Notre Dame Consultation on Intellectual Virtues and Science Education
Notre Dame Conference Center
May 11-May 13, 2017

Background to the Consultation

The *Virtuous Scientist Project* at Notre Dame was motivated by a widely-shared observation that much more could be done to prepare university students for the practice of science in post-baccalaureate careers. But training better scientists is only an adjunct of forming better persons. Our concern is to design science education in a way that equips students with the intellectual virtues, the thinking dispositions, that conduce to good citizenship at a time when science denialism and alternative-facts corrupt public discourse about matters of fundamental national interest.

The cultivation of intellectual virtues in science education is a particularly crucial and salient objective just 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). Yet there are many challenges confronting contemporary science, including those of research ethics, trust, and transparency.

But whether one is able to deliver epistemic goods through scientific practice, or contribute to an informed civic dialogue as good citizens, will certainly hinge on the ability of the scientist to think, interpret, judge, and to keep an open-mind when considering the evidence, among many other dispositions. Indeed, the Committee on Conceptual Framework for the New K-12 Science Education Standards (National Research Council, 2011) enshrines intellectual dispositions (called "scientific and engineering practices") as one of three dimensions around which K-12 science education could be organized (the other dimensions are called "cross-cutting concepts" and "disciplinary core ideas").

The Committee draws attention, for example, to practices including asking questions, defining problems, developing models, constructing explanations, designing solutions, engaging in argument from evidence, and obtaining, evaluating and communicating information—these and other practices are deemed crucial for successful science. Hence, it is clearly recognized that the dispositional qualities of science students as inquiring cognitive agents are just as important for science education as is for learning scientific concepts and core ideas of the various scientific disciplines. To acknowledge this puts us in the domain of intellectual character (Baehr, 2011).

The educational and learning sciences have long recognized the challenge of reforming K-12 science education. Meanwhile, the BIOS 2010 (2003) and Vision and Change (2011) initiatives have targeted science training at the undergraduate level. There is a professional consensus, for example, that a shift is required from fact-to-process based education, with an emphasis on practical, experiential learning or "doing science" with authentic tasks in order to develop relevant competencies, skills and deep conceptual understanding of a discipline's knowledge base.

Yet there are at least two challenges to forming "virtuous scientists" at the university level. One concerns the contextual realities of university teaching and learning. The second concerns how to reform science education in a way that is well-grounded in the appropriate philosophical (virtue epistemology) and educational science (epistemic cognition) literatures. We take up each in turn.

The University Context

University and secondary school educators often express dismay at their students' apparent lack of passion for intellectual goods. Indeed, faculty complaints are endemic and putative causes are many, including under-preparation, lack of motivation, narrow curriculum, the distractions of social media and the untoward effects of high stakes standardized testing.

University students who are the product of elite secondary education are not immune from faculty approbation. In many ways these students are clearly intelligent and motivated, at least as attested by standardized tests and transcripts. Moreover, they have a keen sense of their career goals which govern their curricular choices. The careerist orientation disposes college students to over-value what philosopher Alasdair MacIntyre termed the goals of efficiency (over the goals of excellence) and the pursuit of goods "external to practice" – status, money, fame.

Students are similarly concerned with the standard of teaching and can be forthright when they consider it inadequate. Yet they are more consumers rather than creators of knowledge. They are adept at memorization and test preparation. They do well on exams. When they ask questions, it is for clarification ("is it going to be on the test?") rather than to press for deep understanding. Students will seek out and learn solutions to oft encountered problems, but seem less astute at solving novel and unexpected problems, especially those without easy and straightforward solutions. Many students prefer challenges or experiences with clearly-defined and immediate benefits. Science students can seem especially strategic in their learning, concerned that content and grades will help them achieve their careerist goals. Learning for its own sake, as a "good internal to practice", is less often observed.

If this leads professors to lament the incurious or desultory intellectual climate of their classrooms or the absence of genuine intellectual engagement with ideas, then it suggests that leaving the development of intellectual virtue to the hidden curriculum is not a successful strategy. Moreover, and perhaps more fundamentally, it is not entirely clear how to make intellectual virtue an explicit and intentional target of educational formation even if there is a concerted desire to do so.

One reason why it is difficult to conceive of reform of university science education to encourage intellectual virtues is that the traditional model of teaching ("the sage on the stage") seems to work just fine, and for several reasons. First, students who matriculate are typically admitted to graduate school or medical school, in accord with their career goals. Second, the traditional model fits the general expectation (of parents and students) of what university instruction looks like, especially with respect to content, grades, and assessment. Third, the traditional model typically requires less upfront investment

of faculty time and energy, especially if course structure-and-content is already "on the books." Fourth, instruction leans towards the traditional model given certain institutional restraints, such as class size in introductory or foundational courses, and the physical layout of classrooms as lecture halls rather than seminar or discussion spaces.

Intellectual Virtues and Epistemic Cognition

We think the institutional challenges that confront university science education are widely-shared but ready for remedy. To consider these issues, the *Virtuous Scientist Project* recruited an interdisciplinary advisory group of scholars from across the university, including faculty colleagues in the College of Arts and Letters, the College of Science, the Institute for Educational Initiatives, among other units, to think through how best to train the next generation of scientists in the intellectual virtues.

More specifically, the project wanted to devise, evaluate and implement ways to encourage the development and application of intellectual virtues in undergraduate and graduate education. The premise of the planning grant was that training in the intellectual virtues would help students get more out of their education and become better scientists (and better persons too!). We took up several pressing questions:

- Would it be possible to design a course, develop resources and otherwise build an institutional culture to promote and support the integration of intellectual virtues in science education?
- How could a community of practice emerge across colleges and departments that would elevate intellectual virtues as an explicit target of science education?
- Is there a pedagogy of intellectual virtue? And, if so, would such a practice be scalable, that is, could it be readily adopted by multiple faculty members across departments and colleges, and by other institutions of higher education?

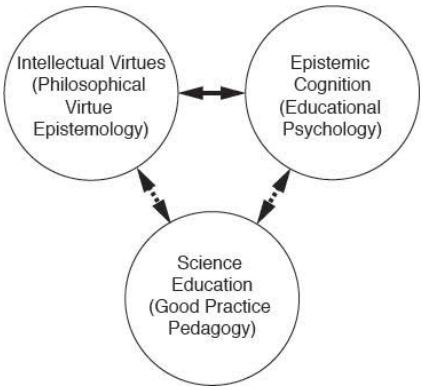
The advisory group wrestled with these and other issues, but it became increasingly evident over the course of the year that the project had to confront two imposing literatures, one in philosophy, the other in educational psychology.

The philosophical literature on virtue epistemology raises questions about the nature and structure of intellectual virtues and their contribution to the practice of inquiry. The educational psychology literatures raise questions about epistemic cognition (e.g., Greene, Sandoval, & Braten, 2016) and the characteristics and development of epistemological reasoning as targets of learning and instruction.

Although the epistemic cognition literature is tightly bound with K-12 science education, it does not seem to address science education at the collegiate level nearly as well; nor is there much evidence that the intellectual virtues literature has significantly penetrated the design of science education curricula, especially in higher education. We noticed, too, that virtue epistemology and epistemological reasoning

are two fields of inquiry, arising in two different disciplines (philosophy, learning sciences/educational psychology), that are not sufficiently integrated in a way that could inform the project's agenda.

The following diagram captures the triune framework that has guided our deliberations.



Consultation Objectives

Hence, our overall objective is to invite to campus prominent scholars who have contributed to one or more of the literatures on intellectual virtues, epistemic cognition and science education to help us understand a number of issues:

1. How should we understand the relationship between virtue epistemology, as articulated in recent philosophical accounts of intellectual virtues, and epistemic cognition, as studied in educational psychology? Moreover, can this relationship be put at the service of science education?
2. Is it sensible to think about the formation of intellectual virtues in college science classes, and if so, what should that look like?
3. How can we use the epistemic cognition literatures to guide the development of science education curricula and to appraise its success?

This is not an exhaustive list of questions pertinent to the formation of virtuous scientists in undergraduate and graduate science programs. Indeed, we anticipate that our interdisciplinary conversation will surface additional issues and questions, and also new lines of investigation.

Indeed, we hope this consultation will form the basis of ongoing reflection that might yield, as one immediate result, a scholarly edited volume to galvanize interdisciplinary research in applied science epistemology. However, we also hope that the conference will in the longer-term, first, encourage the design of model science curricula for colleges and universities, and, second, stimulate a discussion about how scientists learn and train throughout their education. Even more broadly, we also hope that the conference will encourage an interdisciplinary collaboration among philosophers, scientists, and educators regarding the design of model curricula for the pedagogy of intellectual virtue that would have broad application across the sciences and humanities.