DayOneKeynote

Sun, 11/15 2:51PM • 56:25

SPEAKERS

Lauren Margulieux, Jamie Gorson

Jamie Gorson 00:00

My name is Jamie Gorson. I'm a fifth year PhD student at Northwestern University in the Computer Science and Learning Sciences PhD program. I work [inaud], and my research focuses on understanding how students evaluate their programming intelligence with the goal of developing technology in order to increase student persistence. So today I have the honor of introducing Dr. Margulieux. She's an assistant professor in learning technologies in the department of learning sciences at Georgia State University. She has a background in psychology and earned her PhD from the Georgia Institute of Technology in engineering psychology. Dr. Margulieux's psychology experience gives her a great background for making impactful contributions to the CS community. She has won numerous awards for work, including the best paper award at the two most recent ICER conferences, which is the international computing education research conference. Her work spans multiple areas in CS education. What does her long term one of our long term projects is on sub goals, which she defines as functional pieces of the problem solving procedure. And she's thought about how to apply these in many different contexts. Today her talk is titled, learning sciences for computing, education, research theory and research design. And based on her prior experience, I know we're in for a treat. So throughout our throughout her talk, I'm going to monitor the zoom chat, so feel free to ask any questions that might come up. And then when she finishes, I will ask her those questions from the zoom chat. So without any further ado, Dr. Margulieux.

Lauren Margulieux 01:27

Thank you very much. Let me pull this. All right. Oh, good on the slides. Yeah. Okay. Yes, we can see them. Thank you very much for that lovely introduction. So I was asked to come and talk today about learning sciences, particularly for computing, education, research, and how theory and research design connects these two things. And I eagerly agreed, because this is one of my favorite things to talk about. Like Jamie mentioned, I have a background in psychology, I had no real understanding of what computer science was when I started grad school, I joined a department for engineering psychology, which is sort of how you, if you think of psychology as the way that people think and behave. Engineering psychology is how people think and behave while using technology. So I had an interest in educational technology. But I barely even knew it. Computer Science was much less interested in computing education. And, of course, that changed when in my first week or month at Georgia Tech, I met Mark Guzdial and started working on a project with him, and he sort of sucked me into this world. And I'm really glad that he did, because even though I've like I've never formally taken a course in computer science. And I've learned that that sort of novice perspective helps me understand how learners are processing these things. And it helps me bring in my background in psychology and learning sciences to this space, and figure out how to sort of meld it together. So I'm really excited about this conference, and how it's bringing together people from different backgrounds to have this community around computing education, especially because even if you are in a CS department, there's often not a lot of people doing computing science, computer science, education research. So I'm really glad that this community exists. And I wanted to spend just one slide, if I can progress slides, there we go. Talking about this history, and how learning sciences and computing education have this shared background. So in the 1960s, there was this massive shift in psychology from behaviorism, which is study of overt behaviors, to treating what happens in the brain as this black box that could possibly be measured. And there's a shift to cognitive science that was heavily influenced by computer science, as the mechanisms of computers evolved, to understand what the mechanisms in the brain are actually doing and how it is you actually learn and remember things. A good example of this was John Anderson's work, and act are. And basically his conclusions from that is that if you're teaching problem solving, or learning problem solving, everything's just a step by step by step process. and problem solving is just a sum of these different parts. So if you can learn all the parts, given that there's a lot you can solve problems and the 1990s, both learning sciences and computing, education, finally had enough of this mechanisms only approach not to say that mechanisms aren't important, or that, you know, breaking down problems to learn in the pieces of them is an invalid approach. But learning sciences wanted to focus on the inclusion of context. So it's not just about the cognitive process going on in the brain. But learning is dependent on the cognition of learners as well as the environment, the teacher, your peers, your attitudes towards learning beliefs, and whether you'll be successful and the technology that you're using. And so this was pushed by Janet kolodner, in the early 1990s. And it's sort of progressed as a field since then, at the same time, in the late 80s, early 90s, computing, education started thinking about contexts, maybe we need to not be teaching people, these complete, authentic professional tasks, but we can actually make learning activities that are for the benefit of learning, and then eventually progress them to complete professional tasks. And so see more popper sort of spearheaded this idea that learning computer science doesn't have to start with these tools, and just power through it, until it finally makes sense. Maybe we can break it down in a way that is more suitable for learning, especially younger learners. And so that's why computers and education and learning sciences are so intertwined. In my opinion, as well, as I just says, intertwined. Oh, wait, no, that's how you spell that a trend, just forgive me. Um, so that's how these things are sort of interconnected. And so I have three pieces to the talk today, which is theoretical foundations. And the goal of this. This section is that going to talk about several theories that are important in both learning sciences, and computer science education, it's not going to be a complete list. But I'm hoping that you'll find something if you haven't found a theory that you're excited about yet that might spark an interest. of Also, if you're not interested in the theory, at least, I hope you recognize sort of the context in which these theories are like placed in learning sciences. And from those theories, I'm going to talk about a couple of actual instructional design or application pieces that sort of follow from them. Then the second part of the talk is methodological foundations. Of course, this isn't a methods class is going to be sort of from a high level, focusing on the trade offs and different methods and what you can achieve with both and how you can sort of shore up some of the, the under, you know, the weaknesses of different methods. And then the last thing I'm going to do is talk about how you actually apply this theory and methods to research design. We often have classes that talk about theory, and we have to have classes that talk about methods and after classes that talk about data analysis, but other than in psychology, I haven't actually seen classes that talk about research design, it's usually something you get by working with your advisor. So, I wanted to take you through sort of a process that you know, is very common in psychology for coming up with research design, based on your theory and methods. And I wanted to start with what is a theory and what is a method or model and what is a framework? And I will say that these things are influenced by my psychology background, this is you know, for a social science perspective, what we say our theories, models and frameworks and people use, I found people use them sort of to mean different things. So, when I say theory, I mean, something that posits an explanation of why something works based on mechanisms. Following from that is a model and a model can be theoretical, it can also not be theoretical, meaning that it can or cannot include the mechanisms. But a model is a sequence of events that this happens and this happens and this happens and it results and this And last is the framework which is a series of rules or procedures. implement a technique with fidelity. So if you wanted to introduce scaffolding in your instruction, there's a rule set of rules and procedures that would make that effective. If you didn't follow them, it could make it ineffective. So those are the differences that I see between theory and model and framework. Theory focusing on mechanisms model being more of a procedure, and framework being the sort of set of rules that things operate within. And I'm going to talk about a few different types of theories starting with cognition, theories of cognition explain, like I was saying before, as a break from behaviorism, that just looked at behavior. There is a cognition explained internal cognitive mechanisms that produce learning. And I want to start by talking about constructivism. Like I said, these are three examples of theories of cognition. So by no means is it every theory of cognition, but these are the three that are most interconnected between learning sciences, and computing education, and is broadly relevant to a large group of people. That's how I chose these three. And I want to start with constructivism, because constructivism is huge. And learning sciences, it's more or less one of the major theories that spun off learning sciences from cognitive science. Because cognitive science said, you just tell people what to learn. And then they learn it, and then they can do things. And constructivism said that hasn't really worked. So the theory of constructivism is that you can't just be told information and download it into your brain, what you have to do is build information in your head based on the resources that you're provided. And based on the prior knowledge that you have. So if I come into something with a lot of misconceptions, I'm going to have to do a lot of work to undo those misconceptions and then build up my knowledge rather than just have these two, you know, combating conceptions in my head. And so constructivism is that theory that says, you have to be constructing knowledge, and therefore active in some way in your learning, in order to actually build knowledge. And the way that this manifests most commonly in learning sciences research, is this huge debate that is going on. It's far less concluded now but it has been going on for the past 20 years or so, between direct instruction people and minimally guided people. So direct instruction, people say that learners don't know what they need to learn. So you should tell them explicitly, versus the minimally unguided instructed people say you should give them just enough scaffolding so that they can learn it themselves. And that's based on this theory of constructivism. The upshot of that debate, by the way, is that, like in most debates, neither one is completely right. There's some cases where direct instruction is more beneficial. There are some cases where less scaffolding is more or less direct instruction, more minimally guided instruction is more effective. And the cases in which either those are more effective, has to do with the second theory, which is cognitive load theory. And cognitive load theory is a theory from concrete, cognitive science. And it says, You have minimal cognitive resources, which makes sense, and that there's different types of cognitive load, pause by tasks. So the first type of cognitive load is called intrinsic cognitive load. And it's the cognitive load that is necessary to do the procedure or understand the concept that you're learning. And this can't really be changed, unless you are becoming more of an expert in something and therefore, you're chunking different pieces of information into sort of collapsing it into one piece of information, then you can actually reduce the intrinsic cognitive load. But that's not a process that we started. actors have control over, what we do have control over is x, extraneous cognitive load, which is it can sort of be described as the cost of doing business. You have to, in some way, provide information to the learner. And that input like the way that communication method is required to actually doing the task. But you have to do something. So, a good example of extraneous cognitive load is work examples, worked examples always have this sort of story about them, you know, if you take three apples, and you add two oranges, and you have five pieces of fruit or something like that, so that there's apples and oranges doesn't at all matter, but it's still taking up cognitive resources to process that information. And so that's extraneous cognitive load. And there's this false narrative that it should be in the theory of cognitive load, be reducing cognitive load as much as possible. And that's not actually what the cognitive load theory research says. It says that you should be finding an optimal level of cognitive load. So if you have a low extraneous cognitive load, adding details, what's sometimes called seductive details, things that are really interesting, but they're not really all that relevant. And adding these seductive details can be really helpful to actually having a nice level of engagement from the learner. So they're not too bored. If you have something that's got a really high intrinsic target, though, you don't want to be providing any more information, then it's completely unnecessary, so that you're getting this middle level. And the reason that you want this middle level is that you want some cognitive load left over for a process that is called germane cognitive load. It used to be that your main cognitive load was the third type of cognitive load. And now, I'm not even sure if saying germane cognitive load is correct. Now, it's thought of as the sort of separate process from intrinsic and extraneous. But your main cognitive load is the actual process of learning. So creating schema, connecting to prior knowledge, all those sorts of things that help you actually learn, but aren't provided to you through the instruction. So you want to have enough cognitive load leftover to engage in those sorts of processes. But again, you don't want a completely low cognitive load, because that can be really boring. And therefore you won't engage in learning procedures, because you'll be bored. So the last piece, speaking of finding this middle ground, the last theory of cognition I want to talk about is on a proximal development. And some people would argue that this is a theory of cognition, because it includes a lot more than cognition. But the cognitive piece is that the zone of proximal development says that you learn best, when you're in between two conditions, the bottom condition, been tasks that you can perform completely by yourself without any support, at the upper condition being tasks that you can't do, even with support. And so you want to be in this middle ground, where you're doing tasks that require some support, to help you complete them. And you wouldn't be able to do it normally, on your own. And so that's the theory of the zone of proximal development is that you learn best most effectively when you're in between those two spaces. And so proximal development meaning just above, where you would normally be able to perform by yourself. So some implications for instructional design is, and these are tied directly to several models and frameworks that can are used to guide instructional design. The first is the four components of instructional design model. And this breaks down learning complex procedures into four pieces. I'm not going to be able to remember them off the top of my head, I meant to pull this up on the other screen, so I would sound smarter than I am. But so one, for example, is called just in time information. So just in time information is information that it's not really necessary that you know it Mac, as you're working on the task, maybe you want to learn it eventually, there's a lot of information to learn when you're learning how to do a complex task. So just in time information is a type of scaffolding that provides you information as you need it, rather than requiring you to learn it, or remember it during the task. And so that's one of these components of the four components of instructional design. And it's all about breaking down complex tasks. And then also building them back up into a whole task, because it says, a mike actor says that you can't just teach pieces of a task, you have to teach the pieces and then teach the whole task. The second framework I want to talk about is the interactive, constructive, active and passive framework by [inaud]. And this talks about different instructional techniques and how effective they are. So if you're doing passive instruction, meaning that you're not even really taking notes, if you're just listening to a lecture, it can be being a passive, that's less effective than active. Active means that you are taking notes connecting to prior knowledge in some way, but not really manipulating information or adding anything in addition to the information that is being presented. So passive is less effective, active as middle effective, the most effective is the interactive and constructive parts. And these two are sort of the same. It's just that interactive includes talking with your peers, and constructive is by yourself. So they're both building on the information that's being presented. So that you are, you know, constructive knowledge so that you are building your own set of knowledge. And this is building you know, entirely on constructivism. And so that's the most effective. And if you can design instruction so that people are constructing or interacting to construct a knowledge that will be most effective, rather than active or passive. And the last is scaffolding and fading. So connected strongly to cognitive load theory and zone of proximal development, you want to provide enough scaffolding while people are working through tasks, that they are challenged yet successful. And then once they start getting better at those tasks, and gaining those skills, that you are then fading that information, or that scaffolding so that they are being more and more independent. The second type of theory I want to talk about is theories of community. And so these are theories of learning within a social context, which is the most learning. So the first theory of social context that I wanted to talk about that's used a lot in computing, education is cognitive apprenticeship. And this is you as a novice are working with someone who is more knowledgeable. And there's no particular curriculum that you're following, but you are observing what they do, mimicking what they do, getting feedback from them, and then increasing your skills in that way. And this is like the classic form of grad school. So you are working with an advisor. You're not taking classes from your advisor, but you are, you know, attempting to do authentic tasks and getting feedback from them. and improving on those tests all along. The second theory of community is situated learning our community of practice. And so cognitive apprenticeship is more mentor mentee. Situated learning and computed community practices about a whole community. So like this community, CSEdGrad community is an example of this. And the idea is that you have people sort of in the core who are for lack of a better term making trends, saying what's important, giving ideas about you know, where the community should be spending its efforts. And then you have people that get farther and farther from the center, who sort of have less and less influence until at the edges you have people who are totally new. And the people who are totally new are sort of observing, say in the community aligns with their interest. And then if it does, they will become more and more central to that community. And the last theory of community is activity theory, which is an old theory from now, 50 years ago, that has been added to a lot since that time, but the main tenants are that it's a little bit back to behaviorism, really, which, you know, it started. Around the time behaviorism was ending, but it's the idea that you can find out about learning by looking at the activities that people are doing. And activities are sort of product of the learner, the objects that they're using, and the community that they're in. And like I said, this has been expanded over time to include, like, the rules of the society that you're in norms. A lot of other things have been added along the years. But that's what activity theory is all about is that it's not about either the user or the object, or the community, it's how those things intersect, that informs learning and how it happens in a community. The implications for community building are most related to a cause situated learning is legitimate peripheral participation. So like I said, at the center is sort of the core of the community and at the edge, is these newcomers. And so these newcomers are participating in legitimate peripheral participation, which is that they're not, you know, they're not the trendsetters are, they're not setting the agenda for the community. But they are engaging in a way that you know, and acts the values of the community, or ask questions of the community. And that way, they're becoming more and more central to the community. The second piece is boundary objects. And boundary objects are actual objects that are at the boundary of two different communities. And my favorite example of this is Betsy diSalvo's computer science and dance clubs are camps that she does. And so they have these technical experts, who are computer science experts. And they have these dance experts. And by creating this dance that is augmented by E textiles and works with girls in particular, the E textiles are sort of the boundary object between these two things. So you're having the dance people say, Well, this is artistically how we need this tool to work. And you have the CS people saying, this is how you produce this thing. And it creates this object between the two that allows them to communicate, and share skills. And then the last thing is manipulatives, and artifacts, those artifacts can be digital or tangible. And so these are not like boundary objects, but they are tools, physical tools, or sometimes digital artifacts that learners can use, as a way of sharing within a community, their knowledge and skills because especially as a novice learner, it can be very difficult to articulate what it is that you're in thinking or your problem solving process, or anything like that. But if you're using manipulatives, it's a lot easier for someone else to see your process and therefore contribute to it or if it's a teacher, help you like if you're stuck to help you overcome that impasse. So those are some instructional implications for community building. And the last set of theories is there is a motivation. These are beliefs and attitudes that are related to learning. One of my favorite motivation theories, it's quite old, from the 80s is the expectancy value theory. And I saw one paper I sir, the International computing education research conference that included this and I was so excited because I think this community could get a lot of value out of expectancy value theory. And what expectancy value theory says is that motivation is this trade off between your expectation of success or failure, and how much you value the outcome of the task you're doing. So if you think computer science is really valuable, But your expectancy of success is not very high. And then you're not going to be, are you, you know, might find medium motivation, versus if you find it really valuable, but your expectancy of success is really happy and you can be really motivated. The issue sort of is that these two things can feed on each other. So if your value is not very crystallized, not very complete, or concrete, then your value can change based on your expectation of success. And so these are sort of malleable. And that's one of the cool things about expectancy value theory. Another theory of motivation is self efficacy. And writing the paper right now about it, actually, but self efficacy is a huge predictor of academic motivation and success. And there's a lot of instructional ways of improving self efficacy that I don't think we use in computing, education. You know, maybe some of the really, like, the instructors that have really high success rates of their students, maybe they use these and that's sort of one of those genetic law, things about those instructors, but self advocacy can, its highly manipulated bowl. But it's also this huge indicator of success. So I think that's a really important motivation theory. For us. The last theory is mindset theory, which is some of you might know as growth mindset, or fixed mindset. And so this is a theory that says you either have a fixed mindset, which means that you believe you're born with certain abilities and skills, and that no matter what you do, you're not going to be able to really change that. On the other side of it is a growth mindset, which says that if you just work hard enough, you can achieve pretty much anything that you want. And both of those are sort of extreme examples. Because there are cases where a fixed mindset sort of makes sense. Like, you know, if you have a certain body composition, you're probably never going to be able to be a pro athlete, something like that. At the same time, even if you believe in yourself and work hard enough, you might not be able to ever become like, an astronaut, or something. So there is this sort of middle ground, and it's found to be pretty task or domain dependent of either you have this fixed, or growth mindset. And some implications for supporting our students based on these theories of motivation is, one is grit and perseverance. So people who have high self efficacy have what is considered grit. And I know some people don't like that word grit, which is why I put slash perseverance. But high self advocacy is very highly correlated with perseverance, effort, all these sorts of things that make students successful. And like I said, some of [inaud] is pretty manipulatable. So that's an important implication for supporting students. Authenticity related to the expectancy value theory is, if students don't see the value in what they're doing, their motivation is going to be less so authentic tasks, and to be more transparent about what the value is, of course, it's also useful to just explain, you know, this is why we're doing this thing. And the last implication for supporting students is feedback and encouragement. There's some, well, that research would say that you can't rely too much on verbal feedback, verbal encouragement, you got this or you're doing great. That's not in the long term very successful. It's a very temporary boost of motivation. The main thing that students that motivates students is actual performance. But there are so are there are a lot of cases where getting feedback and encouragement can help students to stay motivated, if they're in sort of a acute spot where they're struggling. Alright, so now we're going to go to methodological foundations. And like I said, we're gonna focus on trade offs here. And there's the spec. drum up methods that goes from experimental validity. So you have total control over your study and the conditions and variables within it. Versus ecological validity, which is, it's very authentic to what you're actually studying or the context that you're studying. But there's probably less control. And so for going from top being most experimentally valid, to bottom being most ecologically valid, randomized control trials are the experimental validity goldstar. This is where you can assign people randomly to one condition or another. And those conditions you're manipulating something intentionally, to compare, compare between the two groups. And randomizing is important because it lets you assume that both of the groups are equal, for all the things that you're not measuring, which can be a whole lot of things in education. However, that's usually not an option for us. Most often we do, or not necessarily most often. But a more common option is quasi experimental trials, where you are in education, probably going into a class and assigning an entire class as one condition and another class as a different condition. And so you can try to measure things that might make those classes different to argue that they are comparable. But you're never going to be able to sort of say that they're, you know, the same like you would in a randomized control trial. Next is a design experiment, which is very dear to learning sciences. And a design experiment is sort of like a quasi experimental trial, but you are iterating, on your manipulation, as you go along. So the experimenter in this case is much more involved in the intervention usually, and they are working in a class to try to make something work for that class. And that means changing things as it goes, until they find something that's working. And then later on, they can test in a different environment to see what sort of generalizes or not. And the last option is observational, where you're not changing anything, you're just observing things as they are. And so the trade offs here, it comes in what your findings mean. So if you're in a randomized control trial, like I said, you can say, we assume everything else is equal. Therefore, the difference between groups if there is one is due to this intervention. And a quasi experimental trial, you can make that same argument, but it's a little bit weaker. Because unless you're being really thorough in what you're measuring between the two groups, there's always a chance that there's something making them different. And that might be the cause of any different to see design experiments, you're making something work through this active process. And therefore you can't really say that it's gonna work in any other condition. But you can say that it worked this condition. And then observational is sort of similar that you saw this group of people do this thing. But you can't necessarily say that that is representative of others. If you can't choose which of these you do, or one of these isn't an option. You can, in quasi experimental trials and design experiments, run them multiple times. So if you had one semester, for example, that you're trying an intervention between Class A and Class B, say Class A was a morning Class and Class B was an evening class. So you know, Class B might be more working professionals, it might be late risers, Class A might be, you know, full time students, the people who are awake and functioning in the morning, you can in the next semester, switch it, and therefore you have a much stronger argument that the difference you're seeing is due to the intervention that you're doing rather than the class time and associated characteristics of the Learners design experiments is the same, it's sort of built into the protocol for design experiments is that you work with a class, find something that works, go to a different class. And change it, however, is necessary to make that work, and then tie together all the commonalities to come up with the sort of generalized intervention. And observational is the same you can. observational is a little bit easier to observe different groups of people over and over and over again, and you're going to need a bigger population different, a bigger sample of different groups to say something generalizable about observational data, the stages of learning sciences projects can become, there's four different stages. So and these use all sorts of methods. So the first stage is you're collecting information about learners and the environment, because we're not just concerned with cognition, but we're also concerned with the context in which it happens. So the first step is collecting information about learners environment, this is an observational process of initial design and testing of the intervention. And then also iterative redesign a test is this design experiment stage. And then testing in multiple contexts to contribute to theory is usually a quasi experimental or experimental condition. So applications for research design, I am aware that we are running a little short on time. So the implications for research design is, and I'm going to sort of take you through the process that I go through with my grad students, or the grad students in my program, which is how do you write a really good research question. You want to include the topic that you're studying or your independent variable. You also want to include the measurements or data that you're collecting. So just from looking at your research question, people can see what you did, and what you studied. You also want this, this is like one of my pet peeves, even though maybe it probably shouldn't be is that I don't like research questions that say, Does blah, blah, blah, effect blah, blah, blah. It's like, yes, probably. Instead, you want it to be open ended. So how does blah, blah, blah, effect whatever. And then you move on to your operationalization. And pre computational thinking people out there. operationalization is basically abstraction. So what are the important parts of the construct you're including, and what are you excluding? And how might that affect your validity. So if you are, for example, we're studying how a how grad students take notes on articles as they read them, and how that affects their ability to later recall the information in those articles or use it in a paper, you might define taking notes as highlighting, or writing in the margins, or frequency of highlighting or writing in the margins. It might also be a verbal, like, if someone says something to themselves as they're doing it. Those can all be operationalization of the sort of, you know, abstract term, which is taking notes. And what you're excluding is maybe you didn't measure if they wrote something about a different paper in the paper that they're currently editing. So those might affect your validity, but it's not something that she might be able to necessarily control for. And then the next thing you want to do after you have your operationalization is pick levels of your independent variable. And this is one of the really hard things to do. And you want to say, by picking levels of your independent variable, or you know, how you're going to assign people to different things, you basically have to say, What's an important distinction between the different independent variable, so if you want to assign people to only highlight, that can be an independent variable. If you want to assign people to only write notes in the margins, that could be a level of the independent variable. Or you can have them do both or neither. One of the things is that sometimes you don't need distinctions at all. So if you're measuring something like self advocacy, you have typically a scale that you're getting people that's, you know, from one to 10 or something like that. What should never ever, ever, ever please never, this is a pet peeve of mine. And it's a totally justified pet peeve of mine. It's never used split mean, because when you're doing the split main, you're basically saying, I'm measuring self efficacy. And I have a low self efficacy group and a high self advocacy group. That's a split mean procedure, cuz you're saying, or that's not necessarily but what split mean does is it takes the mean. And it says, say we have a normal distribution around the mean, sign anyone below the mean, is low, and anyone above the mean is high. So these two people on either side of the meme, you're saying that this person has more in common with this person way down here at the bottom of self advocacy, and that this person just about the main has way more in common with the person who's super high in self advocacy than they have with each other. And statistically, if I think a lot of people do this, for statistical reasons, there's no reason to do this, you can just use a continuous variable. And that is way more powerful than having these two groups. Now, if you have multimodal distribution, where you have like a lot of people grouped on here, a lot of people grew up to not have people moved here, you might split those into different groups, but don't make these needless distinctions for levels of an independent variable. And then ask what you're measuring. So these are your dependent variables based on your observations, some basic learner characteristics, the things that people always ask is, Who are your learners pretest, if you want to measure learning, you have to show that they didn't know anything to start with. process data and product data, process data being things that happen while they're learning product data being more like performance. And then fidelity, did your intervention happen as you wanted it to. And and this is my, like, big thing. So this is where I'll end. There's maybe a couple of slides after this. But this is the important thing is, after you have your independent variables and your dependent variables, you want to define your hypotheses. And I suggest you use a chart like this one that has each level of the independent variable, and each dependent variable that you have. And so in each of these, in this cross sections of the chart, you're going to make a prediction. So for the control group, you know, equal performance, or you know, there's no going to be no difference in performance for the [inaud] process data or dependent variable product data. For the first level of whatever independent variable you have, maybe they're going to perform, perform better in the process. So they're going to learn more efficiently or whatever that means. But at the end, they're not going to perform any better than the control group. And then for the second level of the IB, maybe you predict that the process is going to look the same, but they're going to perform better on the actual product, or perform worse on the actual product. And the key thing about this is if you have two levels of your IV that look exactly the same, or you're sort of having a hard time justifying why they would be different, you probably don't need both levels of that IV, you might be able to collapse them into one or the other important thing is that as you're making these predictions, if you're saying, Well, I think you know, for the first level of the independent variable, the process is going to be improved. However, such and such random factor might throw that into question. That's something that you want to add as a not necessarily a dependent variable, but as a learner characteristic to measure. So that if it doesn't happen, like you think it does, you have that data point to say, you know, we didn't see the expected increase here, but it's due to this other thing that we thought might happen. And that's going to bring your limitations way down when you're reading your papers, and analyzing your results. And so with that, I will end.

Jamie Gorson 49:41

Thank you, Lauren for such a great talk. It was really wonderful to see you break down all these different methods and research theories. I think it really helped a lot of people getting into this area. We have some questions from the chat and feel free anybody who's listening to also ask more questions as we go Get Started. But one that a couple people were curious about is [inaud] talks about a lot of the classic theories that are creating this computer science education field. They're wondering how the intersection of more recent critical theories in learning sciences and how you see the intersection of those with these current theories. So she asked, I wonder how you see the intersection of the more recent critical theories in the learning sciences, Eg critical race theory, social political theories, and competing learning research?

Lauren Margulieux 50:31

And that's a great question that's at the cutting edge of where we are at the integration of learning sciences, computing education right now. We had a workshop this summer. That sort of focused on that exact issue more or less, at icls International Conference of the learning sciences. And so I don't have a good answer for you right now. It is something that people are starting to think about. But it's not something that has become fully integrated so far. But I will say that sort of work is highly encouraged and that you should absolutely be doing it.

Jamie Gorson 51:15

I haven't gotten very many other questions, so feel free to keep asking them, but I'll ask one. Before I go back to the questions. But if students are listening to this talk, and they haven't been exposed to these theories before, where would you suggest they go from here to learn more about these theories? If they're interested?

Lauren Margulieux 51:35

That's a good question. I'm trying to think back like, where I learned them, and it was definitely from like, classes that I had in grad school. I'm not sure they're like, well, I am sure that there is sort of a resource out there. You might check out Amy Ko's website and blog that has a pretty extensive resource for computing, education grad students, and it's got a lot of links to related concepts. I'm not sure if it has like these particular theories, or any specific theories included in there. But you can also always my emails on screen. So if you have questions about anything in particular, you can always email me.

Jamie Gorson 52:26

Yet I imagine the handbook also cites many of these theories that you may find,

laure 52:30

yeah, there.

Jamie Gorson 52:32

So we got a question from Marco, he asks, Will Lauren expand on lowering the limitations of poor result using data about learners?

Lauren Margulieux 52:43

Yeah, so. And I always say this to students, when they're working on their dissertation, and we're going through their perspectives, I say, passing your perspective is the hardest part. Because basically, your committee's out goal is to say, if your research doesn't work out like you think it does, or your results don't work out, like you think it's do, which it's never going to, like, ever, in any research you ever do. Is it ever gonna work out like you think it should we as your committee want to make sure that you are still able to say something, it's not that, oh, we forgot to measure this thing. And that's a very likely explanation. And therefore, basically validating your whole study. So you want to think through using that hypothesis sort of chart, all the possible reasons that something might not work. And then if it's a likely enough possibility, try to measure that in some way. So that like, if you say, you know, students performed really well, when they took notes in the margins, unless they did it way late at night, you would want to measure what time they were taking notes. And therefore, if the results didn't work out, like you thought you could see whether there's a difference between the time of day that they were taking notes. And so that would say, you know, it's not if it was not conclusive that the time of day impacted anything, you could say, well, it's not this. It's not this. It's not any of the other likely things that we thought. So I mean, worst case scenario, you just say, well, this didn't work. It didn't work like we thought it would. But you can at least say we considered all these other options that might affect the efficacy of this intervention. And those aren't the thing, the reason or maybe they are, and that really helps write that limitation section.

Jamie Gorson 54:53

Thank you very much. We have one last question for you. 30 seconds left. But there's a question about ethical implications of using students without consent. Do you have any thoughts about just the quickly using computer science students in your research without consent?

Lauren Margulieux 55:15

So I'm guessing this is alluding to the recent changes in IRB, where, if you're collecting information, like in a classroom, through normal classroom activities, then you don't necessarily have to get consent from students to use their data. I might not be the best person to ask this because I sort of see it as what's the harm, like if I'm consciously not changing anything about the class, as students are doing exactly what they would be doing Normally, I don't see an issue after the fact using that data. However, if there is anything that would be changing the class, especially if there's an intervention involved, then I always get consent beforehand. But if it's like, purely observational data, you know, anyone gets in my class. So that's sort of how I see it.

Jamie Gorson 56:20

Great, well, I think our time is up. So thank you so much, Lauren for that talk.