Episode 58: Gerd Kortemeyer

**KL:** Katie Linder

**GK:** Gerd Koremeyer

**KL:** You’re listening to “Research in Action”: episode fifty-eight.

[intro music]

# Segment 1:

**KL:** Welcome to “Research in Action,” a weekly podcast where you can hear about topics and issues related to research in higher education from experts across a range of disciplines. I’m your host, Dr. Katie Linder, director of research at Oregon State University Ecampus. Along with every episode, we post show notes with links to resources mentioned in the episode, a full transcript, and an instructor guide for incorporating the episode into your courses. Check out the show’s website at ecampus.oregonstate.edu/podcast to find all of these resources.

On this episode, I am joined by Dr. Gerd Kortemeyer, who received his master’s in physics from the University of Hanover in Germany and his PhD in physics from Michigan State University. He is an associate professor of physics education at Michigan State University, which a joint appointment between the Lyman-Briggs college and the Department of Physics and Astronomy. He is also the director of the Learning Online Network Computer-Assisted Personalized Approach, or LON-CAPA. His research interest is the effective use of technology in science education, with a particular focus on assessment, analytics, and gamification.

Thanks so much for joining me today, Gerd!

**GK:** Hello! Thanks for having me.

**KL:** So, I’m really interested to hear more about your research in online learning, in particular because I direct the research here at Ecampus, which really focuses on online learning. I want to start just with how did you get started with research in this area? What led you to that?

**GK:** Well, it was sort of—I came in from the technical side. I did theoretical nuclear physics as my PhD project, and that always involved a lot of computation, and our physics department at MSU started very, very early on in online physics teaching. And I just interested in writing some server software, so a predecessor of the system that I’m currently directing is something that I wrote during my doctoral thesis, kind of on the side. And that’s how I got into this whole thing, from a technical angle.

**KL:** So tell me a little bit more about that. So you were working on this project on the side. What was the goal of what you were designing? What were you trying to create?

**GK:** Well, it was a transition. So, it started out with the online physics materials not really being online. There was essentially a stack of HyperCards that were distributed to students on a CD in connection with online homework that was running through a terminal session at the time.

**KL:** Hmm.

**GK:** That was ’93. That was pre- the Web, for most of our students, so it was a combination between things running from a local drive and students opening Telnet sessions in order to enter their online physics answers. And we wanted to transfer that to the Web, so my first project was converting those resources that were on a CD in a system called SuperCard over to Web pages, and then also writing a really rudimentary online homework system to go with that, so that assessment could be embedded into this online course material. That was about 1996, ’97 that we did that, and then after I got done with my PhD, my wife, actually, still needed to finish up her doctoral degree and I needed a job while she still on campus, so I took a postdoc-like position in order to carry this project forward. And yep, that then somehow morphed into my faculty job.

**KL:** So you’ve been working with online education since the very early days. I’m curious to know—because you did start out in kind of a different area that wasn’t kind of educationally focused, even though you’ve kind of morphed into that—what are some of the differences and similarities that you see with your focus on online education research now that may be different from other areas of research that you’ve focused on in the past.

**GK:** Well, I mean, humans are difficult. They are very, very complex research subjects. What I did as a nuclear physicist was, of course, interact with or simulate the behavior of nuclei, of proton, neutrons. Those things are very predictable, at some level, and they will always behave the same way. Humans are irrational, and so it is a much more complex research topic, dealing with humans rather than inanimate nuclei. So in some respects it’s a lot harder to do education research. It is on some level more satisfying, because I like interacting with people, and even though sometimes there’s the whole Internet between us, me and my students, it is still something that has to do with inter-human relations that I find fascinating. On the other hand, it can be very frustrating. Error bars in your research can be much higher than they are in experimental physics, and reproducibility is something that we struggle with, just because humans are a lot more complex than protons.

**KL:** I think you make some excellent points here. Educational research is certainly one of the most difficult things I’ve ever done, so, glad to hear that you find some challenges with it as well. I think what’s interesting about your work is that, you know, some faculty see research on teaching and learning as really competing with their disciplinary pipeline, but this is an area that you seem to have really come to embrace. I’m wondering if you can talk a little bit about that, maybe the transition that you made to focusing in this area, and are you still conducting research that is more disciplinary? How did those things balance out for you?

**GK:** Well, I mean, I’m fortunate in many, many respects. My research, my faculty research area is physics education research. It’s not only online, so I’ll also do research in laboratory settings or in in-class settings, but it is my particular area of scholarship. I’m also currently in a part of our university that strongly stresses the important of the scholarship of teaching and learning, so in that particular part of the university, which is a sort of liberal arts college within the larger university, publications in the area of the scholarship of teaching and learning are equally valued as your typical disciplinary research. I say I’m fortunate because other colleagues are in departments where that is simply not the case, and particularly for people who are pre-tenure, I have to say, they need to first find out how these kind of publications will be valued, because otherwise they might be jeopardizing their tenure track. What we have found is that at Michigan State University, very often, this kind of research was actually the luxury for senior faculty, people who already have reached the higher level of professorship at Michigan State, and for them, they could certainly afford doing this research. For younger faculty members, I am afraid to say, you better find out first before you embark into this.

**KL:** I think that’s an excellent point. I’ve definitely seen differing rules and ideas about how this kind of scholarship should be counted across different campuses, and definitely depending on the campus type, if it’s more research-oriented or more teaching-oriented.

**GK:** It’s not necessarily even the campus type. It’s even by department.

**KL:** Mm-hmm?

**GK:** So, as I’m sitting on tenure committees, as I’m sitting, I’m hearing different department chairs talking very differently about this particular area of research. So, I mean, I’m at a very research-intensive university, just like Oregon State, but the campus type alone won’t determine this. So yes, of course, you need to produce research, but what kind of research is valued or not seems to depend on departmental culture, more so than the campus as a whole.

**KL:** Mm-hmm. Given your kind of extensive experience in this area, I’m wondering if you have ideas for why you think that is, why you think certain departments may be less aware of scholarship of teaching and learning, or they just have different standards. What are your thoughts?

**GK:** Um. I don’t know how faculty culture develops, but as I’m going around giving colloquia across campus, I am finding very, very different audiences in front of me, with respect to the openness to this kind of research. There are certainly the departments that are the stance that they need to filter out students rather than support students. They are surviving the introductory classes is actually seen as a filter into a particular discipline.

**KL:** Sure.

**GK:** Then there are other parts of the university who desperately need students and who would like to discover and support students who later on might work in that area. So there’s a little bit of selectivity that plays into this. Also, I think some departments have been burned in the past by people coming in and telling faculty members, “You have to do everything different. Everything that you are currently doing, you’re going about it the wrong way. This is inefficient, and listen to me. I’m going to tell you how you can best teach.” And you don’t listen to that for too long, so sometimes people coming in from the outside and saying “Everything needs to change in this place” can be very counterproductive, and it can lead to whole departments just basically building a wall and saying, you know, “We don’t want anything to do with that.” So, as instructional reform is being spread across campus, it is very important to first really understand how a particular subject area is being taught, to really understand the classroom culture as it is at the moment, and then, in collaboration with the faculty, make slow changes to it. Because otherwise you just achieve the opposite—people just block and don’t want to hear it. And sometimes, I have to say, people, educational so-called experts come across as quite arrogant, and if a faculty member has been teaching for decades, it’s probably not the best approach to come to that particular person and tell them, “Everything you did for the last 30 years was wrong.”

**KL:** Mm-hmm. Mm-hmm. You’ve raised some excellent points here. I’m excited to hear more specifics about your research.

We’re going to take a brief break. When we come back, we’ll hear a little bit more about Gerd’s research on student work habits. Back in a moment.

[music]

# Segment 2:

**KL:** Gerd, some of your research has focused on student work habits, which I am really interested to hear more about this. I’m wondering if you can start with just sharing what are some of your research questions in this area.

**GK:** Well.... Online systems are giving you a window into student work that you usually don’t have. So, if you are teaching a regular course, you have students in your lecture hall, but you may not really understand what they are doing there, what they are understanding, what they are not understanding. If they are handing in homework or projects, you have no idea how this homework and projects came about. One of the things that computers definitely do very well is gathering data, so if you have a course that has any kind of online component, be it fully online, be it blended, be it flipped, be it whatever mode of online system you would like to run, you are literally assembling gigabytes of data on student transactions and their habits, so this kind of window into how students are learning is not given in any kind of other system. So, in a respect, it’s opportunistic. We have all of this data, we get insights that we usually don’t have, so let’s look at what’s happening there.

**KL:** Mm-hmm.

**GK:** Sometimes you might wish you hadn’t asked, because what this data reveals to you is very often human nature—

**KL:** Hmm.

**GK:** —that may not be what you would have hoped for.

**KL:** So, given kind of the kinds of data that you’re collecting, one of the things I’ve always been really curious about with that kind of data about student work habits—and I’d love to hear more about what exactly it is you’re kind of looking at—is I feel like some of the data that we collect in that area is really noisy, and it’s very difficult to kind of actually see how we can use that data, and I think, for example, about, you know, like, students watching videos. And we’ll say, “Oh, well they watched the video twice.” We know our analytics tell us that. But what it doesn’t tell us is to what degree they were paying attention to the video, or did they get up and walk away, and I always think, you know, did they get up and microwave their piece of pizza while they were, you know, supposed to be watching this video. And I’m wondering if you can talk a little bit about the kinds of data you’re collecting and how you might be dealing with some of those issues. Is that a factor with some of the things you’re looking at, or are you collecting data that’s not so noisy?

**GK:** Oh, the data that we are collecting is extremely noisy, but that is something that physicists are used to. If you are looking at any kind of larger experiment, you’re going to have a lot of background noise that’s usually on top of the data, and you have to filter it out. It’s not only true for physics. That’s true for natural science in general. So it’s something you deal with. Whether you deal with online students or whether you deal with protons, you always have to deal with the background noise. The important thing to remember is not to over-interpret the data, and make sure that statistics are clean on it. The data that we are looking at in particular is of course page accesses, so we are just seeing in what sequence students are accessing which pages, how long they stay on that particular page. We are looking at homework transactions, every time that students are attempting to solve a problem online problem. We are looking at discussion contributions. That actually is also something that a human would have to look at in addition to the computer, because you cannot really get the drift of, you know, what a student has been writing unless you are a human. I don’t trust semantic analysis for that. And you have to be careful, because a page access is not a page access. One of our studies was just looking at clicks alone doesn’t give you meaningful data. You have to look at how long the student stays on the page, and there’s a minimum amount that distinguishes a page access from just a navigational event, scrolling through a page, and there’s also probably a maximum amount of time where the student may have gone away to have a cup of coffee or got themselves their pizza microwaved. So that one actually you have to see in the context of the larger course and see what correlates and what doesn’t. For us, anything that is less than five seconds on a particular page is probably not meaningful. Anything that is longer than ten minutes on a page is probably not meaningful either, because that is an event where they may have just stopped browsing. They come to a certain page, it doesn’t give them what they want, and they walk away. So, somewhere between five seconds and ten minutes is something that we’ve found is a meaningful page access that we can actually get data out of. What we can then see are sequences of events, so, one can look at a student attempting to do a particular homework problem, failing to do so, looking back into the materials, coming back to the homework problem, and then succeeding. So one of the things you can probably get out of that is that the particular pages that the student looked at may have helped them in actually solving the homework problem. Yeah, so that’s the kind of data we’re looking at. We are also looking at data of resubmissions, [inaudible], like I said, you fail on a homework problem, you try again, you succeed. Also, there are time limits on that. So, sometimes we see that students are resubmitting a homework problem within two seconds of a previous attempt. That is probably random guessing. If the student comes back half an hour later, they certainly did something different in between that has nothing to do with the course and may have then helped them succeed on the problem. So timing data, in addition to raw click data, is very important to us.

**KL:** Interesting. I’m wondering if you can talk a little bit about possible findings that have come out of this, and in particular if there’s anything that’s changed your own practices based on, you know, the data that you’ve been analyzing and what you’ve found.

**GK:** Yeah, I mean, the first data, that we probably all suspected, is students don’t read textbooks. I think that’s true for the dead tree variety. That’s also true for the online variety. Can you change that? And what we found is that we can get the students to read a lot more material if there’s more frequent assessment.

**KL:** Hmm.

**GK:** A typical course with two midterm exams, you can clearly see the spikes in page accesses leading up 24 hours to these particular exams. That means students are procrastinating, procrastinating, and then they go through this cramming. You can see the cramming in the data. Most people would agree that that is maybe something that has a short-term learning gain, but usually that just ends up in your shorter-term memory. It doesn’t necessarily get integrated into your knowledge structure if you’re cramming. So, what I have changed in my course is more frequent little quizzes, rather than big high-stakes exams, and that, then, spreads out the reading a lot more across the semester. My suspicion is that that’s the same for the normal textbooks, but of course, we don’t see that. We don’t know if a student is grabbing the textbook, unless they come to your office hour and open it up and it still crackles because, you know, the book had never broken in the spine. But with the online [inaudible] more frequent assessments in the course. How many tries you give them on the online homework—so, we looked at different unproductive student behaviors in online homework. One of them is random guessing, where you just select a random option or you put in a random number. I’ve talked a little bit about the signatures of that earlier: it’s lots of tries in very rapid succession. We can also look at copying. We looked at that in terms of should the student actually succeed on this problem or not, doing some item response theory on it, seeing if the student—is the student even in a position of getting this right on the first try? [We] found that copying is actually less prevalent than random guessing, which is something that surprised us, but we also found that we can regulate both behaviors by the number of tries we give students to solve a problem. If you give them too few tries, students start trying. They’re getting desperate and are trying to get the answer from somebody else or from the Internet or a cheat site or who knows where, because if you tell them “You only have three tries on this,” they may not feel that they are in a position to actually solve it themselves, and they try to get the answer from elsewhere. If you give them too many tries, they put in random garbage. So I have lowered the number of tries in my class. I used to give them 12 tries. I now give them 5 tries. It seems to have made a difference in that particular respect. We also learned that one can put the fanciest movies, the fanciest simulations up in the class, and hardly anybody uses them. So, we had simulations of air drags [??], of planetary motion, of electrons and electric fields and spent a lot of time writing these simulations where students can vary the parameters and look at what happens. Students don’t do that, and I don’t even blame them, because there’s no reward. Many of the students that we have in our classes are not necessarily interested very much into physics, and so they don’t play around. That’s something that you as a physicist might do, because you say, “Oh, cool,” you know, “Let’s see what happens.” But that kind of curiosity is not necessarily given. So, we found that if you want students to conduct experiments online with simulations, you need to embed it into an assessment and reward it with some homework. You know, you would say, “Okay, actually do an experiment here where one sled is double the mass of the other one. Have them collide head-on with the same velocity. What happens?” And then actually reward that with some homework, and then they do the experiment. It is frustrating, but it’s reality, so.... Yes, we also changed our practice there, not necessarily the way we wanted, but we did.

**KL:** Well, Gerd, these things you’re finding are fascinating.

We’re going to take another brief break. We’ll hear a little bit more about Gerd’s work on online teaching and learning research.

[music]

# Segment 3:

**KL:** Gerd, your current research is so fascinating. I would love if you could talk a little bit more about what is up and coming for you. What are kind of the next areas that you’re looking to explore when it comes to online teaching and learning?

**GK:** Yeah, so, in terms of the educational datamining and analytics that I’ve already talked about, the one big elephant in the room, always, is adaptive learning: can we actually use any data that we have gathered from these online systems in order to, for example, make recommendations to faculty and students on which materials either the faculty should assign or the students should look at next. So, the faculty side of that is relatively low-hanging fruit that we try to get in the near future. I’ve talked about the sequential events, where students are trying to master a certain task, are unable to do so. Do some intervening transactions come back and eventually master the task? I think that data could be readily made available through online systems to faculty in order to do better materials assignments for their classes, so that the materials that they have are better aligned with the assessment that they are giving. For faculty, that’s low-hanging, because faculty can intelligently look at these recommendations and then actually, if there’s any kind of mistake in the data or if we are looking at spurious events, can still make an intelligent choice and say, you know, “Yes, that’s a recommendation, but I’m going to ignore it. I’m going to use something similar that I like better.” So, these recommendations to faculty I think are going to come in the very near future. Recommendation to students, automated recommendations to students, are a lot more dangerous. We hope to get there, but the other problem, of course, is you don’t want to lead the student down the garden path. You don’t want to confront them with material that, for bad reasons, seems to be helpful. You don’t want to address student problems that actually they don’t have, so when [inaudible] oh, the student can’t master this and other students have profited from such-and-such, maybe that was a [inaudible] on how you can actually add two fractions, and that’s why they failed on it was because they couldn’t add two fractions, but then you give that to another student who’s perfectly fine with the algebra but has a completely different problem, you may frustrate the student. You don’t want to do that. So student recommendations I would put a lot further into the future. Another thing that we are looking at are games. Many of my students are spending hours and hours in virtual worlds that sometimes have unreal or different physics, and they learn the rules and the physics of that particular virtual world over hours that are voluntarily spent in front of the screen.

**KL:** Hmm.

**GK:** And, of course, you want to exploit that and see if you can’t write video games that actually work in real-world physics. And we did two projects on that so far. The problem is you need to somehow get the same fun factor. I was recently at a conference for meaningful games [capitalize?], and one of the keynote speakers said that one of the features that most current educational games have in common is that they suck.

**KL:** Hmm. [laughs]

**GK:** So, we don’t want to write a game that sucks and is boring.

**KL:** Of course. Yeah!

**GK:** And so, that’s a real challenge: can we write a fascinating game that teaches physics? So, two projects we currently have—one is finished and I need to do some data evaluation on it; the other one’s in the making. The one that we are finished is something that was written during a sabbatical at MIT. It’s called *A Slower Speed of Light*, and it actually illustrates special relativity and what the world looks like if light were slower. And one of the things I totally didn’t expect is that people are posting these gameplay videos. So, there are probably about 400 gameplay videos out on YouTube. People are just playing through the game and they sort of have a running dialogue, a monologue, actually, telling us what they experience and what they see.

**KL:** Mm-hmm. Mm-hmm.

**GK:** That is beautiful data that actually opens a window into what people are getting out of these games, and you can analyze that on the aspect, are they actually learning any physics there? Are they reflecting on the physics that they are seeing? So that’s a current project that I do with a student worker going through these 400 videos and see what people are actually getting out of this on this virtual physics experience. And another one that we currently work on is called *Kirchhoff’s Revenge*, and it’s about circuit laws, and the way that we are trying to write this is similar to the game *Portal*, where actually Kirchhoff abducted you, and the only way that you can ever get out of his dungeon is by going through puzzle after puzzle after puzzle. And we have macroscopic circuit elements that you need to put together in order to achieve certain goals in the game. We don’t know yet! I’m trying to write that with students so that it would actually be appealing to students in the end, rather than me sitting down here and, you know, being the lame old 50-year-old physicist. I’m trying to write this together with undergraduate students and hopefully make it entertaining enough so people want to play it. I’m going to force it down the throat of my students next semester and see what they think, but that’s—I don’t know yet.

**KL:** [laughs] That’s very interesting. I’m wondering what your thoughts are – you know when I think about games and especially educational games I think that one of the things we hope for is that students will kind of learn without realizing that they’re learning and that there will be some kind of unconscious you know, learning that occurring. What are your thoughts on that because I think, you know, is that part of the challenge, of not having fun is that it feels like work and that learn is associated with work and we should try to associate learning with something that’s a little more unconscious?

**GK:** Well I mean, that’s the hope. How do infants actually learn the physical word? Everyone is very, very good at physics, they just don’t know it. But when you look at the things that you do in the everyday world, I mean you get up from the sofa and you walk around. The amount of balancing and censoring import in the understanding of gravity, uh, the understanding of space, all of that is actually amazing! But you learn it intuitively, and people learned it as a toddler by playing around and by falling and struggling and whatever, but you absorbed it in an intuitive way, uh, by playing, by interacting with this kind of world. There’s a moment where you put this in a university class and you put all kinds of vectors on top of that and you know numbers and formulas – it losses all that intuitiveness. Until someone really becomes an expert physicist and can look at the data and say “nah, that can’t be right, somethings wrong here, somethings fishy.” I don’t know how often I’ve heard colleagues, just looking at things, looking at formulas, looking at experiments and say “somethings wrong, I don’t know what but they just can’t be.” So trying to get that kind of intuition I think is very hard to get in the purely academic lecture section that people are in. People acquire that mostly in years by doing experimentation or all kinds of things. Yes we hope that games would open the door to an intuitive understanding of physics, people don’t calculate anything here, it’s not the idea. Ah, people are supposed to intact research, fail research, try again, fail again, eventually succeed, feel good about themselves, get the next challenge – that’s what we hope. It may look different than faculty think, one of the things that was eye-opening to me is that this *Kerchhoff’s Revenge,* the guy, uh, Kerchhoff in that game, is a very cynical guy actually and he’s sort of nasty and puts the player down and you know there’s all kinds of fun elements in the, like little Easter eggs in the game. Faculty look at that and say “oh you know this is just discouraging and this is too frivolous” and you know “how can this guy be so negative in the game?” and students look at the game and they think it’s funny. So I think it’s very important to work closely to these students as these games are being written so they actually are speaking not the educator professor language, but something that is appealing to their peers.

**KL:** Well you’re right, we have absolutely different perspectives when it comes to things like this. Gerd, thank you so much for sharing about this new research you’re working on, it’s fascinating, and also telling us a little bit about your experience with online teaching and learning. I appreciate you taking that time to come on the show.

**GK:** Thank you again for having me.

**KL:** And thanks also to our listeners for joining us for this week’s episode of Research in Action. I’m Katie Linder and we’ll be back next week with a new episode.

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