

# Science Education 201

## Western Washington University – Winter 2021

- Class meetings:** MWF 2:00 pm – 3:50 pm required online synchronous meetings via Zoom.  
Dedicated Zoom Room accessed at:  
Note that you must be log into Zoom with your @wwu.edu account.
- Instructor:** Dr. Andrew Boudreaux (andrew.boudreaux@wwu.edu)
- Office hrs:** via Zoom (same Zoom Room as above), MWF 4-4:30, or by appointment.
- TA:** Alena Eldridge ([eldrid3@wwu.edu](mailto:eldrid3@wwu.edu))
- TA office hrs:**
- Guest instructor:** Susan DeBari
- Website:** Canvas. Access to this site is important. Class materials will be posted here.
- Texts:** *There is no required textbook. Written course materials will be provided via Canvas.*

### Overview of physics

Physics is a wonderful human adventure focused on exploring the world around us. I believe the study of physics can be valuable and rewarding for all students, and can help you develop powerful ways of thinking. For example, physics can help students build skills for tackling complex problems. Physics can help world citizens make informed decisions about current global challenges, such as energy generation and climate change. And physics can simply be fascinating and fun. I hope you will bring a willingness to be intrigued, to share your ideas, and to engage with challenging concepts to this course. I will try to connect physics to your own life and interests. My hope is that students leave the course as “ambassadors” of physics, and of science more broadly, who appreciate, enjoy, and advocate for science.

I think of physics as the most basic of the sciences. Foundational concepts like *energy* and *force* are the main focus. Other sciences draw on these concepts. For example, geologists use the physics of waves to pinpoint the location of an Earthquake, and biologists use the physics of energy to understand metabolism. In physics, we develop models to explain and account for how objects behave. For example, in this course you will develop explanations for:

- what you will see if you look at a blue sports car through red-tinted glasses
- why the brakes on your bike become hot when you use them going down a long hill
- how it is possible for the Voyager spacecraft to continue moving at high velocity away from Earth even though it long ago ran out of fuel

### Overview of SCED 201

SCED 201 is a student-centered, inquiry-based physics course designed especially for students pursuing a career in K-8 teaching. While the course focuses on physics content and concepts (rather than teaching methods), the way the course presents this physics content is intended as a model for how K-8 teachers are expected to teach science. That being said, SCED 201 is not restricted to education majors, and does welcome all students and majors!

The course this quarter will be fully remote and online – with required, synchronous class sessions conducted using Zoom. The course will be broken into three units of study:

- *Unit L: Light and color* (about 2 weeks)
- *Unit EM: Energy-based model for motion* (about 5 weeks)
- *Unit FM: A force-based model for motion* (about 3 weeks)

In each unit, you will work collaboratively with partners to develop concepts and construct and test scientific models, based on evidence from observations. Since we are not able to meet in person, and use the lab equipment in the classroom on campus, these observations will come in the form of interactive computer simulations as well as watching short video clips.

### **Required Background and Learning Outcomes**

This is an introductory course that fulfills a general university requirement. It is intended for non-science majors, and assumes no prior background in physics. The course will emphasize sense-making and understanding, rather than calculations and equations.

I know most students taking this course are NOT majoring in science! While I hope and expect students will bring their interest and curiosity about how the world works to this course, I know many or most of you will not be going on to take more physics courses. I therefore strive to connect the learning of specific physics content to other subjects (such as geology and biology), and also to larger questions about the nature of science and the process of learning. I hope these larger issues will be of value to you in your studies beyond this physics course, and even in accomplishing your goals in work and life beyond school.

This course has three broad and interrelated learning outcomes:

**Physics content:** *Students develop concepts and reasoning based on observational evidence. Students apply concepts to make predictions and explain real world phenomena.*

**Nature of science:** *Students describe general aspects and features of scientific models. Students can trace the development of a specific model (e.g., an energy-based model for motion), linking the features of the model to specific observations, inferences, and assumptions.*

**Learning about learning:** *Students become familiar with basic ideas about how people learn. Students become aware of how their own understanding of physics concepts changes and develops.*

These broad learning outcomes will be developed in more detail as the course progresses. Activities and assignments will be keyed to specific learning outcomes. The goal is for students to know *why* they are being asked to do *what* they are being asked to do. In other words, for students to know what they are supposed to learn and how each activity contributes to that learning.

### **Approach to teaching and learning**

As mentioned, this course is *student-centered*. The course will not involve traditional lecturing or reading a textbook. Instead, students will generate knowledge through their own work and discussion. The instructor will serve as a facilitator, or “learning coach”, rather than the source of knowledge and answers.

During class, you will work through guided activities in small groups. You will collaborate with partners to make sense of concepts and create explanations. You will be asked to respond to poll questions and share your thinking with a partner, in a small group, or even with the whole class. The goal is for students to learn actively, through collaboration and consensus. Learning is not a spectator sport, but instead involves active exertion!

This student-centered approach places a lot of responsibility for learning on the shoulders of you, the student. I hope and expect that students will take charge of their own learning in this course, and seek out opportunities to share their ideas, check their thinking, and ask questions. As an instructor, I will sometimes provide information and summarize answers, but will also often teach by questioning rather than by telling. I see this as providing guidance for next steps in learning, giving students good opportunities to figure out key ideas for themselves.

This student-centered approach to teaching and learning may feel a bit different! I hope you find it engaging and valuable. I also acknowledge it can take some getting used to, and even be uncomfortable or frustrating at first.

### **What to expect during class meetings**

Generally speaking, class meetings will alternate back and forth between two different “modes.” The first part of each class will usually be “full-group mode”. This involves full-group discussion of material you have worked on in breakout groups during previous classes. These full-group discussions will include students sharing out with the class about their thinking, poll questions given to the class to check for understanding, and the instructor summarizing key concepts. The second part of each class will generally be “breakout-group mode.” This involves working through guided activities in breakout groups of 3 or 4 students, while instructors will rotate through the groups to check in and respond to questions.

This course makes use of materials from *Next Generation Physics and Everyday Thinking*, a published physics curriculum. Due to the COVID pandemic, the publisher has granted permission for online classes to use digital versions of the curriculum free of charge. The curriculum is divided into “Units” and “Activities”. Each activity is designed to be completed in one class session. The basic schedule for each schedule will thus be roughly as follows:

- Class starts with full-group discussion and review of the previous day’s activity.
- Then students move into breakout groups to work through the next activity.
- If a breakout group does not have time to finish the new activity during the class meeting, that group is expected to finish working through the activity outside of class so that they are ready for the full group discussion at the start of the next class meeting.
- Once an activity has been reviewed in a full-class discussion, a homework assignment on the concepts from that activity will generally be posted, and due by the following class meeting.

This structure will allow us to stay together as a full group, even though different breakout groups will inevitably work at faster or slower paces through the guided activities. Here is a quick example to illustrate what all of this will generally look like:

*On Wed. at 2pm, class starts with a discussion and review of Activity 5. Andrew B. asks several different students to describe the thinking that their breakout group did on the activity, and then presents a short set of slides and poll questions to summarize takeaway ideas from the activity and to check for understanding. This discussion takes 40 minutes. Andrew B. then posts a HW assignment for Act 5, which is due on Fri. 2pm. Then, on Wed. at 2:40pm, students transition into breakout groups, and begin working through Activity 6. The instructors drop in on different groups to chat and go over any questions. By the end of class, at 3:50pm, most breakout groups have finished working through Act. 6, while one or two groups still have a few questions left. Those groups either work for a few minutes after class, or make plans to coordinate the next day to finish the last few questions. On Fri. at 2pm, class starts with Andrew calling on students to share thinking about Act 6...*

### **Student workbooks**

As mentioned, this class does not have a traditional textbook. Instead, the *NextGen Physics and Everyday Thinking* curriculum is composed of a set of activities with guided questions. You will access these activities during class using electronic documents (for example, GoogleDocs or MS Word files). Students are expected to discuss the questions collaboratively, and are expected to write out detailed answers and explanations as they go. In this way, the curriculum activities become a student workbook that serves as the main written resource for your learning. *In other words, the answers that you and your partners write out during your collaborative work form the textbook for this class!* These student workbooks are NOT a graded assignment. They will not be collected. The workbook is for you! It is essential that you write out detailed explanations in your workbook, to capture the thinking and learning you and your partners are doing. Later on, you will need this record of your ideas when completing HW assignments, completing the quizzes (which are open-note!), and writing your learning commentary paper (see below). Students will be able to decide on their own preferred method for maintaining their workbook – but some suggestions will be made. (My recommendation will be for each breakout group to work in a shared GoogleDoc that has the curriculum activities pasted into it.)

### **Graded course work in SCED 201**

*Inclass participation.* Because this class is student-centered and inquiry-based, there is no substitute for attending the class sessions. Credit is therefore given for students attending the Zoom sessions, participating in small group activities, and sharing their thinking in full-class discussions. During some class meetings, attendance will be taken. During some class meetings, poll questions will be given. These will be ways that class participation credit is awarded. (There will likely be additional ways introduced during the quarter.) If you are present, engaged, and contributing to the learning community, you will receive full credit on these class participation opportunities. Note that there are 27 scheduled class meetings for the course. Class participation credit will be given between 10 and 20 of these class meetings (in other words, on many, but not necessarily all class meetings). These participation credit opportunities will not be announced ahead of time. There are no opportunities to make up these assignments. For the overall class participation grade for the course, students are allowed to miss one class participation assignment “no questions asked.” Any additional missed class participation credit beyond the “one free miss” can only be excused with a valid reason discussed ahead of time with the course instructor. Valid reasons include illness, health issues and family emergencies, but not a vacation to Hawaii!

*Homework.* There will be frequent HW assignments, collected via online submission, to give you practice applying concepts and creating explanations through step-by-step reasoning. Most of these assignments will be graded on the basis of effort and completion. That is, you will receive full credit for making a full attempt on the problems, with no penalty for answers that have flaws or are only partially correct. Again, the purpose is to give you chances to practice the ideas with some feedback in a low stakes kind of way. Occasionally, some HW problems will be graded not only on effort and completion, but also on the accuracy and quality of your physics reasoning. These assignments will be slightly “higher stakes” – to push you a bit harder, and give you a good opportunity to rehearse your skills and check your understanding before tackling quizzes. HW assignments that include problems graded on accuracy in this way will be clearly announced ahead of time. Students are encouraged to work on homework assignments collaboratively with peers, and to discuss the problems with instructors during office hours, but should write answers in their own words.

*Quizzes.* Quizzes are a bit “higher stakes” than the hw, and are the part of the course where you are expected to demonstrate understanding of the physics concepts we have developed. The quiz questions will require you to *apply* the concepts to *new* situations (i.e., rather than situations you have already seen or memorized). An emphasis on the quizzes will be creating scientific explanations. Your quiz responses will be graded not just on participation, but also on the basis of complete and accurate physics answers.

Each quiz is online (electronic submission), “take home” (in other words, done outside of classtime), and open note. On the quiz, you can use all your written notes from the lab notebook you have created working through the NextGen PET curriculum activities. However, students are not allowed to consult the internet or other physics textbooks, and must work independently on the quizzes.

There are four quizzes during the quarter. Each will be “comprehensive” – and will include questions based on the material covered in the entire class so far. However, each quiz will *emphasize* the material covered since the last quiz. Generally, a quiz will be posted on Canvas on Monday at 4pm, and due via electronic submission by the following Wednesday at 2pm. A tentative schedule for the quizzes is found below – but note that these quiz dates are tentative, and might need to be revised. (This is because this class, being student-centered, does not have a fixed pace at which we cover material.)

The total quiz grade for the course will be determined from the highest 3 quiz scores. That is, students can drop the lowest quiz. Please note: there are no makeup quizzes offered, and a missed quiz counts as a drop. Student who miss more than one quiz, with a valid, excused reason that is discussed beforehand with the instructor, will have that quiz “waived”. This means that that quiz will neither count for or against the course grade – instead, the total quiz grade will be determined from the remaining quizzes.

*Learning Commentary paper.* Energy is one of the most important unifying concepts in the sciences. Energy concepts for an essential part of not only physics, but also geology, biology and chemistry. More than half of

this course will focus on energy concepts. To demonstrate your learning of energy concepts, you will write a learning commentary paper. In this paper, you will retrace your learning of key ideas from the energy unit. In the paper, you will be asked to describe, in detail, the evidence and inferences that you used to develop your energy-based model for motion and interactions. You will also be asked to illustrate how the model can be applied to account for a new situation. The learning reflection paper will be 5-8 pgs (typed double spaced, with 1" margins and 12 pt font). A short initial draft will be due during week 7 or 8 of quarter. This will be a chance for you to get some feedback on your initial thinking. Then, the final draft of the paper is due on the last day of class, Friday, March 12. The paper will be graded based on clarity and accuracy of explanations, as well as on grammar and spelling. More details along with a specific grading rubric will be provided.

### **Assignment of course grades**

- Inclass participation (20%)
- Homework (30%)
- Quizzes (30% total. There will be four quizzes, but students drop their lowest quiz score. A missed quiz counts as a drop.)
- Learning Commentary paper (20%)

Letter grades are assigned as follows: 93-100 A; 90-93 A-; 87-90 B+; 83-87 B, *etc.*

### Week-by-week schedule of topics

Please note that this schedule is tentative. Because the course is student-centered, the pacing will vary depending on which concepts are more or less challenging for students. That being said, the schedule below can give you a sense for how the course will flow.

#### TENTATIVE SCHEDULE

<b>Week</b>	<b>Day</b>	<b>Date</b>	<b>Topic/NextGen PET activity</b>	<b>Assignments due (dates are tentative!)</b>
<b>1</b>	W	6-Jan	Overview of course, Mystery Tubes	
	F	8-Jan	Class norms, work on L.1	Syllabus, Survey #1
<b>2</b>	M	11-Jan	discuss L.1, work on L.2	Survey #2
	W	13-Jan	L.2, Ext B	<i>hw L.1</i>
	F	15-Jan	Ext B, L.4	<i>hw L.2</i>
<b>3</b>	M	18-Jan	<b>HOLIDAY</b>	
	W	20-Jan	discuss L.4, review Unit L	
	F	22-Jan	Catch up and review Unit L, EM.1	<i>hw L.4</i>
<b>4</b>	M	25-Jan	discuss EM.1, work EM.2&ExtB	<i>hw Unit L review</i>
	W	27-Jan	EM.2, EM.3&ExtE	<b>Quiz 1 (Unit L)</b>
	F	29-Jan	more EM.3, discuss MakeItStick	MakeItStick HW
<b>5</b>	M	1-Feb	EM.3, EM.4	<i>hw EM.1-2</i>
	W	3-Feb	EM.4, EM.5	<i>hw EM.3</i>
	F	5-Feb	EM.5, Catch up and review	<i>hw EM.4</i>
<b>6</b>	M	8-Feb	EM.5, EM.6	<i>hw EM.1-5</i>
	W	10-Feb	EM.7,EM.8*	<b>Quiz 2 (Unit EM.1-5)</b>
	F	12-Feb	EM.8*, EM.9*, Energy review	<i>hw EM.7</i>
<b>7</b>	M	15-Feb	<b>HOLIDAY</b>	
	W	17-Feb	EM.9*, energy review	
	F	19-Feb	catch up and review	<i>hw EM.8-9</i>
<b>8</b>	M	22-Feb	<b>FM.1</b>	<i>hw Unit EM review</i>
	W	24-Feb	FM.1, FM.2	<b>Quiz 3 (Unit EM.1-9)</b>
	F	26-Feb	FM.2, FM.3	<b>Energy paper draft</b>
<b>9</b>	M	1-Mar	FM.3, FM.4	
	W	3-Mar	FM.4, FM.5	<i>hw FM.1-2</i>
	F	4-Mar	FM.5, FM.6	<i>hw FM.3-4</i>
<b>10</b>	M	8-Mar	Catch up and review Unit FM	<i>hw Unit F review</i>
	W	10-Mar	Instructor choice activity!	<b>Quiz 4 (Unit FM)</b>
	F	12-Mar	Surveys 3-4	<b>Energy paper (final)</b>

## **Additional Information**

*Reasonable Accommodation.* Reasonable accommodation for persons with documented disabilities should be established through Disability Resources for Students: 650-3083; [drs@wwu.edu](mailto:drs@wwu.edu); <http://www.wwu.edu/depts/drs/>

*Title IX and Sex Discrimination.* According to Title IX, violence and harassment based on sex which includes sexual harassment, gender-based harassment, and sexual violence (sexual assault, domestic violence, dating violence, stalking) is prohibited. Under Title IX, rape and sexual assault are forms of illegal sex discrimination. Survivors of sexual violence have the right to file a discrimination complaint or seek advice and assistance from the Equal Opportunity Office (EOO) in Old Main 345 (360) 650-3307; University Police (360) 650-3911 (emergency) or 650-3555 (report); Bellingham Police, 911 (emergency) or (360) 778-8800 (report). There are also confidential resources on campus such as Consultation & Sexual Assault Support (CASAS) in Old Main 585B, (360) 650-3700; Student Health Center, Campus Services, (360) 650-316; Counseling Center in Old Main 540, (360) 650-3164.

*Inclusive classroom environment.* Both myself and the WWU SMATE program are firmly committed to equity in all areas of campus life, and supporting the work and achievement of all students. In this class I will work to promote an environment in which all students feel safe and welcome. The success of this policy relies on the support and understanding of the entire group. It is therefore the responsibility of every member of the class to not participate in or condone harassment or discrimination of any kind.

*Religious accommodation.* Western provides reasonable accommodation for students to take holidays for reasons of faith or conscience or for organized activities conducted under the auspices of a religious denomination, church, or religious organization. Details are found here: <https://syllabi.wwu.edu/>

*Integrity.* As a community, Western is committed to integrity in all aspects of academic and campus life. An excellent resource for guiding students is Western's Integrity website ([www.wwu.edu/integrity](http://www.wwu.edu/integrity)). This site is a clearinghouse of resources that encourages and educates about integrity. Besides covering more common problems related to academic integrity, such as plagiarism and cheating on exams, it also addresses ambiguous areas, such as collaborative work, the use of language translators, and submitting the same paper in different classes. In addition to this site, the University Catalog in Appendix D—Academic Honesty Policy and Procedure—delineates rights and responsibilities. Integrity applies to all of the principles, values and behaviors that contribute to good character, including honesty, fairness, respect, courage and responsibility. All members of the Western community have the right to be treated fairly, and to have support and representation if accused of violating university policies related to integrity. They also have the responsibility to exhibit honest behavior, and to encourage others to do the same. If a student is suspected of dishonest behavior, the instructor must address the issue with the student by use of the official university procedures. Not only does this ensure continuity in dealing with such issues, but provides students formal opportunity for representation and appeal. *Note that these incidents do not appear in a student's academic record*

*Academic Honesty* All Western Washington University students have an obligation to fulfill their responsibilities as members of an academic community. Academic integrity is demanded; moreover, academic dishonesty at Western is a serious infraction dealt with severely. No student shall claim as his or her own the achievements, work, or arguments of others, nor shall he or she be a party to such claims. It is the instructor's responsibility to confront a student and to take appropriate action if such academic dishonesty has occurred. See Appendix D: Academic Honesty Policy & Procedure of the catalog for examples, procedures, and methods of appeal and Ensuring Academic Honesty for appeal rules and timeline. *Plagiarism* is presenting as one's own—in whole or in part—the argument, language, creations, conclusions, or scientific data of another without explicit acknowledgement. See the WWU Library's Plagiarism Policies & Guidelines for guidance.

*Medical Excuse Policy* It is the policy of the Western Washington University Student Health Center to not provide medical excuses for short-term absences that result in missed classes, exams or assignments due to illness or injury. In certain circumstances where the illness or injury is prolonged (an absence of more than five days) and requires medical attention or hospitalization, we will work with students in providing appropriate documentation. Review the [Medical Excuse Policy](#) for details.