# CS6461: Computing Education Research Syllabus

**Course Summary: Governments around the world are increasingly realizing the importance of teaching computer science and how it relates to other disciplines (called *computing*) both to provide for a technology-skilled workforce and to prepare a technologically-informed citizenry in the 21st Century. This course is one of only a handful anywhere that reviews the literature on how people come to understand computing and how to improve that understanding.**

**The course begins with a history of computing education, from the earliest calls to teach everyone to program from Alan Perlis and C.P. Snow in 1961, to the first pedagogical programming environments from Seymour Papert and Andrea diSessa. A particular focus is on supporting differential learning goals for different populations, e.g., the preparation needed for a software engineer is necessarily different than that for a graphic designer who creates scripts to batch process pictures in Photoshop or for an elementary school mathematics teacher who uses computer programming in his class. We build on theory in learning sciences, educational psychology, and mathematics and science education. The latter half of the course emphasizes methods in computing education research (CER) including those in Multi-Institutional, Multi-National (MIMN) studies, laboratory experiments, and classrooms studies.**

**The course uses active learning methods in every session, including small group activities, synthesis activities, and design activities.**

**Learning Objectives:**

* Students will identify learning goals for different populations, identify misconceptions that are likely to occur, and design learning opportunities that will help that population achieve the learning goal and address misconceptions.
* Students will compare technologies to teach a particular audience a particular learning goal.
* Students will describe learning about computing in terms that relate to cognitive science and learning sciences.
* Students will relate current research questions to the ones in the past, and know how to generalize a question to relate it to prior findings in the literature.
* Students will compare the different research venues in computing education research, both to be able to target the right ones for publication and to find appropriate literature for new findings.
* Students will choose research methods appropriate to a research question.
* Students will design a computing education research study in sufficient detail for a funding agency.

**Textbook**: We'll be using readings from the ACM Digital Library (freely available on campus), and Guzdial's new monograph Learner-Centered Design of Computing Education (at the Morgan & Claypool site <http://www.morganclaypool.com/doi/10.2200/S00684ED1V01Y201511HCI033> ). We'll use other readings that are available on the Web or via the Resources folder on T-Square.

## Grades

* 30%: Do **5 Reading Reflections**. There are 6 opportunities for reading assignments. Students can skip one. Reading reflections are marked check or minus (something needs to be fixed). All reading reflections should be typed, with font >= 11 pt. No reading reflection should be longer than 3 pages typed and single spaced.
* 15%: **Class participation**. Class time will be interactive, with little lecture. It's a significant part of the learning in the class to participate.
* 10%: **Research Study Re-Design**. Redesign a research study from a published paper (referenced in *LCD of Computing Ed* or published in ICER, SIGCSE, RESPECT, or ITICSE), to improve on the scope and findings. Due Oct 20.
* 10% **Where would you use this?** Try out any of Scratch, Alice, App Inventor, Snap, StarLogo, NetLogo, Blockly, or Pencil Code. Knowing what you know from class, would you recommend this environment? When? For whom? To learn what? Write a short (2-3 page) paper. Due Nov. 19.
* 10%: **Research Question White Paper**. Write a short (3-4 pages) white paper defining a research question that's worth exploring in CER. Explain why it's an important, interesting, and answerable question. Identify the research community that you are speaking to with this research question. Think first section of an NSF proposal. Due Nov 12.
* 25%: **Research Study Design**. Propose a study to explore your unique research question. Think like an NSF proposal. Plan on 6-10 pages. 15% on paper on day of presentation. 10% on 20 minute presentation (5 minute Q&A) during last week of class.

**Academic Integrity**

Academic dishonesty will not be tolerated. This includes cheating, lying about course matters, plagiarism, or helping others commit a violation of the Honor Code. Plagiarism includes reproducing the words of others without both the use of quotation marks and citation. Students are reminded of the obligations and expectations associated with the Georgia Tech Academic Honor Code and Student Code of Conduct, available online at www.honor.gatech.edu.

**Learning Accommodations**

If needed, we will make classroom accommodations for students with documented disabilities. These accommodations must be arranged in advance and in accordance with the Office of Disability Services. (<http://disabilityservices.gatech.edu>).

**Excused Absence Policy**

<http://www.catalog.gatech.edu/rules/4/>

## Syllabus

Week 1

Aug 18: Introduction to class

* Who are you and what is your experience with computing education?
* Small Group Discussion: What do you want to know about computing education research? What do you think is unknown and worth exploring?

Aug 20: Computing for Everyone. Read Chapter 1 of *LCD of Computing Ed*.

* Pro/Con Debate: "We should teach computing to everyone."

Week 2

Aug 25: Learning Sciences

* If you haven't previously, read Chapter 1 of "[How People Learn](http://www.nap.edu/openbook.php?isbn=0309070368)" and read Chapter 2 of "[How People Learn](http://www.nap.edu/openbook.php?isbn=0309070368)"

Aug 27: The Challenges of Learning Programming. Read Chapter 2 of *LCD of Computing Ed*.

* Small group activity: What's your hypothesis for why programming is hard? How would you test your hypothesis?
* **Reading Reflection:** Using ideas and quotes from Chapter 1 and 2 of "How People Learn" to explain what's hard about learning to program.

Week 3

Sep 1: Read Multi-institutional, multi-national studies in CSEd Research: some design considerations and trade-offs ([ACM DL link](http://dx.doi.org/10.1145/1089786.1089797))

* Compare and contrast: Randomized-control trials (see [definition](https://en.wikipedia.org/wiki/Randomized_controlled_trial)) vs. longitudinal studies (see [definition](https://en.wikipedia.org/wiki/Longitudinal_study)) vs. MIMN studies.
  + What are each good for?
  + Why not use more RCT and longitudinal studies in computing education?

Sep 3: Read Computational Thinking and Using Programming to Learn in *LCD of Computing Ed*

* Generate a list: What are examples of computational thinking?
* Small group activity: Have you ever used programming to help you learn something else? What are the characteristics of when programming helps and when it gets in the way?

Week 4

Sep 8: Read the first Chapter of Changing Minds at [this link](http://www.soe.berkeley.edu/boxer/Chapter1.pdf) and Weintrop and Wilensky from ICER 2015 ([ACM DL link](http://dx.doi.org/10.1145/2787622.2787721))

* Generate a list: What are characteristics of programming environments that support learning?
* Small group activity: How do characteristics of programming for software development and for learning differ?
* **Reading Reflection:** Identify some testable claims about Boxer in diSessa's chapter. How would you test that claim?

Sep 10: Read Media Computation and Contextualized Computing Education in *LCD of Computing Ed*

* A mini-lecture with peer instruction and prediction using Media Computation.
* **Reading Reflection:** When might contextualized computing help, and where might it not?

Week 5

Sep 15: Write a program to create something of interest or answer a question of interest before coming to class.

1. Either download JES (from [Github link](https://github.com/gatech-csl/jes/releases/tag/5.020)) and create a picture or sound that you find interesting.
2. Or Download Python (recommend using the [Enthought install](https://store.enthought.com/)) and use the Computational Freakonomics [website](http://swiki.cc.gatech.edu/compFreak) and [course notes](https://dl.dropbox.com/u/2635522/CompFreak/CompFreakBook-2012b.pdf) to answer a question of interest.
3. Or use the [CSPrinciples Ebook Data Chapters](http://interactivepython.org/runestone/static/CSPrinciples/CSPDataSets/datastates.html) to answer a question about pollution in states.
4. Or try out [Earsketch](http://earsketch.gatech.edu/) to make some music.

Be prepared to show what you made or what you learned in class.

Come to class ready to answer two questions:

* Did this motivate you to learn more about CS or the context?
* Where did programming get in the way, and where did it help?

Sep 17: Read Adults as Computing Learners in *LCD of Computing Ed*.

* Small group activity: What's similar and dissimilar between the teachers and the graphic designers? Identify another class of adults who might need to learn computing. Which group are they more like?

Week 6

Sep 22: Read The state of the art in end-user software engineering ([ACM DL link](http://dx.doi.org/10.1145/1922649.1922658))

* Build two lists: Features of a programming environment that support end-user programming and those that support learning about computing by end-user programmers.

Sep 24: Read Learner-Centered Computing Education for CS Majors by *LCD of Computing Ed*

* Small group activity: Come up with examples from your own experience of (a) CS education that you see as learner-centered and (b) CS education that was not learner-centered.
* **Reading Reflection:** Contrast the adults in Chapter 5 and the non-majors in Chapter 6 with the CS majors in Chapter 7. What's similar and what's different about their learning and the support that they need?

Week 7

Sep 29: Read one of:

1. Spatial Skills Training in Introductory Computing (see [ACM DL link](http://dx.doi.org/10.1145/2787622.2787728))
2. Subgoals, Context, and Worked Examples in Learning Computing Problem Solving (see [ACM DL link](http://dx.doi.org/10.1145/2787622.2787733))
3. Boys' Needlework: Understanding Gendered and Indigenous Perspectives on Computing and Crafting with Electronic Textiles (see [ACM DL link](http://dx.doi.org/10.1145/2787622.2787724))

Come to class ready (a) to summarize your paper and (b) to support/refute these three hypotheses:

* We ought to add spatial skills training in all introductory CS courses.
* We ought to use subgoal-labeled worked examples in all introductory CS courses.
* We have to consider gender and cultural relevance in designing all introductory CS courses.
* **Reading Reflection:** You are the Director of Georgia Tech's Division of Computing Instruction. You may implement one change across all of your introductory courses, and you have very little budget. What will you change?

Oct 1: Read Towards Computing for All in *LCD of Computing Ed*.

* **BIG** list: What do we most need to know to advance computing for all? Where are the research gaps?
* Everyone leave with a personal list of the top three research gaps that you find most interesting.
* **Reading Reflection:** Pick **any** paper referenced in *LCD of Computing Ed* that we did not read separately in this class. Read it and summarize it for me.

Week 8

Oct 6: Read Margulieux and Madden's "Educational Research Primer" (in class Resources)

* Small group activity: For your favorite research gaps, what research methods would you use to fill some of that gap?
* Group activity list: What are the research methods that we need to learn more about?

Oct 8: **RESEARCH METHODS**: Based on the Oct 6 discussion, we'll pick a paper or two to read here to inform our knowledge of research methods.

**Newer Research**

* [Outlier's evaluation of Code.org](http://outlier.uchicago.edu/evaluation_codeorg/)
* [Phil Sadler's PCK Paper](https://t-square.gatech.edu/access/content/group/gtc-7c5e-1c5e-5956-90a5-eeb56ec284e8/Sadler-PCK-0002831213477680.pdf)
* [Miranda's paper on Privilege](https://t-square.gatech.edu/access/content/group/gtc-7c5e-1c5e-5956-90a5-eeb56ec284e8/p68-short3-parker-paper_21.pdf)

Week 9

Oct 13: **No class!** Fall Break.

Oct 15: **RESEARCH METHODS**: Based on the Oct 6 discussion, we'll pick a paper or two to read here to inform our knowledge of research methods.

* Discussion of Research Project: You don't have to do it. You do have to design it.
  + First step: Define your question (due Nov 10), and make it answerable.
  + Second step: Tell us how you'd answer it.

**Older Research**

* [Alan Collins on Design Based Research](http://booksite.elsevier.com/brochures/educ/PDF/Design_Experiments.pdf)
* [Phyllis Blumenfeld on Project-Based Learning](https://t-square.gatech.edu/access/content/group/gtc-7c5e-1c5e-5956-90a5-eeb56ec284e8/blumenfeld1991.pdf)

Week 10

Oct 20: **Research Re-Design Due Here**

Oct 22: Read sample NSF proposals in Resources. (Note: They both weren't funded in this form.)

* Group Dissection:
  + What are the research questions?
  + What are the hypotheses?
  + What are the research methods?
* Small group: Is this do-able? Would you give it a thumbs-up or a thumbs-down?

Week 11

Oct 27: What's involved in reaching and studying different populations? Large scale: Read 37 Million Compilations: Investigating Novice Programming Mistakes in Large-Scale Student Data ([ACM DL link](http://dx.doi.org/10.1145/2676723.2677258)) and Programming in the wild: trends in youth computational participation in the online scratch community ([ACM DL link](http://dx.doi.org/10.1145/2670757.2670768))

* Let’s Make Two lists: What can we know from looking at these kinds of data, and what can't we know?

Oct 29: What's involved in reaching and studying different populations? Small scale interviews/phenomenography: Read Graduating students' designs: through a phenomenographic lens ([ACM DL link](http://dx.doi.org/10.1145/2632320.2632353))

* Small group discussion: What can we answer with a phenomographic approach that we can't learn (easily) in other ways?

Week 12

Nov 3: What's involved in reaching and studying different populations? In the High School: Read A Crafts-Oriented Approach to Computing in High School: Introducing Computational Concepts, Practices, and Perspectives with Electronic Textiles ([ACM DL link](http://dx.doi.org/10.1145/2576874))

* Sharing example about getting into K-12 schools.

Nov 5: **Special Guest: Mike Horn from Northwestern**

9:45-10: As a group, decide on your questions.

10-11: Ask questions of our Skype guest, Mike Horn from Northwestern.

CS Education Research in IDC. Read Strawbies: explorations in tangible programming ([ACM DL link](http://dx.doi.org/10.1145/2771839.2771866)) and "Let's dive into it!": Learning electricity with multiple representations ([ACM DL link](http://dx.doi.org/10.1145/2771839.2771892))

* Come in with something you'd like to know about these papers.
* Ask Mike: What's different at publishing at IDC?

Week 13

Nov 10: CS Education Research in CHI. Read Learning on the job: characterizing the programming knowledge and learning strategies of web designers ([ACM DL link](http://dx.doi.org/10.1145/1753326.1753430)) and Programming in the pond: a tabletop computer programming exhibit ([ACM DL link](http://dx.doi.org/10.1145/2559206.2581237))

* Group list: What makes a CHI paper different from an ICER paper?

Nov 12: **Research White Paper Due Here**

Week 14

Nov 17: CS Ed Research at Georgia Tech. Read two papers. One: Read one of Betsy DiSalvo's papers -- your choice.

Two: Read Engaging underrepresented groups in high school introductory computing through computational remixing with EarSketch ([ACM DL link](http://dx.doi.org/10.1145/2538862.2538906))

1. Group list:
   * How do Betsy and Mark's research questions, hypotheses, and methods differ.
   * What are the research questions, hypotheses, and methods for EarSketch?
   * How would you characterize the CS Ed Research going on at Georgia Tech?

Nov 19: Try it out! Hand in your **Where would you use this?** papers before class. Come to class prepared to demo the environment you picked.

* Debate: For a set of audiences and learning goals that we define in class, argue for your environment to meet that need.

Week 15

Nov 24: *Present Research Designs*

**Research Design Paper Due on the Day of Your Presentation.**

Research presentations are 20 minutes long. Summarize your research problem for the class, then present your experiment design.

Nov 26: **No Class!** Eat Turkey.

Week 16

Dec 1: Present Research Designs

Dec 3: Present Research Designs