



## Keynote speaker

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“Issues of Multi-tasking in the Learning Environment”

**Dr. Clifford Nass:** Thank you. Delighted to be here. So I've been really enjoying the presentations this morning, which have taken a fascinating look at changes at, for the most part I would say, which are at the structural level. The way the economy is changing, the way schools are changing, the way education is changing. (See [slide #1](#))

What I want to talk about here is the way student brains are changing. So we're going to go a little more micro. We're going to dig down a bit and ask the question, “*In what ways do students think differently than they did in the past?*” which is a different question than what are their perceived economic needs or perceived educational needs.

So why would student brains change? (See [slide #2](#)) And the answer has been talked about this morning some. One of the key drivers is digital media. So first of all we have new media. All the time there are new technologies appearing. There are new phones. There are new tablets. There are new computers of various sizes and then there are new media of all kinds. So Google glass, watches, intelligent watches, new voice based systems, all of which are changing the way media works and the way people's brains work with those media.

A second significant change is that we now have multiple sources of content for each medium. So it used to be that when you had a medium, you had some technology, it gave you one stream of content, and if you wanted another stream of content you needed a different medium. But now, of course, computers can show videos and audio and music and let you Skype on them and let you text with them and let you talk on them at the same time and it's not just computers that can do that. Cell phones can do that. Other technologies can do that.

A third key change is a cultural change, which is an orientation toward speed versus accuracy. One of the things we hear many professors talk about now is students will ask us something, send us an email or whatever, and expect a very rapid response, and if we don't give a rapid response they send an email again and again and sometimes when they ask a hard question I'll write back to them and say, “well I had to think about the answer.” And they will say, “no I just want a quick answer,” and I say, “professors aren't in the quick business, we're in the accurate business.” It's a cultural change, that the expectation of getting it right versus getting it fast has changed.

Beyond these cognitive changes, which I'll focus on today, I do want to also note the social and cultural changes because one of the things we talk about with residential campuses is the idea that students benefit from being proximate to, living with, hanging out with other students, which I fully agree with, but there's a

### Digital Media and the Changing Student

Clifford Nass  
Stanford University

Slide #1

### Digital Media Use and College Students

- New media
- Multiple sources of content per medium
- Orientation of speed vs. accuracy
- Culture of student interaction

Slide #2

cultural change in what it means to be *with* other people. Increasingly the idea of face to face has been downgraded and the acceptance that text or email, increasingly text rather than email because again it's quicker, has taken hold and the idea that face to face, being around all these wonderful kids, is not as necessary today. And I want to point out one of the surprising encouragers of that, someone who for the students of today were probably more influenced than almost any other person, by this person who set the train towards the way people now interact, and that's this guy: **Barney the Dinosaur**.

(See slide #3) Now we usually think of Barney the Dinosaur as a force for good, as a force for healthy socialization among kids. He was extremely popular. He's now retired but for the kids and the kids coming up he was one of the greatest influences in their perception of what social and emotional life was like.

Another Key Player in Encouraging Media Use



Slide #3

So what I want to do is analyze the *Barney* theme song to see what messages it gave to our students.

Now the Barney theme song for a long period you could not escape. It's started da, da, da, da, da and we were all driven crazy by children everywhere singing it, playing it. It was incredibly ubiquitous and it had the unfortunate tendency to stick in your head and you couldn't get rid of it, so please forgive me for going through it again. Now I want to do a critical analysis of the lyrics of that song to see what's really going on. Forgive me I'm known not to have a very good voice.

Okay so it starts, "I love you...". Now stop a minute. Here's someone who's never met you, who has never seen you, will never see you, knows virtually nothing about you but feels comfortable saying, "I love you." Now of course we might say, "but leaders throughout history have said that to their populous, many religions have their leaders saying that," so perhaps it's okay.

Okay, next line. "I love you, you love me,..." stop. Now what Barney's saying is not only does he know his deepest feelings about you, he knows your deepest feelings about him. [audience laughter] Even though again you've never met him, seen him, he's never met you or seen you. So loving someone is a pretty trivial thing to do. [audience laughter]

"I love you, you love me, we're a happy family,..." now stop. Many people worry about the decline of the American family but whatever definitions you thought of "family" it likely didn't include a purple dinosaur. [audience laughter] Also note that we can have familial ties and relations without any contact and without any communication. Again, suggesting that family might be a more trivial concept. Okay?

"I love you, you love me, we're a happy family, with a great big hug and a kiss from me to you". Now you might have thought that the reason people like hugging and kissing is its physicality. We hug and kiss because you can touch the other person, but Barney can't. So kids learn that hugging and kissing are now less important, and of course we've seen through our college campuses a decline in dating behavior, perhaps because Barney gave the guidelines. You don't actually have to date to be involved.

So "I love you, you love me, we're a happy family, with a great big hug and a kiss from me to you, won't you say you love me too?" Now let's think about that. Barney's telling us that we should say things that the other person won't hear necessarily. Sounds like blogging. [audience laughter] Sounds like writing comments on blogs. Sounds like posting on Facebook. It doesn't matter who sees it. We're not writing it to

"Issues of Multi-tasking in the Learning Environment"

anyone in particular, we're just announcing. [audience laughter]

"Won't you say you love me too?" Okay, the second verse is even more terrifying. [audience laughter] It starts, "I love you, you love me." Then comes only a line Mark Zuckerberg could write in good conscience, "we are friends as friends should be". Now whatever model of friendship you would advocate it likely would not include no communication, no contact, no engagement. So Barney paves the way for a Facebook-like friendship model in which we really don't interact but we merely connect.

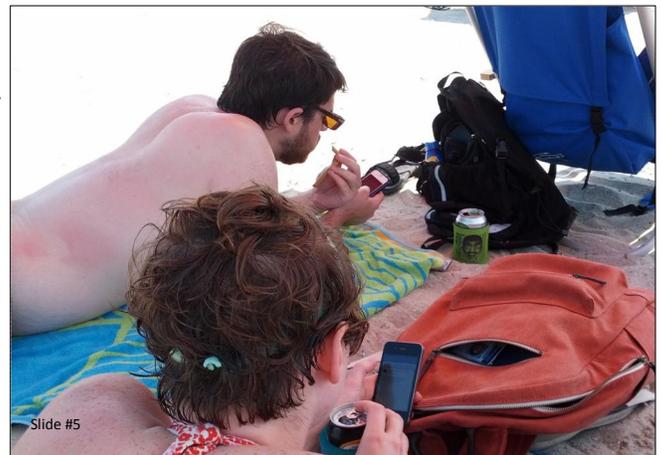
Okay? So I don't want to scare you any further. We'll stop there.

But it leads us to realize that there are really important social dynamics that are playing out, and as we think about campuses with students on them and the virtues of that, we have to think about what we imagine. So we imagine, for example, eating. In virtually every

cultural eating is one of the most prescribed set of rituals, and families in virtually all cultures eat together all the time and the notion is that through the meal we instantiate the norms and values, that they're manifested further by deep conversation, so by paying attention to the food and a Levi Straussian view of structural anthropology where the acts of taboo and non-taboo foods, appropriate and inappropriate foods, we instantiate the notion of morals. Similarly through the social engagement as we sit together, we're sharing food, we're reminded of the similarities between us, we build up these incredible strong norms. We build up these incredibly strong ties, which of course can only be helped by this, (See slide #4) by having technology intervene in that event. So increasingly the conversations we see among kids are not conversations but rather a disjointed thing.



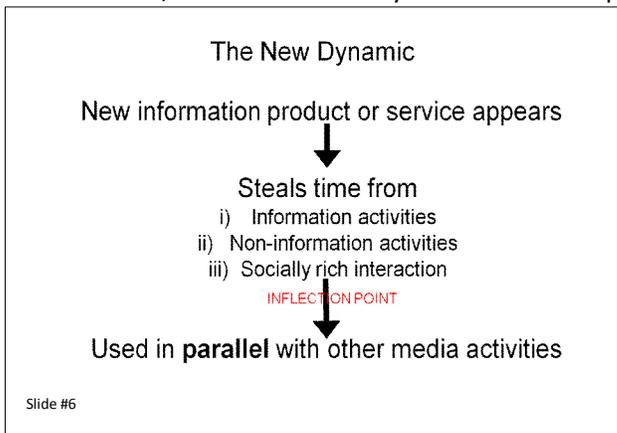
Now it also applies to our physical lives, the raw physicality of life. So take for example the beach. Think of the beach. The wind, the smell of the ocean, the feel of the sand on your feet ... obviously enriched by phones. (See slide #5)



Okay? So the disconnect between the physical world and the real, and the world we, kids are especially inhabiting, means that the notion of a physical place may become less important. You know when I say may become less important, it is not that it truly becomes less important but it is

perceived as less important.

On top of all these trends, technological trends, cultural trends, there's another hugely important dynamic, that answers the question, "is this just a fad, or is this something that's going to continue to happen?" And that's the dynamic of partial media displacement. (See slide #6) The theory of partial media displacement was proposed in the 50's, it turns out it's been working well, it's been a great predictor since the



middle or late stages of the Industrial Revolution and continuing to the present, and the theory of partial media displacement goes like this.

*Whenever a new information product or service appears, the first thing it does is very obvious. It steals time from other information activities. There's a time budget, an information time budget and new technologies steal from the old. So, movies stole time from books, radio stole time from movies, television stole time from radio, computer games stole time from television, the Internet stole time from computer games, etc., a very logical, natural progression.*

But the critical dynamic that makes partial media displacement so powerful is that media doesn't just displace time from information activities. Media also displaces time from non-information activities, which means that every time a, a new media product or service appears, it steals time not just from your information budget but from your non-information time budget, and it also steals time from your socially rich interactions. It takes time away from face to face communication and puts it into media.

Now let's imagine then a day planner, we have a day planner, and we have some time for information activities, some times for non-information activities and every time a new technology product or service appears it steals more and more time for non-medium, socially rich interactions until there's no more time to steal. That becomes a point of inflection. What happens when there's no more time to steal?

At that moment, which happened for teens around the 1990's, it happened for adults sometime in the 2000's, there was no more time to steal from these other things. At that moment we hit a crossroads and we could have gone in one of two directions. One was we could've said, "okay, no more partial media displacement. When a new medium appears I'm either going to use it and throw out some other media activity or I'm going to not use it and keep with the media activities I have." That could have happened but it didn't.

Instead what happened was we'd started using media in parallel. We started double-booking media and then triple-booking media and then quadruple-booking media, so the drive towards multi-tasking is really the horizontalization of media use. Horizontal rescheduling in your day planner where the amount of time

### The New Dynamic: Media Multitasking

Slide #7

you have has become so small, you didn't want to give up using new media so you started using it in parallel. That is the dynamic that has created multi-tasking. A dynamic that's created that in the classroom. A dynamic that's created it when people are using the technology. A dynamic that's created that when people are at dinner and using media.

Okay, so that's a critical trend. **So the new trend, the new dynamic force that's affecting our kids more than any other is media multi-tasking. (See slide #7)** The use of multiple media at one time.

But to be precise it's not just use of multiple media, (See slide #8) it's the use of unrelated information content.

So it's writing a paper while you're texting with friends, while you're reading Facebook, while you're watching a YouTube video of a cat playing a piano, that. It's not what we used to think of as

### Definition of (Media) Multitasking

- Exposure to and use of *unrelated* information content
- Different psychology of related information content

Slide #8

"oh, multi-media will help us because you could listen to a speech by Abraham Lincoln while you read the notes of Abraham Lincoln, while you saw the picture of Abraham Lincoln"; no. That integrated type of thing is what we thought would happen but did not. Instead what happened was we now read about Abraham Lincoln while we're also playing a game while we're also consuming something else.

It turns out that for your brain there's a totally different psychology for related media information. That turns out to be very good for your brain. If you integrate related things and there was a talk earlier today on the panels about the value of integration, integration is not just good for society, it's not just good to be an effective worker, it's good for your brain. If you integrate things in your brain you develop more neural connections and it's very, very good.

### Multitasking is Ubiquitous

- Average college student uses 3 media simultaneously whenever they are using media
  - High multitaskers: 4 or more media at one time
  - Low multitaskers: 1.8 or less media at one time

Slide #9

But I'm talking about the dominate mode which is not that. The dominate mode is unrelated streams coming at you constantly. How common is this? (See slide #9) **The average college student uses three media simultaneously whenever they are using media, on average.** They are never just reading a book, never just even watching television, never just doing a problem set, they have three media. And the top 25 percent, which we call the high multi-taskers, use 4 or more media whenever they are using media. And even the bottom 25 percent still use 1.8 or less. Very, very, very few kids use one media all the time, but even two media is extremely uncommon.

Okay. Now what happens? (See slide #10) Well if you look at the performance of at-the-moment multitasking, when kids try to do multiple things at once, the answer is it impedes performance. There's an enormous number of studies on this and there's actually no contrary studies. If you try to do two things at once, you do both slower than if you did them one at a time. Period, end of story, for information tasks. For physical tasks it's a much more complicated story but for information tasks it is unambiguously clear. How could it be any other way? So for example if you're watching CNN and there's a little feed at the bottom, you know, running along or ESPN for those sports fans, that makes you both not remember the content you heard on the big screen and it makes you not remember the content you learned on the little screen. So you're forgetting both. So it undermines both. Even though you feel like you're getting, "oh, I'm getting two things at once"; you're actually getting a half thing net.

### Focus on Immediate Media Multitasking

- At-the-moment multitasking impedes performance
  - How could it be any other way?
- What about *chronic* multitasking?

Slide #10

Okay, so, but of course it has to be that way. The working memory, basically humans have about three chunks of working memory. We have more in short term memory, we can move things in and out of working memory rapidly, which of course we do, but there just isn't the ability to do more than one information task at one time.

That's so established and so simple we'll often say, "I will not allow students to have laptops in my classroom" or "I will not allow students to have a phone in my classroom or text in my office." The number of media grows; the list of things you have to ban gets bigger and bigger all the time. But you just say, "hey, I really want you to focus. It's bad for you whether you know it or not." That's totally fine but I'm more interested and more concerned about the deeper and bigger effect of chronic multi-tasking.

## "Issues of Multi-tasking in the Learning Environment"

So if we ban laptops in the classroom, the other 23 hours a day the kids are multi-tasking. What are the effects of that on their brain? What are the effects of that on their social and emotional lives? That's the question because that's what we can't control. We can control our classroom but not the other 23 hours and that's the hours that we as college faculty, college administrators, etc., have to live with. We have to live with the brains of these students. So what is happening to their brains? Okay?

Maybe We Shouldn't Worry About *Chronic* Multitasking

- "When it really matters, I don't multitask"
- "Multitasking doesn't bother me because I do it so often"
- "Young brains are able to multitask"

BOTTOM LINE:

Brains change much more slowly than technology

Slide #11

Now when I ask my students-I lived in a freshman dorm for seven years, I just retired a month ago, not from teaching just from being in a dorm -- and when I would ask my kids in the dorm about this they'd say things like this. (See slide #11) "When it really matters I don't multi-task." "Yeah sure I multi-task when I do stuff but when I have a really hard, you know, physics assignment and it's just super complicated I don't multi-task." Or, they'll say, "multi-tasking doesn't bother me because I do it so often I've gotten good." It's like eating or smoking: If you do it a lot it doesn't bother you more if you do more of it. But that's false. And then my favorite is "Young brains,

Professor Nass are able to multi-task; you, dot, dot, dot... okay? So let's see if that's true. Is it in fact the case that young brains are resilient just as young bodies are so much more resilient but older brains cannot?

Well there's a principle underlying this, which is the bottom line principle: brains change much more slowly than technology. This has been a truism in the field of both the psychological and social sciences and in the view of technology. And in fact when I decided to switch from being a computer scientist to a social scientist, I thought, "man, it's just so hard to track new technological innovations all the time, but brains are brains are brains. They've evolved for 100,000 years, they don't change, it's much easier to study them. I'm going to take the easy route and study humans and their brains."

So this was the bottom line, this influenced by own thinking about what I did, it's influenced the social and technological sciences, but let's see is that really true? (See slide #12) Is it true that brains change much more slowly than technology does?

## OR DO THEY?

Slide #12

### Does Chronic Multitasking Affect Cognition?

Slide #13

So what I'm going to do now is give you some tests that we've done with the students. I'll ask you to take them as well. You'll only take a small version of them but they'll give you a flavor of the things that technology has changed the way students can perform at. (See slide #13)

Okay. I'm going to look first at the ability to avoid distraction.

(See slide #14)

Clearly whatever else deep thinking requires, it requires the ability not to be distracted. It requires the ability to pay attention, and

#### Are there Cognitive Effects of Chronic Multitasking?

- Avoiding distraction
- Memory management
- Writing quality
- Task switching

Slide #14

paying attention was for a long time one of the most valued, cultural values, we'll talk a little later about how that's changed. Second is managing your memory. As I mentioned you only have three bits, three chunks, of working memory so we have to be able to move things in and out of memory very quickly. Third I'll talk about something that everybody's been worried about for a long time, writing quality. Do our students write well? Can they write appropriately? And then last I'll talk about the one case where you might think multi-taskers should really be brilliant and that's switching from one task to another.

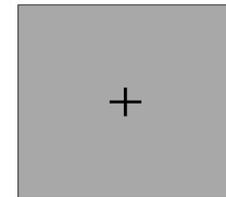
### Focusing on the Relevant

- You will see a group of rectangles twice
- IGNORE the blue rectangles
- Remember the red rectangles
- Say if one of the red rectangles changed orientation

Slide #15

Okay? So let's start digging into the tests. Here's the first test. (See slide #15) This test seems like it should be able to be done by a kid seven years old or older, okay, but we'll see. What you're going to do is I'm going to show you a group of rectangles twice. I want you to ignore the blue rectangle. So in this case I'm telling you what to ignore and I want you to focus on the red rectangles. And to make it easier for you there may be a bunch of blue but there're only going to be two red rectangles, only two that you have to pay attention to. To make it

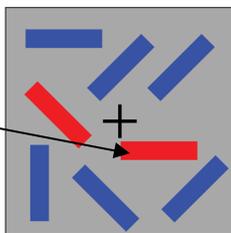
even easier between the first picture and the second picture, the rectangles aren't going to move. All that's going to happen is one of the rectangles is going to rotate. And all I want to know is did one of the two red rectangles rotate. I don't care about the blue rectangles. All I want to know did a red-sounds like seven, seven year old, eight year old? No sweat okay? So let me show you what it looks like. (See slide #16) So there's a 200 millisecond to clear your eyes.



200 ms

Slide #16

Animated box



Slide #17

100 ms

Okay now I'm going to show you a 100 millisecond picture then I'm going to show you a 900 millisecond blank screen basically and then I'll show you the second picture. And what I want you to do, as fast as you can, tell me whether one of the red rectangles rotated. Okay? (See slide #17)

[The screen flashes and for a millisecond the red triangle on the right shifts.] Did a red rectangle rotate? Yes? Very good. It did. Here's the, that horizontal rectangle rotated, excellent. So you guys did great. Well done. If you didn't do well that's okay. [Note slides 18 and 19 were omitted]

We like you anyway, but let's see what happened. (See slide #20) Let's see how the college students did. The kids who multi-task, who don't multi-task, who rarely multi-task, the low multi-taskers, were unaffected by the number of blue rectangles; zero, two, four, six blue rectangles, no difference in performance at all.

What about the high multi-taskers, the top 25 percent? They were crippled by the blue rectangles. The more blue rectangles the worse they did. When there were six blue rectangles they were swimming in a swarm of stuff that they weren't supposed to

### Results

- Low MMs are unaffected by distractors
- High MMs are negatively affected by distractors
  - The more distractions, the worse they do
- High MMs allow irrelevant information into memory
- High and low MMs do not differ in general memory capacity

Slide #20

look at but it was distracting. How could they resist? So their performance declined dramatically compared the low multi-taskers. The more blue, the worst they did.

So high multi-taskers let irrelevant information to memory: they like it in there. Okay? It's not a general memory capacity difference. High level multi-taskers have the same general memory capacity; it just turns out the high multi-taskers allocated in a dumb way. Okay?

Here's the second test. (See slide #21)

In this one I'm going to ask you to watch a movie. See slide #22) If you've seen this before please don't say anything. I'm going to ask you to watch a movie and I want you to tell me how-this is a basketball movie. Its six people. Three in white uniforms, three in black uniforms and I want you to tell me how many times the players in white uniforms pass the ball to each other. Okay? So this is simply a movie. It's about a minute and 20 seconds. How many times did the players wearing white pass the ball? I won't say anything. Just count the players in white.

## Noticing the Irrelevant

Slide #21

See video:

**"The Monkey Business Illusion"**  
Daniel J. Simmons  
2010

[www.youtube.com/watch?v=IGQmdoK\\_ZfY](http://www.youtube.com/watch?v=IGQmdoK_ZfY)

[ Silence as the clip was viewed]

Okay excellent. How many of you got 16 passes? [Clapping]

Excellent. I won't ask who didn't get 16 passes. How many of you saw the gorilla? What gorilla says the half that didn't see the gorilla? Let me just show you that because I feel bad. Let me see if I can zip this ahead. [Re-view the video] Okay so here they are starting to pass the ball, here they are passing the ball [laughing] this guy walked, did this, right, the people who saw it, it did happen right? Okay, walks off, okay, kept going, okay.

Alright great. Okay. How many of you saw the gorilla? How many of you saw that the curtain changed color? Very good, and how many of you noticed one of the players in black left? Good, okay. [laughter]

(See slide #23) So, high multi-taskers were more likely to see the gorilla. Good for them. They were looking where they weren't supposed to and saw the gorilla, but they counted the number of passes wrong. So when we tell them what to do they don't do it. They do something else, which is to say the least a challenge for learning outcomes. Right? No difference in net attention, it's the high multi-taskers are more likely to see the color change,

### Results

- High MMs were more likely to see the gorilla
- BUT .....**
- Low MMs were more likely to get the number of passes correct
- No difference in net attention

Slide #23

more likely to see the player in black go away but less likely to count the number of passes correct which is really what we wanted them to do. Okay? (See slide #24)

So now let's see how this plays out in writing because we all

#### Writing Quality

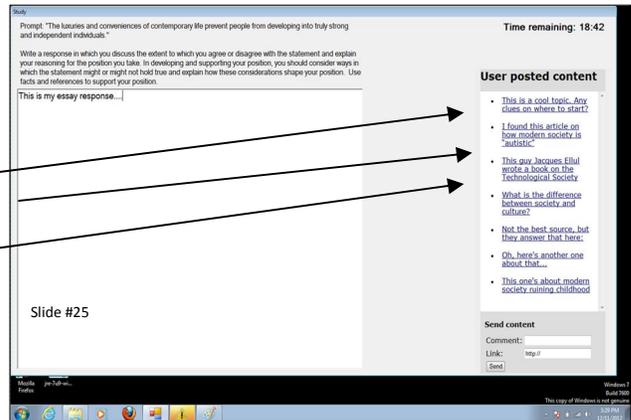
- Participants given 30 minutes to write the following essay:
  - "The luxuries and conveniences of contemporary life prevent people from developing into truly strong and independent individuals.
- Other people are (ostensibly) also writing an essay
- At pre-determined intervals, relevant/irrelevant items are displayed on the news feed
- Assessment of essay (Six point rubric)
  - Organization
  - Coherence

Slide #24

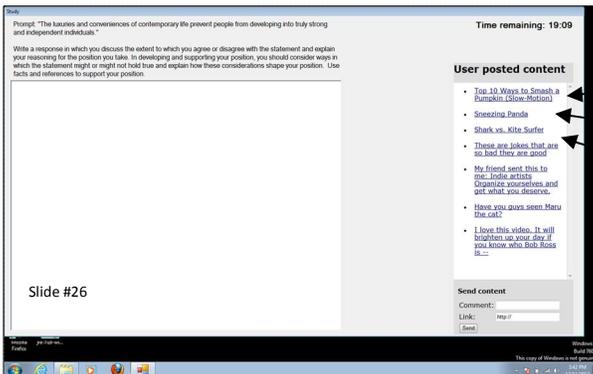
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care deeply about students writing essays. We gave students 30 minutes to write the following essay that's from the GRE. "The luxuries and conveniences of contemporary life prevent people from developing into truly strong and independent individuals." They were given 30 minutes to write this essay. They were alone in a room with a computer. We told them that other people were writing the same essay and we told them that they could cooperate with each other, that the other people we said you can't because your was broken, it wasn't, but we said the other people will be able to send you comments, which you can look at or not as you wish when you write the essay. What we did was at various intervals we were a little comment pop up, much like a text, getting a text message, extremely common among students who have text windows up constantly and Facebook open constantly. And we then graded the essays on a six point rubric, three points for organization, three points for coherence. So here's what it looked like. (See slide #25)

They were given something that looked like this. It was the thing we said. This is where they type in the response and now let's look at what the comments were. [Pointing to the slide on the screen.] "This is a cool topic. Any clues where to start?" "I found this article on how modern society is 'autistic'", "This guy Jacques Ellul wrote a book on Technological Society."



Relevant comments aiding them in the essay, however, in real life what did the comments look like? [Pointing to the slide on the screen.] (See slide #26)



"Top ten ways to smash a pumpkin."  
 "Sneezing panda..."  
 "Shark verses a Kite Surfer"  
 ...these are jokes...right?

Most of the comments, most of the texts kids are getting are not about complex societal issues; they are about smashing pumpkins, kittens, etc.

So does this make a difference to how they write essays? (See slide #27) The answer is that irrelevant side information, which is the dominate form of information that kids get, messed them up. When they got it, when the high multi-taskers got irrelevant content, it was crippling to them. They did much worse. And note, this is the norm in the workplace; this is the norm in our schools especially for college students because they aren't really collaborating, sending stuff back and forth, they're sending junk back and forth, which is okay because they're kids, but it clearly impacts them and it hurts the high multi-taskers more.

### Results

- Irrelevant side information hurts HMMs
  - Much worse essays when content is irrelevant
  - This is the norm in the workplace!
- Relevant side information helps HMMs more than LMMs
  - This type of information is rare

Slide #27

Ironically they were helped some. High multi-taskers were actually helped when they got the relevant comments. Why? Because they were distracted into-they didn't want to focus on the essay but they were distracted into useful information. So it's a rather odd finding but it makes sense. They have no filter for

distraction. So, if by some miracle we can give them good distractions then they do better, but that of course is much tougher than doing bad distractions.

Results

- Low MMs look where they are supposed to look
- High MMs are more casual about where they look
  - There is a cost to this
  - Not an attention "deficit," but a misallocation

Slide #28

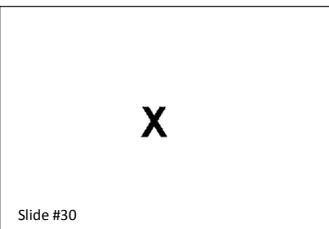
(See slide #28) So fundamentally what happens, low multi-taskers look where they're supposed to look, high multi-taskers are more casual where they look. They look all over. So for those of you wondering about is this related to attention deficit disorder, the answer is yes in one sense, not in another. The sense in which it is not is that is it not-when people say there's an attention deficit it doesn't mean that your net amount of attention is less, it means you're putting attention not where you're supposed to. So kids with attention deficit look just as much as kids with attention deficit, they just don't look where we want them to look or where it's socially appropriate to look or where it's useful to look, but they look.

So next one. (See slide #29) So that's attention. So they're just as distractible as can be. Now the next question is can they manage working memory? We only have three bits of working memory so you would think that a high multi-tasker would be critical to be able to shuttle information in and out very rapidly. So I'm going to ask, give you that test. You're going to see letters one at a time. I want you to say target if the letter matches the letter that appeared exactly three letters ago. So what do I mean by that? If I said A, B, C, A, that would be correct because that was exactly three letters ago there was another A. If I said A, B, A you would say no and if I said A, B, C, D, A you would say no because it wasn't exactly three. Make sense? Okay, alright, let's start.

Managing Working Memory

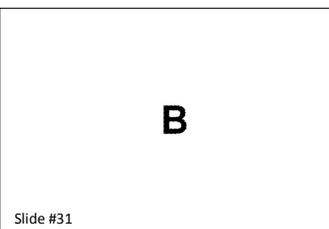
- You will see letters, one by one
- Respond "TARGET" if the present letter matches the letter that appeared 3 letters ago
- Respond "NOT TARGET" otherwise
- Must maintain and update

Slide #29

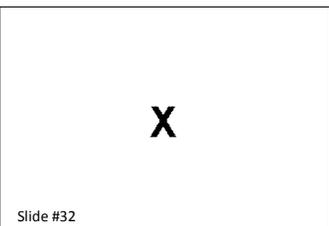


[Pointing to the slide on the screen as the following slide are exhibited in order.]

So, no because it's the first letter.



That was pretty easy. [moving objects of the screen]



No, very good.

**C**

Slide #33

No,

**B**

Slide #34

Good, yes,

**X**

Slide #35

Yes, good.

**B**

Slide #36

I don't remember myself. No, okay.

[The above sequence repeats in a quick brief succession.]

Alright so imagine getting this stream of letters, it's hard, it's challenging but what happens? The low multi-taskers do fine. They don't do, no one does brilliantly on this, but they do fine. The length of the time doesn't matter to them, they do just fine.

### Results

- High MTs do worse and worse as:
  - Letter is seen more frequently
  - They have seen more letters
- High MTs don't remove things from memory
  - There is a cost to this

Slide #37

(See slide # 37) However, the high multi-taskers do worse and worse the more frequently they see a letter and as they've seen more letters. And the particular way they do worse is they keep on thinking they saw the letter three letters ago.

You can imagine it is, people having filing cabinets in the brain but the high multi-taskers sort of, their cabinet, their filing cabinets are over flowing and they're putting in the wrong one and then they say I better put it in all of them because I don't know which one and da, da, da. They just fill their brains with stuff.

So not only are they distracted, they hang on to their distractions making them even less able to perform. So, high multi-taskers just don't remove things from memory.

Alright, I'm going to give you one last test. (See slide #38) This is the one where you would have guessed if there was anything high multi-taskers would be good at, would be *switching from one task to another*.

So we're going to do that. The way we're going to do this is a little more subtle than the others. What you're going to do is you're going to see the word "letter" or "number" followed by a letter number pair like 2B or G9. If you see the word "letter," then I want you to say "yes" if what you see is a vowel and "no" if it's a consonant. If you see the word "number," I want you to say "yes" if it's even and "no" if it's odd. Does that make sense? So basically you have to either look at one or the other. This isn't really a distraction task because with two objects distraction's an issue, but what I'm going to do is I'm going to do something like "number," "number," "number," "number," "number," "letter" and you're going to have to go "ah, I have to switch." It's called the switch task. [\[Pointing to the slide on the screen.\]](#)

**Task Switching**

- Test of ability to switch back and forth between two tasks
- You will see a cue ("LETTER" or "NUMBER"), followed by a letter/number pair (e.g. "2b")
- After seeing "LETTER", say "yes" if the letter in the pair is a vowel
- After seeing "NUMBER", say "yes" if the number is even

Slide #38

Task Switching

**NUMBER**

Slide #39

So let's see what it looks like. Ready?

Task Switching

**4b**

Slide #40

[audience response]  
"Yes"

Task Switching

**NUMBER**

Slide #41

Task Switching

**8g**

Slide #42

[audience response] "Yes"

Task Switching

**LETTER**

Slide #43

[silence]

Task Switching

**6c**

Slide #44

[audience delayed response]..."No"  
Yeah, see you had a pause because you had to say wait, I've got to do letter now.

Task Switching

**LETTER**

Slide #45

Okay?

Task Switching

**e9**

Slide #46

[audience response] "Yes"

Yes because it's a letter and it's a vowel. Good.

Task Switching

**LETTER**

Slide #47

[silence]

Task Switching

**g6**

Slide #48

[audience response] "Yes"

Good

Task Switching

**NUMBER**

Slide #49

[silence]

Task Switching

**8p**

Slide #50

[audience response] "Yes"

Yes it was switched again.

It turns out that, amazingly, high multi-taskers are worse at switching from one task to another. (See slide #51) The one thing you would have thought they would be good at, they're bad at. They can't even switch as fast because they can't help thinking about the task they're not doing. Their brains just fill with stuff and they can't separate the wheat from the chaff. They like the chaff, the wheat, whatever connects the wheat and the chaff, the stalk, they like everything and they want it all in their brains but there's a cost for that. So the great irony is that high multi-taskers are bad at multi-tasking. The things they do all the time they're bad at.

Results

- HMMs are much slower in switching
- HMMs can't help thinking about the task they're NOT doing
- *HMMs are bad at multitasking*

Slide #51

Why Do High Multitaskers Exhibit Deficits?

Slide

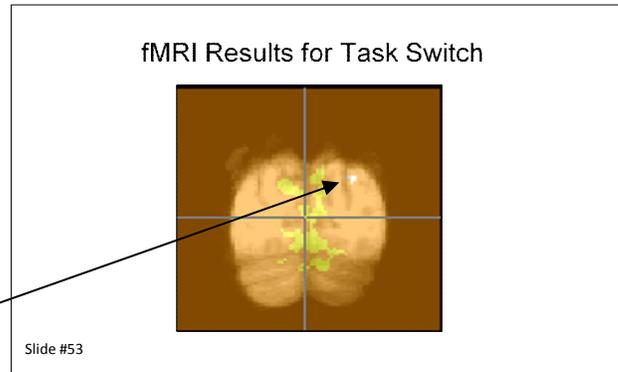
Now I've been promising you the brains. So this is the way when I was young psychologists looked at the brain, we watched what people did and we deduced things about the brain. Nowadays you've got to look at the brain. It's a real strange change for me. (See slide 52)

So what's going on in their brains is summarized here.

(This is functional magnetic resonance imaging. It's a brain scan where we look at what parts of the brain are activated during various things. See slide #53) This is a view coming from the top. Unfortunately this is

the left and this is the right. Sorry it's backwards, from you, left and right. This is coming straight down on the brain. This is the front of the brain. This is the back of the brain. Okay?

So this is a summary of the averaging of all the brains we looked at. Half of those brains were high multi-taskers, half of those brains were low multi-taskers. If you had done this study around 2003 when you looked at the task switching thing I showed you, you would have seen a little white dot right here in the left pre-frontal cortex. It's called the stopping mechanism. It's what your brain uses to stop a task and start another. It's the key to multi-tasking. These were the brains of everyone when these studies were done in the early 2000's. It is now the brains, still, of low multi-taskers. So quite logically low multi-taskers brains look like previous brains. High multi-tasker brains look like this, the yellow, that's the extra brain activity. So this white is the extra brain activity used by the low multi-taskers. This is the extra brain activity used by the high multi-taskers. Notice this is about 20 times more brain activity.



Now, my goodness, with that much brain activity they should rock and roll, they should be incredibly fast, they're mobilizing their brain to solve this problem. Wrong.

They're mobilizing their brain to look around. This turned out to all be part of the visual cortex. So now you have to picture the scene. You're in a dark metal tube, you are strapped down, your head is in a vice, there is a single screen right above from you that is just ...[low audio], do you guys see it? There is nothing else to see because it's all black and you're locked down. Every time there was a switch, the multi-tasker said "great, an opportunity to frantically look around." And even though there was literally nothing to, I mean nothing, like black, they looked around frantically whenever they were given the opportunity to. That's the brain of high multi-taskers.

And high multi-taskers right now are 25 percent of the population but do any of us think that number's shrinking? Or what is more likely is that the low multi-taskers are going to become high multi-taskers over the years.

### Here's the Student of the Future

- Can't focus where they are supposed to focus
- Can't ignore irrelevant information
- Can't manage working memory well
- Can't switch tasks

Slide #54

Okay, so here's the student of the present and especially the future. (See slide #54) They can't focus where they're supposed to focus. They can't ignore irrelevant information. They can't manage a working memory well and they can't switch from one task to another. Teach them.

### What Learning Models Have to Change

- 50 minute classes
- Reading the whole book
- Communication among students
- Online learning

Slide #55

(See slide #55) Well it's going to be challenging and it means we're going to have to think a heck of a lot differently about a lot of things that we've been trying to think the same way about.

For example, 50 minute classes are unmitigated torture

because there aren't enough opportunities for distraction. They can't focus for 50 minutes.

*Reading the whole book.* No, I mean it is remarkable, I mean you're all laughing which is both good and sad. When we were, when, I'll speak for myself, when I was in college and likely when many of you were in college, we would assign books and increasingly we assign pieces of books, and even more frighteningly and annoyingly students think that is the same thing.

So I had a student come up to me the other day and go, "Professor Nass, I loved your book." I said, "thank you. Which part did you like the best?" He said, "well I only read chapter one." And I said "well, what did you mean you liked my book?" He said "well, chapter one." I said, "you know it's funny when you write a book, you sort of write many chapters and you figure people will read them," etc. and it didn't seem to make a dent. So increasingly we're not assigning the whole book, we're assigning pieces. Why? Because kids don't think, can't think, in the ways that sustained focus demands.

*Communication among students.* If students are not really looking at each other in the face that tells us that it's much harder to argue for dorm life. In fact one of my favorite, or depressing stories in the dorm. I was in the dorm. Again, I lived in a freshman dorm for a while and I'm looking down the dorm and I see one of the kids and I say, "oh, what are you up to?" She says, "I'm texting Fred." I said, "oh, I just passed Fred like a second ago." She said, "I know." So I said, "why are you texting him if he's like two doors down?" So she pauses and says, "it's more efficient." So I said, "look I live with freshmen. Efficiency is virtue number 873 for freshmen. Freshmen never think about efficiency. It cannot be efficiency that's driving this behavior." Then she said, "well, you know it really doesn't matter whether you see the person first face to face." I said, "well, I have to tell you this story. Last year I had the worst thing that can possibly happen to anyone. I went to my 35th high school reunion and I met a woman who gave me the love letters I had written her 35 years ago. It was so...fortunately I was a scientist so I could read them; otherwise it would have been impossible. And I read these love letters and I told her, I told the student now, I said, "they were filled with, because of course we didn't have internet, we didn't have Skype, we didn't have phones, there was one phone in the whole dorm, right, and everybody could hear what you say so you couldn't call and we had long distance charges, again, a concept you don't know." And I said, "you know we couldn't see each other, we couldn't hear each other so the notes are filled with how difficult it is not to see her face, not to hear her voice, how hard it was to know what she was thinking and feeling and this was clearly an important thing." And she said to me, "that's so quaint." I said, "you know, it is I suppose but on the other hand I said there's a large area of psychology called like face identification, face recognition, emotion detection, etc. all of which assume that seeing another person might be important."

But then I thought about Barney and thought maybe not. So it's really a challenge and one of my favorite examples is online learning. So approximately three times a week I get an email from someone who says, "should I ban laptops from my classroom? Should I ban computers from my classroom?" And I say, "well you know here are the tradeoffs and stuff." I said, "you know, but the real question is should we ban computers from online learning?" Now think about that, right? We can barely get kids to pay attention to us when we're standing up here dancing, singing, doing all this stuff and what do they do, they want to use the computer. So now we say here's a solution to prevent them from using the computer. Let's put all our classes on computer. I bet when they're, you know, when they're studying and taking an online class they're not Facebooking, they're not just, you know they're not doing YouTube, they're not doing all this other stuff, just like when they write our papers and do our assignments. They're ruthlessly focused on the material at hand.

Okay? The fact you're laughing means there's something really problematic about online learning that peo-

ple aren't facing, which is simply that when you put kids in front of a computer the first thing they want to do is not learn. They want to text, they want to communicate, they want to have fun. That's all okay, it's perfectly okay but it means that if our models are kids are going to be much more focused in online learning because, I don't get it. We have to think about totally new ways of designing things if we recognize the fact that kids, you give kids a computer with an internet, they're not looking at one thing at once. And yet that's our model for online learning so we're really going to have to think about that.

How can we help kids then to manage this information? How can we teach them? Well it's very, very hard, it's very hard to get kids to change but here's some things that even if your kids don't do you can do at least and help yourself.

(See slide #56) The first is to use the *20 minute rule*, which means when you're doing any information activity try to do it for 20 minutes at a time. Try to focus, even for email. So it's very funny, I go around to companies all the time and they say 20 minutes of email, that's the most ridiculous thing. Email is stupid, annoying, worthless, takes up all my time, it's just ridiculous. Who would spend 20 minutes on email? So I say, "fair enough." Please clock how many minutes you do email tomorrow. They'll come back and go oh, 200. I said, "well I thought you said it's not worth 20?": They said, "but yeah when you do it one minute at a time it doesn't feel so bad". I said, "yes but it hurts your brain and it makes you less productive and the fact that you're switching all the time means it takes more minutes to do email." So in fact the little drips and drabs actually slow you down and make you put more time into email. So when people say email ain't worth 20 minutes, you ask them how many minutes it is worth and if the answer is 200, there's something broken.

Second one is *change policies and encourage multi-tasking*. This is at least for, increasingly for businesses, the environments our kids are going into, people are demanding that people have, in the workplace, text windows open all the time even when they're trying to get work done, etc., and it's just highly distractive.

*Change of culture of responsiveness*. One of the reasons kids multi-task is the idea is they should do something right away and I say to the kids in my dorm, I say, "look, you know, sure you can do it right away but if you actually did it when you were really thinking hard you could give a better answer." And their answer is "nah, it's quick, it's good." So we need to change that culture of responsiveness to support kids.

Fourth is to, in fact, *ban laptops in class*. It really does make sense or at least tell the kids the consequences. You know, ban them, say, "look it has short term effects and it has long term effects and if they don't believe it one thing we're doing is building a website so all the kids who say oh, multi-tasking, I can multi-task, nothing affects me, can actually go on a website and see and you won't be surprised to learn whenever you get a kid to do that, they discover that they're actually very bad at it."

### Managing Cognitive Issues

- Use the 20 minute rule
  - Even for email!
- Change policies that encourage multitasking
- Change culture of "responsiveness"
- Ban laptops in class
- Strengthen executive functions

Slide #56

What About Multitasking, Heavy Media Use, and Emotion?

Slide #57

And finally *strengthen executive function*. There's all sorts of ways we're looking at. It's still a challenging question. How can we get kids-executive function is the things I just tested you on; the thinking, switching etc.?

Okay, let me just very briefly mention the impact of multi-tasking on emotion. (See slide #57) I'll go through this very quickly because I

want to leave time for questions.

(See slide #56) Basically, to make a long story short, *multi-tasking has negative effects on kids' emotional development*, and the reason is that if I'm, the way kids learn about emotion, when you're young, is by looking at other people.

### Results

- Multitasking is problematic for students
  - Less feelings of normalcy
  - Less sleep
  - More friends who are bad influences
  - Less positive feelings from offline friends
- Online media use is problematic for students
  - Same effects

Slide #59

### Link between Multitasking and Emotion

- Emotional skills require attention and practice
  - Emotions are learned through attending to others
    - It's hard to learn when you're not focused or looking elsewhere
  - "Emotion atrophy": the more you have to respond rapidly to people's emotions, the better you become at:
    - Emotion detection
    - Emotion response
    - Emotion regulation

Slide #58

(See slide # 57) You watch them, you watch their faces and their bodies, you listen to the tone of their voice and you watch how they handle the situation. One thing we've been noticing across college campuses is kids having much more emotional difficulties, especially emotion regulation, when something bad happens they're crippled, they're paralyzed. They don't have

resilience. We've talked a lot about resilience. One of the ways you learn resilience as a kid is to watch slightly older kids manage their emotions, but to do that you have to be watching. If I'm talking with you and doing this, I'm not really watching your face, I'm not really getting what are called the paralinguistic cues, of emotion and your voice characteristics, etc., so it becomes an enormous problem. And in fact the research shows that kids who multi-task frequently show much less emotional understanding, much less emotional ability, less healthy social relationships.

(See slide #60) On the other hand, face-to-face interaction, this is why it is good to have kids in a place, it turns out to be fabulous for kids. This is based on research on 8 to 12 year olds. We're about to do similar on actual college students but of course they become college students and 8 to 12 is a critical age of emotional development. Kids who are heavy face-to-face interaction kids, even if they use online media as well, as long as they get that face to face stuff they show greater feelings of normalcy, greater social success, more sleep, less friends who are bad influences, more positive feelings from friends and it prevents the negative effects of online.

### Results

- Face-to-face interaction is great for students
  - Greater feelings of normalcy
  - Greater social success
  - More sleep
  - Less friends who are bad influences
  - More positive feelings from offline friends
  - Prevents the negative effects of online

Slide #60

In a study we just got finished two days ago we looked at the ability to detect emotions, this is among college students. Low multi-taskers no matter how much face to face time they had in the past week, showed consistently good abilities to detect face, to detect emotion in faces. High multi-taskers with low face-to-face interaction were much worse at detecting emotion. So again, whenever I'm talking with you and we all know kids like this right, in fact if you walk around out here, as just as I was walking here I saw kids eating lunch together and some of them were together and some of them were together in the trivial sense of physically proximate, but they were all sitting there texting away and talking and, you know, interacting,

but the problem, of course, is if they don't really face the faces, they lose it.

### Other Results

- Facebook is the happiest place on earth
  - Positive comments are "liked" more
  - Photos are almost all happy faces
  - Positive comments are dominant; negative comments are hedged
- Growth of parallel play

Slide #61

(See slide #61) Another problem is that *Facebook has become the happiest place on earth*, displacing Disneyland because if you think about it, all the faces on Facebook are happy. People post happy faces, and most of the comments are happy and positive comments get more likes, right, because it's hard, someone writes I had a terrible day and you click "Like." [audience laughter]

But there's a subtle consequence of that because in the news feeds, the feeds of your comments, the ones that are liked more get seen more, so what happens? The positive comments are seen much more

than the negative comments. So what do you do? You say, "hmm, I guess I should do positive comments," and it escalates. But the problem with that is that negative, sad, difficult emotions are much more difficult to learn how to deal with than positive emotions. Happy is easy. Sad is hard.

So there's a wonderful line from Anna Karenina, the first sentence of Anna Karenina, is "All happy families are alike. Every unhappy family is unhappy in a different way." And it's actually a brilliant insight by Tolstoy that the same is true of brains. Positive emotions don't take up much brain capacity. Negative emotions use much more brain, get much better remembered, much more attention, much more processing and they're much more complex.

However if kids don't track these negative emotions, we're dooming them to negative emotions. It's a great irony. If you're not confronted with and see and manage negative emotions, you will have them more, which is why we're seeing, we think one of the reasons we're seeing higher rates of depression among college age kids, much higher rates of lack of resilience among college age kids, it's because they don't practice bad stuff.

And of course I tell the kids in my dorm, "of course I would have avoided negative things as a kid. I would have been happy to have an easier childhood but I learned from that." Those learnings have to come and if they don't come when you're younger we have to deal with them in college, but of course it's much harder to deal with them then so we're dealing with the outgrowth.

Also the *growth of what I call parallel play*. Kids sitting next to each other in my dorms, the lounge in my dorm, kids will be sitting around and each will be sitting with their laptop watching a video, doing this and that, they're not really interacting but they think they are. So I once said, "hey kids, the lounge is for not working on your computer, the lounge is for schmoozing, talking, you know, etc. really being engaged with each other etc." And they're like "no, we're talking." And I said look this is not talking: "Hey how's it going? What's next?" That isn't talking. That's not really engaging so that's something we have to do.

(See slide #62)

### Managing Socio-Emotional Issues

- Make face-to-face sacred (it's magical!)
- Train students in basic social rules
- Ban laptops in social gatherings

Slide #62

To manage that, to help kids, *we have to make face-to-face time sacred*, we have to encourage in every way we can, kids to do it increasingly, and we're talking, some people were talking earlier about the skills you need in the workplace. When I go around to businesses one of the biggest skills *they're noticing are deficient are basic social rules*. Kids today have much more difficulty in, for example, resolving conflict in a team, because when there's conflict they race to text or email, and we all know how effective email is for resolving confusion, for clarifying conflict and ambiguity, it's a fabulous medium for that, right?

But the problem is they don't know how to manage their own emotions. They don't know how to cleverly read and rapidly read other people's emotions so what happens? They retreat. As a result you have more friction. So actually ironically I'm being asked to go to businesses and teach Social Rules 101. Things that well-brought up kids used to know and even not well-brought up kids used to know. But now increasingly businesses have to do that so one of our obligations if we're really trying to train students for the 21st Century is to teach kids social rules.

And then finally banning laptops in social gatherings. I know it sounds funny. You're going like social gathering, laptops? Look at your kids. That's what they're doing.

Thank you for this invitation to speak.

[ Applause ]

**END**