The Virtuous Scientist Project:

Intellectual Virtues, Epistemic Reasoning and Science Identity

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Educational Responses to a Post-Truth World: Diverse Theoretical Approaches to Improving Thinking about Scientific Issues

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Summary

The *Virtuous Scientist Project* is motivated by a conviction that much more could be done to prepare students for the practice of science in post-baccalaureate careers. The cultivation of intellectual virtues in science education is a particularly crucial objective because science is widely acknowledged as the premier knowledge-generating enterprise; and "if anything can deliver the epistemic goods, it is science" (Roberts & Wood, 2007, p. 4).

But training better scientists is only an adjunct of forming better persons. Our concern is to design science education so that it equips students with the intellectual virtues that conduce to good citizenship at a time when science denialism, alternative-facts, and post-truth corrupt public discourse about matters of fundamental national interest (Krief et al., 2017). If training better scientists and science literate citizens is an adjunct to forming better persons, then science education is in the business of character formation. The virtuous scientist has both well-cultivated intellectual virtues and sophisticated understanding of the epistemic claims that derive from the nature of science.

To this end, the *Virtuous Scientist Project* proposes deep integration among three fields of study: virtue epistemology, epistemic reasoning and science education. *Virtue epistemology* affirms that the dispositions of the agent and the formation of character is crucial to intellectual formation (Baehr, 2011; Battaly, 2012). The educational psychology literatures raise questions about *epistemic cognition* and the characteristics and development of epistemic reasoning as targets of learning and instruction (e.g., Chinn, et al. 2011). The *science education* literatures raise questions about the nature of authentic inquiry and what students come to know about science (Chinn & Malhotra, 2002); but it also investigates the pedagogies that contribute to the formation of a professional STEM identity (Nadelson et al., 2017).

In this paper we map the terrain among the three fields and advance several claims: Intellectual virtue is an important (albeit neglected) component of epistemic cognition (Chinn et al., 2011), but integration between the two fields requires "science identity" as a bridge construct to provide a motivational component to the work of virtues and epistemic

cognition. Science identity is a form of character formation that includes virtue and epistemic commitments as part of self-identity. Consequently, science identity is an important goal of science education. Indeed, epistemic cognition and the formation of intellectual virtues requires the right kind of intellectual setting that includes emulation of exemplars and mentored apprenticeship in a community of practice that is intentionally conversant in the language of epistemic virtue and the epistemic claims of science.

Our research agenda includes development of assessments of science identity and select intellectual virtues, such as narrative methods that track epistemic cognition and virtue in the evolving narrative of the self. We outline the objectives of a research consortium that will examine scalable features of science education that conduces to virtuous science; and test the hypothesis that achieving epistemic aims may well hinge on the intellectual character of students. We conclude that the virtuous scientist is a product of science education that combines virtue epistemology and science epistemology.

Background and Context

It would not take long for any gathering of university professors to lament the incurious or desultory intellectual climate of their classrooms or the absence of genuine intellectual engagement with ideas by students. Although no disciplinary major is immune from such concerns, students' seeming wont of intellectual passion and curiosity is a pressing concern in university science departments, if only because science is widely acknowledged as the premier knowledge-generating enterprise; and "if anything can deliver the epistemic goods, it is science" (Roberts & Wood, 2007, p. 4).

The Virtuous Scientist Project at Notre Dame was first initiated in response to this issue and our working solution was to somehow inculcate intellectual virtues proper to science—science virtues--- in science classes by wholesale reform of the undergraduate curriculum for at least some majors.

However, as our work unfolded we began to think more expansively about the role of intellectual virtues in science and society, beyond the college classroom, acknowledging the many challenges that confront contemporary science, including those of ethics, trust, and transparency internal to scientific practice; and challenges that confront a science literate citizenry when science denialism, alternative-facts and post-truth ideology corrupts public discourse about matters of almost existential urgency.

Recent editorials in prominent science journals lament the undervaluing of scientific evidence and how easily scientific consensus is ignored in the service of ideological agendas. The editorials argued that the methods of science need to be defended as one core value of modern society; and that scientists need to accept some of the blame for the post-truth reality.

When scientists fabricate data, cherry pick data to support claims, engage in *p*-hacking or HARKing, tout misleading credentials, game the peer review system, tolerate plagiarism, and cloud transparency with respect to conflicts of interest—these practices call into question the integrity of scientists and undermine confidence in scientific consensus.

These failings undoubtedly reflect the wont of virtue among some scientists (we would claim), but there is also widespread misunderstanding in public discourse about the very nature of science, the epistemic claims that it makes and our intellectual stance towards them -- a misunderstanding that scientists are obliged to correct.

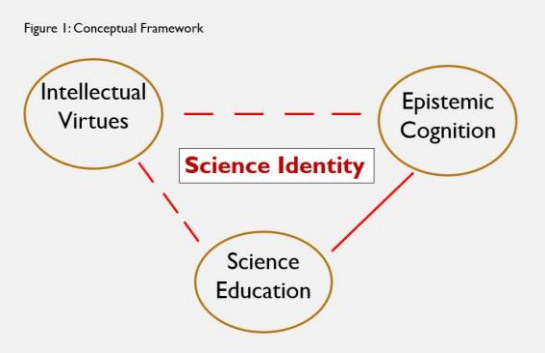
The Virtuous Scientist Project is concerned to reform collegiate science education at our institution to better prepare science majors for post-baccalaureate science careers, certainly, but also to equip students with the intellectual virtues that conduce to good citizenship at a time when science denialism and comfort with alterative-facts is rife in crucial public policy debates.

Science education is not just for scientists. We argue that training better scientists and science literate citizens is in the service of forming better persons; and that *science education is in the business of character formation.*

Conceptual Framework

The conceptual framework that guides our project integrates three literatures: 1) conceptions of intellectual virtues framed by ethicists in

virtue epistemology; 2) research on epistemic cognition and science epistemology in educational psychology and the learning sciences; and 3) best practice pedagogy in science education.



As the bold red-line in the figure illustrates, there is a long-standing relationship between science education and the epistemic cognition literatures, but virtually no relationship among the other literatures, as illustrated by the dashed lines. That's where we come in. We propose that all three domains are reciprocally related and require a concept of science identity to ground the formation of the virtuous scientist.

Intellectual virtues require a concept of self-identity to capture the motivational characteristic of a particular virtue –how it becomes something a person with the virtue would characteristically do. Epistemic cognition requires a concept of self-identity to bridge the gap between formal and personal/practical epistemology; or to account for the need of students, on some accounts, to "internalize the standards of the research community as their own." The language of internalization and "making it one's own" implicates identity processes. Indeed, what drives science inquiry may be less the "epistemological idea" (which has no motivational component) but rather the notion that mastery of science epistemology is the result of al committed self who identifies with the project of science.

Science Virtues

Well, then, what are intellectual virtues? Virtues are dispositional features of character that contribute to flourishing. The classic writings on virtue by Aristotle still resonates in contemporary debates about ethics (e.g., MacIntrye, 1984), but there is now a surge of interest on the role of character traits in facilitating the acquisition, transmission, and application of knowledge (e.g., Battaly, 2012; Zagzebski, 1996), a field called virtue epistemology, with science being the paradigm case (Roberts & Wood, 2007).

The work of science can only be accomplished, on this view, by individuals who have certain capacities and dispositions well-formed by education that is not simply technical training in specialized skills but in the formation of human excellence (Roberts & Wood, 2007). Intellectual inquiry can go well or poorly depending upon the personal qualities of inquirers, and so attention must be drawn to *intellectual character traits* (Baehr, 2011).

It is hardly possible to care about the truth, to pursue a question with dogged, careful perseverance, to interrogate the evidence carefully, to be industrious and open to surprise, to want to learn from others, to treat interlocutors and critics and their texts with justice, to participate in the shared collaborative work of science ---it is impossible to do these things without love of knowledge, without open-mindedness, intellectual humility and courage, without curiosity, a sense of firmness and fairness, and other virtues. Forming the agent's character is key for the work of science and for the "life of the mind" that aims to deliver epistemic goods.

Hidden Curriculum. But too often the development of intellectual character traits so crucial to scientific inquiry is remanded to the hidden curriculum of science education. Universities do very little to help students develop intellectual virtues but should insofar as intellectual virtues are crucial not only for obtaining truths but for fostering the motivation for truth. As philosopher Heather Battaly (2016) put it: "Getting truths does matter," she writes, "but one can get truths as a result of wanting good grades, or an award, or bragging rights, and not because one cares about the truth for its own sake" (Battaly, 2016,p. 163). Caring about truth is also an intellectual virtue and we should want our students to care more about love of knowledge than about good grades.

Good Student v. Good Scientist. Yet how do we get students who have spent their educational career chasing "transcript values" -- course points, GPA and class rank -- to desire knowledge and truth for its own sake as a "good internal to practice"? We propose that the intellectual virtues

requires a concept of *self-identity* to capture the motivational characteristics proper to science virtues. Identifying with intellectual virtues, identifying with science is to emphasize the *importance of what we care about* (Lapsley, 2016; Lapsley & Stey, 2014); and identifying with science virtues as central and constitutive of the self is a powerful way to transform "good student identity" (students who pursue transcript values) into "good scientist identity" (who pursue truth and knowledge for its own sake).

Science identity has been studied mostly as a variable that predicts persistence in the STEM-pipeline, but we think it is also crucial for how students think about scientific issues, how they conduct themselves as scientists and undertake the responsible conduct of research; and the most robust form of science identity is one imbued with intellectual virtues proper to science.

Epistemic Cognition.

But there is one more piece to the model---epistemic cognition. How students think about knowledge and truth is also crucial to the formation of virtuous scientists. Best practice science education should lead students to a deeper appreciation of the formal epistemological characteristics concerning the nature of science. Effective science education should result in more sophisticated epistemic understanding that should not only put students on the road for more successful doctoral preparation as scientists in post-baccalaureate science careers, but also prepare everyone else for their role as science-literate citizens in a world that needs clear-eyed appreciation of the nature of science and the epistemic goods it delivers.

Research on epistemic cognition typically examines the often reciprocal relationship between students' epistemological beliefs and content learning in STEM disciplines (e.g., Borgerding et al., 2017; Bromme, Pieschl & Stahl, 2010; Muis, 2004; Sandoval, 2014). Our approach to epistemological beliefs is novel. We argue that moving the needle on epistemic cognition will also require attention to intellectual virtues. It also requires attention to matters of self-identity, to whether students approach their STEM coursework as "good students" or "good scientists".

For example, students who endorse science as "certainty of knowledge" are more likely to enact a "good student" identity that emphasizes the importance of memorization, and getting good grades (Carlone, 2003, 2004). After all, if science consists of discrete facts known with absolute certainty as affirmed by external authorities, then the main educational goal is to memorize them like any good student would. Hence the "transcript values" that permeate many STEM classrooms are likely associated with the epistemological beliefs that students bring with them that affirm the importance of being a good student. But moving students towards a "good scientist" identity will require more active thinking (cf, Carlone & Johnson, 2007) and cultivation of thinking dispositions (Richhart, 2002) that we associate with the development and internalization of intellectual virtues and growing sophistication in epistemic cognition.

The following model suggests one way to get to science identity as an outcome on the basis of epistemic cognition and science virtues.

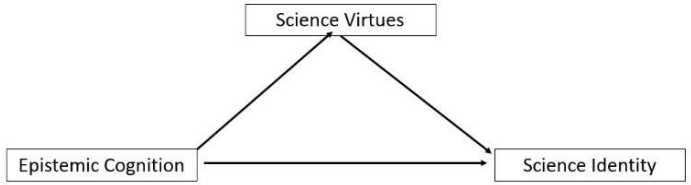


Figure 2: Model of the Relationship Among Epistemic Cognition, Science Virtues and Science Identity

Science Education.

How does one develop moral or intellectual virtues? Aristotle famously argued that virtues are acquired through a process of direct instruction, exposure to exemplars and practice. Direct instruction is required to formally introduce students to virtues, to name them and provide a schematic lens by which to appraise their science apprenticeship. Exposure to exemplars (e.g., instructors, authors of readings, invited speakers, scientists of historical significance) and repeated practice encourages intrinsic motivation to care about truth for its own sake (Battaly, 2016). Providing opportunities for self-reflection encourages students to take ownership of their own development of intellectual virtues and to internalize them as stable dispositions of character (Baehr, 2011). Richhart (2002) suggests that repeated practice of "thinking dispositions" (e.g., SEE-

THINK- WONDER; CONNECT-EXTEND-CHALLENGE; Saying what…saying why,,,saying other things to try") is the sort of practice that builds intellectual character traits.

We are currently working through our implementation plan. It will include:

- University instructors forming a learning community (community of practice)
- Include intellectual virtues as explicit course goals
- Direct instruction about intellectual virtues in web-based modules that address (1) scientific virtues as character strengths; (2) explicit instruction on target virtues; and (3) reflective exercise on the difference between the dispositions of good students vs. good scientists
- Self-reflection projects and monthly virtue diaries

As a theoretical note for the future, we think there is much to gain by conceptualizing intellectual virtues as analogs to the work of cognitive strategies, so that the psychology of intellectual virtue should be akin to using specific strategy knowledge; or learning a "meta-memory acquisition procedure" (Pressley, Borkowski & Sullivan, 1984). Specific strategy knowledge and meta-memory acquisition procedures should help us deploy the requisite intellectual virtues----and here I am channeling Aristotle---in the right situation, at the right time and in the right way.

We think finding a way to integrate intellectual virtue education and the cognitive strategy-metacognition literature is an exciting prospect for the future.

Assessment

Our proposed assessment strategy is summarized below.

Intellectual Virtues	**Assessment**
Love of Learning	VIA Inventory of Strengths
Intellectual Pursuits	VIA Inventory of Strengths
Curiosity	VIA Inventory of Strengths
Perseverance	VIA Inventor of Strengths
Love of Thinking	Need for Cognition Scale
Intellectual Humility	Comprehensive Intellectual Humility Scale Multidimensional Intellectual Humility

Epistemic Cognition

Epistemological Beliefs Scale (Conley et al., 2004)
Epistemic Certainty (Trautwein & Oliver, 2007)
Scientific Epistemological View (SEV Scale (Liu & Tsai, 2008)

- Role of Social Negotiation
- Inventive/Creative Nature of Science
- Theory-Laden Explanation
- Cultural Impacts
- Tentative Feature of Knowledge

Science Identity

Science Person?
"Do you see yourself as a biology/chemistry/physics person?" (PRiSE)
Science Identity?
"How do you rate yourself as a science student?" (Stets et al., 2017)

Science Centrality: 4 items (Stets et al., 2017)

- (1) In general, being a scientist is an important part of my self-image";
- (2) "I have a strong sense of belonging to the community of science";
- (3) "Being a scientist is an important reflection of who I am"; and
- (4) "I have come to think of myself as a scientist."

Science Virtues Internalization (6 items, adapted from Aquino & Read, 2002)

- Priming instructions: 8 intellectual virtues
    - I want to be the person who has these characteristics
    - Being someone who has these characteristics is an important part of who I am.

- I could never imagine myself having these characteristics (R).
- Having these characteristics is not really important to me.
- I strongly desire to have these characteristics
- These characteristics are not very important to who I am as a person (R)

Summary

- Explicit cultivation of intellectual virtues is required to improve thinking about scientific issues.
- The project of forming intellectual virtues is a special kind of personality development that is ideally the project of college-age emerging adults.
- Training better scientists and science literate citizens is an adjunct to forming better persons; and hence science education is in the business of character formation
- The character formation proper to science is the articulation of a science identity, that is, an identification with science that is central, essential and important to self-understanding. Science identity is the target of character-based approaches to intellectual virtue; and provides the motivational structure to put into practice what one knows to be ethically required.
- The pathway(s) to science identity partly runs through advances in epistemic cognition. But advances in epistemic cognition is also driven by cultivation and practice of intellectual virtues.
- Education for intellectual virtue, on the Aristotelian model, will require a deliberate, explicit combination of direct instruction, reflection on exemplars and practice of thinking dispositions.

References

Alfano, M., Iurino, K., Stey, P., Robinson, B., Christen, M. & Lapsley, D. (2017). Development and validity of a multi-dimensional measure of intellectual humility. *PLoS One, 12*(8), e0182950. doi.org/10.1371/journal.pone.0182950

Aquino, K. & Reed, A., II. (2002). The self-importance of moral identity. *Journal of Personality and Social Psychology, 83,* 1423-1440.

Baehr, J. (2011). *The inquiring mind: On intellectual virtue and virtue epistemology*. Oxford, UK: Oxford University Pres.

Battaly, H. (2016). Responsibilist virtues in reliabilist classrooms. In J. Baehr (Ed)., *Intellectual virtues and education: Essays in applied virtue epistemology* (pp. 163-183). New York, NY: Routledge

Battaly, H. (2012). Virtue epistemology. In J. Greco & J. Turri (Eds.), *Virtue epistemology: Contemporary readings* (pp. 3-32). Cambridge, MA: MIT Press.

Borgerding, L., Deniz, H. & Anderson, E.S. (2017). Evolution acceptance and epistemological beliefs of college students. *Journal of Research in Science Teaching, 54*, 493-519

Bromme, R., Pieschl, S. & Stahl, E. (2010). Epistemological beliefs are standards for adaptive learning: A functional theory about epistemological beliefs and metacognition. *Metacognition and Learning, 5*, 7-26.

Cacioppo, J.T. & Petty, R.E. (1982). The need for cognition. *Journal of Personality and Social Psychology, 42*, 116-131.

Carlone, H.B. (2004). The cultural production of science in reformed-based physics: Girls' access, participation, and resistance. Journal of Research in Science Teaching, 41, 392-414.

Carlone, H.B. (2003). (Re)producing good science students: Girls' participation in high school physics. *Journal of Women and Minorities in Science and Engineering, 9,* 17-34.

Carlone, H.B. & Johnson, A. (2007). Understanding the scientific experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*, 1087-1218.

Chinn, C.A., Buckland, L.A. & Samarapungavan, A. (2011). Expanding the dimensions of epistemic cognition: Arguments from philosophy and psychology. *Educational Psychologist, 46*, 141-167.

Chinn, C.A. & Malhotra, B.A. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Science Education, 86*, 175-218.

Conley, A.M., Pintrich, P.R., Vekiri, L., & Harrison, D. (2004). Changes in epistemological beliefs in elementary science students. *Contemporary Educational Psychology, 29*, 186-204.

Krief, A., Hopf, H., Mehta, G., & Matlin, S.A. 2017. Science in the post-truth era. *Current Science, 112,* 2173-2174.

Krumrei-Mancuso, E.J. & Rouse, S.V. (2016). The development and validation of the Comprehensive Intellectual Humility Scale. *Journal of Personality Assessment, 98,* 209-221.

Lapsley, D. (2016) Moral self-identity and the social-cognitive theory of virtue. In L. Annas, D. Narvaez & N. Snow (Eds). *Advances in virtue development: Integrating perspectives* (pp. 34-68). Oxford, UK: Oxford University Press.

Lapsley, D., & Stey, P. (2014). Moral self-identity as the aim of education. In L. Nucci, D. Narvaez & T. Krettenauer (Eds.), Moral and character education 2nd Ed. (pp. 84-100). New York: Routledge.

Lee, M-H., Johnson, R.E., & Tsai, C-C. (2008) Exploring Taiwanese high school students conceptions of and approaches to learning science through structural equation modeling analysis. *Science Education, 92*, 91-220.

Liu, S-Y., & Tsai, C-C. (2008). Differences in the scientific epistemological views of undergraduate students. *International Journal of Science, 30,* 1055-1073.

MacIntrye, A. (1984). *After virtue* (2nd Ed.). Notre Dame, IN: University of Notre Dame Press

McGrath, R.E. (2014). Scale and item-level factor analysis of the VIA Inventory of Strengths. *Assessment, 21*, 4-14.

Muis, K.R. (2004). Personal epistemology and mathematics: A critical review and synthesis of research. *Review of Educational Research, 74*, 317-377.

Nadelson, L.S., McGuire, S.P., Davis, K.A., Farid, A., Hardy, K.K., Hsu, Y-C.,Kaiser, U., Nagarajan, R., & Wang, S. (2017). Am I a STEM professional? Documenting STEM student professional identity development. *Studies in Higher Education, 42*, 701-720.

Nadelson, L.S. & Fannigan, B. (2014). A path less traveled: Fostering STEM majors' professional identity development through engagement as STEM learning assistants. *Journal of Higher Education Theory and Practice, 14*, 29-40.

Pressley, M., Borkowski, J. & O'Sullivan, J.T. (1984). Memory strategy instruction is made of this: Metamemory and durable strategy use. *Educational Psychologist, 19*, 94-107.

Richhart, R. (2002). *Intellectual character: What it is, why it matters, and how to get it*. San Francisco: Jossey-Bass

Roberts, R.C. & Wood, J.W. (2007). *Intellectual virtue: An essay in regulative epistemology*. New York: Oxford University Press.

Sandoval, W. (2014). Science educators' need for a theory of epistemological development. *Science Education, 98*, 383-387.

Stets, J., Brenner, P.S., Burke, P.J. & Serpe, R.T. (2017). The science identity and entering a science occupation. *Social Science Research, 64*, 1-14

Trautwein, U. & Oliver, L. (2007). Epistemological beliefs, school achievement and college major: A large-scale longitudinal study on the importance of certainty beliefs. *Contemporary Educational Psychology, 32,* 348-366.

Zagzebski, L. (1996). *Virtues of the mind*. New York: Cambridge University Press