INTEG 220: The Nature of Scientific Knowledge

Tuesdays & Thursdays, 2:30-3:50, EV2-2069

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Course Description

Scientific knowledge is essential for understanding our world and living in it. But what is science, exactly, and what makes an approach "scientific"? Why should we trust science and what makes it more trustworthy? Who gets to count as an expert? We will address these and other questions by examining the *epistemology* of science (i.e., the nature of scientific knowledge). The course is divided into two parts:

1. **The philosophy of science**, which deals with how scientific knowledge is generated. We'll look at the nature of scientific observations, experiments, and reasoning, as well as how science makes progress. We will also talk with scientific experts about how they practice science and how those practices relate to the philosophical issues we've discussed.
2. **The social nature of science** considers how scientists' social identities and philosophical views about science influences their research. Topics will include the role of values in science, the benefits of diverse scientific communities, scientific expertise, and public understanding of science. We'll also discuss how interdisciplinary collaboration can improve science.

Learning Objectives

By the end of this course, you should be able to achieve the following objectives. The first two involve basic levels of understanding, while the next three sit at a higher level on Bloom's Taxonomy of Learning. The last four are skills you will develop that can be applied in many other contexts, both professional and personal.

Knowledge & comprehension:	• **Explain** different views of the nature of scientific knowledge • **Describe and discuss** key issues regarding science and society
Application & analysis	• **Critically analyze** a relevant epistemological issue • **Apply** a course concept, theory, or idea to a real-world context
Transferable skills:	• **Think critically** about science and its relationship to social issues • **Enhance** your ability to read and engage with difficult material • **Practice** and improve your writing skills • **Develop comfort** with ambiguity

Required Textbooks & Tools: What Will I Need for This Course?

All course materials, or links to them, will be posted on LEARN. We will also be using the following online tools (see LEARN for details as to how to access and use each of these tools):

- **Perusall** is an online tool for social reading; it allows you to highlight text and ask a question, leave a comment, and/or reply to others. We will use Perusall for all assigned readings in the course.
- **PEAR** (Peer Evaluation, Assessment, and Review) will be used for peer evaluation.

There is one required textbook for this course: *What is this Thing Called Science?*, 4th edition, by A.F. Chalmers. **You will need to purchase an electronic copy of the book through Perusall.** The cost is about $25 CAD. Unfortunately, this is the only option for using the text in Perusall given copyright restrictions (other e-copies of the book will *not* work in Perusall's system).

Assessment: How Will My Work Be Graded?

You will be assessed on a variety of activities, including readings on Perusall, course engagement activities, a creative group project, and an individual learning portfolio. See below for a description of each assignment; detailed assignment instructions will be posted on LEARN.

Assignment/Activity	Weight	Due Date (due by 10pm ET)
Course Engagement		
• Assigned readings on Perusall	20%	Throughout the term
• Your choice of engagement activities	15%	Throughout the term
Group Project		
• Group project presentation & deliverable	20%	Due Friday, November 24
Learning Portfolio		
• Critical reflections	--	See LEARN for due dates
• Mid-term portfolio	15%	Due Friday, October 6
• Final essay & portfolio	25%	Due Tuesday, December 12
Your best work (highest mark on individual assignment)	5%	

Course Communication & Expectations

Communication with the Course Instructor and Teaching Assistant

There are multiple ways for you to communicate with me and with the course TA.

- You can **post questions in the LEARN Discussion Forum**, "Course Q&A for Katie and Emma." Anonymous posts are allowed. If you think your question might apply to other students (e.g., if it's about assignment guidelines or course policies), this is the best platform to use so other students can see the question and response(s). You're also welcome to respond to other students' questions!
- You can speak with me during **student drop-in hours** (aka "office hours"), listed above.

- **You can also email me or the TA directly**. UW policy requires that all communication with students must be through the student's University of Waterloo email account or via LEARN. If a student emails the instructor or TA from a personal account, they will be requested to resend the email using their UW email account.
- Note that I am usually offline after 5pm and on weekends. My inbox can get quite full, so if you don't hear back from me within two business days, feel free to send a follow up email – I appreciate friendly reminders! **It's helpful if you add '220' to the subject line so I don't overlook your email.**

What You Can Expect from Me

My method of teaching (or "pedagogy") aims to challenge and empower students to think critically, take an active role in their education, apply what they're learning to real-world issues, and develop valuable skills that can be used outside this course. I ask for your help in creating a collaborative learning community where we support and challenge one another. You will have several opportunities to practice reading challenging material, hone your writing skills, and engage with others. The TA and I will support you.

What We Should Expect From Each Other

Given the nature this course, it is important that students actively engage with the course content and with each other to contribute to a supportive and collaborative learning environment for everyone.

- The TA and I are committed to creating a positive learning experience where diverse perspectives are valued. I request that we all work together to create a classroom culture based on open communication, mutual respect, and inclusion. Disagreements and debates in academic discourse are expected and welcome, but personal attacks and oppressive discourse will not be tolerated.
- I strive to ensure an open and welcoming classroom for all students. If I ever miss the mark, or if you have suggestions for enhancing our learning community, please don't hesitate to talk with me or the course TA. We are all learning together.

Required Assignments: What Will You Need to Do?

Course Engagement

Active engagement is an essential part of this course. We will take a philosophical approach to examining diverse ways of knowing. Just as many scientific fields require hands-on laboratory practice for deep learning, doing philosophy requires practice. This involves **actively engaging with texts** (e.g., identifying an author's thesis, uncovering the structure of an argument, or raising objections to an argument), as well as **participating in thoughtful dialogue with others**.

A significant part of your grade will be based on your engagement with course material and with other students. This includes (1) assigned readings/videos on Perusall, and (2) your choice of engagement activities. Anyone should be able to get a high mark on engagement with enough time and effort!

Assigned Readings/Videos on Perusall (20%)

- This part of your grade will be based on **completing the assigned readings on Perusall**. Completion means doing the reading and annotating the text (i.e., highlighting text and adding comments or questions, or replying to others' comments or questions). Due dates are listed in Perusall & LEARN.
- Your grade will be based on how many of the required readings you read and annotate. If you do 100% of the readings on time, you will receive a mark of 100; if you do 90%, you will receive a 90, etc. **You**'re **allowed to complete two of the readings late with no late penalty** (the late window will stay open for two weeks; see Course Engagement assignment directions on LEARN for details).

Your Choice of Course Engagement Activities (15%)

- In addition to the readings, you will be expected to complete **your choice of engagement activities that contribute to a collaborative learning environment**. Such activities might include posts or replies in LEARN Discussion Forums, volunteering to contribute to the collaborative class notes, reading relevant supplementary material and posting a summary on LEARN, applying what you've learned outside class (e.g., in another course or through a conversation with a friend or family member) and sharing that experience on LEARN, etc. Other activities are welcome!
- **You are expected to regularly attend class**. You can miss up to one class session for any reason without it negatively affecting your Course Engagement grade. In addition, each student can declare one 48-hour absence for the term, as per university policy. If you must miss class due to illness, be sure to self-declare your absence on Quest. (See the Absence Policy, below.) Additional absences may negatively affect your Course Engagement grade.
- At the end of the course, you will **write a summary & reflection on your course engagement and suggest a grade range that you think best reflects the work you did**. (See the Course Engagement assignment directions for details.)

Group Project (20%)

- Towards the end of the course, you will work in groups to research and analyze a real-world issue related to course topics from the second half of the course (e.g., diversity in science).
- Your group will receive one grade on this assignment, unless one or more group members email the instructor to request differential grading. Assignment instructions will be provided on LEARN.
- Each student will be asked to fill out a short peer evaluation of each of their group members, which will be part of your Course Engagement grade.

Learning Portfolio

There is no final exam in this course; instead, you will work on a learning portfolio throughout the course that demonstrates what you learned and gives you an opportunity to critically reflect on your views. This portfolio will include short summaries and critical reflections on course topics and readings, as outlined in the assignment instructions on LEARN.

Mid-term learning portfolio (15%)

- About half-way through the course, you will be asked to pull together any reflections you have written thus far and submit them as part of a mid-term learning portfolio.

Final learning portfolio (25%)

- At the end of the course, you will bundle all of your individual reflections from the course and write an essay that highlights what you have learned, drawing explicit connections to course material, and considers how you might apply your knowledge and skills in other contexts.

Your Best Work (5%)

The graded assignments above add up to 95%. The last 5% of your course grade will be applied to your best individual work. (The exception to this is your Perusall grade, as readings are graded on a pass/fail basis.)

- For example, if your highest mark is on the Mid-term Portfolio, that assignment will be worth 20% of your course grade instead of 15%. If your Final Portfolio is the highest mark, it will be worth 30%.

Late Policy

Assignments are **due by 10:00pm ET** on the dates listed in LEARN. You must submit your work to LEARN or PEAR as instructed in the assignment directions. If you have technical problems submitting your work, email me *and* the TA immediately and attach your assignment before the deadline to avoid late penalties.

- Each student will be given a total of **3 grace days** for submitting late work. These grace days can be used for one assignment or broken up over several assignments (so, you could hand in your Mid-term Portfolio one day late, your Final Portfolio two days late, and everything else on time; or, you could submit your Final Portfolio three days late and everything else on time).
- After all the grace days have been used, there will be a **5-point penalty** for each day or part of a day an assignment is late (including weekends).
- **You do not need to inform the instructor or TA when you use a grace day**. We will track late days and apply them after the final project is in; we will apply grace days first to the late assignments that are weighted most heavily in the overall course grade. If you have more than three late days in total, we will then apply a 5-point late penalty for each additional day an assignment was late.
- Because of these grace days, **no other extensions will be given,** except in extreme circumstances.
- All course work must be submitted no later than Thursday, December 14th at 10pm.

Absence Policy & COVID Contingency

- Students who must miss class due to COVID-19 or other illness must enter absences into the system. Students can self-declare one COVID absence of up to 10 days per term via Quest.
- In addition, students can self-declare one absence for any reason for up to 2 days via Quest, as per university policy.

  - ***Note for INTEG 220:*** *students can have an additional unexcused absence without it affecting their Course Engagement grade. However, such an absence will not lead to an assignment extension; instead, students must use a grace day or receive a late penalty.*
- Further absences require documentation, which students enter via vif.uwaterloo.ca. Absences will be accommodated according to the academic regulations section of the undergraduate calendar.
- In the event of instructor illness, classes may be temporarily suspended and/or classes may be temporarily moved online, depending on the severity of instructor illness and self-isolation requirements. Should the University of Waterloo require the suspension of in-person instructional activity, all classes will be conducted online.

Academic Integrity

- Written assignments must include **proper citations** and a complete list of references. Failure to do so is considered a violation of academic integrity and will be reported to the Associate Dean. (See below for more details on UW's policy around academic integrity.)
- Students may be allowed to use Generative AI (GenAI) tools like ChatGPT in some circumstances, but must include a statement of how GenAI was used. (See the section on GenAI, below.)
- Text matching software (Turnitin®) will be used to screen assignments in this course. This is being done to verify that the use of all material and sources in assignments is documented. If you do not wish to have your work screened by Turnitin, you must contact the instructor via email at least one week in advance of the assignment due date to request an alternative evaluation method.

University Resources: What Supports are Available to Help Me Succeed?

The University of Waterloo provides several resources and support services to help students achieve the academic success they are truly capable of. Most students access some of these services at some point in their degree. I strongly encourage you to make use of any services that might be beneficial to you. I have provided a list of UW's support offices below and on LEARN (click on "Content" and scroll to the bottom).

Mental health issues & Counseling Services

The University of Waterloo, the Faculty of Environment, and the Department of Knowledge Integration consider students' well-being to be extremely important. We recognize that students may face health challenges – physical and/or emotional. **Please note that help is available.** Mental health is a serious issue for everyone and can affect your ability to do your best work. Counselling Services is an inclusive, non-judgemental, and confidential space. They offer confidential counselling for a variety of areas including anxiety, stress management, depression, grief, substance use, sexuality, relationship issues, and more.

All students are encouraged to download the WatSAFE app which is available free through the google and iOS app stores. The WatSAFE app provides on- and off-campus contacts for students in distress, including international students, and other information related to campus safety and security.

- **NOTE from the course instructor:** I have provided mental health resources on the course LEARN site (click "Content", scroll to the bottom, and look for "On (and Off) Campus Resources").

- I also encourage you to take a look at the wellness programs offered by Counseling Services, which can assist you with areas like stress management, managing your mood, procrastination, , depression, etc. Most programs are free. (I took some of these several years ago, when UW was offering workshops for faculty, and I found them to be incredibly helpful.)

AccessAbility Services

AccessAbility Services , located in Needles Hall Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the Accessibility Services at the beginning of each academic term.

- **NOTE from the course instructor:** AccessAbility Services can offer support for a variety of disabilities such as ADHD, chronic pain, etc. If you think you might benefit from accommodations, even for temporary issues, I strongly encourage you to contact Accessibility Services ASAP. Whether or not they can offer you academic accommodations, Accessibility Services advisors can connect you with other support resources on campus.
- Note that **INTEG 220 has no exams**, thus no testing accommodations will be needed. I will also ask for volunteers to contribute to collaborative class notes; this will be useful to all students, including those who require a note-taking accommodation.

Academic Support Services

- The Writing and Communication Centre (WCC) at UW offers writing workshops, online resources, and virtual appointments to assist students with all aspects of the writing process. They also facilitate PJ-friendly undergraduate writing groups if you'd like company while you write!
- UW's Student Success Office (SSO) has created several resources to help students develop good learning strategies, such as time management, note-taking, and reading critically.
- The Centre for Career Action (CCA) advises students regarding further education and career paths.

University Policies

Religious Observances

Students need to inform the instructor at the beginning of term if special accommodations need to be made for religious observances that are not otherwise accounted for in the scheduling of classes and assignments. (*Note: there are no exams in this course and students are allowed two unexcused absences*.)

Intellectual Property

Students should be aware that this course contains the intellectual property of the instructor, TA, and the University of Waterloo. Intellectual Property, or 'IP', includes items such as lecture content, both spoken and written (including any audio/video recordings of such content); lecture notes and other materials prepared for the course (e.g., PowerPoint slides); and assignment instructions. Sharing IP without the

owner's explicit permission is a violation of IP rights. For this reason, you must ask for permission from the instructor via email before sharing course materials with anyone not enrolled in the course.

Respectful Behavior

Policy 33, Ethical Behavior, addresses expectations for all members of the university. The general principle of Policy 33 is that "each member of the University endeavor to contribute to the existence of a just and supportive community based on equality and respect for individual differences." Disrespectful or offensive behavior will not be tolerated. For more information about what constitutes discrimination, harassment, or a poisoned environment, see Policy 33, Ethical Behavior. Furthermore, Policy 71, Student Discipline, covers academic *and* non-academic offenses, such as disrupting other students' learning. In particular, Policy 71 prohibits "disruptive, dangerous, aggressive or threatening behavior, including by electronic means."

The instructor and TA are committed to creating a safe, respectful, and supportive learning environment. If you have been the target of hostile or disrespectful behavior, or you think you have witnessed another student engaging in such behavior towards other students in class, please email the instructor immediately.

Academic Integrity

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. (Check the Office of Academic Integrity for more information.)

Generative AI

Generative artificial intelligence (GenAI) trained using large language models (LLM) or other methods to produce text, images, music, or code, like Chat GPT, DALL-E, or GitHub CoPilot, may be used in this course with proper documentation, citation, and acknowledgement. Permitted uses of and expectations for using GenAI will discussed in class and outlined on assignment instructions.

Recommendations for how to cite generative AI in student work at the University of Waterloo may be found through the Library: https://subjectguides.uwaterloo.ca/chatgpt_generative_ai. Please be aware that generative AI is known to falsify references to other work and may fabricate facts and inaccurately express ideas. GenAI generates content based on the input of other human authors and may therefore contain inaccuracies or reflect biases. In addition, you should be aware that the legal/copyright status of generative AI inputs and outputs is unclear. Exercise caution when using large portions of content from AI sources, especially images. More information is available from the Copyright Advisory Committee: https://uwaterloo.ca/copyright-at-waterloo/teaching/generative-artificial-intelligence

Note that you are accountable for the content and accuracy of all work you submit in this class, including any supported by generative AI.

Discipline

A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for their actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in

learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

- ***NOTE from the instructor**: Students who plagiarize or cheat on an assignment typically receive a 0 on that assignment and another 5 marks off the final course grade; they will also be placed on probation. Students who impersonate others, distribute confidential academic materials, or receive and use such materials will typically receive a 0 on the affected course assignment, as well as suspension. Penalties become more severe after the first offence and can lead to expulsion.*

Grievance

A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4 for details. When in doubt, contact the Undergraduate Advisor for further assistance.

Appeals

A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to Policy 72, Student Appeals.

Land Acknowledgement: On What Traditional Territory is This Course Located?

This course is being taught on the traditional territory of the Neutral, Anishinaabeg, and Haudenosaunee peoples. The University of Waterloo is situated on the Haldimand tract, land taken from the Six Nations that includes ten kilometres on each side of the Grand River.

- If you would like to know more about the role of land acknowledgements, and/or about the Indigenous peoples on whose land many of us live, work, and study, see: http://www.lspirg.org/knowtheland.
- For information about steps that UW is taking related to Indigenization, see https://uwaterloo.ca/faculty-association/information-faculty/faculty-guide-working-waterloo/indigenization-waterloo.

Tentative Schedule of Course Topics & Readings (subject to change)

Week 1: Introduction & Course Overview

- Log into and set up Perusall; read and annotate the Course Syllabus in Perusall
- Fill out the pre-course survey

Week 2: What is Science?

- Read Chalmers, Intro & Chap 1, "Science as knowledge derived from the facts"
- Read Chalmers, Chap 3, "Scientific experimentation"

Week 3: Scientific Reasoning

- Read Chalmers, Chap 4, "Deriving scientific theories from facts"
- Read Firestein, "Ignorance and how it drives science"

Week 4: Scientific Progress

- Read Chalmers, Chap 5, "Introducing falsificationism"
- Read Chalmers, Chap 7, "The limitations of falsificationism"

Week 5: Science in Practice

- Read Chalmers, Chap 8, "Kuhnian paradigms as scientific worldviews"
- *No reading due – work on Midterm Portfolio*

(FALL BREAK, OCTOBER 9-13)

Week 6: Science & Values

- *Optional reading – Firestein, "The unreasonable success of failure in science"*
- Read Douglas, "Rejecting the ideal of value-free science"

Week 7: Diversity in Science

- Read Longino, "Values and objectivity in science"
- Read Phillips, "How diversity makes us smarter"

Week 8: Indigenous Knowledges

- Read Nicholas, "Western science is finally catching up to traditional ecological knowledge"
- Read Whyte, "What do Indigenous knowledges do for Indigenous peoples"

Week 9: Trust in Science

- Read Harker, "Manufactured scientific controversies"
- Read Whyte & Crease, "Trust, expertise, and the philosophy of science"

Week 10: Public Understanding of Science

- Read Goldenberg, "Public misunderstanding of science? Reframing the problem of vaccine hesitancy"
- *No reading due – work on group project*

Week 11: Scientific Expertise

- *No reading due – group project presentations*
- Read Collins & Evans, "Rethinking scientific expertise"

Week 12: Interdisciplinary Collaboration

- Read Plaisance & Kennedy, "A pluralistic approach to interactional expertise"
- Read Eigenbrode et al., "Employing philosophical dialogue in collaborative science"

Week 12+: Course Reflection & Wrap-up

- Final course assignments are due during the exam period