[Auto-generated transcript. Edits may have been applied for clarity.]

Today we have something really exciting in store for you at the Center for Innovation in Applied Education Policy.

We have, for the first time ever,

two high school students who are going to be joining us with their mentors and a very interesting

conversation around how one becomes a high school student researcher in the age of AI.

And our hope is that through this talk today,

this discussion that will be inviting lots of middle and high school students across the state of California and beyond to really be

thinking about how they themselves might get more involved in doing student-led research and studies on topics that are interesting to them,

both within AI as well as about it. Our panelists today are four esteemed folks that Carrie will introduce in a moment.

Dr. Holmberg will say something about their background.

But as you know, as usual, we'll be moderating this together so that there is a flow of discussion.

And we hope that that discussion will invite you all to think more deeply about the topics that are being raised.

Before we start, we always say at our Center that what grounds us, what moves us is Assessment for Deeper Learning (AfDL).

And that includes things like deeper learning itself.

But we're really interested always in the idea that the skills and knowledge that

students must possess to succeed in the 21st century work world also include,

we believe, civic life. That is, that deeper learning has all sorts of knock-on effects and transferable skills in the areas of critical thinking,

problem solving, collaboration, communication, and probably most importantly,

what some of us think of as higher-order thinking that one of the reasons we care so much about this work of helping students grow into

themselves as professionals as we want to allow them to evaluate and synthesize and frame and use their knowledge in new contexts.

And I think really today you have an absolutely excellent use case of how this

can occur when students are given the opportunity to engage in deeper learning.

For some of you, it may be a new idea to hear about assessment for deeper learning.

And so we want to always center in our work the fact that good instruction and good

student work is always connected to what we call assessment for deeper learning,

which prioritizes assessing critical thinking, problem solving, collaboration, communication skills, as well as core content.

The key idea here is that assessment for deeper learning is always formative in nature,

and it emphasizes continuous improvement of student work and student research in this case.

So don't be surprised if we ask a few questions in that direction as we go forward.

Carrie? Yes. Thank you. Brent. It's my pleasure to introduce our four panelists today.

I'll begin with Hudson Etkin. Hudson Etkin is a senior at Los Altos High School with plans to study mechanical engineering in college.

Motivated by a love for problem solving. Inspired by his experience tutoring underprivileged students within his school's AVID program,

he worked with a team to conceptualize, build, and conduct empirical research into the effects of AI tools on reading comprehension.

We'll be hearing more about that today, hoping to work towards a world where AI might democratize education for all.

The study's manuscript has been accepted for publication in Frontiers

in Education.

Beyond that, he has developed and grown a movie discovery app to 2.5 thousand users,

leads the world's largest high school hackathon, Los Altos Hacks, and interned for a political accountability startup. For fun,

He enjoys playing varsity soccer and casual pickleball with his friends.

Kai Etkin. Kai Etkin is a high school student passionate about research and leveraging AI for education and social good.

The peer reviewed empirical research Kai co-authored, accepted for publication in Frontiers in Education,

explores AI's impact on reading comprehension and its potential to build educational gaps.

Bridge. Excuse me. Bridge educational gaps. He's also a director for Los Altos Hacks, the largest high school hackathon in the world,

and co-leads the AI for Social Good initiative at Los Altos High School.

An avid debater and soccer player, Kai combines his passions for technology and education to advocate for responsible, research-backed AI solutions.

His other activities include volunteering to improve senior digital literacy, video editing, developing apps, and refereeing youth soccer games.

Boy, are we in for a good time today, Carrie. Indeed.

Ryan Carter, Ed.D. Ryan Carter, Ed.D. is a counseling educator with over 20 years of experience in K-12 public education.

He has served as a program coordinator, school counselor, teacher, instructional coach,

and educational leader at diverse institutions throughout the Bay area.

In addition to his work in secondary education,

Dr. Carter is a research fellow for the center for Innovation and Applied Education Policy at San José State University.

Dr. Carter holds a master's degree in counseling and a doctorate in educational leadership.

His additional scholarship focuses on the connection between educators' beliefs and behavior,

equity-oriented, support-oriented support frameworks and best practices for supporting at-promise students.

In his free time, Dr. Carter enjoys recharging his batteries through fitness and music.

Cami Rolle, PhD, Dr. Rolle

is a clinical assistant professor in the Department of Psychiatry and Behavioral Studies.

Dr. Rolle completed her doctoral training in neuroscience at Stanford in 2020.

Doctor Rolle's clinical interest is focused on the individualized, neural-driven targeting of psychiatric treatments.

She is passionate about the translational bridging between animal and human neuroscience,

specifically focused on maximizing the methodological rigor in human neuroscience to better translate findings between species

in psychiatry research. In addition to her work in research,

Dr. Rolle is passionate about disseminating her research and training in cortical limbic

circuits and their role in emotional regulation and development to resource families

supporting the growth of youth with a history of trauma.

She is integrated into the organizational efforts of a number of nonprofits dedicated to supporting the foster community,

and is determined in her efforts to inform and strengthen youth-centered therapies through neuroscientific understandings.

Well, now that we know we have an outstanding panel assembled, let's get to some of our guiding questions.

Carrie, do you want to read those out for us first before I take them one by one? Yes.

What got you interested in AI? How has your high school research project related to AI changed your experience of school?

Your study highlights the differential impact of AI tools based on baseline reading comprehension.

How do you suggest schools or educators assess the suitability of these tools for students with varying levels of proficiency?

How much of AI did you use in the design, development, implementation, and evaluation of the results of this study?

What advice would you give to middle and high schools about how to do projects like this?

Now, for those of you out there in zoom land are wondering if these questions are softball.

I think you can disabuse yourself of that.

We've got the right team to go at this, and we just decided we'd open up to everybody on the panel and ask this question.

So what got you all interested in AI? Okay.

Yeah. So definitely as high schoolers as both Hudson and myself are, like, everybody knows about ChatGPT. ChatGPT got released in November of 2022.

I was in eighth grade. Hudson was in 10th grade. And like in the words of Dr. Carter, it fell into our lap.

It immediately, just like kind of exploded when when you see something so accessible that can do so much,

of course everyone's going to start using it.

I remember when I was in eighth grade, like it got released around the time that we had just started a poetry unit,

and literally pretty much every single poem that was turned in on that unit was ChatGPT like,

that's just it was it was something that was like never seen before.

I personally remember being absolutely blown away by the capabilities, but just beyond the fact that it's like so prevalent in our daily lives as,

students, it has a lot of potential, not only in education but in a lot of sectors, of course.

And personally, we saw education as one of the the biggest sectors that I like not only has the potential to enhance,

but is going to enhance like is going to affect, for better or for worse, inevitably. It obviously has meaning as we alluded to in our in our bios.

We believe it has like a, a very, very like huge potential to democratize education.

You know, it provides a completely like a very, very cheap and very, very,

like infinite essentially,

because it's just some code like potential tutor or just ways to bridge these gaps in education that we know are so prevalent in today's society.

And obviously, I would say everybody can kind of, understand that,

like the benefits of education and how transformative education can be not only to like someone's life,

but also to society and any like steps or tools that we that like, we have the potential to, to develop to help like work on that.

That issue we just believe is a huge, huge thing that we should work on.

And that's kind of just what got us like, interested in in the first place. That's fantastic.

Hudson, do you want to chime in and say a bit about what got you interested in AI?

Yeah, so actually it's so similar to Kai, definitely in my motivations for wanting to,

work in AI, especially at the intersection of AI and education.

And I think so what actually got us interested in doing research was we initially wanted to build,

since both of us come from like programing backgrounds, we've built a lot of apps, stuff like that.

So we initially wanted to build an AI textbook app, like helping make textbooks like easier to read,

since it's like they're very dense and people don't really read them nowadays.

Helping to make it easier to read and with a bunch of different AI tools.

But we were looking through the research, trying to see of what is the like, the actual efficacy of these AI tools.

And we saw there largely was no research,

and especially because like I saw a stat today that like 50% of high school students use AI at least once a week.

And it's so prevalent in our schools and so many companies are bombarding districts with AI products, bombarding students with their products.

And there's just very little clarity from the research world of how what is the actual effect of these tools?

So we realized that that was the salient bit, was that we should...there was a huge gap there,

and we wanted to fill that gap by conducting our own study.

So yeah, so basically that led us because that led us to start our research within an institution.

And it's been like, it's just been very fulfilling. It's been awesome working in that field.

So I just want to underline, underscore the,

the incredibly important insight that you all had about addressing research gaps and thinking about AI as a possible solution,

but a solution that may not have enough research yet to know what's effective, what's not.

So what's exciting about your vision for this sort of research is, you know, how do you address those gaps?

And you're doing it pretty early.

As high school students, let's talk to the folks who have not necessarily got out of as early as their high school experience.

Tell us a little bit quickly if you can, Ryan and Cami about, you know, what you got you interested in AI.

Okay, I could start. I did want to add one thing to my bio that was not on there.

I'm the proud high school counselor of Hudson and Kai,

and I mention that because I have seen them and all of my other students experience this, like, rapid descent of AI into their educational lives.

and so I think what I've also seen during that time is just this wild pendulum

swinging between how we as educators do or do not integrate or allow AI to be integrated into into students' education.

You know, when it first descended, I think it was initially viewed as absolutely problematic and almost synonymous with academic dishonesty.

And within a short amount of time, everybody's got Gemini, you know, accounts in their Google School suite.

So it's just it's created a lot of gray area, a lot of question marks.

And watching students try to navigate that has been really interesting.

So that's one thing that's been really interesting. I did want to just say one other thing specific to Hudson and Kai's research is that, you know,

my interest as a school counselor and as a researcher are deeply

entrenched in equity-oriented, equity-oriented support frameworks.

And so what was really jumping out at me about Hudson and Kai's research was that they were looking at,

if and how AI tools could be used really as equity tools to kind of level the playing field.

And with a particular focus on high stakes college admissions testing, which I think everybody here, you know,

is familiar with the ongoing debate about how these tests may advantage students from privileged backgrounds and disadvantage students from,

underserved backgrounds.

And so the idea that, you know, these tools could be used to kind of bridge those gaps was really interesting to me as a

as a researcher and a practitioner. Love it.

Cami, do you want to say a few words about what got you interested in AI? Before we move on to the next question?

Yeah, yeah, I think I think for me, what got me interested was Hudson and Kai.

AI is not something that we use in the field of neuroscience or psychiatry actively right now.

We maybe use it for document editing and writing of some of the million grant documents that the federal government requires.

But otherwise it's really not actively used in any of our research.

And so when they approached me wanting to try and understand AI specific to reading comprehension,

it was something that was more or less novel to me and how that operates with education.

But what's exciting to me is that in neuroscience, we have a lot of people developing exciting tools, right?

Different tools that can aid in different types of research or therapeutic pursuits.

And what often we miss is in that excitement is doing the correct research

validation to make sure that that is not just a in theory and exciting idea,

but is practically useful.

And often we actually find that there's some type of baseline stratification and therapeutic efficacy of these exciting tools.

So what's very what's very cool to me about this work is in this education AI space, they did just that.

They went and did the research that that's always needed.

When an exciting tool gets released about how this could be utilized in education and then found something that we often see in neuroscience,

which is that baseline performance is super relevant to the utility of this,

and that it may even actually not less than being even helpful may actually be hurtful in situational context.

And I think that that was that was really exciting to see. But but in terms of what got me interested, it was really them.

That's really helpful. I love the intersectionality of various perspectives, including those who...

...folks who work outside the school system and those who work within it.

I will say this, you're in the right place if we're talking about baseline anything,

because we do have training in psychometrics, and we do know a little bit about the idea of what it means to measure something well.

We'll leave that for another discussion with these two young men when they come back with their next paper,

and we'll hit them a little harder on validation studies. But for today, what we're going to say is.

...as well as, frankly, the ways in which it created a social environment for you to a students,

that is, you were able to interact with adults in new ways,

that I think were kind of exciting for those interested in what we call real world immersion for the high school experience.

Well, let's just ask a question. How has your high school research project related to AI changed your experience of school and schooling?

I think that's that's a good question. Definitely a lot. I think to start, it might help to give some context.

Just a quick elevator pitch of what our findings essentially were.

So what we did was we took 230 college-aged participants.

We sourced them online from this platform called Prolific.

And essentially we built, you know, as Hudson mentioned, we have a background in coding development.

So we built out a portal with four AI tools using the GPT, the model that's behind ChatGPT.

And we built these four tools, and then we had all 230 participants go through our tools and then take,

ACT quizzes and read like the corresponding passages.

And we did this.

And what we ended up finding was that when we split our participants in a group of low performers and high performers at baseline,

we're looking at their performance on a control passage with no AI.

The low baseline performers were significantly helped by every single AI tool.

But like on the complete flip side, the the high baseline performers...

So those that like performed well without AI on a control, they were hurt by every single one of the AI tools.

So this was just completely, like, shocking to us.

You know, these findings even held up when instead of splitting our participants by how they did in our control,

we split them by their SAT or ACT score, which they took up to five years ago.

And these findings largely still held up. So what this showed us was that, like, it was really just not exactly what we were expecting.

We thought it would just be all up or all down. We hadn't really, like, thought about this.

That, that his was even a possibility. So what this really taught us was that we need caution, like a healthy amount of skepticism.

And whenever we're using any sort of AI tools, because the fact that this the very, very same tools, the very,

very same pieces of code that boost outcomes by 20% in some people, could also hurt outcomes by 20% in other people.

So like essentially in school, AI is being used a lot, whether we like it or not.

But what this has essentially taught both of us, and I'm sure Hudson can touch on this, is that we need to be skeptical.

We need to be cautious. We cannot just jump into using AI tools.

And that goes for educators and all that. I would say it just gave us a lot of skepticism.

And I'm sure Hudson can relate to that. Yeah, definitely.

Uh, especially like, uh, as an mentioned before, lots of tools are marketed to us.

And now I have to be like I'm a little dubious of their efficacy given what we've discovered,

especially because a lot of the tools that we tested are varied.

A lot of different products use similar tools. And then I would add to, I would like to add two things about, related to this question.

So I tutor, as I mentioned in my bio, I tutor at my school and it's like, because I've spent so much time working in,

like AI tutoring, that type of thing, I think a lot about what AI tutors have to look like and what human tutoring looks like, what the differences is.

And I think there's, at least from my experience, tutoring,

there's a huge component of human empathy that I think AI is largely missing, like knowing that.

Like a student is getting bored or bored by one train of explanation just by looking at their face.

And there's just that type of human empathy that is really hard for an AI to replicate.

And then completely unrelated, but, at our school, we have this program called ASI, which is Advanced Scientific Investigations.

And in that program, I'm conducting a different research study, where I, um,

me and my partner are looking to Parkinson's and C Elegans, which is a

little model organism worm.

And that's been like that

That's been a program that has that I've done completely through school.

So this, this AI research was completely out of school. That was a program completely in school.

And so that that program has been very interesting too. You know we think about the idea of cross-fertilizing a really effective school,

typically from the research tells us that there's actually a synergy that's going on between outside of school and inside of school.

So it's really exciting to hear that you're applying what you've learned with mentors outside, back inside in different spaces and vice versa.

I really liked what you said about what Carrie and I've written about in our book on feedback, where we talk a lot about modalities of feedback,

and we think really hard about how feedback has to be not only verbal, but can also be written.

And then we call something body kinesthetic. That is the degree to which there are cues and signs and visualizations.

And it's so interesting, Hudson, to hear you say that.

Well, I thought that Gemini last night did a really good job of making me feel good because she said, that's a great question.

That's not the same as having an empathetic, interactive reading tutor or any other kind of tutor.

And so, it's just nice to see that you all differentiate that.

I'd like to let our two other experts on the panel say a few words.

If you see anything happening in terms of these high school-based projects,

sort of having synergies in other spaces around your school or outside of the school.

Dr. Carter?

Well, I think, you know, my response to this question is that this is just really given me a much less

much less of a binary view of I write that I have to land one way or the other, as many educators have kind of felt as this was being introduced.

And so Kai and Hudson's project is really, I think, just opened my eyes to the complexity of

these tools as possible supports for some groups of students and maybe not others.

And so I think, yeah, it's just it's kind of given me a lot more critical thought around it,

similar to what the guys just said about their thinking around it.

You know, Dr. Rolle, I have to say

I mean, one could imagine that, that universities are now training up their researchers as much earlier than they used to.

I mean, in my model it was go to master's program and then think about what you're going to

do for a PhD program and then hope you get adopted by some PhD program and advisor,

and then maybe it'll take you a few years to figure out how to even figure out what a research question is,

let alone with a methodology, is you have sped up that process, apparently, and given us insight into that.

High school students can begin a track of learning how to do research.

So, I mean, do you see impacts past this test case of two?

I mean, greatly. I think...

I think like in relation to kind of talking about how integrating with high

schoolers could be in universities and research programs can be beneficial.

I think from my perspective, we see a ton of high schoolers trying to get involved in research,

and what happens is they come in, just to be totally transparent,

they come in as volunteers into our research labs and do data entry and do data collection.

And it's it's giving this and I always lean away from

these experiences in our own work because it just doesn't give you the representation of research that gets you excited, to be honest.

It's not, it's not the whole thing.

And I think what what was mind blowing to me about the way that Hudson and Kai did this is they just flipped the narrative here.

This is not the traditional way that you get research experience in high school.

This is the first time I've ever seen high schoolers get research experience this way.

And they just went and did it, and they did the research themselves.

And this is this is as close as you get to real research experience as a high school that I've ever seen.

And it's really giving them a sense of whether, how it feels to ask a question and answer it with data and that they can do that

independently without having to kind of go through the traditional process

that is the research trajectory traditionally.

So from my perspective, I wish we did this more, and I wish that this path towards really understanding research was

was better integrated into the high school system because it's the first I've seen it.

And I think it's it far exceeds our kind of "Come in, collect the data."

And you can now say you know research, which is not an accurate representation.

I think this is a far better version. Well for those of you who remember the old DIY, I believe it is.

Or maybe I've got that wrong. Do it yourself. You imagine a world in

which young people

like Kai and Hudson are going to actually put on YouTube or other more up-to-date mechanisms to share how to become a researcher in 10th grade and

what the tools are that are necessary and what the connections and contacts are to help you advance the work, which then again flips

the script has just been said on the pathways to learning what research is.

Well, let's ask a question that's a little bit more close to, again, your own research.

And you have here your study highlights the differential impact of AI tools based on baseline reading comprehension.

How do you suggest schools or educators assess the suitability of these tools for students with varying levels of reading proficiency?

In other words, do we need to do more studies, or do you think we can learn a few things right away about how we're approaching,

you know, improvements through AI bots for reading?

Yeah, I think I can talk about that. So.

I think so, so we'll work for us, so when we initially had this question, we wanted to know what is the effect?

We expected that like this that these tools that I've seen this this and this product have,

and whatever... we expected that these tools would have a positive effect.

And so but what we did was we ran a pilot. We built our whole portal, built everything, and we ran a pilot study in 15 people.

And it was a small data set.

But what we found was this differential effect where it helps, the tools help lower performance, but actually hurt higher performance.

And that was just completely out of out of the blue. We did not expect that at all.

So I think that that makes a case for pilots like Khan Academy.

They're building their own AI system right now.

And what they're doing is they're doing a lot of pilots by going into one district and there or going to one district,

one school, one classroom even, and they're having the kids use it.

And then they sit there and they watch them and they look at the data and.

basically use this pilot to figure out like these effects that they wouldn't

have anticipated and how to and how to like make these tools better iteratively.

And then I found an example in the New York Times actually, this, this chat bot that did not, they didn't pilot anything.

They just went full into the, the LA, Los Angeles School District called Ed, and then the company went bankrupt for fraud or something.

It was just a whole mess. But...

But that it was it actually harmed the outcome because it didn't take the caution that they they assume that it's it's is AI.

Everybody saying the AI is going to, democratize education, whatever.

They assumed that it would work. So they just put into schools full blast and

And that is just like, like and that carelessness can actually harm outcomes.

And like students' learning outcomes that should not be messed with, that should we should have the utmost caution with those outcomes.

And which is why I just like I think just pilot, pilot, pilot,

because there's no there's no harm to doing some type of pilot like that, except, yeah, there's just no harm to it.

And it's very beneficial.

You know, it's a really interesting challenge for us as researchers in the education space because we are bound by something called Institutional Review Board.

I'm sure that Dr. Rolle knows all about the protection of human

subjects,

and there are very high standards for research for us to be able to get any permission to go

into any middle high school or elementary school to do any kind of an intervention study.

And I'm always struck by, it seems like some of these pilot, pilot,

pilot programs either get around that or they figure out a way to offer it as some sort of a free tool to be experimented with.

Now, you trained and did most of your study on a sample volunteer pool.

So in some sense, you stepped around that problem that I'm describing.

But it sounds like you're cautioning that if we go into a real school district and we're

working with real eighth graders and we're dealing with differential levels of reading,

for example, we really better be very careful about how we interact with those human subjects, with those real people,

because we could have negative consequences in terms of their experience,

let's say not only of the tool, but maybe even more importantly, of reading itself.

I was curious about this.

You know, one of the things that came to mind is that you all had defined reading comprehension as the main target of the study.

And some people would argue that that reading is situated in a much broader space than,

you know, can we read a text and perform a response to the text?

Some people would say, like, if you got a young person reading seven books today, that's a miracle worker.

You would be a miracle worker if you could get people to read seven books.

So I just want to ask you to like just at a personal level,

do you think that that reading and reading comprehension are broader than the ability to respond to short text?

Do you experience reading as a bigger challenge in your own life to get interested in reading?

Yeah, absolutely. I can take that. Unless Kai wants to jump in.

You can get that. Yeah. I think reading is like, at least I grew up reading all the time.

I remember in elementary school I would read while walking to class, and I would walk into poles

I grew up a reader and I don't have as much time to read now, but I still try to read as much as I can

and there's just so much knowledge that, like, this is why I wanted to work with tech,

with textbooks in the first place, because there's just so much knowledge conveyed in books.

So it's bigger than just like the reading comprehension skill of reading a little passage in our study.

But I think but I think we chose that because we chose reading comprehension because it serves as a proxy for learning.

Because if you have good, solid reading comprehension skills,

you can like, that carries you through learning at whatever level, going from kindergarten to like, higher education.

And it's all such a huge factor of success.

Especially like we chose these small passages, passages from the ACT, but that the ACT and the SAT

those tests are huge in terms of college admissions and like success in later life.

Then so we, so of course, reading comprehension is much bigger than the small passages that we looked into.

But the point about, so our study or like long title was that what was "the comprehension of standardized passages."

So we're just looking specifically at that. But we think that it

provides a glimpse into reading comprehension as a whole.

And then beyond that, learning as a whole, which is like it's that's why we say it serves like a proxy. Hudson, that's beautifully handled.

I don't think any graduate student at a top university could do much better than that.

The reason I ask that question is only because I have an obligation as a graduate of UC Berkeley's Graduate School of Education,

where some of the top reading specialists in the country are.

And I know that we've had lots of debates in my own graduate experience,

about what reading comprehension is, because there's something called The Reading Wars.

Who knew? Who knew there were wars about reading, too.

And there's this debate about whether phonics or whole language, the appropriate approach to work with elementary school students.

But it's a different kind of problem than you're trying to solve.

You were trying to figure out whether this high stakes test, which is presumed to be predictive,

right? of GPA in the first year of most students could be thought of as an important intervention, a place where you could help.

So I think that's great. I also would say, if there's any other thoughts, please, I'm willing

before we move on to the next question, does anyone want to comment on this question and look at it from a different angle?

Yeah. So quickly touching on your IRB point...

So like that was like one of the big reasons that we did do our study online because we so we ended up being IRB exempt,

but we just thought it was going to be like very, very difficult, especially as minors ourselves to be able to get the IRB approval to go in.

But that is something that we reference in our "Areas of Future Research."

Like in person, actually being there in a classroom, could be very interesting to see how these articles would hold up.

But going back to the actual question, how should like schools and educators assess how these tools are suitable for who?

Another big thing on top of what Husaon talked about with the pilots is definitely diagnostics.

So in our research, we found that obviously depending on like where you are at the start,

that's going to affect how you are affected by these AI tools.

So just basically based off of our research, the higher performers are the ones who would get hurt,

that's if they scored a 70% or above on the multiple choice quiz on their control passage.

And then if you scored below 70%, then you were considered a low performer, and then statistically, you would be more likely to be helped.

So what we kind of propose is using a diagnostic like we did, let's say,

like you want to just give them some random passage, have them take, have them read it with no way to have them take a test.

And if they got a 70 or above, then maybe they are considered a higher performer.

And according to our research, they're going to be hurt or they're more likely to be hurt.

And if they score below 70, then statistically they are they also are going to have a higher chance of being helped.

So basically giving them that diagnostic to see where are we at baseline.

And then based on that, maybe give it to them maybe.

Don't you always like you don't want to give it like someone someone or something that might actually hurt them.

And then uh, another big part that I think Hudson talked about at the very beginning

is that like when we got into this, there was a very, very sparse body of literature.

And I mean, there's more or less still is. That's what kind of what we were hoping to contribute to.

But what we like, think educators really, really should do is look at the research, like there's the literature bodies growing and growing,

and that's like always the best way empirical, peer reviewed research is always the most solid

way to like, understand how something, like the effects that something has.

And instead of letting, like, you know, like sales pitches of like, you know,

"AI will democratize education" or, like and "This tool will improve..."

like, don't like, don't really look at the the sales tactics and like

the ideals and the fairy tale notions that AI is going to democratize education.

Instead, we think that they should like, look at the empirical effects.

What? Like what are the numbers? What is the proof? Don't fall for these, like fairy tale notions.

Yeah, that I think those are just a couple of big things.

This is really, really helpful.

And, you know, you've got my brain buzzing on all sorts of other things that I need to just throw in here because we are the Center,

You know, Jack Stenner and the folks over at Lexile did a lot of work for almost now

25, 30 years on, looking at the question of readability, reading

comprehension effects, of tools that would measure how well a student reads at current level and what is the next closest thing they could read,

given the lexical level, frankly, that they're at. And many schools have adopted Lexiles today.

If you look around, you'll see Lexiles as part of the discussion of how we measure reading comprehension.

And I just found it interesting that in your study, in some sense, it's it seemed to suggest that you were saying,

we're in a brave new world where we're facing these AI intervention tools that we didn't have in previous decades.

And so the studies really need to start focusing a little bit more on those tools.

And so again, I just invite you to think about over time that you're going to be entering a pretty big world, past this world right now.

And I hope that you continue on to really consult the reading research,

but also the research on measuring, reading, and really looking at how your study stacks up.

And it may be that your study appoints new directions for people who are doing work in measuring what we call reading comprehension.

So I'm just gonna leave that as a thought.

That's a friendly suggestion that we're your buddies here, but some people might come at you pretty hard depending on what venue you were in.

talking about reading comprehension. And I'm sure you're aware of that.

That's why you're out talking to everybody, right? So you can get feedback. Well, let's take the next question.

How much of AI did you use in the design, development, implementation and evaluation of the results of this study?

Because we know that students are using AI tools in order to, for example,

write a five paragraph essay and maybe even revise portions of that essay and maybe even find evidence to support a thesis.

In other words, they're using those tools and the E. L.A. classroom, the language arts classroom,

but we're really curious in this particular kind of almost

extracurricular project,

what were you using AI for in the design, development, and implementation and evaluation of your study?

Yeah, definitely. AI's been very useful.

So I think what I want to touch on, at least that's the most, most salient for me was in our literature review. Because we were completely,

completely new to this field and we had, like, no idea, no idea anything about the field of AI in education.

And there's tools that exist like Google Scholar and most of the tools that exis, they can find research on,

but it's not great for interrogating the research and interrogating the whole body of literature.

So what...There's a couple of AI tools, like there's like extensions on ChatGPT

And there's a couple standalone AI tools that I used that I was able to basically talk to the literature,

and I was able to say, like, is there a literature in this thing?

Or I was gonna say: "Find me a paper that tells me this, this or this"

and that was super useful and just the literature review for our own purposes to find where we want to like,

inform our study and also literature review when we were writing the paper,

to inform things like writing the introduction. I think Kai can touch on some stuff about building the instrument.

Yeah, definitely. So Dr. Carter told us that you guys were very interested in, like, how these instruments are built and

the AI process in that and, like, coincidentally, AI actually did play a pretty big role in how we built the instrument.

So we developed the portal. But like, there was things like the ACT, for example, these like,

ACT practice tests were released by the ACT, but they were in PDFs and they were in like newspaper columns.

It wasn't like a simple copy and paste. And they're like the multiple choice questions,

they had, like their questions, and then they had all sorts of like colors and formatting and everything.

It wasn't like a simple thing that we could get into our database and put onto our portal.

So that was like one of the very, very huge uses of AI.

And one of the things that AI is, is more or less like fabled to do.

It's it's fabled there--I don't know if that's the right word--but it's like always been said that it's going to help

do these monotonous tasks for us, free the humans to do, like what humans can really do.

And that's kind of exactly what it did. So we had these like huge PDFs of super unstructured, unformatted, disorganized data,

and we were able to use AI to turn all of that into just structured data that we were able

to then use something that literally would have taken us hundreds of hours to do manually.

Maybe that's an exaggeration, but would have taken us a long, long time to do manually.

We were able to use AI for that. Just because it can just take in so much data and process it so quickly.

And then another thing I think was, yeah, yeah.

So we definitely used it in coding.

So, you know, as, as Hudson and I, have been talking about, we like, we've been, you know, coding for a long time.

We worked on a movie app before this. And we, that was like around the time when ChatGPT started to get released and like, it's like like

code generation has always been a strength of generative AI, and it's just very helpful for like, you know, why does my function not work?

Or like, why is this like syntax not work and stuff like that? So we definitely used it for coding

and building the portal. And then and then, of course, like, you know, the prompts for our tools,

like the Socratic method prompt had to use a lot of, like, prompt wrangling and stuff like that, all sorts of things.

We just, like, spent, like, hours on the prompts trying to perfect them, wrangling with them.

In fact, it's like, this is like a well known thing that you often have to do, often have to be like very, very strict with it.

And Hudson even one time, like, he was like, if you don't return it in this format, my wife and kids will die.

Like, that's that's like the type of strictness that you need to just wrangle with these prompts.

So I definitely think that it played a very big role in building the instrument,

like just the disorganized stuff that just would have been super monotonous and take hours to do.

We used it for coding and also just, you know, wrangling with these prompts.

So that leads us to believe what we're hearing is that AI was a partner in this research process that you had two

doctors who could help you with curating and understanding perhaps your results as well as your design issues.

But you were kind of interacting pretty heavily. What were you using again?

What were the tools that you were using to do this?

Because, again, other students who might be interested, they might want to know ChatGPT we know, but what else is out there?

Yeah. So, um, so now the landscape is drastically different than it was when we were like,

especially during the literature reviews early on, like it is middle to late 2023 and stuff moves so fast I think now.

So what we used back then was this tool called Consensus to find

papers and to find literature for the lit. review at least.

And then we used a lot of ChatGPT for just all sorts of things.

And then I think now you could probably use Perplexi...So ChatGPT has a very expensive deep research tool.

but I think a lot of companies are doing things like that.

I think like Perplexity has good free search where it gives you the sources.

It's less tailored towards academic things like Consensus was...still is.

But it's it's very, very good.

Yeah, I think just definitely just, like, you can just look around and there's just so many products that are all doing similar things, helping.

And because this use case is so important and literature review takes so long

there's a bunch of tools that have cropped up that help with that specific task.

Well, we were glad to see you smile at one point, because we know you had joy and fun and play as much as you did all the hard sweat and tears.

I do have to say to Dr. Rolle and Dr. Carter and Dr. Holmberg that as an academic,

I know that peer reviewed articles are oftentimes paywalled and hidden behind certain sorts of databases.

And it's not the case that these tools today have access to all that information.

In fact, I've been consistently frustrated on the literature review that Carrie and I

are working on right now for a book that it really is not getting behind much,

and we're getting a lot of generic, publicly available material.

So I do caution any of our users or listeners that as they push into the realms of these two young men who have really broken the mold,

they also be very careful on literature review. There really are challenges and concerns.

And I want to give you two the word on that, because I'm sure you were aware of that and working with your mentors.

Yeah, definitely. It still takes critical thinking.

Seeing like, a lot of the research was like, papers that come out of Indonesia with zero citations.

So it takes wading through those types of things and then having mentors is very helpful to know,

especially when you're writing our paper and like,

for an introduction. I had to find a ton of sources in helping, like having mentors to know,

like, we probably shouldn't be citing this or and stuff like that.

So I definitely don't take... this goes for just AI in general:

Don't take what AI says as fact. You still have to...

It can help speed up the process, but you still have to apply critical thinking.

I assume it's better now.

Back then, it was kind of difficult, as you said, like wading through a bunch of generic

or like, not so great sources.

But I do think that there's, that it can help also give you broader strokes, broader summaries of the field,

broader summaries of a particular topic in the field that actually cite the the different papers that it's referencing.

So there's still a place for graduate school, luckily, and for graduate faculty who can help to curate.

But, you know, I think what you're all saying is, you understand, skeptical, critical,

higher-order thinking skills that interrogate as you've used those words, you know, the sources.

And I think that's no different than it was when we had Wikipedia or that we had some other Google search.

It's always been true that we have to do that. So I'm very excited to hear you say that.

All right. Well, here's towards the end of our talk today.

This is the most interesting part. And I know that Carrie and others are going to have something to say here, but I just.

Well, Carrie, just go for it. You were going to take this last one.

What advice would you give to middle and high schools about how to do projects such as yours?

That's that's a really good question. I think that it's, I think it's like two parts. I think like high school and middle school students,

we can definitely offer some advice, but also like the schools themselves.

So I think I'll start with like the actual students. Definitely.

All of this, like everything that we've accomplished is not just because of me and Hudson.

Like it would not have been possible without our mentors, Dr. Rolle and Dr. Carter.

So definitely seek out mentors. Like they make the whole process... like it's...none of this would have been possible without them genuinely,

and we truly appreciate their support. And just getting mentors is just a huge, huge benefit.

They have like years of experience that there's just no way you could ever have.

So I, we, I don't think we can stress that enough.

Another thing is for like self learning things like for for this paper, for example, statistics,

I think things like just watching lots of YouTube videos, like reading lots of articles online to self teach yourself these things.

You just got to be hungry for more information online

Just take whatever you can get. For us, YouTube was a huge thing for statistics, things like that.

So I would say, I would say for me, the two biggest things are just get mentors and be be a hungry self-starter and learner

with things like YouTube or online, things like that. Yeah, I can add on to that.

So I think more to the do-it-yourself kind of thing...

I haven't talked about literature review, just like that is

extraordinarily important. Reading papers and getting a sense of the field.

And as you do that, if you read the paper through, you read through their methods, you read through their experimental design,

and you, just through doing that over and over, you kind of get a sense of how are these experiments designed,

What questions do I ask? Like where like we found, we found that we can use Prolific from reading a different paper or actually not or...

Yeah, I don't remember that. But I remember we did something from reading a different paper.

And a paper on, Dr. Rolle sent us a paper on Prolific.

Okay. There it is. Yeah. But just lots of different things that you pick up on from reading, like

the paper all the way through and clicking on the citations in the references that they found interesting.

And just digging deep into that and like, going farther down that rabbit hole, you learned so much about how to conduct your own research.

And then, so that's like the outside of school, type of like do-it-yourself kind of perspective.

And then I mentioned that inside of school, we, our school has a program called ASI where we have a mentor, Dr.Tori Johnson, who can

who kind of guides a class of 30 kids who are all trying to conduct their own research

and guides us through how do we write a protocol... like all those different things

So I guess for schools, implementing programs like that is so valuable, like giving that opportunity,

like at our school, they have more applications for the program than they can take because like,

it's very, as, Dr. Rolle touched on, there's lots of, there's lots of demand for research within high schoolers.

So if you can get a qualified mentor, schools, like, implementing those programs is hugely valuable.

Yeah, I think that's all.

Yeah. Go ahead, Kai. Okay. And then I think kind of related to what I was talking about is just tune in to webinars like these.

You know, the one that we're on right now. Again, thank you to SJSU for hosting this.

Thank you for Dr. Carter to having this, like, giving us this opportunity.

But I think just webinars like this and just and similar are just super, super valuable.

Appreciate that. Well, look, let's hear from our last two experts on the panel.

What's been your experience? While you were coaching or giving advice or consultation to our middle and high schools?

Something to think about. Dr. Rolle, why don't you go first and then Dr. Carter, you can go after.

And then we'll close it up. Yeah. So you cut out for a second there.

But but the gist of what I think you're asking is kind of what

do you recommend?

And it would be advice. I think that just to like perspective take for a second on how Hudson and Kai went about this.

They didn't kind of come in and try to lead the show without having experience in this field.

And I think something they touched on that, that I do think is really important is mentorship.

And I say that because I still contact my mentors, I still use my mentors.

And I think establishing mentors early is never going to be anything

but a help in your trajectory in your career, whether you go into research or not.

I think as research is just like transparently becoming a necessity in college admissions process,

it really is like it's becoming something that and more and more students are needed

no matter what career that they're going into or what they're trying to go into.

I think that I first had a reaction of like, why are we pushing this so early?

And now I'm starting to understand, especially after working with Hudson and Kai, the value of of learning about research.

And it's made them more critical thinkers and how they're digesting research and how they're digesting science and how they're looking in into

the world of like experimentation in general. And so I think that it's a really positive thing to to jump in and whether the

question is what you want to be asking in your long term career is less important.

And I say that because I work with a lot of high schoolers, and I think often there's this feeling of like, I don't know yet.

Like I don't know what I want to do. How would I possibly navigate asking a research question,

and what I sense Hudson and Kai did is they they went ahead and just picked something

they were interested in without getting completely drowned in all the possibilities,

which happens all the time. And I think it was very novel to see the approach of like, this is cool, let's try this.

And what they've now learned is the entire research process and the entire the entire scope of how you

ask questions and how you go through all the parts to answer it and then disseminate the results.

And I think that that's invaluable.

So that I think my recommendation would be, if you want to go about getting research experience, partner with a lab,

partner with a mentor like they did, and then go ahead and find something you're excited about and dive in.

I think I would be I would caution against kind of drowning in the overwhelm of all the things you could do and instead,

just like pick something and move forward. That is fantastic.

Dr Carter, since you are the liaison, literally between our Center and your school,

as well as the person who's seeing things from multiple perspectives,

why don't you take us out with a few thoughts? There are, I'll speak more, toward recommendations for schools.

Hudson touched on the program that we have at Los Altos High School, which is, um, called Advanced Scientific Investigations.

This is a program that really grew, has really grown significantly over the last several years.

We went from one section with one teacher. We now have two teachers teaching this course.

And it really gives students an opportunity to explore, research and develop through project-based learning.

I would also say to schools

to tap into the existing talent that you have that you may not realize is there for the purpose of mentorship.

You know, you have a lot of teachers, educators, counselors, administrators who are not teaching as their first career.

They have backgrounds in scientific research, and they have backgrounds in business.

And they are a wealth of expertise to share with students.

And it may be hidden, based on what they're teaching day in and day out.

And so I think really like exploring schools when you're going to get innovative with curriculum,

looking in your own backyard and seeing what's there,

because you probably have way more talent, for mentorship than you might even realize on a daily basis.

Same with your students.

You know, if there's one thing I've learned from, Hudson and Kai, it's just, I mean, we have some incredible students at our school.

But these two, I mean, they are ready now to mentor other young, aspiring researchers on things like, Dr. Duckor you mentioned the IRB process.

They've been through it. On building literature review.

You know, they're ready to help support other students. And I'm going to work with Kai on that next year, hopefully as he moves into that ASI program,

because I think he could really help some other people aspiring toward publication.

So I think the last thing I'll just say to schools is don't underestimate the interest

the student interest in research, as Dr. Rolle said, there is immense interest, in student research and the program, like ASI

has really helped students who historically have had to just make cold calls to

professors at Stanford to get their foot in the door in any kind of research.

And that used to be what they all did all the time. And now they, you know, they're still doing that

and that's great. And they also have this program at school where they're getting project-based learning and research mentorship there as well.

So those are just some ideas for schools.

Well, I think that right now we are on the precipice of something very new that we hoped for 25 years ago all across this country,

which was a renaissance in student-centered, project-based

and performance-based tasks that are really authentic and meaningful to the students we serve.

And we have a huge opportunity here with these models of what you all have shown us to begin to rewire and reconnect to the real world.

So I cannot tell you how much we appreciate you. I hope you can hear me.

I know I've had a bit of a crack up on this connection, but it's been an incredible hour.

And we thank you very much for attending. We hope that you'll watch this video.

It will be posted fairly shortly on our website at the IAEP Center at San José State.

Grateful to everybody today who was here. And thank you for attending.

Have a great day. Thank you so much for having us. Bye.

Bye bye,