Foundations of Educational Neuroscience (BEP-570)

College of Education, The University of Alabama

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Course Description

This is an introductory course on Educational Neuroscience, an emerging area of research grounded in multiple disciplines including (but not limited to) educational psychology, neuroscience, cognitive science, and learning sciences. The purpose of this course is to provide an introduction to major issues and topics in these domains and discuss implications for educational research and practice.

Educational Neuroscience started as a conversation between brain sciences and education. However educational neuroscience is now becoming a field in itself. A field is defined by the grand questions that guide investigations, methodologies, a body of literature and a community of scientists. These are yet to be realized for educational neuroscience. Discussions in this class and the work students pursue after taking it will hopefully contribute to the efforts in defining this new area of research.

Course Objectives

- Students will explore major themes and paradigms in learning, brain, and cognition.
- Students will discuss the implications of primary research in brain science for educational research and learning design practice.
- Students will synthesize, criticize and interpret empirical work and theoretical perspectives in a specific domain of their choice that relate to their research interests and future research agenda.
- Students will formulate ideas for future empirical research in their field of study that incorporate perspectives and methodology from brain science.
- Students will compare and contrast various research methodologies in learning sciences, educational psychology and cognitive neuroscience.

Prerequisites

There are no prerequisites for this course.

Overview of Weekly Themes & Schedule

1. An introduction to educational neuroscience (Aug 20)
2. Research methods in educational neuroscience and educational psychology (Aug 27)
3. Language development (Sept 3)
4. Literacy development (Sept 10)
5. Social development (Sept 17)

6. Mathematical development (Sept 24)
7. Science learning and scientific reasoning (Oct 1)
8. Computational Modeling (Oct 8) ****Project proposal due****
9. Executive mechanisms & self regulation (Oct 15)
10. Emotion and cognition (Oct 22)
11. Embodied cognition (Oct 29)
12. Evolution of cognition (Nov 5)
13. Culture, brain, and cognition (Nov 12)
14. Criticisms of educational neuroscience (Nov 19)
    - Thanksgiving Week (Classes Dismissed) Nov 21 – 29
    - ****Final project paper draft due (Dec 1)****
15. **Student-led project presentations & discussions (Dec 3)**
    - ****Final Project Paper due (Dec 11)****

Course Activities

Weekly Readings & Reflections

You are expected to read all weekly readings. There are also some recommended readings. Most weeks we will have one chapter from the textbook (see below) and one review or primary research article. You will be able to download all readings from the Blackboard site.

You will write a reflection about each week's readings that will synthesize ideas from the readings for the week and post these on the forum for that week in Blackboard. You are expected to submit your reflections by 8:00 AM on the day of the class (Thursday). At the end of your reflection you will pose two discussion questions to be covered in class. The discussion questions should be in a separate paragraph and in bold-text, so that viewers of your post can quickly spot your questions for the week.

Course Project

The project is an opportunity to focus on an area that is of interest to you. There are multiple options for the course project as explained below.

Option 1) Literature Review

You will determine an area of research relevant to educational neuroscience, review the literature in this area, and author a literature review that synthesizes the main findings and discusses the controversies and gaps in the literature.

Option 2) Research Proposal

You will propose a research study that addresses an open question relevant to educational neuroscience. The proposal should include a literature review section that summarizes the main findings and points to a gap in the literature, which would be targeted by the proposed study. Clear research questions should be posed. The research proposed should utilize behavioral as well as neuroimaging methods.

Option 3) Book Review

You will choose a book relevant to educational neuroscience and write a review. The review should provide a summary of the contents of the book, situate the perspectives presented in the book in the larger landscape of research in cognitive and educational neuroscience, and point to the strengths and weaknesses of the arguments presented.

Deliverables

The deliverables for the project include:

- **Project proposal (due Oct 8, 2020)**: You will submit a proposal for your project that indicates which of the three options mentioned above you chose, explains the topic you will focus on, and why you think this topic is important. For the first two options, you will also include a preliminary bibliography of work in the area chosen, with at least 20 citations.
- **Project presentation & discussion session (Dec 3, 2020):** In the last class you will give a (~15 min) presentation on your project to share insights from your semester long exploration.
- **Project paper (draft due Dec 1, final version due Dec 11)**: You will submit a max 5000 words paper based on your proposal. You will share a full draft of your paper with another student in class by December 1st. Using the online system, each student in class will provide feedback to another student's paper. After making revisions based on the feedback received, you will submit the final version of your paper by December 11th.

Grading

Readings, reflections and class participation Reflection: 2pts; Discussion question: 1 pt; Class participation: 1 pt	14x4 = 48 pts
Project Proposal	11 pts
Project presentation & discussion session	11 pts
Project final paper	30 pts
Total	100 pts

Grading scale: A: 90 - 100, B: 80 - 89, C: 70 – 79, D: 60 – 69, F: 0 - 59

Textbook (TB)

Mareschal, D., Butterworth, B., & Tolmie, A. (Eds.). (2014). Educational Neuroscience. John Wiley & Sons. (both digital and hardcopy available from the UA Library)

Weekly Readings

"**Opt**:" marks optional readings (unmarked readings are required). The articles have links to pdf files.

1. An introduction to educational neuroscience (Aug 20)

- [TB Chp1] Butterworth, B & Tolmie, A. (2014) Introduction
- Thomas, M. S. C., Ansari, D., & Knowland, V. C. P. (2019). Annual Research Review: Educational neuroscience: progress and prospects. Journal of Child Psychology and Psychiatry and Allied Disciplines [link]
- **Opt**: Howard-Jones, P. A. (2014). Neuroscience and education: myths and messages. Nature Reviews Neuroscience [link]

2. Research methods in educational neuroscience and educational psychology (Aug 27)

- [TB Chp 2] Dick, F., Lloyd-Fox, S., Blasi, A., Elwell, C., Mills, Debbie. (2014). Neuroimaging methods.
- Han, H., Soylu, F., & Anchan, D. M. (2019). Connecting Levels of Analysis in Educational Neuroscience: A Review of Multi-level Structure of Educational Neuroscience with Concrete Examples. Trends in Neuroscience and Education [link]
- **Opt**: [TB Chp 5] Tolmie, A. (2014). Research methods in educational psychology.

3. Language development (Sept 3)

- [TB Chp 6] Knowland, V., Donlan, C. (2014). Language development.
- Kuhl, P. K. (2011). Early Language Learning and Literacy: Neuroscience Implications for Education. Mind, Brain and Education [link]
- **Opt:** Kuhl, P. K. (2010). Brain Mechanisms in Early Language Acquisition. Neuron [link]

4. Literacy development (Sept 10)

- [TB Chp 7] Fern-Pollak, L., Masterson, J. (2014). Literacy development.
- Schlaggar, B. L., & McCandliss, B. D. (2007). Development of neural systems for reading. Annual Review of Neuroscience [link]
- **Opt**: Hruby, G. G., Goswami, U., Frederiksen, C. H., & Perfetti, C. A. (2011). Neuroscience and Reading: A Review for Reading Education Researchers. Reading Research Quarterly [link]

5. Social development (Sept 17)

- [TB Chp 10] Blakemore, S.J., Cohen Kadosh, K., Sebastian, C., Grossman T., Johnson, M. (2014). Social development.
- Burnett, S., Sebastian, C., Cohen Kadosh, K., & Blakemore, S. J. (2011). The social brain in adolescence: Evidence from functional magnetic resonance imaging and behavioural studies. Neuroscience and Biobehavioral Reviews [link]
- **Opt:** Redcay, E., & Schilbach, L. (2019). Using second-person neuroscience to elucidate the mechanisms of social interaction. Nature Reviews Neuroscience [link]

6. Mathematical development (Sept 24)

- [TB Chp 8] Butterworth, B., Varma, S. (2014). Mathematical development.
- Ansari, D., & Lyons, I. M. (2016). Cognitive neuroscience and mathematics learning: how far have we come? Where do we need to go? Zdm [link]
- **Opt:** De Smedt, B., & Grabner, R. H. (2016). Potential applications of cognitive neuroscience to mathematics education. Zdm [link]

7. Science learning and scientific reasoning (Oct 1)

- [TB Chp 9] Fugelsang, J., Mareschal, D. (2014). The development and application of scientific reasoning.
- Klahr, D., Zimmerman, C., & Jirout, J. (2011). Educational Interventions to Advance Children's Scientific Thinking. Science [link]
- **Opt**: Masson, S., Potvin, P., Riopel, M., Foisy, L. M. B., & Lafortune, S. (2012). Using fMRI to study conceptual change: Why and how? International Journal of Environmental and Science Education [link]

8. Computational Modeling (Oct 8)

- [TB Chp 9] Thomas, M. S. C., Laurillard, D. 2014). Computational modeling of learning and teaching.
- Soylu, F., Holbert, N., Brady, C., & Wilensky, U. (2017). Embodied Perspective Taking in Learning About Complex Systems. Journal of Interactive Learning Research [link]
- **Opt**: Wilensky, U., & Reisman, K. (2006). Thinking like a wolf, a sheep, or a firefly: Learning biology through constructing and testing computational theories—an embodied modeling approach. Cognition and instruction [link]

9. Executive mechanisms & self regulation (Oct 15)

- [TB Chp 12] De Haan, M. (2014). Attention and Executive Control.

- Blair, C., & Raver, C. C. (2014). School Readiness and Self-Regulation: A Developmental Psychobiological Approach. Annual Review of Psychology [link]
- **Opt**: Diamond, A. (2013). Executive functions. Annual Review of Psychology [link]

10. Emotion and cognition (Oct 22)

- [TB Chp 11] Jones (2014). Emotional Development
- Pessoa, L. (2008). On the relationship between emotion and cognition. Nature Reviews Neuroscience [link]
- **Opt**: Immordino-Yang, M. H., & Damasio, A. (2007). We Feel, Therefore We Learn: The Relevance of Affective and Social Neuroscience to Education. Mind, Brain, and Education [link]

11. Embodied cognition (Oct 29)

- Gallagher, S. (2017). Enactivist interventions: Rethinking the mind. Oxford University Press. [Chapters 1 & 2] [link]
- Anderson, M. L. (2003). Embodied Cognition: A field guide. Artificial Intelligence [link]
- **Opt**: Smith, L., & Gasser, M. (2005). The Development of Embodied Cognition: Six Lessons from Babies. Artificial Life [link]
- **Opt**: Barsalou, L. W. (2008). Grounded Cognition. Annual Review of Psychology [link]

12. Evolution of cognition (Nov 5)

- Anderson, M. L. (2014). After phrenology: Neural reuse and the interactive brain. MIT Press. [Chp1, pgs 1-43] [link]
- Schoenemann, P. T. (2006). Evolution of the Size and Functional Areas of the Human Brain. Annuall Review of Anthropology [link]
- **Opt**: Corballis, M. C. (2010). Mirror neurons and the evolution of language. Brain and Language [link]

13. Culture, brain, and cognition (Nov 12)

- Kitayama, S., & Uskul, A. K. (2011). Culture, mind, and the brain: current evidence and future directions. Annual Review of Psychology [link]
- Duque, J. F. D., Turner, R., Lewis, E. D., & Egan, G. (2010). Neuroanthropology: A humanistic science for the study of the culture-brain nexus. Social Cognitive and Affective Neuroscience [link]
- **Opt**: Tcheang, L. (2013). Culture and Math. Cognitive Neuroscience [link]

14. Criticisms of educational neuroscience (Nov 19)

- Bowers, J. S. (2016). The Practical and Principled Problems with Educational Neuroscience. Psychological Review [link]
- Howard-Jones, P. A., Varma, S., Ansari, D., Butterworth, B., ... (2016). The principles and practices of educational neuroscience: Comment on Bowers (2016). Psychological Review [link]
- **Opt**: Gabrieli, J. D. E. (2016). The promise of educational neuroscience: Comment on Bowers (2016). Psychological Review [link]
- **Opt**: Bowers, J. S. (2016). Psychology, not educational neuroscience, is the way forward for improving educational outcomes for all children: Reply to Gabrieli (2016) and Howard-Jones et al. (2016). Psychological Review [link]

***** Thanksgiving Week (Classes Dismissed) Nov 21 – 29 *****

15. Student-led project presentations & discussions (Dec 3)

Recommended Books

Educational Neuroscience

- Dehaene, S. (2020). How We Learn: Why Brains Learn Better Than Any Machine... for Now. Penguin.

Embodied Cognition

- Varela, F. J., Thompson, E., & Rosch, E. (2016). The embodied mind: Cognitive science and human experience. MIT press.
- Maturana, H. R., & Varela, F. J. (1987). The tree of knowledge: The biological roots of human understanding. New Science Library/Shambhala Publications.
- Clark, A. (1998). Being there: Putting brain, body, and world together again. MIT press.
- Gallagher, S. (2017). Enactivist interventions: Rethinking the mind. Oxford University Press.
- Chemero, A. (2011). Radical embodied cognitive science. MIT press.
- Anderson, M. L. (2014). After phrenology: Neural reuse and the interactive brain. MIT Press.

Evolution, Learning, & Cognition

- Geary, D. C., & Berch, D. B. (Eds.). (2016). Evolutionary perspectives on child development and education. Springer.
- Tomasello, M. (2009). The cultural origins of human cognition. Harvard university press.
- Shubin, N. (2008). Your inner fish: a journey into the 3.5-billion-year history of the human body. Vintage.

Learning Sciences

- Papert, S. (1980). Mindstorms: Computers, children, and powerful ideas. NY: Basic Books, 255
- DiSessa, A. A. (2001). Changing minds: Computers, learning, and literacy. Mit Press.

Reading & Literacy

- Dehaene, S. (2009). Reading in the brain: The new science of how we read. Penguin.

Mathematical Cognition & Learning

- Lakoff, G., & Núñez, R. (2000). Where mathematics comes from (Vol. 6). New York: Basic Books.
- Dehaene, S. (2011). The number sense: How the mind creates mathematics. Oxford University Press
- Butterworth, B. (1999). The mathematical brain (p. pp). Macmillan.
- Geary, D. C., Berch, D. B., & Koepke, K. M. (Eds.) (2019). Cognitive foundations for improving mathematical learning . Academic Press.
- Berch, D. B., Geary, D. C., & Koepke, K. M. (Eds.) (2018). Language and Culture in Mathematical Cognition. Academic Press.
- Berch, D. B., Geary, D. C., & Koepke, K. M. (Eds.). (2015). Development of mathematical cognition: Neural substrates and genetic influences. Academic Press.
- Geary, D. C., Berch, D. B., & Koepke, K. M. (Eds.). (2014). Evolutionary origins and early development of number processing. Academic Press.

Neuroscience Methods

- Luck, S. J. (2014). An introduction to the event-related potential technique. MIT press.
- Poldrack, R. A., Mumford, J. A., & Nichols, T. E. (2011). Handbook of functional MRI data analysis. Cambridge University Press

Data Analysis & Coding

- Cohen, M. X. (2014). Analyzing neural time series data: theory and practice. MIT press.
- Cohen, M. X. (2017). MATLAB for brain and cognitive scientists. MIT Press.

Critical Work

- Satel, S., & Lilienfeld, S. O. (2013). Brainwashed: The seductive appeal of mindless neuroscience. Basic Civitas Books.
- Uttal, W. R. (2013). Reliability in cognitive neuroscience: A meta-meta-analysis. MIT Press.

Neuroscience Miscellaneous

- Glickstein, M. (2014). Neuroscience: A historical introduction. MIT Press.

Policy Statements

Policy on Missed Exams and Coursework

It is important that students turn in all assignments on time. Except in the case of documented severe illness, funeral of a family member, or a personal, catastrophic or religious event (as defined by the University policies), assignments submitted late, within three days of the deadline, will receive a 50 % grade reduction. Late assignments, after three days of the deadline, will not be accepted.

Attendance Policy

Class attendance is required. It is expected that you undertake appropriate prior preparation for each class period and actively participate during class. Attendance will be taken. If you have 2 to 4 unexcused absences, a full letter grade (e.g., from an A to a B) reduction will be applied to your final grade. If you have 5 or more unexcused absences a two letter grade reduction will be applied to your final grade.

Notification of Changes

The instructor will make every effort to follow the guidelines of this syllabus as listed; however, the instructor reserves the right to amend this document as the need arises. In such instances, the instructor will notify students in class and/or via email and will endeavor to provide reasonable time for students to adjust to any changes.

COVID19 Safety & UA Return Plan

All University faculty, staff, and students are expected to maintain a commitment to the health and safety of our campus community. Due to the current COVID-19 pandemic, specific health and safety standards are in place to minimize exposure and community spread on campus. In the interest of your health and safety and that of all UA students, faculty and staff, the University reserves the right to change the mode of instruction or schedule of instruction at any time, based upon prevailing public health and other guidance. While the method of delivery may change, educational instruction and opportunities will continue. As such, the University will not provide a refund of tuition, in whole or in-part, based on any such changes. Detailed information on changes in format or schedule can be found at https://studentaccounts.ua.edu/ and https://financialaid.ua.edu/.

All students must be familiar with and abide by the requirements outlined in the UA Return Plan | UA System Comprehensive Health and Safety Plan. Students must (1) wear a mask or face covering at all times while participating in face-to-face class; (2) adhere to social distancing standards; and (3) comply with all other health and safety restrictions. If a student refuses to comply with the requirements, the student will be asked to leave the class and reported for a conduct violation. Unless a student has an exemption from the requirement to wear a face covering, (more information can be found at http://ods.ua.edu/covid-19-disability/), the student will be reported to Student Life for further disciplinary action. More information on these requirements and UA Healthcheck system and screening can be found at http://healthinfo.ua.edu/returnplan. You are expected to visit the site and comply with all noted requirements related to in-person class attendance.

Mission of the College of Education

Our mission in the College of Education is to be a leader in Alabama and across the nation in teaching, scholarship, advocacy, and service by developing professionals with pedagogic and disciplinary expertise who advance the intellectual and social conditions of all learners in a globalized society.

Conceptual Framework Summary

The vision of the College of Education (COE) at The University of Alabama is to develop effective, ethical, and reflective professionals who advance the theme of the COE: Unite, Act, and Lead (UA Leads). By engaging in theoretically informed and intellectually advanced effective practice our graduates will

UNITE with the larger community to collaboratively nurture cultural competence, empathy, and a vision of equity and justice for all learners;

ACT to develop the full potential of all learners to be excellent professionals in their fields; and

LEAD through continuous research-based critical inquiry of policy and reflective practice to enable transformative change in our diverse local and global communities.

Dispositions

We strive to create programs that emphasize Fairness and Equity, Reflective Stance for Professional Practice, a Commitment to Diversity, and a Culture of Collaboration.

Statement on Academic Misconduct

Students are expected to be familiar with and adhere to the official Code of Academic Conduct provided in the Online Catalog (https://catalog.ua.edu).

Statement on Disability Accommodations

- Contact the Office of Disability Services (ODS) as detailed in the Online Catalog.
- The Office of Disability Services (ODS) is the central contact point for UA students with disabilities. The goal of ODS is to ensure that University programs and services are accessible to qualified students with disabilities. For student who may require their services more information is available at http://ods.ua.edu. ODS is located at 1000 Houser Hall and their phone number is 348-4285 (voice) or 348-3081 (TTY).

Severe Weather Protocol

Please see the latest Severe Weather Guidelines in the Online Catalog. The link for the Severe Weather Guidelines is https://ready.ua.edu/severe-weather-guidelines/

Statement on Pregnant and Parenting Students

Title IX is a federal law that prohibits discrimination on the basis of sex in an education program. Among the types of gender discrimination covered by this statute, Title IX protects against discrimination related to pregnancy or parental status. Protection extends to students who are pregnant or who have either had a false pregnancy, termination of pregnancy, have gone through childbirth, or are recovering from any of those conditions. Title IX regulations also prohibit a school from applying any rule related to a student's parental, family or marital status that treats students differently based on their sex. For more information, please go to http://provost.ua.edu/uploads/3/9/7/6/39760652/student_pregnancy_faq_final_8_11_17.pdf

Statement on Religious Observances

The University of Alabama respects the religious diversity of our academic community and recognizes the important of religious holy days and observances in the lives of our community members. For more information, please go to http://provost.ua.edu/religious-observances.html

Statement on Academic Work Duplication

Any submission of academic work designed to meet the requirements of a particular credit-bearing course is assumed to be work completed for that course and only that course; the same material submission, or material that is substantially similar, may not be used to meet the requirements of another course. Any violation of this rule may result in a referral to the Associate Dean for Student Services and Certification for disciplinary action.

UAct Statement

The UAct website provides an overview of The University's expectations regarding respect and civility. The website link is https://www.ua.edu/campuslife/uact/