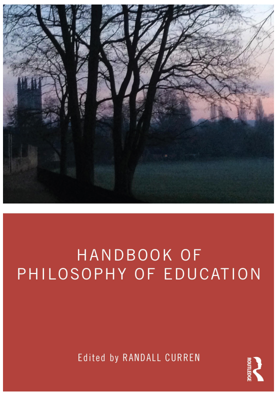

Handbook of Philosophy of Education

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Understanding as an Educational Objective

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UNDERSTANDING AS AN EDUCATIONAL OBJECTIVE

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Explain, describe, illustrate, show your work – such instructions frame homework assignments, problem sets, term paper instructions, exams. Students are expected to display their grasp of the topics the assignments concern. To succeed, it is typically not enough for students to parrot back the information they have been given or routinely apply rules they have been taught. They are supposed to draw on what they've been taught and demonstrate that they can do something academically appropriate with it. If such demands are properly keyed to the courses of study – if, that is, they actually provide insight into what students have learned – they afford evidence that objectual understanding – that is, understanding of a topic or subject matter – is a fundamental educational goal. Educators organize programs, courses, lesson plans, and individual assignments with the goal of enhancing the understanding of the subjects they teach. Then they assess student work by judging the extent to which it manifests enhanced understanding. The aim of achieving and leveraging understanding frames the delineation of disciplines as well as curricular and pedagogical decisions about how and what to teach, how and what to assess. My aim in this paper is to explain and justify education's emphasis on enhancing understanding.

Following Kvanvig (2003), let us distinguish between propositional understanding and objectual understanding. The difference is captured in the grammar of attributions. If a sentence has the form, "*S* understands that *p*" or "*S* understands why *p,*" the understanding in question is propositional. It pertains to a particular matter of fact that can be expressed in a proposition. If the direct object is a noun denoting a topic, a subject matter, or a body of information – "*S* understands φ" – the understanding is objectual. In what follows, I will use the term "understanding" without a modifier to refer to objectual understanding. My thesis is that a major goal of education is and should be increasing and deepening objectual understanding. The scope of such understanding can be narrow or wide – understanding chemistry or covalent bonds, basketball or the Lakers' defensive strategy, the French Revolution or the storming of the Bastille. The topic may be a priori or a posteriori, normative or descriptive, factual or fictional. One might understand the extinction of the dinosaurs, the obligations of citizens, the importance of Cantor's theorem, the dangers en route to Mordor. Regardless of these differences, such understanding is holistic. It concerns systematic links across a range of phenomena, not a discrete, isolated matter of fact. Although it typically embeds some understandings-why and understandings-that, the objectual understanding of a topic is not exhausted by or reducible to propositional understanding.

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Understanding a Topic

From the earliest grades, students study history, a discipline that seems thoroughly grounded in facts. We might suppose that the goal is for them to come to know important historical facts – for example, when the Battle of Hastings took place or who invented the steam engine. Standard instructional practice belies this. History teachers are not satisfied with the performance of students who merely know what happened. To see why they are not, it pays to follow Morton White and distinguish between a chronicle and a historical narrative (White 1965). A chronicle is a record of facts about the past; a historical narrative establishes connections among them. The distinction is conceptual, not chronological. Although a chronicle provides data for a historical narrative, we should not imagine that its chronicle is complete before a history is written. A chronicle and the associated history each influence the development of the other. As a history emerges, a historian realizes that the chronicle needs additional facts. Still, the distinction is epistemologically useful in that it enables us to isolate different elements in our understanding of the past.

A chronicle is just a list of facts. It makes no connections. The position of an entry on the list is arbitrary. No order is even implicit. So, for example, a chronicle of facts about Julius Caesar available to fifth-graders might include:

Died: 44 BCE
Roman general
Born: 100 BCE
Killed on the Ides of March
Kidnapped by pirates
First Roman emperor
Crossed the Rubicon
Fought in the Gallic Wars
Married three times
Marched with his army on Rome.

If the instructional objective were simply that the students know these facts, the teacher could just require them to memorize the chronicle. Successful students could then reel off the facts by rote. But the history teacher's objective is different. She wants the students to begin to understand Caesar's rise and fall, the ways it related to earlier events and set the stage for later ones, the ways it impacted the history of the Roman Empire and of the West. That requires a history, not just a chronicle. The students should learn to appreciate how the facts listed in the chronicle relate to one another as well as to further matters that do not appear on the list.

A history organizes the facts listed in the chronicle, relating them to one another. It establishes a temporal order, causal relations, dependencies; it makes logical connections, draws distinctions, provides explanations. It uses words like "because," "in order to," "after" and "therefore," which are not to be found in the chronicle. The historical narrative omits and augments. For example, an elementary school history of Caesar's rise and fall might omit mention of his multiple marriages on the ground that they don't seem to matter to the understanding it seeks to provide. It might augment "crossed the Rubicon" to emphasize that Caesar crossed from the north to the south because he was heading for Rome. It might contend that his intention to lead his army to Rome explains his crossing the Rubicon. It might take his crossing the Rubicon as evidence that Caesar was ambitious. It might go on to suggest that his ambition led to his assassination. The history then weaves the facts of the chronicle into a narrative that makes sense of the episode it deals with.

Although the narrative seems simple, it is epistemically complex. To convert a chronicle into a history requires criteria of relevance, evidence, and importance. Decisions about ordering, augmentation, and omission go beyond the facts that the chronicle supplies. Taxonomy and vocabulary may be crucial. Does the available evidence support the contention that Caesar was ambitious? Does it support the contention that he crossed the Rubicon out of ambition? Answers to such questions depend on the criteria of acceptability in play. They determine whether the chronicle supplies the sort of evidence required to attribute character traits and motives. Through the historical narrative, the students begin to glean insight into such matters.

The students are given the narrative, not just the chronicle. They may experience it as a seamless whole, telling the story of Caesar's rise and fall. It might seem that all the epistemological work is done by the writer of the text; the students are oblivious to it. But the seemingly seamless narrative admits of a sort of epistemological factor analysis – a factor analysis that figures in what they are expected to do with the narrative. They need to take it apart. They may be asked to distinguish between the brute facts which would appear in the chronicle and the interpretive elements which would figure in the explanations of those facts. For example, they may be expected to recognize that the sorts of considerations that could reasonably be adduced to argue that Caesar was ambitious are different from the sorts of considerations that could reasonably be adduced to argue that he fought in the Gallic Wars. They may be expected to distinguish between important and unimportant facts. Does it matter that he was kidnapped by pirates, or is that just an odd bit of trivia? In preparing to write an essay, they may be advised to start by making a chronicle of the facts they want to include, then to go on to write an account that connects those facts.

In describing a chronicle, I said nothing about what qualifies a statement of fact for inclusion. Even though a chronicle is just a list, it is not an arbitrary list. It is a list of facts about a particular episode, event or era. We wouldn't find "Platypuses are monotremes" or "The Red Sox won the 2004 World Series" in the chronicle we have been discussing. They have nothing to do with Caesar. Nor would we find "Caesar disliked beans," since even if it is true, there is no evidence for it. Evidently, statements of fact qualify for inclusion in a particular chronicle by being recognized as satisfying disciplinary demands for accuracy, relevance, and justification. The discipline of history underwrites the statement that Caesar was killed on the Ides of March. It certifies that the statement satisfies its standards. Disciplinary norms thus figure in establishing criteria for inclusion in a chronicle. Omissions matter. If the chronicle is constructed in a way that omits important material, or the narrative excludes or elides it, the history is flawed. So the student who begins work on her essay by writing a chronicle should recognize that the facts that she lists should be ones that historians would deem relevant, accurate, and sufficiently well established. To satisfy that requirement, she needs at least an implicit grasp of the discipline's criteria.

The narratives, both those the students read and those they write, may disclose gaps and incongruities. Questions arise, grounded in the connections that have been forged. If Caesar was a general, fighting a land war in Gaul, how did he even encounter pirates, much less get kidnapped by them? How did his participation in the Gallic wars bear on what happened when he moved on Rome? As her understanding of history grows, the student should be able to identify significant gaps, incongruities, and biases in the emerging account, and begin to recognize or develop strategies for resolving them. Minimally, she should appreciate that the gaps, incongruities, and biases show how and where her current understanding is limited. For this she needs to take a critical stance. Even a fifth-grader's understanding of Caesar's rise and fall involves considerably more than knowledge of discrete facts. To make sense of the episode requires respecting the relevant epistemic standards, norms, and criteria. It involves making the sorts of connections that satisfy the grade-appropriate standards of the discipline and eschewing those that do not.

There is nothing special about history here. A similar schema applies to the emergence of understanding in other disciplines. Although White applies his conception of a chronicle exclusively to the discipline of history, we can think of scientific understanding starting with a chronicle of scientific facts – perhaps facts about covalent bonds. The chronicle might consist of a list of covalent compounds:

Oxygen – O_2
Chlorine – Cl_2
Water – H_2O
etc.

It might include statements like

Covalent compounds share two or more electrons.

The scientific chronicle would not include the statement that the compounds are covalent *because* they share two or more electrons. It would not say how they come to share electrons or why it matters that they do. Explanatory connections go beyond the material expressly presented in the corresponding chronicle. A scientific account, like a historical narrative, systematizes and organizes the material in its chronicle to establish logical, spatiotemporal, and explanatory connections. Unlike most historical narratives, however, a scientific account includes models that serve as mediators (see Morgan & Morrison 1999), linking individual matters of fact with overarching scientific laws. We understand the facts by, in effect, filtering them through the mesh that a model provides. The models are not themselves statements of *fact*, however, for they are known not to be true. I characterize them as felicitous falsehoods (Elgin 2017). Others take them to be approximations (see Khalifa 2017; Grimm 2016). Either way, an understanding that represents covalent bonds as Lewis structures, or one that appeals to $pV = nRT$ to explain the relation between temperature and pressure in a gas, does not restrict itself to literal truths. The permissibility of such deviations derives from the science's conception of the sort of understanding it seeks to provide. That conception underwrites the conviction that the deviations from truth are, in the context where the models function, not difference-makers (see Strevens 2008). A student incorporating such models and laws in her understanding of the phenomena ought not, of course, take them to be true. Rather she needs to appreciate both that they are not strictly true and that their divergence from truth does not discredit them.

To go from a scientific chronicle to a systematic understanding involves establishing relations that underwrite explanations, observations, demonstrations, and experiments. As in the move from a chronicle to a history, some elements of the scientific chronicle may be set aside on the grounds that they are mere curiosities or outliers that the science need not accommodate, or on the grounds that they fall within the province of a different discipline. Factors that were not listed in the chronicle may be introduced. These might include as yet undetected matters of fact, such as further covalent compounds, distinctions between types of covalent bonds, intermediate steps that need to be filled in, as well as new or refined models and idealizations. They are justified to the extent that they strengthen the network.

The emerging account must satisfy relevant criteria of evidence and relevance. It must exclude considerations that are deemed scientifically impermissible. Although it may be reasonable for the historian to adduce Caesar's ambition to explain his crossing the Rubicon, it would be impermissible (except perhaps metaphorically) for the scientist to adduce the atom's ambition to complete its electron shell to explain a covalent bond. Like the student of history, the student of a science must be sensitive to the gaps and incongruities in her nascent understanding. She should recognize questions it leaves open, and should have some idea how scientifically to approach them. She needs to understand the relevant scientific methods, what they deliver, and why and to what extent their results are creditable. Here too, understanding goes beyond knowledge of established facts. The successful chemistry student must do more than memorize the chronicle. She needs to grasp the connections the science finds among the items listed in the chronicle. She also needs to appreciate why the science takes these connections to hold, to be explanatory, and to be significant. Only with an appreciation of the relevant methods, norms, and standards does the student understand the subject matter.

This way of putting things may sound intellectually too sophisticated to characterize K-12 student learning. But it is, I suggest, what students achieve when they come to understand a topic. That understanding dawns slowly. There is no suggestion that young students are self-consciously aware of the norms, standards and criteria implicit in their substantive grasp of a subject matter. But even young students are regularly asked to explain, to give examples, to extrapolate to further cases, to draw inferences that go beyond the explicit content of the instruction they have been given. To do so non-accidentally, they need to be at least implicitly aware of the epistemic norms, standards, and criteria that govern the discipline. Over time, I suggest, if they continue in the discipline, what was implicit becomes explicit. They learn how to think like a historian or a chemist or a geographer. As they internalize and endorse the epistemic norms and standards, those norms and standards provide a basis for critical assessment of the ways the discipline approaches its subject. Although this may not be explicit, they come to understand not just the subject, but the nature of their understanding of the subject.

What does this achieve? *An* understanding of a topic is a network of acceptable epistemic commitments in reflective equilibrium – that is, a network whose elements are reasonable in light of one another and the network as a whole is at least as reasonable as any available alternative when judged against one's antecedent commitments about the subject. Such a network of commitments must be grounded in fact, be duly responsive to evidence, and enable non-trivial relevant inferences and perhaps actions to foster one's cognitive ends (Elgin 1996, 2017). These conditions need to be spelled out.

To say that an understanding must be grounded in fact is not to say that it must consist only or even mainly of true statements of fact. Contemporary science consists largely of idealizations and models that are known to be literally false. Many earlier theories were only approximately true. Such science nevertheless constitutes an understanding of the phenomena because the ways that and the extent to which the models diverge from the facts make no difference to the understanding they figure in. For example, at the level where the model is apt, the factors that the ideal gas law, $pV = nRT$, ignores are trivial. So, setting them aside, as real but unworthy of consideration, fosters the understanding of gas dynamics.

Divergences from truth are also common in early education. A young student's initiation into botany is apt to involve an extremely simplified explanation of photosynthesis. The complexities of the topic and the methods for investigating it are beyond his reach. But even if such a highly simplified explanation qualifies as grounded in fact, it might seem that the requirement that the network of commitments be at least as good as any available alternative precludes attributing any genuine understanding to the child. There are a vast number of better, albeit more complicated, alternatives on offer. What this objection shows is that the requirement is indexed to an audience. The network of commitments about photosynthesis gleaned by the second-graders constitutes an understanding insofar as, given their level of cognitive development, it is at least as good as any alternative available to them. It would be both unreasonable and fruitless to bombard them with the information that botanists regularly draw on. A good second-grade lesson would provide the students a basic grasp of the process, which gives them something to build on. It is true enough. The schematic understanding he achieves provides a springboard for further learning. It puts young students in a position to take the next steps. Understanding comes in degrees. So, a second-grader can display some understanding of photosynthesis; a fifth-grader, a greater understanding, a graduate student in botany a far greater understanding.

An epistemic network must answer to evidence. This requires that there be evidence, identifiable and certifiable as such. Networks for which there is no evidence, and networks which make predictions which are not borne out by evidence afford no understanding. Astrology, for example, does not constitute an epistemic network. Even if astrological commitments are mutually supportive, astrologists make causal predictions about the influence of celestial arrangements on terrestrial events which are not borne out. Either they are trivial, or they are too vague to be tested, or they are falsified upon testing. The evidence requirement does more than discredit pseudo-science. It underwrites the idea that students should recognize not just what an account claims, but also what evidence supports it. They should be poised to reject accounts that are not backed by evidence. They should be able to answer the question, "How do we know that?"

Beyond the Information Given

Students should be able to go beyond the information given. Trivial inferences count for little. They simply articulate what was obvious anyway. But students should be able to solve further problems, extrapolate to new cases, draw effective analogies, generate plausible hypotheses on the basis of what they have learned. This is the educational dimension of the requirement that the network enable non-trivial inferences and actions. Its importance is not exhausted by what it shows about current mastery. A network in reflective equilibrium should provide leverage for further inquiry. It should equip students to build on what they currently understand. In demonstrating their mastery, the students discover that they can do more with the material than what they have been explicitly taught. This puts them in a position to see not just that, but also how, the subject is open-ended. There is more to be discovered.

The growth of understanding is flexible, fallible, and dynamic. A network's equilibrium may be upset by new findings – findings that its methods enabled it to uncover. This is an asset, not a liability. It enables us to remove previously accepted errors, ill-advised strategies, unreliable methods. Whether or not the current equilibrium is flawed, it is open to further elaboration and expansion. So, the acceptability of a given network of commitments is not expected to be permanent. New questions, techniques, and standards are apt to call it into question. In light of new considerations, it is susceptible to reevaluation. That being so, there is benefit in students' revisiting material they previously studied. More is involved than learning a few further facts. When the students who studied Caesar in fifth grade learn more about the history of Rome, they may conclude that Caesar's multiple marriages, which they had dismissed as merely personal, actually played a role in forging important political alliances. They then have reason to integrate Caesar's marriages into their emerging understanding of the period. That gives them an incentive to query other considerations that they had set aside. Because the networks of epistemic commitments that constitute understandings of a topic do not purport to provide the last word, they are springboards for the advancement of understanding. The recognition that current understanding is limited and may be flawed makes sense of how investigators proceed at the cutting edge of inquiry. It also makes sense of what goes on in education. There is then a continuum from the earliest education up to and beyond the cutting edge of inquiry.

A good exam asks students to manifest their disciplinary understanding of the material being studied. A high school chemistry student taking an exam on covalent bonding will cast her answers in the language of chemistry: molecules, atoms and electrons, as well as Lewis structures, orbitals and bonds. That terminology marks the distinctions that are deemed to be important to chemistry's understanding of its domain. In properly using that terminology, she shows a recognition of how the science frames its topics. Although she will make some literal statements of fact – e.g., "H_2O is a covalent compound" – her answers are apt to involve statements and diagrams that describe the phenomena via models and idealizations that are not literally true. In her reliance on models and diagrams, she is no different from professional chemists. To be sure, theirs are more sophisticated. But both the student and the professional understand covalent bonds in terms of models that diverge from the phenomena. For her answer to be duly responsive to evidence, she must draw on, and frame it in terms of, the sorts of considerations that chemistry counts as evidence. It will not do to simply assert that she has it on good authority that H_2O is a covalent compound, even though it is, and the authority she relies on is epistemically responsible. Her answer should, at least implicitly, reflect that she recognizes evidence is relevant and why. She should make it clear that it is reasonable to reflectively endorse her conclusion given evidence of this kind. Her understanding of covalent bonds should enable her to draw non-trivial inferences about the subject. She thus needs to be sensitive to the kinds of inferences that are acceptable in high school chemistry, and which of these are relevant to the question. She needs to be aware of what considerations and modes of argument she can draw on to back her claim. She should recognize what factors she cannot afford to omit. The student is expected to be and display that she is attuned to the methods, standards, resources, and orientations of the discipline. It is not enough to give a list of known facts about covalent bonds. Depending on the question, she may be asked to go further – not only to draw non-trivial inferences, but perhaps to speculate about what would be the case if the bond were weaker.

Reflective Endorsement

An understanding of a topic is a network of commitments in reflective equilibrium. *To* understand a topic is to accept such a network – that is, to be willing and able to use it in non-trivial inferences and actions when one's ends are cognitive (see Elgin 2017). A willing but clueless chemistry student has no grasp of covalent bonds. An unwilling but clued-in chemistry student is loath to reason and act on what the network of commitment provides. The ability requirement involves competence. For Mariah to understand the phenomenon, she must be able to reason appropriately about, and engage in appropriate actions regarding, covalent bonds. This might involve inferences, analogies, extrapolations. It might involve designing and executing experiments or contriving idealized models. It would also involve knowing the limits within which her reasoning and actions are appropriate. If she is able, she can do such things. The willingness requirement is a matter of reflective endorsement. In being willing to accept the network, Mariah adopts it as her own. She acknowledges that it provides resources to promote her cognitive ends with respect to a branch of chemistry.

Epistemic acceptance is a higher-order stance; it involves more than merely appreciating what the network is committed to. Jennifer Lackey's creationist teacher vignette shows this. Stella, Lackey says, is a young earth creationist. For religious reasons, she flatly rejects the theory of evolution. Nevertheless, she teaches it to her biology students (see Lackey 2008). She is adept at working within the theory's network of commitments. She can show how and why it supports the claim that *Homo sapiens* evolved from *Homo erectus*. She readily works out the implications of the theory. But she does not reflectively endorse the theory or its implications. She considers them wildly incorrect. She recognizes both that and why the theory of evolution is the consensus opinion in biology. But she does not understand the origin of species in terms of it; for when her ends are cognitive, as opposed to merely pedagogical, she is unwilling to use it. She refuses to stand behind it. Her students take the further step. Convinced by her teaching, they hold that the theory of evolution accounts for the diversity of life on earth. They reflectively endorse the theory. They are willing and able to draw on the resources it supplies to provide reasons for biological claims.[1] Unlike their teacher they understand the origin of species.

To reflectively endorse a network of commitments is to undertake an epistemic responsibility. The agent must consider herself willing and able to supply reasons in defense of the network and the inferences and actions it licenses. She has thus to recognize the relevant reasons and their strength. Again, this may sound epistemically too ambitious. But it amounts to her being in a position to give a cogent answer to questions like "Why should we think *that*?" If a fourth-grader gives a grade-level appropriate answer to such a question, she discharges her epistemic responsibility. Recall that a network that provides an understanding equips those who reflectively endorse it with the capacity to make *non-trivial* inferences. Such inferences are neither easy nor obvious. So, a student who understands a subject both needs to and is equipped to use her own judgment about the subject.

Although what she has been taught supplies resources, she has to go further – to manipulate the commitments to answer new questions, formulate and solve new problems, perhaps set new epistemic ends.

A worry arises. Inasmuch as the networks a student endorses are largely the fruits of her education, might her pretensions to epistemic autonomy be spurious? If she considers *e* to be evidence for *p* only because this is what chemistry counts as evidence, or she considers *s* to be a reason for *q* only because that is what history counts as a reason, she seems to be a victim of indoctrination. Her opinions are not her own. That she stands behind the disciplinary mandates shows only that the indoctrination was effective. But education is not indoctrination. It involves the development of both critical thinking skills and the propensity to deploy them (see Siegel 1988). If the student both appreciates that this is what chemistry counts as evidence, and she is convinced that chemistry gives her good reason to count it as evidence, the situation is different. For then she reflectively endorses the standards by which chemistry judges such things.

Students should learn both why practitioners in the different disciplines favor their criteria of reason or evidence, and how those criteria can responsibly be challenged. This is not so difficult as it might seem. Even young students have the ability to recognize when a consideration they are inclined to credit does not fit comfortably with what they have been taught. When a student who has been taught that every event has a cause learns that radioactive decay involves the random emission of particles, she recognizes that the new information does not fit what she has learned. Even if she is in no position to resolve the tension, the recognition itself gives her a stance for thinking critically about what she has learned. When a student who has been taught that justice is blind learns that a disproportionate number of African Americans are convicted of crimes, she has reason to question what she has been taught. This is not to suggest that she always will or always should abandon what she has been taught. But the tension she finds is evidence that all is not epistemically well. If the student has been deprived of cognitive resources for looking further, or has been disincentivized from looking further, she is a victim of indoctrination. If she recognizes the mismatch, has an incentive to look further, and has some idea about how to look further, she is capable of functioning as an epistemically autonomous agent. If she is motivated to look for mismatches and investigate what they reveal, her education has served her well.

Equilibrium can be destabilized by new insights, new information, new methods, new perspectives. So rather than treating what they have learned so far as fixed and final, students need to learn when and how to revise their views. Rarely, if ever, are there clear-cut decision procedures for making such revisions. In learning to think critically students develop the skills and propensity to consider what is to be said for and what is to be said against accepting (or continuing to accept) a commitment *c*; what are the epistemic and non-epistemic risks that accompany accepting *c*, rejecting *c,* suspending (that is, neither accepting nor rejecting) *c*; what plausible alternatives there are to *c* and what is to be said for and against each of them. In acquiring these skills and propensities, they learn to use their own judgment. To use one's own judgment is not a matter of deciding on the basis of a whim or a personal preference. It is a matter of weighing alternatives when the answer is not clear (and sometimes when grounds on which to weigh are themselves matters of controversy). Since whatever an epistemic agent chooses is what she reflectively endorses, she recognizes that she is expected to be able to defend her choice, to provide reasons (even if not conclusive reasons), to stand behind her choice and her reasons for making that choice.

Conclusion

I have argued that familiar pedagogical and assessment practices presuppose that a central goal of education is to promote objectual understanding. I have drawn my examples from K-12 classes to emphasize that the goal runs through the fabric of education; it is not restricted to the ivory tower. I highlighted the capacities students develop to extend and critique what they are explicitly taught. These capacities are integral to epistemic autonomy.

Still, one might wonder *why* promoting such autonomy should be a goal of disciplinary instruction. If the topic is the structure of covalent bonds or the rise of the Roman Empire, why isn't it preferable to simply convey the currently best grade-level-accessible information about the topic and grade students on the basis of their ability to reproduce that information? It is overwhelmingly likely that current experts know more about the topic than students can glean from their clumsy, awkwardly designed science projects or their sketchy, less than well- documented term papers. This would make sense *if* our goal were to bring it about that the students have the best currently available information about the topic they are studying. When that is the goal, deferring to experts, and insuring that students grasp expert opinion is justifiable. So, for example, it might be a good strategy in sex-ed classes on avoiding sexually transmitted diseases. But history and science (as well as other academic disciplines) are different. Insisting that high school chemistry students know the current (duly simplified) consensus on covalent bonds, merely because it is the best scientists can now do, seems unwarranted. It invites the challenge, "Why do we have to learn *that*?" The challenge is reasonable, not only because few of them aspire to be chemists, but also because scientific understanding is dynamic. The consensus is apt to change. So, if we want to say that students should master the current (duly simplified) consensus, the reason must be more than its status. It must be because the mastery they acquire through learning about what is now understood about covalent bonds will equip them with something valuable – something that will endure when they have forgotten that chlorine is a covalent compound, and when the consensus evolves.

They learn how to see and think about a range of phenomena from the orientation that a particular discipline provides. That orientation supplies standards of evidence and argument, modes of representation, techniques, models, and measuring devices. It shows how to access the phenomena from a particular point of view, and it shows why such access is both valuable and open to legitimate challenge. To gain these benefits, however, the students need to adopt the orientation. They need to learn to operate within its parameters, to satisfy its standards of rigor, to assess their outputs by its requirements. That is, they need to function as epistemic agents, not mere spectators.

The account I have sketched may seem remote from everyday teaching and learning. It credits even the youngest students with perhaps surprising levels of epistemological sophistication. But when we reflect on the assignments teachers give and on the capacity of students to complete those assignments successfully, we recognize that even young students are adept at identifying evidence, drawing inferences, making analogies, formulating and defending arguments bearing on the topics they study. Teachers are apt to focus on day-to-day learning objectives; policy makers, on year-to-year objectives. But insofar as these objectives are justified, their rationale lies in their broadening and deepening the resources students possess for thinking well. Subject matters ground education. They put students in touch with the world. And they equip students with resources for thinking broadly and deeply about the world. "All which schools can do or need to do for pupils, insofar as their minds are concerned…, is develop their ability to think" (Dewey 1916: 152).

(Related Chapters: 1, 3, 4, 10, 11, 12, 26, 27, 28, 29.)

Note

1 Scholars can understand theories that they do not reflectively endorse. So, Stella's stance vis à vis the theory of evolution might be like a classicist's stance toward ancient Greek religion. Each takes a body of commitments as the object to be understood. Each understands what the theory is committed to. But neither understands the phenomena the theories purport to concern via the theories in question. See Malfatti 2019.

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