.* And sure enough, a few years later, those middle and high schoolers graduated, and went to work for Boeing and NASA and Lockheed Martin and a hundred other pieces of this giant industrial machine, and in 1969 we were on the moon. Thirteen years, and a lot of smart people who actually gave a crap—those were the ingredients.

Today, we don't have a space race. We don't have a cold war. We don't have one big, unified message that we're sending to all our promising middle and high school students. I bet most of you have asked your parents what they think you should do when you grow up. And I bet most of them have said something like "Anything you want, sweetie. You can do anything you put your mind to."

I've got a slightly different answer to that question. Because yes, it's true, you *can* do anything you put your mind to. But I'd rather you *not* spend that potential on building iPhone games or trading stocks or running a local business. I'd even rather you not spend it on firefighting or cancer

research or volunteering in Africa, because we've already *got* plenty of people who are heroic on everyday scales.

What we don't have is enough people working on the truly important problems. The ones that are going to make or break this century, that may very well make or break humanity. The ones where changing the territory to match the map means leveling mountains and reshaping oceans. *That's* where we need heroes. And that's why I'm here, in a classroom with a bunch of teenagers—because if I can get just *two* of you to show up, ten years from now, once you've finished leveling up, then I've already made more of a difference than I would have by just showing up myself. You guys *matter*—you guys are *needed.* You're the difference between a future that's written by sleepwalkers, and a future that's written by heroes.

Unless, of course, you decide you aren't. Either way, though, honing your mental tools is probably a good idea. So let's get back to work, shall we?

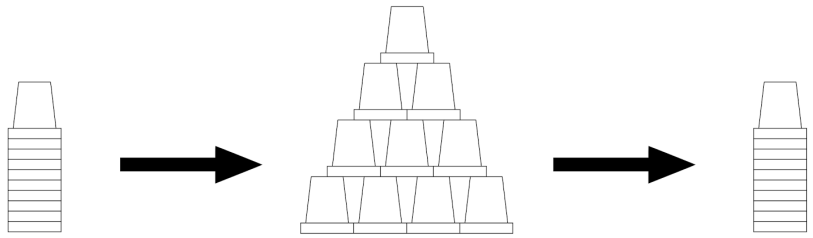
Invisibility Cloaks

The Dunning-Kruger Effect

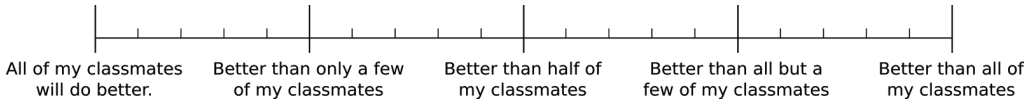
Description:

Students open their dropboxes to find and complete self-estimates in five categories (dexterity, word manipulation, number manipulation, spatial thinking, and geographic knowledge), with confidences attached. They then proceed to rotate through five stations where those skills are tested. A discussion follows in which the results are analyzed and explained.

1. Using ten cups provided by your teacher, you will be asked to build a pyramid or tower like the one shown below, and then unbuild it, as quickly as possible. You will be timed as you complete this task three times, and your average will be recorded as your score for the activity (with lower scores being better, like in golf).



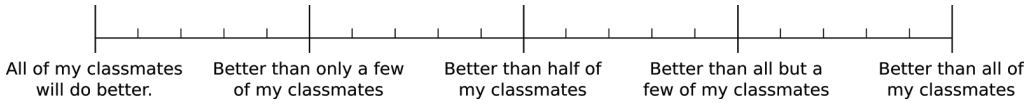
Relative to your classmates, how do you predict you will perform at this task?



2. You will be given a four-letter word, and asked to transform it into a different four-letter word by changing one letter at a time, as in the example below. Each time you change a letter, you must be left with a real word. Your total time in seconds will be multiplied by the total number of transformations to give you your score for the activity (with lower scores being better, like in golf).

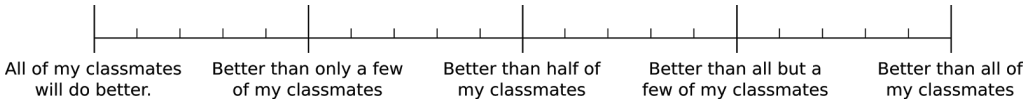
   *Example: from **TEAR**, get to the word **LIES** as quickly as you can.*
   TEAR → HEAR → HEAD → HEED → DEED → DIED → LIED → LIES

Relative to your classmates, how do you predict you will perform at this task?

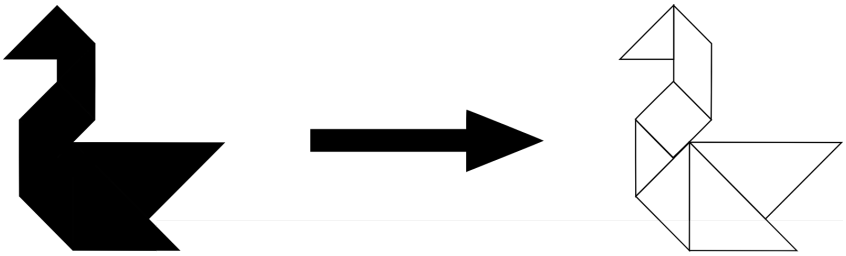


3. You will be given a set of two-digit multiplication problems to solve. Your score for the activity will be calculated by taking the number of correct answers and dividing it by the amount of time it took you to finish (with higher scores being better, like in basketball).

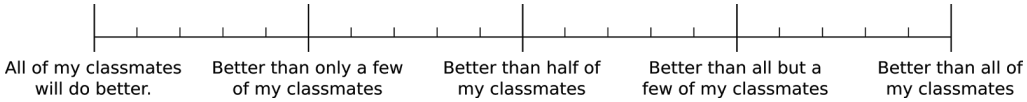
   Relative to your classmates, how do you predict you will perform at this task?



4. You will be provided with a set of silhouettes that can be formed using tangrams, as in the example below. Your job is to arrange the tangrams to form each of those shapes as quickly as possible. Your score for the activity will be the time it takes you to complete every silhouette (with lower scores being better, like in golf).

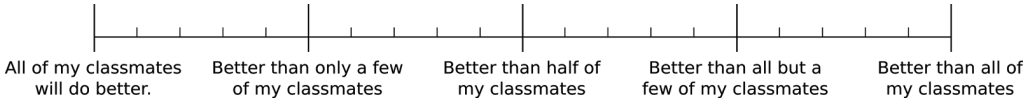


   Relative to your classmates, how do you predict you will perform at this task?



5. You will go to [http://www.sheppardsoftware.com/Europe/Eur_G2_1024_768.html] and complete the activity there, which is to click and drag various European countries into their proper places on a blank map of Europe. Your score for the activity will be your average error in miles multiplied by the time it takes you to complete the task (with lower scores being better, like in golf).

   Relative to your classmates, how do you predict you will perform at this task?



Goals:

- Introduce students to the *Dunning-Kruger effect*, or the systematic and predictable over- or under-evaluation of one's own competence, inversely proportional to it.
- Provide some fun and varied mental challenges to allow students to play to their various strengths.
- Continue to emphasize the human tendency to be more sure than is justified.

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)

Materials:

- Cup stacking cups (2 sets)
- Printed word transformation worksheet (20)
- Printed math worksheet (20)
- Tangram sheets and tangrams (4 sets)
- Computers with internet access (4)
- Timekeeping devices & timekeepers (other teachers or students assigned to that role)

Timeline:

- 0:00 - 0:05 Introductory discussion (invisibility cloaks), explain activity
- 0:05 - 0:10 Student predictions (with confidences attached)
- 0:10 - 0:50 Rotating through 5 stations (~6min/station +2min transition time)
- 0:50 - 1:00 Discuss results and debrief

Instruction and Differentiation:

No special considerations

Hints and Cheats:

N/A

Side Quest Tie-Ins:

- The starting and ending words for the word transformation problem are both Oracle keys, whose answers interrelate to provide useful information (TBD)

Discussion and Debrief:

- Underskilled overestimate; overskilled underestimate
- Transparency illusion (maze problems; hindsight bias)

The “Ratio” Part of Rationality

Bayes’ Theorem and Imperfect Evidence

Description:

A lecture with examples to serve as both a mathematical and an approximate/practical introduction to Bayesian updating.

Goals:

- Establish a basic understanding of the concept of imperfect evidence and incremental updating
- Provide students with a visual model that allows for accurate rederivation of Bayes’ Theorem without depending on memorization
- Lay groundwork for requiring students to explain/weight/justify evidence in later challenges

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)
- Generating simple tests (understanding scientific method)
- Making coherent arguments (and recognizing incoherent ones)

Materials:

- Problem sheet for moderately clever students (20)
- Problem sheet for significantly clever students (20)

Timeline:

- 0:00 - 0:05 Introduction (compliments from friends)
- 0:05 - 0:10 Problem domain (drug test, four everyday examples, cancer screen)
- 0:10 - 0:15 Five minutes by the clock for students to solve cancer screen
- 0:15 - 0:25 Math & slides (deriving Bayes)
- 0:25 - 0:40 Thinking through everyday examples
- 0:40 - 0:50 Carving up reality (gathering imperfect evidence)
- 0:50 - 1:00 Flex time/Q&A/break

Instruction and Differentiation:

Prediction: the most significant difference between students during this lecture will be the speed with which they come to deeply understand the connection between the mathematical logic and the general idea that evidence can be weak or strong (or can support two opposite conclusions at once). For that reason, the default “speed” of the lesson will be as-slow-and-painstaking-as-

possible, with the intention of supporting and catering to the students who are experiencing the greatest trouble with the concept.

Corollary: no matter how slowly and carefully explained, odds are there will be a student who needs it explained more slowly and more carefully. Overcorrection danger: rather than signalling "this will be hard" (which can encourage defeatism and lend narrative coherence to difficulties that would otherwise have failed to seem significant), a more appropriate signal is "this is a totally cool new way to see the world, that will allow you to be less wrong than the people around you; don't worry if it takes you a while to let go of the old way of thinking about things."

Differentiation, then, will exclusively take the form of "fast tracks." There are two mainline fast tracks, one of which will also lead into a side quest.

- **For $-\sigma <$ students $< +\sigma$:**
  - These students will be instructed to abandon the mainline lecture some time during the mathematical or graphical explanation
  - The worksheet provided is labeled "Pretty Sure I Got This," and contains straightforward calculations on the examples given at the start of the lecture, as well as a few others
- **For $+\sigma <$ students $< +n\sigma$:**
  - These students will be instructed to abandon the mainline lecture as soon as their answer of 7.8% is confirmed.
  - The worksheet provided is labeled "I Can Do This In My Sleep," and starts with a general derivation of P(A) from the given Bayes' Theorem (question for students: why do we not need to derive P(B) or P(B|A)?). It then continues through moderately more complicated problems working from the examples given. The answers to those problems will unlock a clue or other piece of information, sparking a side quest (TBD).

Hints and Cheats:

N/A

Side Quest Tie-Ins:

See above (tie-ins only for advanced students)

Discussion and Debrief:

[Slide 1] Your friend says that your hair looks good today. Does this qualify as evidence? What does System 1 say? What does System 2 say?

[Slide 2] Multiple possible universes: Good hair likely
[Slide 3] MPU: Good hair unlikely
[Slide 4] MPU: Compliments unlikely
[Slide 5] MPU: Compliments likely
[Slide 6] MPU: Completely insincere friend

[Slide 7] MPU: Completely trustworthy friend
[Slide 8] MPU: Implications of overlap

You're applying for an afterschool job at the pet store by the mall, and the manager is your best friend's dad, so you're pretty sure they're going to hire you. It pays ten dollars an hour, and you can work fifteen hours a week—that means you'll be able to save up over a thousand dollars before summer!

However, when you get home, you find out that, not only did you not get the job, but you've also been grounded, and you've also been pulled out of all your other afterschool activities. Apparently, you failed the routine drug test that was part of your application. It's 99% accurate, and you tested positive for cocaine, and you are in trouble.

"But I'm innocent!" you squeak. "Are you kidding me? Cocaine? There's only like four people in the whole school who mess around with that kind of stuff, and I don't hang around with any of them!" In fact, as they're dragging you upstairs, you overhear your friend's dad saying that one of them got expelled last year and is now in juvenile hall, which means there are really only three, out of all six hundred kids you go to school with. Three, not four, because you really are innocent.

But how on Earth are you going to prove it?

There are countless situations where we don't have perfect evidence. In fact, if you want to get technical, you *never* have perfect evidence, not even for things like two plus two. But most of the time, we can't even get close:

You're walking through the hallway at school when you spot the new kid going nuts, kicking and screaming at the vending machine. Is he insane, or just having a bad day?

Someone's been stealing the Pop Tarts out of your lunchbox. You don't want to make any accusations until you get a clearer picture—Greg's more likely to steal stuff, but Lauren really likes Pop Tarts, so you don't know what to think.

You're playing an online shooter, and there's only one enemy left, about 400 yards away. Most of the people who play this game can't hit you from that far, but a bullet pinged your helmet the last time you stuck your head out, and they could be sniper class.

One of the people on your team has been sending you some mixed messages, and you can't quite tell whether they're flirting with you or not. Your friend Brett says it's definitely a crush, but he also thought that Australia was in Europe, so his advice may or may not be worthless.

You could gather more information on all of these situations, but the evidence wouldn't be rigorous by scientific standards. There's no hard-line experiment you can do to find out whether someone

likes you likes you, after all. Maybe they were just being nice. Or maybe they wanted something from you. Or maybe they were showing off for Alexis, who's also on your team.

Situations like this show up in the adult world as well, often under circumstances where large sums of money or large numbers of lives are at stake. Consider the following classic problem:

> *Out of all the women who get screened for breast cancer at age 40, 1% actually have the disease. The routine test catches 80% of the women with cancer, and gives false positives for 9.6% of the women without cancer. Your friend's mother gets screened when she goes in for her yearly checkup, and the test comes back positive. Based off the routine test, what are the odds that she actually has breast cancer?*

This is the sort of question that comes up all the time in hospitals. The doctor who is treating your friend's mother has to make recommendations regarding further care. If those decisions are regularly too cautious, the hospital could end up losing millions of dollars each year to unnecessary tests and procedures. And if those decisions aren't cautious enough, patients with treatable diseases could die because no one paid enough attention to the warning signs.

So it's in everyone's best interests to have an actual, rational understanding of just how much we should trust the results of the initial test. What do *you* think the odds of her having breast cancer are? Take five minutes to jot down some calculations. If it takes you less time than that, go back up and see if you can do a similar calculation with your drug test results. (...)

Go ahead and register how confident you are in your answer, please. If you just made a gut estimation, register your confidence in that, too. (...)

How many of you got 7.8%? ...no, not seventy-eight percent, *seven point eight* percent. Yes, that's right, the odds that your friend's mom has breast cancer, based off this one test, aren't even one in twelve. If it makes you feel any better, over 70% of doctors get this question wrong, too, which is why we're teaching you about this example right now. If you want to be less wrong than the people around you, this is the type of problem you *need* to understand.

I'm going to go ahead and give you the math. Those of you who don't want to listen to the walk-through can race ahead; if you finish, register how confident you are and you're free to engage in side quests.

$$P(A|B) = P(B|A) * \frac{P(A)}{P(B)}$$

The probability of A given B equals the probability of B given A, times the probability of A, divided by the probability of B.

What this says in terms of the cancer problem is a little tricky, so I'm going to say it three times. We can calculate the odds that she has cancer *given that her test came back positive* by taking the odds that her test would come back positive *if she had cancer,* multiplying it by the odds of having cancer, period, and dividing it by the odds of getting a positive result, period.

Okay? So we're saying that A is "has cancer," and B is "got a positive result on the test." So the probability of A, has cancer, *given* B, got a positive result on the test, is equal to the probability of

B, getting a positive result, *given* A, actually having cancer, times the probability of having cancer, divided by the probability of getting a positive result.

One more time: the odds that someone who got a positive result *actually has cancer* are equal to the odds of *having* cancer *producing* a positive result, times the odds of having cancer at all, divided by the odds of getting a positive result, period.

Do NOT worry if that all went over your head. We've got three levels of explanation here … some of you maybe got it from just the equation, some of you maybe got it from what I just said, and the rest of you are going to get it from these pictures.

Basically, what we're doing is trying to figure out how new evidence changes the odds. Originally, we would have predicted about a 1% chance that our friend's mom had breast cancer. That's the number for the general population, remember? Let's pretend that this [Slide 9] is all of the forty year old women in the universe. That's ten thousand dots, in case you were wondering; a hundred on each side. Actually, let's make the dots lighter, so we can see our colors on top [Slide 10].

Okay, so … ten thousand women, and one percent of them have breast cancer. Say it with me, that's how many women? …correct, one hundred, as shown here. Yes, in pink. I saw an opportunity, and I took it [Slide 11].

Now, the next thing we want to look at is the probability of getting a positive result on the test, period, ignoring whether or not the woman actually has cancer. We actually have to do a little bit of math, since that probability wasn't directly stated in the problem. But we know that one hundred women have cancer, and eighty percent of those will get a positive result, so that's … what? …correct, eighty women. And we know that nine point six percent of the women who *don't* have cancer will get a positive, so that's .096 times … how many women don't have cancer, in this sample? Nine thousand nine hundred, so that leaves us nine fifty. Nine fifty plus eighty equals a grand total of one thousand and thirty women who will get a positive on their breast cancer screen [Slide 12].

Now we need to nudge our pink and green squares together, to represent the fact that there is overlap between the women who have breast cancer and the women who test positive. Figuring out the overlap isn't hard—we know that eighty percent of the women with cancer get a positive on the test, so we just push the squares together until eighty percent of the pink is overlapping with the green. Fortunately, since the pink is exactly one hundred women in this example, that makes the math easy—eighty dots will belong in the overlap [Slide 13].

Now we have everything we need to visually understand our original question. Given that a woman has received a positive test result (i.e. that she belongs in the green zone), what are the odds that she does, in fact, have breast cancer (i.e. also belongs in the pink zone)? In other words, what's the probability of pink *given* green?

To think of it another way, once we shrunk our universe down to *only* the women who'd received positives, we no longer have to think about all the rest of the people out there. We can, effectively, look at just the green, and compare the overall green section to the overlap [Slide 14].

The math doesn't always connect to the picture very well in my head, so it's okay if you only understood one half or the other for right now. But just to recap:

A represented women with breast cancer, so P(A) was 1% (in this case, one hundred out of the ten thousand total women).

B represented the total number of women who got a positive on their test screening, so P(B) was the nine hundred and fifty false positives (9.6% of the 9900 without cancer) and the eighty true positives (80% of the 100 with cancer), all divided by our total of ten thousand, for a final probability of 10.3%. In other words, a little more than one in ten women will get a positive result.

P(B|A) was the likelihood that you'd get a positive test result if you *did* have cancer, which they told us was 80%.

P(A|B) was the number we were looking for, the likelihood that you *have* cancer if your test result is positive, which you can visually see is around ten percent, but calculating it out gives us .01 times .8 divided by .103, or 7.8%, rounded.

P(A) = .01
P(B) = .103
P(B|A) = .8
$P(A|B) = P(B|A) * \frac{P(A)}{P(B)} = \frac{.8 * .01}{.103} = 0.0776699$

Wowsers! Okay, pencils down. Brains only, for the next few minutes.

Visualize the whole world of people in your drug test situation. What are the important numbers? Ninety nine percent of the positives are accurate. Ninety nine percent of the negatives are accurate. Three out of six hundred students are on cocaine. That's our initial data.

Imagine it graphically. First, imagine six hundred students, and try to envision just how small the three students who are actually on drugs are, relative to the total space. A test that's ninety nine percent accurate is probably going to catch all three of them, right? We'd be surprised if it missed one, and *shocked* if it missed two.

Now imagine the other five hundred ninety seven students. If they all took the test, too, about how many false positives would we expect to see? …right, six. So the *total* number of positives here would be around nine, right? And of those nine positives, we'd only expect *three* to actually be drug users, which means that the test is only right a *third* of the time that it comes out positive.

But wait. It's ninety-nine percent accurate—how can it be right only a third of the time? It's because of the relative weighting of the two populations. There are *so many people* who aren't using drugs that even a very very small percentage of them showing up as false positives outweighs the number of students *actually* on drugs. Just like the fact that there are so many women *without* breast cancer means that even a pretty low false-positive rate, just 9.6%, creates a

relatively large *actual population* with false positives. It's the translation from percentages to numbers that determines the magnitude of the effect.

This is a fact that a lot of people ignore, to the detriment of their decisionmaking. Let's say a patient shows up with mephitic ocular ryoma, which is at least twice as gross as it sounds. Let's say that mephitic ocular ryoma is the hallmark of a terrible terrible disease that affects one out of every ten thousand people and costs ten thousand dollars to treat … 90% of the people with that disease have this symptom. But let's *also* say that mephitic ocular ryoma happens to around one percent of people with the common cold, which afflicts fifty percent of the population.

See where I'm going with this? One percent of half the population is half a percent, .005. But even *ninety* percent of only *one ten thousandth* of the population is .00009. The actual scary disease is so rare that it's *fifty times more likely* that the patient with mephitic ocular ryoma just has a common cold with weird symptoms. But if the doctor doesn't do the numbers, if the doctor just goes with the *representativeness heuristic* and starts treating what *looks like* a terrible terrible disease without doing some further testing, bam—there goes ten thousand dollars.

If the math doesn't *quite* feel natural yet, that's fine—you can just memorize the formula, and plug things in, or draw the pictures and rederive it. What's more important here is the mental familiarity with updating. Let's go back through some of those other early examples, just using some rough common sense numbers.

The new kid is kicking the vending machine and yelling. *Before* you saw him kicking the vending machine and yelling, what odds would you put on him having anger issues—one in fifty? Okay, so two percent of people are crazy mad, or mad crazy, or whatever. Now, what percentage of the population just goes nuts once in a while, for *any* reason? Like, not thinking about whether it's because of anger issues or because they didn't get enough sleep or because they're stressed about a test—whatever. Twenty percent sound reasonable? So, if two percent of people have anger issues, and are mad like that, like, *all* of the time, then that explains about two out of the twenty total percentage points that we're allotting to vending machine temper tantrums. In other words, it's about nine times more likely that the new kid is just having a rough time adjusting.

Pop Tarts—Greg, or Lauren? Which is more likely—the probability that Greg the thief stole your Pop Tarts, or that Lauren the Pop Tart lover temporarily became a thief? It all depends on the relative strengths of Greg's thievery, the prevalence of Pop Tarts in the natural environment, and just how badly Lauren loves them, but you're more likely to hit the right answer if you actually assign numbers to each probability as independently as possible and then think systematically.

Online shooting game—one bullet pinging off your helmet could have been a coincidence, but let's think it through before you stick your head out again. We've got A, the likelihood that someone is a sniper, and B, the likelihood that a bullet fired from 400 yards away will hit you. Somebody who plays a lot of shooters, what percentage of players are good snipers? Okay, five percent. How about, out of every shot fired, how many of them hit a target 400 yards away? Okay, one out of a hundred. And if he *is* a good sniper, how often is he going to make a shot like that on his first try? It's okay, we can ballpark it. Okay, ten percent.

So we're trying to figure out the probability of him being a sniper *given* the fact that he pinged your helmet. Plugging it in, that means we need to multiply the probability of him pinging your helmet *if* he's a sniper (ten percent) times the probability of him being a sniper, period (five percent), divided by the odds of that shot happening at all (one in a hundred). .1 times .05, divided by .01 gives us .5, which is fifty-fifty odds that he's a sniper—a *big* jump up from the base rate of five percent. And yeah, we pulled those numbers out of our butts and they may be misleading, but just having gone through the brainstorming with System 2 gives us a better grip on the situation than we had back when all we had was System 1. A shot like that is *very* unlikely, and snipers are only *somewhat* rare, and the *vast* majority of the people who are going to pull that shot off are going to be snipers, so we should be extra careful before sticking our head out again.

And as for the flirter—well, we've got A, the probability that this person is into you, and B, the probability that *anybody* would act that way around you, whether they were flirting or not, and then we've got B *given* A, the probability that somebody who *is* into you would take those particular actions. Let's say there's a ten percent chance they're into you, and a forty percent chance that anybody talks to you that way, and finally let's say there's a ninety percent chance that someone with a crush on you would flirt like that. So we've got .9 times .1, divided by .4, and we're looking at almost a one in four chance that you're in luck. The evidence isn't exactly earth-shattering, but we've more than *doubled* your prior assessment of the odds, which is pretty significant if you ask me. And the next time you talk, you'll get *more* evidence, and you can slide the bar a little further, or bring it back a little bit, depending.

This is the heart of *rational updating*—this *is* the ratio in "rationality." There are three Big Ideas in play, here, and they're all important. The first is that *any* given observation has many different possible causes. You can't ever treat an observation as proof of one thing and only one thing—the universe isn't that cut-and-dried, and remember, *you could be wrong.*

The second big idea is that how we interpret any event, and the new information we get out of new observations, depends on information we *already* had. If we've seen that new kid kick and scream at the vending machine before, that can and *should* color our interpretation of seeing him lose it a second time. We don't start our observations over every time the sun rises; we interpret the sun rising *in the context of the fact that we've seen it rise every other day, too.*

Finally, the idea that it's actually worth attaching numbers to things, even if the numbers are completely made up. Remember when the test that was 99% accurate turned out to be wrong two out of three times? Or when the breast cancer test really only indicated an eight percent chance that someone has breast cancer? A lot of the time, the numbers are just a guide to help clarify your thinking, make sure you've accounted for all the important factors. But if you can get reasonably close with your starting estimates, then the numbers can show you truths you wouldn't have uncovered otherwise. System 1 is good for a lot of things, but when it comes to juggling numbers, System 2's where you want to be.

Day 3

Better today than we were yesterday, better tomorrow than we are today.

The theme for day three is self-improvement, especially iterative and intelligent modification of one's own behavior. In short, where days one and two were about becoming less wrong, day three is about becoming more right.

• UtH: 10 Kinds of People (clicker game)	9:00 - 10:00
• UtH: The Power of Chains (trigger action planning)	10:00 - 10:45
• Break	10:45 - 10:55
• UtH: The Narrative of Victory (framing and prehindsight)	10:55 - 11:45
• Lunch + video	11:45 - 12:15
• CC: Keep the Change (the coin problem and Bayes revisited)	12:15 - 1:05
• IDAMOS: Parkour Vision (seeing paths and opportunities)	1:05 - 2:35
• MI: Plants vs. Zombies (iterative algorithms)	2:35 -

10 Kinds of People

Operant Conditioning and the Clicker Game

Description:

Students enter the classroom to find the word CLICK written in two-foot-high letters on the board, and the clock counting down from one hour. The teachers say nothing, and wait for everyone to sit, at which point they begin an unannounced clicker game:

There is a behavior which the leader of the group wishes to see (such as standing on one foot, singing, dancing, acting out a scene from a movie, or saying a particular string of words in a particular order). Beginning with whatever behaviors are already extant, they reinforce whichever behaviors *most closely resemble* the desired behavior with positive feedback—in this case, a click. As the reinforced behaviors spread and become universal, the clicking slows or stops, forcing the group to begin experimenting again and allowing a genetic shaping process to take place.

For the introduction, the goal is to shape the students into a circle, all holding hands. Once this goal is achieved, approximated, or discarded due to time constraints, the general concept of the clicker game is explained, and all of the students are given clickers. One or two students are sent out of the room while the next task is discussed, and the game begins when a task is selected and they are brought back in.

Goals:

- Introduce the concept of operant conditioning/shaping, and tie it to behavior change and self-improvement
- Force critical thinking on process—which behaviors should be shaped first, and which should be ignored?
- Establish strict protocol for use of the clicker—“tools, not toys”—to lay the groundwork for student use in later camp activities.

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Effectively recruiting and coordinating with others
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)
- Generating simple tests (understanding scientific method)
- Seeing or devising solutions (including unorthodox ones)

Materials:

- Clickers (20)

Timeline:

- 0:00 - 0:15 Teacher-led round

- 0:15 - 0:20 Explanation and planning for round 2
- 0:20 - 0:30 Round 2
- 0:30 - 0:35 Planning for round 3
- 0:35 - 0:45 Round 3
- 0:45 - 0:55 Round 4
- 0:55 - 1:00 Discussion & debrief

Instruction and Differentiation:

No special considerations

Hints and Cheats:

N/A

Side Quest Tie-Ins:

- The first shaped behavior contains clues or strategies for a future activity (TBD)

Discussion and Debrief:

- The power of small rewards and immediate feedback (hyperbolic discounting)
- Change behavior gradually, building on past successes, so that every step is successful
- If others can do it to you, you can do it to yourself

The Power of Chains

Trigger Action Plans

Description:

Students receive a lecture/introduction to the concept of trigger action planning, and then take part in a guided brainstorming activity to select and install new triggers.

Goals:

- Introduce the concept of triggers
- Model the process of inventing and installing a trigger
- Give students the skills required to invent and install their own triggers in the future

Student skills:

- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Seeing or devising solutions (including unorthodox ones)
- Making intelligent plans (and identifying bad ones)

Materials:

- Scratch paper

Timeline:

- 0:00 - 0:10 Introductory lecture (the Sphex)
- 0:10 - 0:15 Group brainstorming (trigger action pairs)
- 0:15 - 0:20 Modeling a trigger action plan
- 0:20 - 0:25 Think-pair-share (brainstorming a problem domain and possible triggers)
- 0:25 - 0:30 The importance of rehearsal
- 0:30 - 0:40 Triplet trigger action planning

Instruction and Differentiation:

No special considerations

Hints and Cheats:

N/A

Side Quest Tie-Ins:

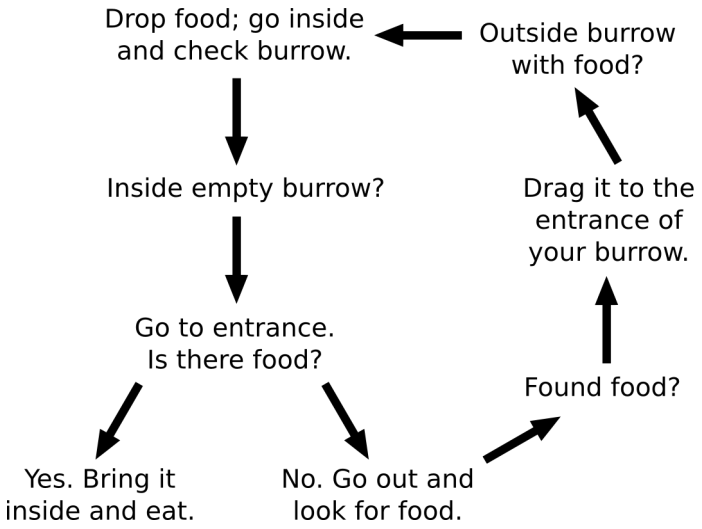
- During discussion, the whole class will install a trigger action pattern that will be a crucial part of a later mission (TBD)
- The word “Sphex” is an Oracle key that will trigger a side quest (TBD)

Discussion and Debrief:

There is a certain kind of wasp called a Sphex, which lives in tiny underground burrows. When a Sphex catches dinner (usually a cricket), it drags it back to the entrance of its burrow, leaves it outside while it checks inside for predators or other problems, then reemerges to bring it in and eat.

However, scientist Dean Wooldridge made an interesting discovery. If you drag the cricket a few inches away while the Sphex is inside checking the nest, the Sphex will *not* come outside and simply collect its dinner. Instead, it will pause, set out as if in search for food, find the cricket, drag it back to the entrance, and proceed inside alone to check the burrow again. This process will repeat itself no matter how many times the Sphex has already done its inspection.

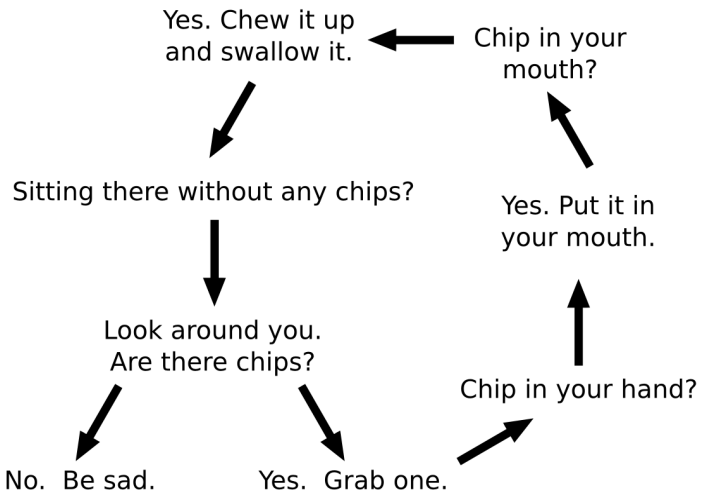
In other words, what appears to be a program along the lines of "go out and get dinner" is actually a series of much smaller programs, each of which is independent of the others. You could program the Sphex's behavior into a computer as a flowchart:



One of the weaknesses of computer programs is that if they are not carefully written, they can get caught in an "infinite loop," repeating the same steps over and over again, just like the Sphex whose dinner keeps getting moved. Basically, the Sphex has a series of triggers, and each trigger sets up one and only one next action. It can't "zoom out" to comprehend the larger picture … all it knows is what's right in front of it, and it only follows one instruction at a time.

Human beings *can* zoom out, and understand complex patterns. But unless we have a reason to, we generally don't. Remember, it takes effort and attention to turn on System 2. In situations that don't require that effort and attention, we rely on the autopilot of System 1, which behaves only a little smarter than a Sphex.

Think about the snack you just ate—were you *consciously trying* to eat it? Did the acts of picking up a chip, putting it in your mouth, chewing, and swallowing take anywhere near your full attention? For most of us, the answer is no, and when we look closer, we can usually break our automatic behaviors down into a series of triggers and actions, just like the Sphex.



We could even add a step like “Got chewed-up food in your mouth?” “Yes.” “Swallow it!” The important thing is to recognize that when we talk about triggers and their resulting actions, we’re not looking for things that require conscious thought and effort. We’re looking for things that *just happen*, like water flowing downhill. Places where that’s *just how the world works.* You hear a ping, and you check your phone. It’s automatic—you don’t do it, it does itself.

And as it turns out, a *huge* percentage of what we do every day falls into this category. Most of the time, System 2 stays asleep—we just act. And since System 1 isn’t stupid, our actions usually make sense, and move us toward our goals, and if we’re asked to justify or explain them, we can make up a pretty good story about what we were thinking and what we intended to do at the time.

But ever found yourself in trouble, and your parents or teachers are glaring at you, and saying *What were you THINKING,* and you kind of shift back and forth and mumble and don’t quite look them in the eyes because *you honestly weren’t thinking anything?* System 1 all the way—you were on autopilot, following your triggers, just doing what you do.

So let’s brainstorm some trigger action pairs. What are some triggers we all have, and what are some that only you have? I’ll give you an example of one of my own that I bet at least a few of you share. When I see *this* [presents picture of a Volkswagen Beetle], I pretty much immediately punch somebody. Like, it takes *more* effort *not* to punch somebody, because punching is my default, reflex response to spotting a Punch Bug.

[Remainder of the discussion is fluid, based on student feedback.]

Important points:

- Triggers are good for one-time reminders, noticing behaviors you want less of, and getting you started on behaviors you want more of
- Triggers should be short, simple, and extremely specific; ideally, *related* to the action
- Rehearsal (effort) up front is the key—you’re essentially paying now to avoid paying later

The Narrative of Victory

Storytelling your way to success

Description:

Students receive a general introduction to the effects of narrative on mood and wellness, as well as specific instruction in the Lobian trick, adopting and discarding labels, and prehindsight.

Goals:

- Convince students that narrative matters, and that they can exercise control over it
- Install specific triggers for affecting narrative
- Teach contingency planning based on prehindsight

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)
- Making intelligent plans (and identifying bad ones)

Materials:

Set of three side quests for students to tackle if they don't have one of their own (TBD)

Timeline:

- 0:00 - 0:10 Discuss priming (old age example, racial bias in testing, sports)
- 0:10 - 0:15 Lobian trick (questioning narrative relevance)
- 0:15 - 0:20 Where do narratives live? "You are who you practice being."
- 0:20 - 0:25 Installing and rehearsing triggers
- 0:25 - 0:30 Planning introduction (Magic: The Gathering)
- 0:30 - 0:35 Side quests and brainstorming
- 0:35 - 0:50 Guided prehindsight

Instruction and Differentiation:

No special considerations

Hints and Cheats:

N/A

Side Quest Tie-Ins:

See above (side quests explicitly included)

Discussion and Debrief:

- PRIMING
    - Test subjects reading words like “grey,” “wrinkle,” “Florida,” “forgetful,” or “bald” then walked significantly more slowly down hallways.
    - When subjects are told that a test has been carefully constructed to eliminate racial bias, allowing (e.g.) black students to do just as well as white students, racial bias *actually shrinks*, sometimes disappearing entirely
    - When subjects are told that a physical skill test (e.g. a golfing challenge) is a test of *sports intelligence*, white participants do significantly better than black ones. When subjects participating in the same challenge are instead told that it is a test of *natural athletic ability*, black participants do significantly better than white ones.
- Simple narrative examples
    - “Don’t be nervous, because girls don’t like guys who are underconfident.”
    - “You’ve got a 20% chance of success” vs. “You’ve got an 80% chance of failure.”
    - **Is this useful** rather than **is this true/false**
- System 1 narratives vs. System 2 narratives
    - A System 1 narrative is quick, automatic, and visceral—it *feels* true
    - A System 2 narrative is slow, deliberate, and verbal—it *sounds* true
    - S1 can influence S2 narratives! S2 can influence S1 narratives!
    - S2 narratives *become* S1 narratives (slowly) with repetition and evidence (S2 believes what it sees, and trusts negative more easily than positive)
- Triggers
- Planning fallacy/Murphy’s Law
    - Magic: The Gathering example
    - Students asked to predict when they would finish their projects
    - People tell themselves *good* stories (“Things didn’t go according to plan”)
- Students brainstorm a side quest, or select one from choices provided
- What could go wrong? vs. What went wrong?
- Lather, rinse, repeat

Keep the Change

The Coin Problems: Bayes Revisited

Description:

After a brief recap of takeaways from the previous day's lesson on Bayesian updating, students use a balance scale and a limited number of trials to determine which of various objects is unlike the rest in its group.

Goals:

- Continue to refine student understanding of how to integrate imperfect evidence
- Begin developing the skill of devising tests that will distinguish between possible realities

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)
- Generating simple tests (understanding scientific method)
- Seeing or devising solutions (including unorthodox ones)

Materials:

- Introductory lecture slides
- Balance scale
- Nine "coins," one of which weighs a subtly different amount
- Twelve "eggs," one of which weighs a subtly different amount and contains a prize

Timeline:

- 0:00 - 0:05 Bayes revisited: All Dark wizards are Slytherins
- 0:05 - 0:10 Bayes revisited: Evidence supporting two hypotheses (mom slams door)
- 0:10 - 0:20 Nine-coin problem with solution
- 0:20 - 0:50 Twelve-coin problem

Instruction and Differentiation:

No special considerations

Hints and Cheats:

- There are items on the Opportunity Cost table which can be formed into a balance scale, thereby reducing the need for the "official" scale (an "egg," a bar with two cups, and a triangular prism that can serve as a fulcrum).
- The eleven non-special "eggs" contain a magnetic material. There is a magnet attached to the "egg" out on the Opportunity Cost table.

Side Quest Tie-Ins:

- Notes hidden around the room again? As in the Arch? (TBD)
- The item inside the correct “egg” should be valuable in a mainline mission (TBD)

Discussion and Debrief:

- If the students do not deduce the correct solution, they may get it from the teacher iff they spend resources (questions, utilons) to get it

IDAMOS Day 3

Parkour Vision (flow, making plans, seeing opportunities)

Description:

Students change shoes/clothes if necessary, and assemble in lines. The teacher gives a brief recap of skills learned thus far, and then launches into warmup activities, this time introducing the concept of *physical conditioning.* Then the lesson proceeds, with a focus on flow and preplanning.

Goals:

- Provide an outlet for pent-up energy
- Reinforce the power of planning and practice
- Remind students about the concept of overestimation
- Continue the process of building physical confidence and competence

Materials:

Note: this list is changeable depending on timing/funding. Equipment is nice, but parkour can be done outdoors at no cost.

- Porto-wall
- Three Goldiboxen
- Six Twix

Timeline:

- 0:00 - 0:15 Intro & warmup
- 0:15 - 0:25 Conditioning (QM, wall pushups, overjumps)
- 0:25 - 0:35 Game (zombie tag)
- 0:35 - 0:55 Stations (gap jump and wall pass footwork)
- 0:55 - 1:15 Stations (drop rolls and vault series)
- 1:15 - 1:30 Free play

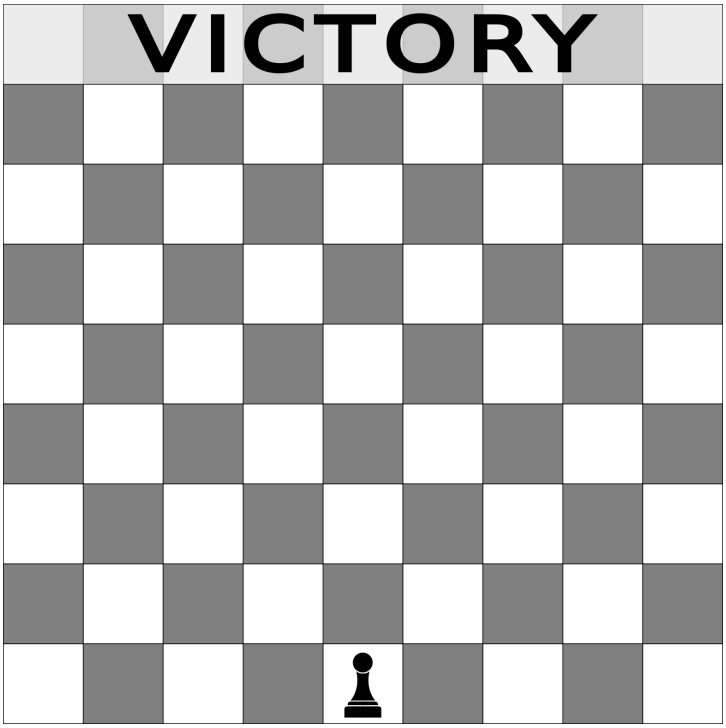
Plants vs. Zombies

Iterative Algorithms

Description:

Students are divided into two large groups (attackers and defenders), and from those large groups four battle pairings are made (3v3, 3v3, 2v2, and 2v2). Students practice in these pairings until it's time for the final challenge, at which point they self-assort into defenders (who have the prize, and stand to lose it) and attackers (who don't have the prize, but can potentially seize it).

Students play on a 9x9 grid. Attackers have a single pawn, and defenders have a number of walls (walls lie along the boundary between squares and prevent movement between them). The goal of the attackers is to reach the other side by giving the pawn instructions that will get it there, and the goal of the defenders is to prevent the attackers from reaching the other side by placing walls in such a way as to block the pawn. Defenders must, at all times, leave the attackers at least one clear pathway to the goal. A round consists of up to three minutes of planning, followed by whatever time is necessary to run the simulation.



Phase 1 (rounds 1 - 5)

During the first phase of the game, attackers have access to the following commands:

- Go straight until you hit a barrier or the edge of the board (hereafter LimUp)
- Go left until you hit a barrier or the edge of the board (hereafter LimLeft)
- Go right until you hit a barrier or the edge of the board (hereafter LimRight)

In the **first round**, attackers may give their pawn only one instruction, and defenders may place only one wall (assuming intelligent attackers and defenders, defenders should win this round).

In the **second and third rounds**, attackers may give their pawn two instructions, and defenders may place two walls (assuming intelligent attackers and defenders, odds are 50-50).

In the **fourth round**, attackers may give their pawn three instructions, and defenders may place three walls (AIA&D, defenders should win this round).

In the **fifth round**, attackers may give their pawn four instructions, and defenders may place four walls (defenders should win this round).

Phase 2 (rounds 6 - 10)

During the second phase of the game, attackers gain the following commands, in addition to LimUp, LimLeft, and LimRight:

- Go down until you hit a barrier or the edge of the board (LimDown)
- Go up one space (OneUp)
- Go left one space (OneLeft)
- Go right one space (OneRight)
- Go down one space (OneDown)

In the **sixth, seventh, and eighth rounds**, attackers again have four commands, and defenders may place four walls (defenders can get lucky, but attackers really should win these rounds more often than not)

In the **ninth round**, defenders may place up to six walls (attackers still have four commands).

In the **tenth round**, attackers may start in any space along the bottom row (they still have four commands, and defenders still have six walls).

Phase 3 (rounds 11 - 15)

During the third phase of the game, the pawn gains *directionality*. This affects the previous commands thusly:

- LimUp becomes LimForward, or LF: “continue in the direction you were previously moving until you hit a barrier or the edge of the board.”
- LimLeft keeps its name (LL), but becomes “reorient 90 degrees counterclockwise to your current vector, and continue in that direction until you hit a barrier or the edge of the board.” LimRight (LR) follows the same pattern.
- LimDown becomes LimBackward, or LB: “reorient 180 degrees to your current vector, and continue in that direction until you hit a barrier or the edge of the board.”
- OneUp becomes OneForward, or OF
- OneLeft and OneRight (OL and OR) follow the same pattern as LL and LR, but for one space at a time
- OneDown becomes OneBackward, or OB

Additionally, attackers gain the following commands:

- Move forward until impeded by a wall or the edge of the board, then reorient 90 degrees counterclockwise to your original vector and move forward until again impeded (ForwardThenLeft or FTL)
- Move forward until impeded by a wall or the edge of the board, then reorient 90 degrees clockwise to your original vector and move forward until again impeded (ForwardThenRight or FTR)
- Move forward until impeded by a wall or the edge of the board, then reorient 90 degrees counterclockwise to your original vector and return to your previous position (ForwardThenBack or FTB)

In the **eleventh round**, defenders have eight walls, and attackers may start on any space along the bottom row and have four commands.

In the **twelfth, thirteenth, fourteenth, and fifteenth rounds,** the previous round determines the changes to the starting situation:

- If the defenders *lost* the previous round, they get +2 walls in this round
- If the defenders *won* the previous round, the attackers get +1 command in this round
- If the previous round was a tie, nothing changes

Phase 4 (final challenge)

Students come together as a class, and briefly discuss what made various strategies successful or not. Then the following commands are added to the attackers' repertoire:

- Move forward until impeded by a wall or the edge of the board, then reorient 90 degrees counterclockwise to your original vector and move forward until again impeded, **or** until the barrier ends, in which case reorient back 90 degrees clockwise and move forward again until impeded (ZigZagLeft, or ZZL).
- Move forward until impeded by a wall or the edge of the board, then reorient 90 degrees clockwise to your original vector and move forward until again impeded, **or** until the barrier ends, in which case reorient back 90 degrees counterclockwise and move forward again until impeded (ZigZagRight, or ZZR).
- "Look" in all directions, and then move in the direction that allows you to go the furthest. Assign a default choice in the event of a tie:
    - Look, and then prefer north, east, south, and west, in that order (L↻)
    - Look, and then prefer north, west, south, and east, in that order (L↺)

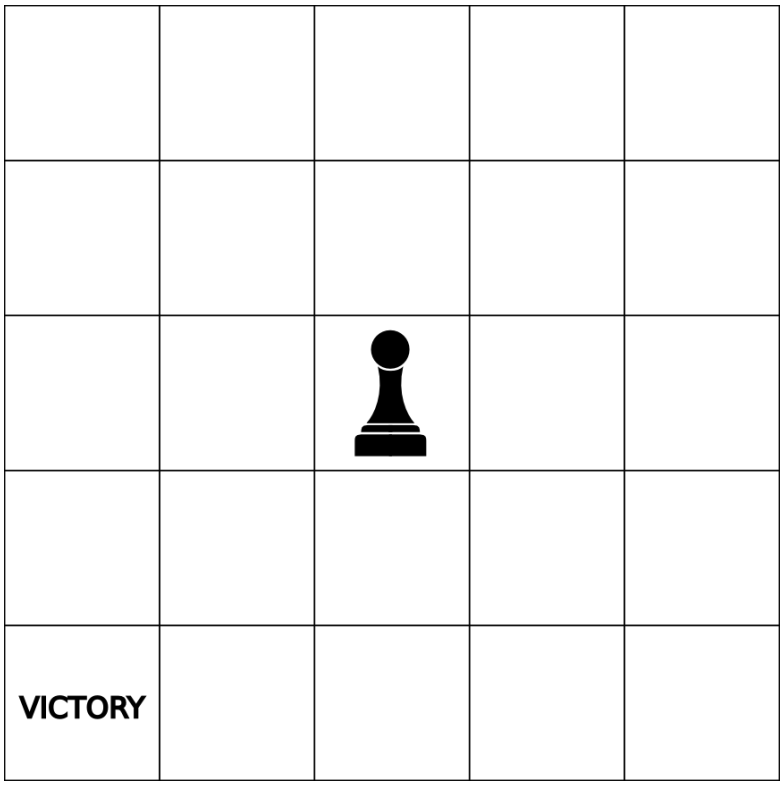
Students then

Complex Coordination

Achieving Victory in a Partially Mysterious World

Description:

Students are shown the following gameboard:



The pawn is in the starting position. To achieve victory, the class (working collectively) must make it to the VICTORY square in ten or fewer moves.

The class is divided into four groups. At the start of each round, the teachers draw the numbers 1, 2, 3, and 4 out of a bag in random order; each group has a "button" that it may choose to press (or not) during that round. So, for instance, if the order is 2, 3, 1, 4, then the members of group 3 must decide whether it would be good or bad for them to press their button after 2, but before 1 and 4. Once all four groups have made their decision, the combined effects of the buttons determine the movement of the pawn.

Students do not know what their buttons do; they may or may not decide to try figuring it out formally.

- Group 1: Pushing the 1 button causes the pawn to move ↑ one square.
- Group 2: Pushing the 2 button causes the pawn to move → one square.
- Group 3: Pushing the 3 button causes the next button's effects to be inverted (so 3 followed by 2 causes the pawn to move ← one square).
- Group 4: Pushing the 4 button causes the next button's effects to be cancelled.

A move consists of the numbers 1, 2, 3, and 4 being drawn out of a bag in random order, and then the actions associated with those numbers taking place (or not) in that order.

The class is divided into four groups. Each group controls a “button,” and for each move, that group votes on whether or not to press their button.

Goals:

Student skills:

- Calibrating confidence/acknowledging uncertainty
- Identifying questions and problems worth considering (subset: recognizing confusion)
- Effectively recruiting personal mental resources (i.e. understanding your toolkit)
- Effectively recruiting and coordinating with others
- Evaluating and integrating evidence (and discarding irrelevant/inaccurate information)
- Generating simple tests (understanding scientific method)
- Seeing or devising solutions (including unorthodox ones)
- Making defensible decisions (and rejecting unsound ones)
- Making intelligent plans (and identifying bad ones)
- Making coherent arguments (and recognizing incoherent ones)

Materials:

Timeline:

Instruction and Differentiation:

Hints and Cheats:

Side Quest Tie-Ins:

Discussion and Debrief:

Glossary:

clicker	An actual dog-training clicker, used to signal approval or to reinforce desired behavior. Initially, the clicker will be exclusively in the hands of the teacher, and a click will be closely followed by a compliment or tangible reward (utilons, or a clue for the next challenge). However, it will quickly turn into a tool for all students to use, starting with a "clicker game" in which clicks are used for operant conditioning, and progressing toward discussions and debates where a click becomes a fast, binary show of agreement or approval.
dropbox	A small, opaque box with a lid (like a pencil case or a cash box) placed at or near each student seat. Instructions, clues, rewards, and other objects can be placed in the box, to be removed on command at the appropriate time; it is also a place where students may store work for collection or leave private notes or comments for the teachers. *Not* fiddling with the contents of the dropbox prior to specific permission will be a high-priority norm, clearly explained and strictly enforced.
oracle	A simple website with a Google-esque interface. Students enter various hints, questions, and passcodes uncovered during camp activities, and receive new information in return. For example, entering 633087 (the correct answer from a day-one challenge) gives a student valuable information for decoding the cipher on day five.

centered on key-value pairs that will allow students to enter various hints, questions, and passcodes, and receive information in return.

Day 3

- RC: Hula Hoops

Day 4

- RC: Square Ropes

Day 5

- RC: Tarpsy Turvy

Day 6

- RC: Marshmallow Tower

Day 7

- RC: Holy Pipe

Day 8

- RC: Remote Control (silent crowd, brainless speaker, blind mover)

Day 9

- RC:

Day 10