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Where social and epistemic networks meet

Srecko Joksimovic
Senior Lecturer, University of South Australia

Abstract

In addition to the commonly used data sources about learners and their knowledge practices, data about learners' social interactions have also attracted significant attention of learning analytics researchers. Social network analysis (SNA) emerged early as one of the cornerstones of the learning analytics research, providing the opportunity to automatically extract large-scale networks from learners' interactions across various environments, such as LMSs and different social media platforms. Epistemic network analysis (ENA), on the other hand, recently emerged as a technique to analyse coded data of individual and collaborative learning. ENA is a graph-based method for analysing associations between coded data and represents an operationalization of the learning science theory of epistemic frames. As such, these two methods represent complementary approaches that, combined, provide comprehensive understanding of knowledge processes at the individual and group level.
In this talk, we will review the strengths and opportunities that SNA and ENA provide methodologically for learning analytics. In so doing, we will evaluate various educational contexts and demonstrate the depth of analytical insights obtained when these two network-based approaches are utilised together. Finally, although both methods build on strong theoretical underpinnings, we will discuss the role of Connectivism as a theoretical base to further develop social and epistemic network signature – SENS, as coined by Gašević and colleagues.

Brendan:

Okay, so welcome everyone. I'm really excited to introduce today's speaker Srecko Joksimovic who is a senior lecturer at the University of South Australia in Adelaide. And I really feel lucky that I got an opportunity to meet. I think I don't know how many years ago now, at a summer institute for learning analytics in Michigan, which were where we first started talking about trying to bring together SNA and ENA and I learned a ton from him through that process and I'm really hoping that you all will get a chance to learn a ton from him as well. So without further ado, I'd like to hand things off to lecture so we'll talk about kind of where SNA and ENA intersect. Take it away.

Srecko:

Two critical things for them as they said before we started the whole, the meeting, I'm really happy to be here. Did y'all hear again it's been a while since we started all the discussion and I think we should pick up some of that sometime soon. And it's. It might be a bit unfortunate because this presentation I guess he's coming in, not such a good time for me it's, it's Friday and it's early morning. But besides that, it's. I'm still having a lot of questions, other than answers so let's see how that's gonna go from here. Thank you see my slides, random. Okay. So, see starts moving. Yep.

So I will try to give a little bit of the background why we actually why we're doing social and then again epistemic data analysis and how we try to combine these two. I would say complementary perspectives into one analytical model. And it might not be clear but yes collectivism has something to do with this. And I'll try to talk a little bit about how I see the role of connectivism in the whole discussion and where we can take this discussion from here.

When I talk about the ENA, I'll be using ENA and what constitutes tog Rafi, as you know, pretty much, which I know is not the right thing to do but there's somehow. That's what came into the oldest analysis, so it's been an already said I'm. I'm a senior lecturer in data science here at Australia University South Australia, working with a really good group of people with George Shane Rita Sasha evacuating is here and a few more colleagues who are really, really amazing to work with.

My background is in computer science but I did my PhD in school of education, University of Edinburgh that's where I think that's where, where David and I met and started the whole discussion about DNA. And my research currently focuses on understanding the abilities of both groups and individuals to develop necessary skills and competencies for solving complex real world problems and I see DNA and quantitative graphic playing a really important role in in my research domain.

So why we talk about networks at all so knowledge is network, right, so we're never engaged in the learning something we engage with the network elements that space across the centuries and knowledge is also distributed across a range of people and resources being able to build a

plane, for example, requires connected expertise from more than one individual and each of them having distinct knowledge so it's actually really difficult to integrate those different perspectives to single, single one. When we are trying to solve some of those complex problems. Distributed cognition on one hand, three its knowledge is existing with a network of artifacts and human actors, but cognitive agents that we are facing now and it we will be facing more and more, a slight side. Well, a lot, a lot different, because the agents we have nowadays in the dream will be facing more and more have more active impact on our actions as non human actors in human knowledge network, and let's get started. It's really new. And what I forgot to say the beginning, please feel free to interrupt in any time and I'm happy to jump in on some of the questions and if something is not clear.

So, why we're doing social network analysis and as you will see, social network analysis started the whole research starting a long time ago. And usually what goes with this. This approach is it's not what you know it's who you know and who you interact with. And it especially becomes important in the, in this age when we all learn online and we, when the connection with other people is seamless and easier than I would have been. So, the history of social network analysis dates back to 1930s with our study that analyzed interpersonal relations, and the formation of cliques at a time there were a few more groups that started something similar, but this one, this was, this one was more of the most popular at the time. Then in the 1940s we saw that social anxiety was first introduced. While social network analysis received significant uptake in 1950s and 1960s Ramin in his seminal work in 1979 reviews is the concept of centrality and then we have in 1980s 1990s, granovetter and Brooke, Burt introducing their seminal work that actually shaped the whole research on social network analysis as we know today. Of course with the emergence of social media and new technology and development of learning analytics we had more uptake especially of social network analysis as a method for for understanding learning.

And it became really one of the coolest cornerstones of learning analytics research. And one of the some of the first papers published relating it back to social network analysis.

It allows us basically what ESNA allows us to do is to move from the understanding how individuals, learn and what did you just do to take that more comprehensive understanding of how groups interacting how we interact with others, to, to build knowledge and to learn in educational research.

What we've seen before is that most of the time we rely on understanding how structural positioning how those centrality measures can help us predict some kind of cognitive learning outcomes whether these being a final cause Gradle quiz assign a quiz scores or something like that. It helps us understand how a sense of belonging, how social positioning relates to the course of the section. And, and some of the work talks to comprehension of learning materials and social network position.

So what I'm going to do I will just briefly guide you to some of the work in in social network analysis and show you how we moved from that descriptive network analysis to something

more complex, and how that researcher on social networks actually evolved to do educational research and specifically running ethics research. Some time ago jogging in a mall said, careful who you hang out with and who your classmates are because it might influence your, your GPA. What this study showed and they analyzed 10 years of student enrollment networks in the master's degree program in Canada. So what they show is basically the student social capital at criminal attitude to their cost progression is positively associated with their academic performance to those who had more social capital and who had more connections, they tend to, to have significantly higher performance but in that sense. It was also important. Whether you're connecting with those who are high performing students or low performing students.

In this sense, they, they have rationalized this notion of social capital two different measures of social centrality, and it seemed what came is the most prominent, it's finding is was basically, it's not just that you know a lot of people but it's more about knowing those who know a lot of people. And, and it was really interesting and one of the first studies in that, that what we did on a slightly different front we try to understand, building on the notion, and this first touch base on natural connection to understand how also of course facilitators learners and technology might have might shape the flow of information in, in, in, connect with smoke. So, some of the assumptions of connectors and say that at the beginning there will be chaos. Well, if George defined something you would find it quite normal. And then, as the course progresses, they will those knowledgeable orders will emerge, and they will drive discussion so we try to rely on methods of source of social network analysis to, to show that this teaching function can be distributed among the influential actors in the network. And as the course progressed, both human and technological actors comprising the network, assume this teaching function, and had an influence on how network developed and this was different actors, different social media because in connected. You're not tied to one specific platform, but it was more about how you engage with others to Twitter how you engage with others through to blogs and so on.

So, there's also interested in those official course facilitators preserved this high level of free influence over the flow of information. But over time, few groups emerged that that actually connected on the different, different topics that they were interested in.

However, if you take a deeper look and that's what those three studies that somehow appeared at the same time at the same conference and arguing for the same, same direction of how as nourishes research to the wall. ESNA research is not very conclusive so you can't really say that higher degree centrality will always be associated with higher with better outcomes, or any other sensuality.

The thing is, what we tried to do to some extent that was all those studies in these different research groups. It was going to do, I think. Try to understand. Is there anything else actually that might be might have an insight on how that an excellent necklace form and what else is there, that actually helps us understand when different centrality measures might be associated with better outcomes and when that might not be the case. So what we did basically in all those studies. We relied on statistical network analysis so this is the first shift that

happened basically from descriptive. Now when I say descriptive it's about understanding different centrality properties that are different indicators of how well we're connected within a certain network, and how that predicts certain elements, certain outcomes of interest.

But here, we're shifting a bit further from this descriptive analysis, trying to get that statistical network analysis on top of the on top of the, of the network analysis to try to shape the narrative around when different, the centrality measures might actually be predictive of the outcome and when they might not be so what we did in in our basically we linked. This does encourage you to see million ties theory that basically says that being a central northern network is not always associated with higher outcomes sometimes if you're if you're bridging a closed a closed tightly connected cliques, you might not benefit because you never gonna connect these two totally opposite network networks. So, basically the underlying findings from those studies that relationship between social connectivity performance and engagement is not really stable over time.

And what else is important is the differences in the factors, framing learners interactions affect the association between the social centrality and different measures of performance. So we tried to make that shift from descriptive to statistical network analysis to gain more significant insights into how the dynamics of networks actually shaped the social interactions. But then, like it wasn't enough, Sasha came and said, Well, wait, there is something wrong here.

So all the, all the statistical network models built on the gen two models that come from our understanding of social relations, how people communicate how they talk to each other. In, being in online space and that's where ESNA has been applied more commonly with the emergence of offline systems and social media nanotechnology is still the same network, network, network learning is, is a broad field the research says that basically that in this digital environment, we appear to language and language and discourse. So, what we say the artifacts we produce. That's basically what shaping what actually presents us in this online environment. But the. The fact is that I'm not interacting with Brandon anymore. I'm interacting with the artifacts Burnham produce, whether that's discussion forum posts or some other format. But still, the nature of this interaction might be might be different.

So what was the main argument behind the work Sasha did with her colleagues, is that most of the time, what we do when we model interactions in online settings is that we try to understand who talks to whom, and to project, and to build the network, in a sense, I replied to this person, but as a matter of fact, that's not what actually happened I applied to this particular port. And the second example actually shows that approach suggested in this study, what they say they say, let's try to model, network is forum based on using forum based modeling approach rather than modeling relationship between people. They suggest using post to post activity as the network to be simulated what it can do, then it can randomize ties in the post to post that are based on why learners post on the forum and what would be the more representative of how and why online interactions actually happen in this approach. First is a lot of still allows them to look at learner dice, but not as being simulated once, but as projected from the random network of posting behavior.

So, to cut a cut, cut the long story short, the suggestion is to simulate basic networks using hypotheses about learning behavior in socio technical systems, rather than social relations between people, because there might be some differences.

What happened what they what they found in in this study, and it was particularly interesting is the degree appears to be an artifact of learning activity. So, most of the time you will see that the measures we tried to capture modeling the social network networks some discussion forum post degrees anxiety. But basically, if you, if you have more discussion forum posts it's highly likely that you will have more, more, a higher degree of course. And the argument they made here is that perhaps decreasing, it on its own can be really used as an measure of social capital, but rather as as some kind of proxy of the, of the learning, learning activity. On the other hand, weighted clustering coefficient and the notion, who do we talk to and how we tend to group within the different cohorts may be related to social behavior. So although our posting behavior relates specifically to learning activities and what we are asked to do in a specific context of a course or wherever learning is tendency to cluster with other colleagues, still might come from underlying assumptions developed from social behavior. So what seems to be the case, we seems like we need more generic models for network formation that are based on our understanding of how socio technical digital learning systems work rather than something that you just took over from social behavior and other sciences and translated into this new settings.

If you don't know this quote where this comes from then you never saw that video on quantum photography and you should take a look at it. So, DNA is a complimentary perspective is no if your face is not in social sciences, I would say, research in general and more specifically, really used to matter the lending analytics research. And it allows us to identify and quantify connections among the elements encoded data and represented them into the dynamic network models. So it's not just that. So, what I find really important about content tog Rafi and epistemic analysis, in particular is not that just, you can just understand the visualize the relationship between different elements. You can also quantify all those relationships with, with using different statistical methods. And it's somehow it's natural. I don't like talking about mixed methods or quantitative methods are the two methods.

To me it's more like what kind of pressures you're trying to solve. It's not really, you know, I don't care about fundamental values, but most of the problems you're trying to solve nowadays require that cross disciplinary approach require. I would see.

I lost the vote, but comprehensive perspective to integrate both worlds, if we if we talk about quantity quality we can't understand. Nowadays problems using just one perspective and DNA is really good in going across different perspectives.

So, I will guide you to too few of the studies that we did, we did in a good time. It used to give me that the guy says what kind of insights ENA on its own, allows us to gain from some of the some of the work we did in this. I think you'll have two studies. There's a slightly different than us different data sources. So, for example, we all know that learning led analytics dashboards

are becoming more and more popular in as a way to provide students with personalized feedback.

What we don't know is basically how students, interpret those dashboards and how they make sense of all the information that we push back to them.

And I had to take and say Thank you Lisa for this really amazing work this was really interesting, interesting study. And so what we try to do is basically we employed randomized control trials to examine student sense making of learning outcomes dashboard, showing for different frames of reference. And to what extent this impact of dashboards was mediated by baseline self regulation.

The study basically you think about protocols to capture how students make sense of four different dashboards, with different frame of reference and when I say frame of reference, that means that there were four dashboards, one of them was self reference this dashboard comprised graphic displaying individuals, total time spent on different learning activities.

Then there was course reference. So information shown on these dashboards was basically supported also by cause recommendation. How much time. You should be spending on different activities. Then peer reference in the, in a sense, like, this is where you are. This is the peers are. And the last one was it gets more complex course and peer reference showing you the information. Basically, you see the stand in relation to the course accommodation and in relation with where, where your peers might be standing.

So, in a in this case was used for modeling dissociation between the codes, describing the reason for paying attention to specific graphics in the dashboard affect the responses to dashboards and actions to take in response to seeing the different types of dashboards and have the motivation change out to seeing performance data.

So what was interesting here is that, and I hope George will hear this negative effect is not bad, negative effect is not bad. So it's not necessarily adverse to June decibel sometimes unresolved those days but we can see the strong link between negative effect and timing study environment management and different graphical aspects of the dashboard. And it depends if we talk about self reference there's a good chance they tend to think more about whether the graphic provides a clear trend, how I'm progressing throughout the course. If we talked about course reference dashboards, then it's more about just linking the, the negative aspect and time management.

But when it comes to peers, is also can we break down, can we drill down, can we can we get that comparison across different with different with or without this. And the last one the most complex one was basically how those visual features allow us to, to can easily understand the features that the dashboard represent.

So that was one example another one, and this one was using thing called protocols what we did, we coded data, we found, according to different theoretical famous but. The next one, use, and that's I guess the most commonly way to use DNA and quasi orthography in general, but the other one was somewhat different. Because what we did here we had a context where professional healthcare professionals, engage in, in, in professional development. So, at the end of the series of three courses three modules. A, B and C, how they label them, they would take a high stake applied knowledge test. And in this cohort we had most of them, passing the test but some of them failed, and given how important this test was it was important to understand.

What are some of those underlying principles of mechanisms, you can identify from their interactions that could tell us that some of them will pass or fail the test at the end of interactions, three modules, and what we observed here was, in fact, show you. Yep, I have this as well. We looked learners, within specific session. And what are the activities, they were a Dave. David taking within the specific session where they're assessing learning resources whether they are trying some assessment, where they were submitting some written artifacts and so on. Of course, when we, when we tried to fit in a, despite on our own, cause do activities was actually turned into the columns. So that's how we approach the whole thing. So, what, what, what we were able to find out.

Is it those who weren't what's important as well. We forgot to mention in the previous slide those first two modules in B. They focus on learning essentials in those, those two modules, those professionals are expected to cover different learning resources and to read and view different videos, and to support different critical case and now it's the last module is primarily focused on the analysis on the on the on the assessor what he found out is it on this SVD one dimension that that's y axis, right. So, we saw that progression, and the importance of that early engagement with the, with the core course content though who those who were there from the very beginning who tend to engage with the learning asset essentials modules to submit those critical key clinical activities from the very beginning and to engage with the quizzes, from the very beginning in the first six and a second six months.

They will those who are more successful in the, in the final knowledge, knowledge, applied knowledge test, but those who are waiting until the last year and just focused on the, on the activities and exams, they tend to do fail the test, like basically the whole idea here is like what I was trying to show. It's not that you have to, so that we just use ENA to analyze data after some inductive coding after interviews analyzing that kind of data we can also generate that we can automatically pull data from started from learning management systems and similar environments.

Okay, so we saw one perspective we saw somewhere that something probably most of you already knew about ENA but

what we tried to do several studies, is to bring those two perspectives together. So, it's not that. They just yeah they all come from, from Gulf base metas na na na, and that's what they have in common, but these two perspectives. Provide complimentary insights into the

problems that you're trying to solve. So the first study that we that we did was about understanding the making sense of the teacher agency for change. Agency for change, or the or the capacity to shape, critical responses to problematic situation is often framed as a matter of implementing some kind of bigger external change agenda. And for example, research has provided useful insights on how the exercise agency to implement new national standards for example, but sometimes teachers might also resist this change. So this study that we did, examine the deviation between teachers, sense of agency for change in their underlying beliefs, through the lens of inclusive pedagogy. So what we did find the assumptions that change towards more inclusive practices is socially embedded process. We employ the social network analysis to examine the association between teachers agency, inclusive pedagogy and their social networks, social networks analysis has been applied to understand how this teacher agency shaped educational change.

However, the nature of these change depends on teachers underlying beliefs and the way of acting that can reinforce or distort the existing norms. So what we did with ENA in this case was to examine teachers agency in relation to the underlying beliefs and understand of change and the social and the social institutional context the shape what teachers, see, see possible within their practice.

So how we did this. There was a teacher reflection on the agency for change, online tool, teachers in two schools in Sweden would go and say, What is the problem you're trying to solve what is the what is the problem, you see as as something you would like to tackle, or something that someone else asked us to solve as, as the notion of. When you play as a role of implementing. Who do you talk to when you try to solve this problem. And what is the nature of this relationship, whether it's seeking for advice, whether it's just cooperation, or something different.

And why, providing basic reflection on the outcomes, and the contents of specific purpose of interaction described in the previous two sections. So, again, what we did, we did, we coded, each of the reflections trying to find the different themes emerging from teachers reflection. It turns out that of course day to day activities, drive changes and what kinds of roles did teachers take in as a genetic approach to, or just as role implementers. So the four teams that we've found emerging from case study with student learning and well being, lesson planning, of course and professional learning program improvement and logistics. And the final one was about working conditions. They're just from coding, but what is interesting from the DNA perspective, is the results show significant differences between teachers. When acting as agents, compared to the situation when teachers are acting as role implementers.

They have been epistemic frame from for, for agency that's the one on the left indicates a strong connection between inclusive pedagogy codes and interactions with teachers. Evidence with those decline between school capacity and capacity and teacher and judge.

On the other hand, digital logs revealed that practices that hinder any inclusive pedagogical approach appear to be linked to the epistemic frames of roll implementers. So when we drill

down a little bit deeper and try to understand school and student barriers. There are these were linked more to providing some opportunities for smaller group of students rather than implementing inclusive pedagogy across the broad across the board, social network analysis on the other hand provided a complimentary perspective that showed important differences between teachers. When acting as agents of change in comparison to teachers interactions when acting as role implementers, on average, when acting as agents teachers tending to interact with more people in comparison to situations in which the active digital input.

Both networks show that teachers and support staff work together frequently when talking change in the students. Many of these interactions are collaborative, in a way, while the introduction is good school leaders are infrequent, and focused on either communication or advice. So, what we basically did here is that we applied na and na is S, to complimentary approach but not necessarily feeding one into the other, it's more of providing two complimentary insights on a single problem. What we tried to do some time ago. And this is the study that David venden Darren and I did some time ago now. So we, what we actually tried is to provide that more seamless link between the two how one method can feed into the, the other one. And just a heads up, going through to the next few slides. I won't be talking about technical details I'll be more focusing on what kind of fascist we were trying to answer and how one method fits into, into the other.

And what kind of insight, we were able to get. So, it is not just to look at specific problem using one and then the other approach. It was more about can we actually combine those two analytical methods in something that would get us more comprehensive understanding of the, of the problem at hand. Fundamental claim for providing more seamless integration between ENA, ESNA, realizing this necessity to capture the complexity of interactions between interrelated cognitive and social dimensions that emerge from social ties and in collaborative discourse. The idea that it is difficult to evaluate the quality of collaborative learning by just looking at who's talking to whom without knowing what they're talking about, or by modeling, what is being said, without tracing the interpretive contributions of the of the individuals involvement in their head have been different approaches to combine content and the social network analysis like Martin Dillard back in 2006 2007. He proposed combining

ESNA with content analysis, which is more positive in a way. This is this would be, I guess, one step. From there, trying to provide that that more seamless integration between ESNA, social and content analysis or epistemic. So the whole idea is fairly simple. Or maybe not so simple. What we did in this study we started from oma Corporation traces, specifically analyzing the discourse produced in in those industrial corporations to extract social ties and to run some kind of content analysis of the, of the artifacts created in those interactions. So when we, when we talk about this course it was, it was fairly simple we what we applied was topic modeling and we tried to find to extract different topics that students were talking about acoustic cause progression.

So we applied our automated method for content analysis, and on epistemic efficacy top of that, just to understand what the topic is talked about and to quantify the relationship between

different topics. On the other hand, we try to understand social interactions modeling social relationships, emerging to this discussion forums and doing social network analysis to extract roles, they play in the network to emerging communities and to understand network processes deduct the drive from formation of distances, it was quite complex, but it every single step and that's what I'm trying to, I will try to communicate the next few slides.

Every question we are trying to ask, was somehow combination of the two methods and how we actually did this. So, first question was basically about understanding. Does students talk about influences, who they talk to they talk with, and how we did this. We applied. Both models, one based on SLA properties and demographic academic attributes, and then another one that traditionally included in a class assignments as parameter parameters off select to mix them so what we actually did. We try to model to use statistical network analysis to, to understand the social dynamics, the genetic formation, but instead of using simple properties, such as reciprocity or some of those commonly used. We try to model homophily based on different epistemic classes emerging from the epistemic network analysis. And that seems to give us better model fit than just with typical SLA properties.

Another thing is the content of students talk related to their role in a group communication. First thing was about exploring visually how different classes but then we also paired whether those different DNA clusters, were significantly different based on their ethnic centrality measures. And here I think we observed three or four weighted degree clauses and in between as it turns out, yes, those, those a classes were different. With respect to their two different sets and demands.

And finally, we might have one more question. Do coops have causal links students talk about different things depending how well they do in the class, and that's something that came across from previous ESNA studies that students who perform well, they tend to group together and they tend to talk about similar topics so what we did. First, we ran committed to action, ESNA and use that as an input to basically do to.

After and committed action identified to two groups of high performing a lot of performing learners and then tried to compare their epistemic networks. And finally, we tried to use different ESNA and DNA properties in in regression model to try to predict the outcome. Turns out, when we combine two, two approaches and features coming out from both analytical methods. We were able to fit better models and to get more insights into intelligence performance. So, what about connectors, how the whole story with connectors and fits here.

I'll try to publish this shortly. As we all know, technology is a central agent in all areas society today is altering the way we communicate interact and collaborate. Knowledge resides in network and as we said, as we are moving ahead, it's not it's not about yes knowledge sits somewhere over there. It's more about that those cognitive ages are becoming more active in any way they try to humans. And in the way they shape our knowledge. connectivism on the other hand, recognizes that those three domains of connectedness, or I don't know the other word at the biological of neuronal level, at the conceptual and socio technical level and

immediately should be clear that sense as approach states occurs across these two conceptual and social levels now the principles collectivism and where I see that those connections which says, learning and knowledge, rest in diversity of opinions, learning is the process of connecting specialized nodes of of information or information sources and capacity to know more is more critical than what is currently known. And I'm not going to go through to all those because I think I'm almost out of time, but what my point here is ENSA is separate domains. They built on certain theory theoretical assumptions, there is a theory behind both methods. In a press upon the network system of meaning about understanding the meaning emerge that that comes from, let's say, those interactions. It's an A. On the other hand, represents that real connection that connection that actually were established in, in, in, in the real world.

Connectivism as a framework or learning theory allows us to theorize those connections, create representations across various levels of systems at the mental level, social show meanings and physical objects artifacts of or technological affordances. So, as a theory.

I think that connection sits right under sense in a way of informing, how can utilize this rather interesting combination of ENA, to understand how learning and knowledge processes are old and how we can understand learning in this digital age. Using sets. So basically, the arguments will be an SME have their own models, he says, should have a different underlying theory that informs research around sets.

I tried to go to shows research that comes from ESNA and show you how we were we shifted from that original research on providing some statistics to more statistical network analysis. We touched briefly on some of the potential of DNA there is way more to it than then then we saw and what I was trying to make as an argument is that what I see how I see ENA, going from here and where I see this, this stronger integration between SNA and ENA and collectivism as an underlying theory but what were actually. Where's the main potential of using sense, what we say and how we measure, for example cooperation of cooperation, teamwork nowadays. So there are different frameworks out there, like, one of the most, most established frameworks on assessment the teaching of comp of 21st Century Skills talks about cognitive skills and talks about soft skills, those being thoughtful relation learning and knowledge building participation perspective taking in social negotiate negotiation.

Most of those frameworks and ICD and empezar being one of those as well. They put students in a specific context, that's very well structured and students are expected to take several boxes that would show some evidence of social and cognitive skills that sense allows us to do is to go beyond that and to understand how those two evolve together. And what we tend to ignore in the in the current framework of the assessment.

Most of the time, those environments actually give us just not do not interact with each other every day appears they interact with eight and Sasha, showed us that this might be different from how we interact with other people. And that's, that's what kind of families can't ignore and I think it seems to be based on the current research that sense might be one way of reshaping our thinking how we measure complex skills, and how we use this as an analytical

method. But more importantly, we see sense, as, as, as, as going forward is about understanding the nature of interaction between humans and machines.

Why this is and this is where we link again to the connectors and collectivism is actually agnostic to where knowledge resides, whether it's in other people, people in networks in humans machines. Doesn't really matter. it theorizes that that the process of Knowledge Building, as, as a network process. So at the moment. As technology becomes more intelligent, it, it becomes questionable can we actually build on the, on the existing theory that we know is the article methods to understand how those more intelligent machines actually shape our interactions and how we interact with each other, and just try to.

As I said at the beginning, not very good timing because I still have a lot of questions that need answering but networks are complex and networks are temporal and what we even in the in this first iteration of bringing SLA and DNA together. What we ignored is basically a temporal dimension, what we did was just process analysis. At the end of the course. But networks evolve network, develop, how do we, and there is a lot of research recently on social network analysis that include the temporal aspect, how we combine these two elements in one when we, when we do anything we do sense when we combine these two approaches, they both allow for temporal analysis, how we integrate them into one thing. How do we account for different financial aspects in understanding in understanding blending using the using senses as an approach. What happens with motivation nothing, how we capture for those things. And when we talk about connectivism we talk about learning in the digital age. What seems to be more Cooke closer to some of the some of the recent development is about knowledge processes, and it's not a digital age it's more of age of AI for lack of better word, because we are not learning anymore Just as we used to. We engage into SAS making decision making all kinds of different processes that lead to Knowledge Building.

Learning being just fine with them but machines can also learn what machines, might not be able to do is to make sense and interpret those information that way we can.

And why AI will just because just because those all those agents we interact with are becoming more intelligent. So, as Sasha, showed in her study as we progress through to descriptive to statistical to being made to questioning me, whether those network models, coming from theories of social behavior can we translate them into these new settings. Do we need generative models for sensors Well, can we build out the models based on connectivism that would support research on that combines sense, social entities epistemic analysis in one model and nine over time. Sorry about that. I'll just wrap up here, as I said, lots of questions and I'm happy to take some of your questions.

Trash. Excuse me stressful. Thank you very much. That was a tour de force. Would you mind, stopping to share your screen so we can see everybody in the gallery mode and everybody can give you Juno applause and whatnot. All right.

Great job. Thank you very much. I think we have time maybe to sneak in one question from the audience I see a lot of applause going on there and I apologize for my dog right now, but that's just the beauty of the, of the world we're living in these days. So, I'd like to take a question from the audience. So if someone like otherwise I have one that I'd like to ask too. But, does anybody have a question that they want to put in the chat or to ask?

Let's see.

Otherwise, I can go ahead and ask the question real quick. My dog might have something to say about it.

Actually, David did you have a question that you wanted to ask and I can, I can mute myself.

I always have a question I want to ask but. So, search go one of the things that I'm curious about is how you're thinking about the different excuse me the differences between a CMA and an NA, and, in particular, what you've taught, you've made a very convincing case that they're looking at different objects of study. But I'm wondering if you also see them as fundamentally different techniques or mathematical techniques, in the sense that could we use ESNA tools to look at the kinds of networks that DNA is looking at and vice versa or are there. There's something underlying that's different about the structure as well as kind of the intent of the two techniques.

Well what we did before, is that we try to use some of the graph based methods to analyze to analyze topics emerging from, from different discussions in a way we tried to do with DNA but what we were able to discover from there is how different keywords for example group together but we couldn't actually move beyond that point understand how those actually topics, interact within a specific context what actually in a allows us to do anything. Ines. They are similar, but in essence, they are different enough just to provide those two complementary perspectives that we actually need an understanding Kava to learning in general. And I think that, definitely.

I don't think that we can just use ESNA in the same way we use DNA, and anything that we there is a need for both methods, definitely.

It just showed us.

Thank you.

All right, my dog has quieted down now. Do we have, we might have time for one more question that we could sneak in before we're at time here. Does anybody else have anything that they want to add or ask a stretch go in the chat or go ahead and unmute yourself if you'd like to ask. Yeah, I apologize it pushed a bit longer than I expected.

That's okay you gave us a lot to think about which was good. I mean, personally, one of the things I thought was kind of interesting is thinking about different agents, and you know what are the things that are going to be connected between and what types of things are flowing. One of the things that you know I've thought about a times is, is, is it, access to resources being put in there lots of different networks we can consider not just necessarily social or stem I mean there's multiple, you can have multimodal multimodal epistemic networks right, you can have I liked in one of your social networks where you had different edges or different things that we're connecting in terms of the quality of, of how people are connecting to each other. And I think that, to me, one of the things that you highlighted pretty well was kind of the flexible nature, we still have to I liked also that you focused on theory. We're going to need to be guided by theory in terms of how we are thoughtful in terms of constructing these models but there's a lot of exploration to be done in terms of how these different approaches can be pushed forward into the into the future.

So I don't know that at least stuck out to me and you're talking I don't know if you have any things you want to add on that. Yeah, I mean, basically, we. There are a few recent calls from NSF foundation, NSF agencies about funding different projects that focus on understanding how we work with machines, but basically what seems to be missing there and that would came to this to this Ed snare research that I tried to tackle a little bit is also. Can we just translate these distinct approaches that we use to 10 social interactions to this new context where we interact with something different. It's not just human in a loop and emotion only introduce something that's artificial, but it has more influence on the way we cooperate. It used to be before, usually. Previously you could take a note you could ask Siri to do something for you but now we are going more towards cognitive agents that would take more active role in those interactions in if we can't translate social behavior.

What we know from social behavior to online context if you currently have. How can you translate those existing theories of learning, or understanding knowledge processes into something that big something artificial that's even more. It's even more active in in shapes those interactions in totally different ways. So that's where I see this combination of the of the methods really important. And as you said random. It's not just, it's not going to be one type of networks one type of links between the two nodes. They has to be very more. And one way, I would like to see in ans, going forward is bringing the temporal aspect of this what we missed last time and that's what we should be going for.

I know there is any allows for trajectory analysis and how things change over time. But when we integrate two methods. How we do that in a in a in a seamless and efficient way.

Yeah, that's great. Well, I just want to thank you again Tresco for a great talk very interesting. And I'm going to give a quick plug to someone who's actually heading down to Australia soon to start a job at Monash University. Next week or next sorry next month, excuse me, Zack, Zack Swiecki he is going to be talking. He said we're all in this together, which I think is a great title right now modeling interdependence in collaborative settings. So please remember to sign up for that and join us. Let's give one more round of applause and thanks to stress go for a great

webinar, and thank you guys all for being here and we hope to see you next time. It was great. Thank you. Thanks so much. Thanks everybody for coming.