Academics

An Introduction to Habits of Mind and Foundational Concepts

MINERVA®

The Minerva curriculum is designed to help our students become leaders, innovators, broad and adaptive thinkers, and global citizens. Our learning objectives are informed by the literatures on leadership and creativity, as well as on interviews and surveys of large employers in a variety of disciplines. These data have led us to define four types of core competencies the students should develop in order to become successful leaders, innovators, and broad, adaptive thinkers in a wide variety of disciplines. Two of these competences focus on types of personal abilities: *thinking critically* (evaluating claims, analyzing inferences, weighing decisions, and analyzing problems) and *thinking creatively* (facilitating discovery, solving problems, and creating products, processes and services). The other two of these competencies focus on types of interpersonal abilities: *communicating effectively* (using language effectively, using nonverbal communication effectively) and *interacting effectively* (negotiating, mediating, and persuading; working effectively with others; resolving ethical dilemmas, and having social consciousness).

In the early twentieth century, "Great Books Programs" were popular — but there are too many books and too many questions about how to select them, and such programs waned. Instead, we have adopted a "Great Cognitive Tools Program": We explicitly teach students the Habits of Mind (cognitive skills that come to be triggered automatically, with practice) and Foundational Concepts (fundamental knowledge that is broadly applicable) that foster each aspect of thinking critically, thinking creativity, communicating effectively and interacting effectively; we do not simply hope that such key skills and knowledge will be incidentally acquired as students learn other material.

The Habits of Mind and Foundational Concepts (HCs) are introduced during the first year, when all students take four, year-long Cornerstone seminars: Formal Analyses (which focuses on core aspects of thinking critically), Empirical Analyses (which focuses on core aspects of thinking creatively), Multimodal Communication (which focuses on core aspects of communicating effectively) and Complex Systems (which focuses on core aspects of interacting effectively). This material is then used (and assessed) during the subsequent three years while students major in specific subjects.

To be included in the curriculum, a Habit of Mind (H) or Foundational Concept (C) must:

1. be derived from an aspect of one of the four core competencies noted above;
2. lead students to be able to do something useful in ordinary life after graduation (specialized knowledge comes later in the curriculum);
3. be broadly applicable, as indicated by the fact that it is used in courses offered in at least two of Minerva's majors;
4. be justified either by empirical findings, proofs, or well-established best practices--particularly those that support functioning ethically in a global context; and
5. lead to specific behaviors that can be evaluated with rubrics; the HC cannot be so general or vague that it cannot be systematically and reliably evaluated.

What follows is one example of each major category of HC. There are more than 100 of these HCs, which are roughly equally distributed over the four core competencies. Each HC is the learning objective of a class session. In some cases, two or even three sessions are devoted to a single HC (based on how difficult it is), and in some cases we introduce two highly related HCs at the same time (e.g., those dealing with payoff matrices and game theory). The set of HCs is adjusted each year, based on our feedback from students, faculty, and employers.

Each HC is accompanied by a rubric, which indicates how the students will be graded on their use of that HC. The rubrics span a grade of "1" (indicating that the student did not understand the material) to "5" (indicating that the student understood it deeply and applied it in novel ways), with intermediate scores indicating intermediate levels of mastery. All class interactions and class assignments are graded using these rubrics.

All HCs are introduced during the first year, but graded during the subsequent three years. In fact, the grades at the end of the first year are provisional; they are adjusted up or down each semester, depending on how well the student used the material in subsequent classes.

After each paragraph that describes the H or C is an example of how that skill or knowledge can be applied in life after college. We also indicate in which course it is introduced:

CS = Introduced in Complex Systems

EA = Introduced in Empirical Analyses

FA = Introduced in Formal Analyses

MC = Introduced in Multimodal Communications

I. Thinking Critically

A. Evaluating Claims

One aspect of critical thinking focuses on evaluating claims, which requires identifying them and their components. In order to do this, one must rely on the ability to check whether conclusions are plausible and must use principles of information literacy. In addition, one often must recognize whether claims are grounded in sound science and supported by probability and statistics.

#estimation FA

Use estimation techniques to determine whether quantitative claims are plausible. (H)
When considering quantitative claims, it is useful to conduct a plausibility check. This can be done quickly using approximations and round numbers, and by establishing limits (minimum and maximum values that the number could reasonably be expected to take).

Application example: A politician claims that undocumented workers account for over half of the murders in your city. You check, and 34% of murder victims and 49% of murderers are under 25 years old. In your city, most undocumented workers are over 35 years old, and thus the claim seems implausible.

B. Analyzing Inferences

Inference is the rational creation of new knowledge from old. It is broadly applied. One must be aware that even if a claim is correct, inferences made from it may not be. Formal logic provides a method for determining which inferences are valid and which are not. Inductive reasoning is about generalizations made from specific cases. Because many inferences are based on human observation, one must be aware of specific biases in human attention, perception and memory. And when drawing inferences about expressive works, such as works of art, one must appreciate the historical and cultural context of the work, its internal organization, and how individual experience shapes our interpretation of it.

#induction FA

Formulate multiple plausible generalizations from available evidence, and consider how to use deduction to distinguish among the generalizations. (C)
Induction involves using evidence to support a conclusion, going from a set of instances or examples to a generalization about them. Importantly, strong inductive arguments do not guarantee the truth of the conclusion. Inductive reasoning is always biased in various ways. Applying inductive reasoning requires (1) being aware of the biases, and (2) considering the inducted generalizations to be only tentative conclusions, which must then be evaluated in their own right.

Application example: You notice that the stock prices for four software companies have increased. Based on these observations, you can induce numerous possible generalizations, such as: a) the value of all stocks has increased; b) the value of software stocks per se has increased; c) the local currency has lost value; d) all of these companies invested in a common asset that gained value; and so on. You now consider deductions to discriminate among the alternatives. For example, if it's "a" and not "b" you should find comparable rises in other types of stocks.

C. Weighing Decisions

Evaluating claims and analyzing inferences are important in part because they help us decide how to act. To make decisions rationally, one must analyze the alternative choices and identify their respective trade-offs. Decision-support tools can help us with such analyses, identifying and mitigating undesirable biases.

#utility CS

Consider different types of future costs and benefits for all stakeholders. (H)

When making decisions, one must always consider trade-offs between future costs and benefits and must consider them from the different perspectives of all stakeholders. When making decisions that affect people (as virtually all decisions in the real world will do), such reasoning must occur at multiple levels of analysis, ranging from effects on the individual to effects on groups at different levels of scale. Sometimes, a decision that maximizes overall benefits will be very unpopular with a subgroup; one must learn to anticipate and mitigate the negative effects of such cases.

Application example: You are about to hold an annual meeting and are hosting it at the hotel you've used for the past six years. You have already printed the invitations and coordinated with the guests, speakers and nearby restaurants. A week before the date, you receive a letter from the hotel manager informing you that he has to charge you three times what he charged you the previous year. You consider the costs and benefits for each stakeholder of staying the course and holding the meeting at this hotel: For yourself, the costs are severe; you won't be able to cover your expenses. The benefits are that you are familiar with the venue and wouldn't have to redo all of the invitations and arrangements. For the attendees, the costs would be a larger registration fee while the benefits

are clarity in the arrangements and a familiar venue. For the hotel manager, the costs include losing you as a client and the benefits are increased revenue — which would be limited to this one upcoming meeting (you definitely won't meet there the following years). Presenting all of this to the hotel manager results in a useful negotiation, where he only increases the amount by 50%. (Based on a chapter from *How to Win Friends and Influence People* by Dale Carnegie.)

II. Thinking Creatively

A. Facilitating Discovery

There are no recipes or set of rules for how to make new discoveries. However, certain practices can set the stage, facilitating discovery. Among such practices are the ability to create well-formed hypotheses, predictions and interpretations of data. In addition, research methods can be used effectively to increase the likelihood of making a new discovery. Finally, one can facilitate discovery by considering systems at multiple levels of analysis and identifying the type of system being studied.

#modeltypes EA

Recognize how models can be used to explain a set of data and generate new predictions. (C)
Many kinds of models (ranging from conceptual to physical to mathematical to simulation) are used in science. A theory generally guides the construction of a model, indicating which aspects of a model are relevant. Models are used to explain data or to test a theory, often through visualization. One can vary the nature of inputs to a model and the specific constraints on its behavior and then observe how the model behaves (e.g., simulations can be run in specific circumstances and the results observed) —thereby deriving new predictions for how the phenomena in question should change when subjected to those inputs and constraints.

Application example: You've been getting a stomachache after eating at home. You notice that the sponge you use to wipe your dishes is always wet. You think about the germ

theory of disease and hypothesize that soap and hot water only kill some bacteria — leaving the survivors to have lots of offspring. If so, perhaps you are infecting yourself by wiping the dishes with that sponge. You think about how to model this, and realize that to model the situation you need to know how quickly bacteria breed, how susceptible they are to soap and hot water, how sensitive humans are to their effects, and various other factors; without knowing these details, you really aren't in a position to test your hypothesis.

B. Solving Problems

A problem occurs when there is an obstacle en route to a goal. When first encountering a problem (when no known solution is available), one must use creative thinking to solve it. Often such creative thinking relies on using specific heuristics (rules of thumb) and techniques. However, solving problems effectively requires one to be aware of biases and to mitigate their effects when they interfere with reaching a good solution.

#constraints EA

Identify and apply constraint satisfaction as a way to solve problems. (C)

A problem exists when one or more obstacles to a goal must be addressed. Obstacles often cannot be overcome easily, in large part because there are constraints on what sorts of actions are possible or realistic. Constraints are requirements on the solution; they do not determine it, but do place boundaries on what is possible. Thus, part of solving a problem is to identify the constraints on what can be done. If the constraints are well-defined, problems often can be solved by devising ways to satisfy all of the constraints at the same time (this approach to problem solving is known as "constraint satisfaction").

Application example: You are moving into a new house and need to decide where to put the furniture in your bedroom. You have

an old sofa, which is missing a rear leg and sits on a telephone book — and so you don't want to put it in a location where it can be seen from behind (this is a constraint). You also have an old bed, with a headboard that must lean against the wall (another constraint). And you have two end tables, which must be set to either side of the headboard. And a large chair and reading lamp, which must be near each other. Once you pick a wall for the headboard, the positions of the other pieces of furniture may be determined; there is only one other place where the wall can accommodate the headboard and once it and the end tables are set up, there is only one other place large enough for the chair and lamp. The mere act of satisfying all of the constraints simultaneously almost dictates the solution to the problem!

C. Creating Products, Processes and Services

Various methods and techniques can help one to create new products, processes and services. Such methods and techniques include iterative design thinking, application of principles of perception and cognition, and reverse engineering.

#designthinking MC

Apply iterative design thinking to conceive and refine products or solutions. (H)

Great work rarely springs fully formed in a first draft. Thus, iteration, using design principles at every cycle, is typically required to produce a good product or the best solution to a problem. An iterative design process gives one's efforts greater reach and impact.

Application example: You've learned that design thinking involves first defining the problem, then thinking of possible solutions, prototyping the solutions, and testing the results — and then iterating until a satisfactory solution is achieved. With this process in mind, you design a poster to announce a concert.

You think about what will appeal to the audience and design a prototype. You show it to a few friends, who tell you that the poster looks too cluttered, so you simplify it. You then notice that the colors clash, so you change one of the background colors. Doing this makes the lettering fade into the background, so you then adjust the size of the font. The final result is much better than what you had initially.

III. Communicating Effectively

A. Using Language Effectively

Most communication occurs through language, both spoken and written; thus, it is crucial that one know how to use language effectively to communicate.

#composition MC

Communicate with a clear and precise style. (H)
Effective communication requires a clear and precise style that reflects the voice of the communicator and that is appropriate for the intended audience. Communicators should use the fewest words necessary (they should respect the principle of "parsimony") and should select words carefully to be as clear as possible. Avoid passive voice, stilted diction, elaborate structure, and imprecision; write and speak simply, directly, and sincerely. Understand when to use paraphrase, quotation, or summary to incorporate necessary information smoothly into your communication.

Application example: You are visiting your aunt at her new house in the countryside. She leaves a convoluted voicemail about how to find her property, in which she tells you to drive on one road for "a while," then turn "toward the property that just got sold," and take a right at the Millers' farm. You have no way to know which property was recently sold or where the Millers live. She then retracts some of her directions and suggests a detour around one road (you're not sure which) to avoid construction.

You realize en route that your cell phone's battery is dead. You try to follow her instructions as best you can, but quickly get lost. You wish her directions had been clear and precise.

B. Using Nonverbal Communication Effectively

Nonverbal communication often plays a crucial role in how well a verbal communication is received. These elements of communication not only convey connotations, but color the entire message.

#multimodaldesign MC

Apply principles of perception and cognition in design, including those for oral and multimedia presentations. (H)
A large body of research has documented many characteristics of human perception and cognition, resulting in a set of principles that captures how humans organize and interpret what they see and hear. Products, ranging from simple graphs to complex devices, from teapots to tactile surfaces, should be designed to respect these principles; products that violate these principles are difficult for humans to use. These principles can be used both to evaluate products and to guide creation of new ones.

Application example: You watch people leave the building where Minerva has its headquarters. More than half of them try to pull open the doors, but the doors are designed to be pushed open as you exit. You look carefully at the door handles, and see that they are identical to the ones on the outside of the doors — which clearly invite being pulled. You realize that the shape of the handles encourages people to pull on them, which is inappropriate for a door that should be pushed.

IV. Interacting Effectively

A. Negotiating, Mediating, and Persuading

Effective interactions with people require anticipating the effects of a particular message, registering the actual responses, and adjusting communications accordingly. Such dynamic interactions lie at the heart of negotiating, mediating, and persuading.

#negotiate CS

Use a structured approach to negotiation to reach desired objectives. (H)

Effective negotiation involves give and take between stakeholders to reach mutually beneficial agreements. Negotiating successfully requires a structured approach, which includes clearly identifying interests, agreeing on a process, and being prepared to sacrifice some objectives to achieve others. Negotiators must prioritize objectives but remain flexible and open to compromise. Approaching negotiation as a structured process raises the likelihood of a successful resolution.

Application example: Your company has assigned you to negotiate the construction of a new factory in Asia. You can't get anywhere if the city you are negotiating with doesn't give you tax benefits. So, that's your first priority. When that is settled, you go over the details. The city officials don't agree to subcontract the cement work to the offshore contractor you prefer and they disagree on your choice of heavy machinery supplier. You are willing to concede the offshore contractor because the company they prefer has comparable pricing and

quality, but you know that only this specific machinery supplier has exactly what you need. By first making a concession about the cement work, they are more willing to take your offer and resolve the "small" detail of the equipment supplier.

B. Working Effectively With Others

Each of us plays many roles when interacting with others, sometimes acting as a leader and sometimes acting as a follower or team member. Specific behaviors and practices can facilitate such interactions.

#differences CS

Recognize and leverage people's different skills, abilities, traits, attitudes and beliefs. (H)
People differ in their skills and abilities as well as their traits, attitudes and beliefs—all of which affect how they interact with other people and their contributions to cooperative projects. Effective interactions rely on assessing such information about other people and framing interactions with them in a way that is compatible with their characteristics. In addition, although groups do benefit from having members with diverse viewpoints and backgrounds, it also is important to recognize the need for shared perspectives and values within groups.

Application example: You are trying to motivate two members of your team, Robert and Larry. Robert cares a lot about what other people think of him, and so you point out that everybody else on the team–and in the organization as a whole–will be grateful for his efforts. Larry, in contrast, doesn't care much about what other people think of him, but cares a lot about "making a difference" in the world--and so when you talk to him you focus on that.

C. Resolving Ethical Problems and Having Social Consciousness

The way one resolves ethical problems has a direct effect on how one interacts with others. One factor that should contribute to such thinking hinges on having social consciousness, which is a concern for others and the common good.

#ethicalframing CS

Identify ethical problems, framing them in a way that will help to resolve them. (C)

Ethical problems occur when an action or outcome conflicts, or has the potential to conflict, with ethical principles. In order to avoid or resolve such problems, it is necessary to consider different ways of framing the situation on the basis of the relevant ethical principles. Ethical theories provide a useful approach to framing ethical problems by providing coherent sets of principles to apply systematically, and to compare to alternative approaches.

Application example: Your organization needs to hire more people, and you aren't getting enough applicants. You decide to give a bonus to all employees who bring in someone for an interview. An employee complains that this is a set-up, inducing people to behave unethically: People will be biased to bring in their friends, even if they don't think the job is right for them. You acknowledge that this is an issue, and revise the policy: Employees will get a bonus only if the people they bring in are hired and stay more than 3 months. You also explain that you trust your employees to uphold their own ethics, as well as the company's.

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