



T&L 571: Research in STEM Education | Spring 2019

Wednesday 5:45 – 8:30 3 credits
 VMMC 102Q; SPRK 233; SAC 45; TFLO 224
 College of Education | Washington State University

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Office hours: face-to-face or via Zoom, by appointment

Overview and Purpose of the Course

We will review and discuss research related to STEM education goals, policies, instructional practices, student outcomes, and curriculum. Through reading, discussion, and writing, you will have opportunities to understand the historical and socio-political context for the current emphasis on STEM education, how STEM education is being interpreted and implemented in formal and informal educational settings, and varied goals and critiques of STEM education.

There are multiple definitions of STEM education in the field. We offer a definition provided by the Southwest Regional STEM Network (2009) as a starting point for analyzing STEM as a curricular concept:

STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy. (p. 3)

Learning Outcomes

Learning Objective At the end of this course students will develop deeper understandings and/or skills in relationship to:	Evidence of Learning
The questions and methodologies in current research on STEM teaching, learning, learners, and curriculum; the gaps in this research	Class discussion participation Online discussions Final paper
How STEM education is situated in current contexts (e.g., opportunities for all learners in the 21 st century; new standards in all STEM areas; international economic competition)	Class discussion participation Online discussions Final paper
Critiques of the emphasis on and implementation of STEM education	Class discussion participation Online discussions Final paper
Scholarly dialogue focused on STEM education	Facilitation of class discussion Class discussion participation Presentation & discussion of final papers
Academic writing	Final paper

Course Foci:

- Conceptualizing STEM education in terms of curricular, instructional, and school foci
- The affordances and constraints of an integrated/transdisciplinary curriculum approach in relation to the nature and practices of science, mathematics, engineering, and technology
- Research on STEM learning and other affective outcomes associates with STEM education (e.g. attitude, interest, and identity)
- Characteristics of the implementation of STEM curricula and programs
- Challenges associated with implementing STEM education curricula, programs and schools
- Implications for STEM professional learning for inservice and preservice teachers and administrators

Course Assignments (descriptions follow)

Assignment (% of Grade)	Due Date	Points Possible
Discussion Board #1: Original post & responses to two colleagues	Post due on or before Jan. 20 th Responses on or before Jan. 27 th (5 pts each for responses)	10 10
Discussion Board #2: Original post & responses to two colleagues (18.5%)	Post due on or before Feb. 17 th Responses on or before 24 th	10 10
Co-facilitation of class discussion (14%)	Sign up for specific date	30
Prepared participation in class discussions (12%)	Weekly (2 pts each class)	26
Final paper (46%)	April 26 th or before	100
Presentation of final paper (9%)	Sign up for April 17 th or 24 th	20

Attendance Policy

Because class discussion and activities provide the main source of learning for this course and make-up activities are not provided, absences are likely to decrease students' ability to master the course material. If a student misses more than two classes for any reason, the student will need to meet with the instructor to discuss the reason for the absences and plan for addressing the missed time. More than three unexcused absences may result in a loss of credit for the course.

Late Assignment Policy

Late assignments are accepted only after a mandatory meeting with the instructor, unless the student has received prior permission.

Grading

Grade	Percent	Grade	Percent	Grade	Percent	Grade	Percent
A	100 – 93	B	86 – 83	C	76 – 73	D	66 – 60
A-	92 – 90	B-	82 – 80	C-	72 – 70	F	59 or less
B+	89 – 87	C+	79 – 77	D+	69 – 67		

Preparation & Participation in Class Sessions

The format of this course is that of a discussion seminar. Our success depends on each person's preparation and careful reading of the assignments, and then a willingness to participate in class discussions by offering ideas, posing questions, and co-constructing meaning with your peers.

To prepare for class, *use interactive reading strategies* to begin making sense of the assigned readings and to develop your ideas, questions, possible connections to other readings, and your confidence to discuss these in depth during class.

While other sources or personal experiences are often relevant, it will be the theoretical frameworks, methodologies, and results of the assigned papers that will ground the class discussions.

Your grade will be determined by my perception of your level of preparation as well as your active participation during class sessions.

Discussion Board Posts & Responses

Begin a discussion thread with an original post. Others will be responding to your original post; if you can, keep the discussion going by responding to those who respond to you. Additionally, read the original posts of all your colleagues. You are only required to respond to the ideas of at least these two of your colleagues; optimally you will read everyone's posts. The more we can interact with each other's thinking and press on and/or expand on other's ideas, the more we all learn and the deeper we think.

For each of your original posts, do the following:

- **Select** a specific idea or related ideas from the readings and class discussion to expand upon in your post.
- **Reflect** on the content of relevant readings and on the accompanying class discussion.
- Based upon this reflection, develop a post in which you:
 - **examine** how the reading and class discussion about the identified idea(s) impacted your own professional understanding and the possible outcomes of your learning;
 - **analyze** the implications of the targeted idea (for example, a particular theoretical framework for studying student outcomes in STEM programs; the essential elements of STEM high schools; methodologies for research on learning outcomes in STEM programs) for subsequent research on or implementation of STEM education.

Expectations:

1. Your written comments are at the level of analysis and critical reflection; do not merely describe the idea or agree with others' statements. (see below)
2. You clearly ground your analysis and reflection in ideas from the readings, and cite these appropriately using APA style (Author last name, year).
You may include a **short** quote; please reference the quotation using standard APA style: (Author last name, year, p.#). Use quotes sparingly!!

3. Be **concise** and **coherent**. I recommend you write this first as a Word document, proofread, edit it, **save** it, then copy and paste into Bb. Stay focused on the main point(s) you want to make. Present your ideas in a way that will be interesting to others and stimulate discussion.
4. Your responses to at least two colleagues' posts move the conversation forward, take it deeper, bring in new perspectives, raise relevant and meaningful questions, and/or make connections to other relevant, interesting, grounded work.

Original posts:

Exceptional (10): Extremely well thought-out and formulated ideas; meets all criteria for an 8.5 (below) and offers deeply insightful perspectives and scholarly ideas. Citation of ideas is accurate.

Excellent (8.5): Post includes original ideas, specifically references ideas from the readings, and is responsive to others' ideas from class. All posts/responses are substantive in that they are grounded in scholarly perspectives rather than only personal experiences, and synthesize, analyze, and evaluate ideas. Post raises questions, stimulates others' ideas, and/or raises /challenges/considers alternative perspectives.

Satisfactory (7): Post contributes substantively to the discussion and is thoughtful. Further development, depth, and/or specificity is needed in some areas, but overall the ideas are conveyed well. Ideas from readings need to be more explicitly considered.

Needs Development (3): Post is submitted but ideas are underdeveloped, unoriginal, and/or characterized by application to experience but not to scholarly ideas.

Expectations Not Met (0-1): Response is not substantive and/or not respectful.

Responses to others' posts:

Excellent (5): Response contributes to ongoing conversation, is substantive, thoughtful, clear.

Satisfactory (3.5): Response contributes to ongoing conversation but lacks thoughtfulness and/or clarity.

Expectations not met (0-1): Response not substantive in furthering conversation or comment is not respectful of others or response not provided.

Co-Facilitation of Class

Each student will co-facilitate the class discussion once during the semester. Choose a session topic in which you are interested or a date that works best for you.

The session you lead should be *a combination of presentation and discussion* facilitated by you. Consider ways of making the presentation informative, interactive, and memorable. Ground the class discussions with the key ideas from the assigned readings.

You may also draw from additional relevant sources, including short video clips, other articles, and reports. If you do use additional literature, be aware others will not have read these so you will need to be intentional in your support of ways to help them engage with these ideas.

Be prepared to stimulate others' thinking and answer questions from the class throughout. You are encouraged to *use visual aids* (e.g. powerpoint, handouts, graphic organizers, short video clips), *activities*, or any other instructional approach you think will help others engage in the conversation.

Prepare for two hours of class time.

Suggestions & Expectations:

- Expected: Meet EARLY with your partner (email, skype, google docs, google hangout, etc.) – at least a couple weeks prior to your facilitation week.
- **REQUIRED:** Prepare some discussion questions and/or another type of framework to *help your colleagues prepare* for the class discussion.
- **REQUIRED:** *Send the above questions, etc. to Tamara at least 3 days before* your seminar date (so, by Sunday evening). She will post these on Bb to stimulate others' thinking about the readings.
- Expected: Begin by framing the conversation for us, possibly by summarizing a key argument of each article or across the articles. This might be 10-15 minutes. You can be creative in how you do this.
- Use discussion protocols if you feel it will help get everyone's ideas on the table. Do not feel like you have to fill up all the time with your talk. Facilitate discussion by putting out a prompt, then let the conversation unfold. Serve as a critical friend in pushing ideas, probing people's comments, and then let them talk.
- Use breakout groups by site, if desired or possible. Or, if you have other activities that do not allow for this, that is ok. **Let Tamara know the schedule before Wednesday afternoon (before 4:00 so she can tell the AMS operators whether we will be doing breakout groups.**
If you use breakout groups, bring everyone back together to begin a synthesis of ideas, or continued analysis of group's main discussion points.
- Expected: Provide closure to the discussion.

The following criteria will be used to evaluate your facilitation of the class discussion:

<i>10 points: Content/Scholarship</i>
Discussion made significant use of readings, focused on key issues, and maintained a scholarly intellectual level (the latter involves reflection, synthesis of ideas, analysis and use of data and results provided in the paper, etc.)
<i>10 points: Learning Opportunities for your Colleagues</i>
Students were given chances to wrestle with important ideas; discussion provided opportunities to develop understandings of main themes, results, and implications of the readings; connections to topics not highlighted in the readings were made as appropriate
<i>5 points: Clarity/Organization</i>
Discussion had an appropriate balance of free-flow and order; discussion was organized in a manner that allowed for development of ideas the facilitators wished to highlight as well as ideas generated by student participants
<i>5 points: Engagement</i>
Discussion included novel and interesting approaches that captured student interest and motivated students to participate and learn

STEM Education Literature Review

Culminating Assignment | T&L 572 | Spring 2019

The culminating outcome for this course is a review of the professional literature to synthesize current knowledge about a specific area or theme in STEM education. Honey, Pearson, and Schweingruber (2014) lay out many themes in their framework for integrated STEM. We will explore many of these themes across the semester – see the weekly focus questions. Your literature review will go more deeply into a specific area of STEM education that you wonder about. There are different kinds of literature reviews – see chapter 1 in Frederiksen & Phelps for a discussion about the reasons for different types. See, especially, the main purpose of a literature review and the common mistakes on p. 12 (Frederiksen & Phelps, 2018).

The best way to begin your review is to generate a researchable question (e.g., “What are the supports and barriers to teachers’ enactment of STEM education curricula in traditional secondary schools?” “What is the relationship between middle school girls’ participation in all-girls after-school STEM programs and their perseverance in any of the STEM disciplines in high school and beyond?”). You might also have a working hypothesis that you can “test” (support, refute, identify important nuances in your assumptions) with a thorough review of the existing literature (e.g., “Elementary engineering design experiences help students do better in elementary mathematics.” “Typical school structures create barriers to teachers’ enactment of STEM learning experiences.”). Notice that you could turn these hypotheses into questions that guide your investigation. Also notice that each of the examples above propose a relationship between at least two factors relevant to STEM education. This is not always necessary, although framing your review of the literature in this way helps you avoid merely describing one element of STEM education (e.g., “What does integrated STEM education mean?”), something that might have already been done and will not make much of a contribution to the field. See Frederiksen & Phelps, chapter 3, for suggestions on how to focus your topic.

An appropriate number of articles for most subjects should be at least 10-15 readings, but you are encouraged to go beyond this. You are free to use a few (2-3) practitioner (i.e., articles that focus on classroom activities) or popular press articles in your review, but the majority of sources should be research in nature and from commonly-cited journals. You should also read the primary source rather than draw a secondary source, such as another author’s literature review. See chapter 2 in Fredricksen & Phelps for an explanation of different kinds of publications and sources and chapter 5 about evaluating the strength of a source. They also provide good strategies for developing key words and searching databases in chapter 4.

Keeping track of the sources you find and the bibliographic and substantive information about each is critical to your process. And to producing a solid review. Please see chapter 6 for tips on how to manage your sources as you go.

Then -- note that a literature review is not just a serial summary of a collection of articles. Rather, the review should provide a thematic discussion of key findings from the research literature. You should “talk through” the literature and not “about the literature;” in other words, your conclusions about what the articles say in totality should be what frames the paper, rather

than the individual articles themselves. Good reviews provide structure to what the reader should know about the topic, and then detailed information related to the pieces of that structure. The reader should gain an understanding of the core issues and associated evidence-based information related to your topic. You are encouraged to discuss key findings and other details of individual articles, but this should only be done to serve the larger purpose of addressing the major themes and issues. Further, identifying and discussing details that connect across articles is at the heart of a good review. Again, having a process that you follow from the start will serve you well (in terms of frustration) and help you produce a strong, well-grounded, synthesis. **Please please please** skim chapter 7 in Fredriksen and Phelps early on so you set yourself up for success.

Then, be sure to look at chapter 8 to help you lay out your paper and take it to a meaningful depth. Also, look over the rubric to guide your self-assessment and improve your paper before turning it in. Always ask someone else to read your paper for typos, awkward sentences, etc. before turning it in!!!

The timeline for this assignment is as follows (NOTE: please consider turning in work BEFORE the given date – these are deadlines):

- Jan. 30** Theme or area of review due
- Feb. 13** Preliminary list of references due; a very brief (1-2 sentence) description of each article is required, as is information on your plans to identify and use any other references
- March 6** Penultimate list of references due, with a very brief description of each.
- March 27** A brief discussion or outline of the main sections or structure of the paper due
- Apr.17 & 24** Class presentations
- April 26** Final Paper due - The paper should be approximately 15 pages plus references

In addition, you will be required to give a 10-15 minute scholarly talk on your paper during class near the end of the semester. You are encouraged to NOT attempt to tell us everything you found out, but to present the major themes and core issues related to your topic. **Do not** give a serial review of the articles you read, although specifics from individual studies should be used to illustrate major points. The focus of your presentation should be on your larger analysis and conclusions. Your colleagues will be provided with time for questions and comments following your presentation, so please do not plan to go beyond your allotted 10-15 minute presentation time limit.

There are 100 points for the paper and 20 points for the presentation. Note that the rubric for scoring the paper is in the last chapter of the Fredriksen & Phelps book. Guidelines for the presentation will be provided.

References

- Frederiksen, L., & Phelps, S. F. (2018). Literature reviews for education and nursing graduate students. Retrieved from <https://press.rebus.community/literaturereviewseunursing/>
- Honey, M., Pearson, G., & Schweingruber, H. (Eds.). (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research*. Washington, D. C. : National Academies Press.

Course Schedule

The weekly focus questions provide a focus for your reading. Be prepared to discuss the listed articles, reports, and chapters on the day they are listed. This is a working draft; readings may change based on interests and questions that arise as the semester progresses.

<i>Date / Focus Questions</i>	<i>Readings (See complete citation on reference list)</i>
Week 1: Jan. 9 Why STEM education? What is STEM education?	<ul style="list-style-type: none"> - Bybee, 2010 - Honey, Pearson, & Schweingruber, 2014: Ch. 2: A descriptive framework for STEM education, p. 31-48; Ch. 1 optional - Vasquez, 2014
Week 2: Jan. 16 What is STEM education? Why such a press for STEM education?	<ul style="list-style-type: none"> - Gonzalez & Kuenzi, 2012 - Holmlund, Lesseig, & Slavitt, 2018 - Kloser, Wilsey, Twohy, Immonen, & Navotas, 2018 - Washington State STEM Education Innovation Alliance, 2018)
Week 3: Jan. 23 What has the past decade of research on STEM education shown about: STEM models & programs?	Laura Grant, Guest Speaker <ul style="list-style-type: none"> - Capraro et al., 2016 - Herschbach, 2011 - Lesseig, Firestone, Morrison, Holmlund, & Slavitt, 2018 - Roehrig, Moore, Wang, & Park, 2012
Week 4: Jan. 30 What perspectives inform STEM education implementation? What perspectives inform research on STEM education? <i>Lit review theme due</i>	<ul style="list-style-type: none"> - Chiu, Price, & Ovrachim, 2015 - Crismond & Adams, 2012 - Honey et al., 2014: Ch. 4: Implications of the research for designing integrated STEM experiences, p. 77-93. - Kelley & Knowles, 2016
Week 5: Feb. 6 What areas of research on STEM ed are most pertinent in the next decade of research and implementation?	Facilitators 1& 2: <ul style="list-style-type: none"> - Honey, Pearson, & Schweingruber, 2014: Ch. 6: Findings, Recommendations, and Research Agenda, p. 135-152 - Means, Mislevy, Smith, Peters, & Gerard, 2015: Note the summary table on p. 65-69
Week 6: Feb. 13 What has the past decade of research on STEM education shown about: STEM schools? <i>Prelim reference list due</i>	Guest Speakers from Vancouver iTech Prep <ul style="list-style-type: none"> - Bruce-Davis et al., 2014 - Erdogan & Stuessy, 2015 - LaForce et al., 2016 - Peters-Burton, Lynch, Behrend, & Means, 2014

<p>Week 7: Feb. 20</p> <p>What has the past decade of research on STEM education shown about: professional learning for teachers?</p> <p>Challenges in and support for implementing STEM education?</p>	<p>Facilitators 3 & 4:</p> <ul style="list-style-type: none"> - Honey et al., 2014: Ch. 5 Context for implementing integrated STEM, p. 107 – 130 - Lesseig, Nelson, Slavit, & Seidel, 2016 - Nadelson et al., 2013 - Tsybulsky, Milner-Bolotin, & Chachashvili-Bolotin, 2018
<p>Week 8: Feb. 27</p> <p>What has the past decade of research on STEM education shown about: Student attitudes, interest, and achievement?</p>	<p>Sarah Pooler, Guest Speaker</p> <ul style="list-style-type: none"> - Honey et al., 2014: Ch. 3: Integrated STEM experiences: Reviewing the research, p. 64- 71, 94-97 - Guzey, Harwell, & Moore, 2014 - Maltese, Melki, & Wiebke, 2014 - Wang et al., 2011 - Yoon, Dyehouse, Lucietto, Diefes-Dux, & Capobianco, 2014
<p>Week 9: Mar. 6</p> <p>What are alternative points of view or critiques on STEM education?</p> <p>Penultimate reference list due</p>	<p>Facilitators 5 & 6:</p> <ul style="list-style-type: none"> - Burke & McNeill, 2011 - Donovan, Mateos, Osborne, & Bisaccio, 2014 - Jordan, 2019 - Wassell, Hawrylak, & Scantlebury, 2015
<p>Mar. 13</p>	<p>Spring break WSU</p>
<p>Week 10: Mar. 20</p> <p>STEM across different settings: What have we learned?</p>	<p>Facilitators 7 & 8:</p> <ul style="list-style-type: none"> - Krishnamurthi, Ballard, & Noam, 2014 - Marginson, Tytler, Freeman, & Roberts, 2013: Focus on the Executive Summary and Key Findings
<p>Week 11: Mar. 27</p> <p>What has the past decade of research on STEM education shown about: Equity, writ large, and opportunities for populations underrepresented in STEM courses and careers?</p> <p>Lit review outline due</p>	<p>Henriette Burns, Guest Speaker</p> <ul style="list-style-type: none"> - Hudley & Mallinson, 2017 - Hwang & Taylor, 2016 - Museus, Palmer, Davis, & Maramba, 2011
<p>Week 12: Apr. 3</p>	<p>WSUV spring break NARST Work on your lit review!</p>

Week 13: Apr. 10 STEM as transdisciplinary: What are the benefits and challenges of disciplinary integration?	- Bennett & Ruchti, 2014 - Honey et al., 2014: Ch. 3: Integrated STEM experiences: Reviewing the research, p. 51-63. - English, 2016
Week 14: Apr. 17	Student presentations
Week 15: Apr. 24	Student presentations
April 26 or before	Literature review due

Useful websites:

Papers for Successful K-12 STEM education (2011)

http://sites.nationalacademies.org/dbasse/bose/dbasse_080128#.UgEJJBa1eaG

Papers on STEM ed

<http://hub.mspnet.org/index.cfm/23197>

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WSU College of Education (COE) Conceptual Framework

The WSU College of Education's conceptual framework is based on six proficiencies:

1. Knowledge Base
2. Theory and Practice in Education
3. Learners in Cultural Contexts
4. Engaged Learning with Meaning and Purpose
5. Ethical Leadership
6. Local and Global Responsibilities toward a Sustainable and Just Future

General Information

Academic Integrity. Academic integrity is the cornerstone of the university and will be strongly enforced in this course. Any student found in violation of the academic integrity policy will be given a failing grade for the course and will be referred to the Office of Student Conduct. Please take time to read the full statement on student conduct at <http://www.conduct.wsu.edu/>.

Disability Accommodation. Reasonable accommodations are available for students with a documented disability. All accommodations must be approved through your WSU Disability Services office. If you have a disability and need accommodations, we recommend that you begin the process as soon as possible. For more information, contact a Disability Specialist on your home campus.

- **Spokane** [/students/current/StudentAffairs/disability/index.html](http://students/current/StudentAffairs/disability/index.html)
- **Pullman** <http://accesscenter.wsu.edu>
- **Tri-Cities:** <http://www.tricity.wsu.edu/disability/index.html>
- **Vancouver:** <http://studentaffairs.vancouver.wsu.edu/student-resource-center/disability-services>

WSU Safety Statement: Washington State University is committed to maintaining a safe environment for its faculty, staff, and students. Safety is the responsibility of every member of the campus community and individuals should know the appropriate actions to take when an emergency arises. In support of our commitment to the safety of the campus community the University has developed a Campus Safety Plan, <http://safetyplan.wsu.edu>. It is highly recommended that you visit this web site as well as the University emergency management web site at <http://oem.wsu.edu/> to become familiar with this information.

Classroom and campus safety are of paramount importance at Washington State University, and are the shared responsibility of the entire campus population. WSU urges students to follow the “**Alert, Assess, Act**” protocol for all types of emergencies and the “**Run, Hide, Fight**” response for an active shooter incident. Remain **ALERT** (through direct observation or emergency notification), **ASSESS** your specific situation, and **ACT** in the most appropriate way to assure your own safety (and the safety of others if you are able).

Inclusion statement. The instructor of this course is committed to teaching equitably and inclusively, addressing the academic needs, concerns, and interests of every student, regardless

of age, gender, race/ethnicity, religion, social class, sexual orientation, English language proficiency, or disability.

Instructional approach. The primary instructional approach used in this course will be small and large group discussions. An emphasis will be placed on active student participation in discussions and activities.

Professional communication. The faculty members of the Teaching & Learning Department and the College of Education emphasize the importance of effective written and oral communication for professional educators. Students of the program are expected to demonstrate that they can meet standards of professional communication on all of their assignments. A student who fails to adhere to the conventions of writing (e.g. makes consistent grammatical and/or spelling errors, frequently misuses words or phrases, fails to organize writing in an effective manner) may be required to work with the Writing Center or complete additional coursework. Students who fail to meet expectations after being provided with opportunity for remediation and improvement may be removed from the program. Students will also be held accountable for demonstrating that they are capable of clear and professional verbal communication.