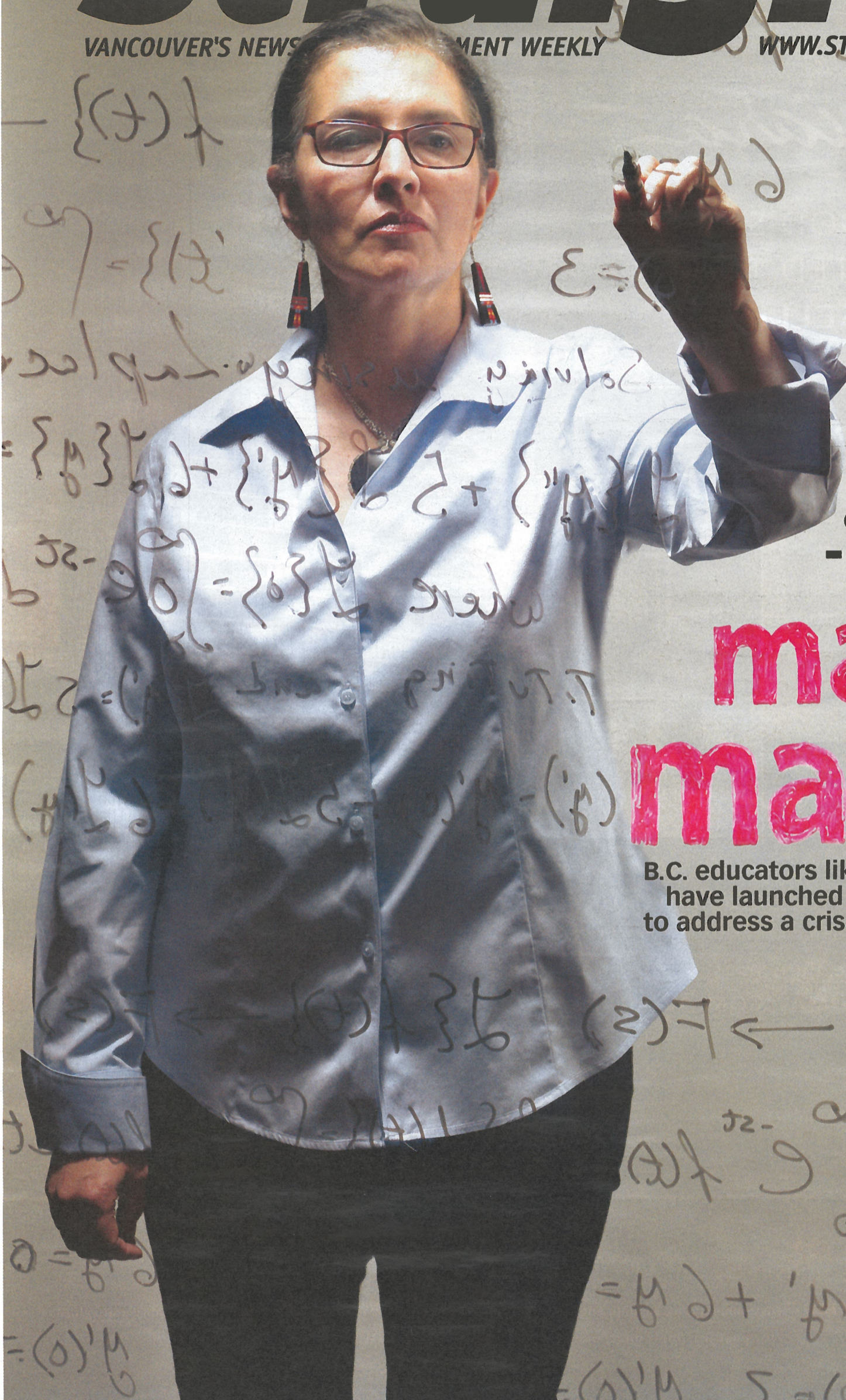


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math mania

B.C. educators like Melania Alvarez have launched new approaches to address a crisis in math learning

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BY CHARLIE SMITH

UBC math professor George Bluman is used to speaking to Chinese audiences. Last spring, he gave a series of lectures in China about teaching calculus. In a recent phone interview with the *Georgia Straight*, he also revealed that he has worked with three postdoctoral students from villages in China, including one from Inner Mongolia.

So it shouldn't come as a surprise that in late October he was invited to speak to a group of Chinese-speaking parents at the Burnaby Public Library about the state of math education in B.C. Their nonprofit academic organization, the Educational Quest Society of Canada, was created in June "to provide Chinese communities with professional suggestions concerning education...and to exert an influence on improving and reforming the elementary and secondary education in British Columbia".

"I was the only non-Chinese person present," Bluman said with a chuckle. "They are very concerned about the decline in education."

At the meeting, Bluman expressed his deep concern about the elimination of mandatory Grade 12 math exams in B.C. In 2004, the provincial government made this test optional; in 2011, it cancelled all optional Grade 12 exams, which means there's no standardized Grade 12 math test



UBC professor Fok-Shuen Leung says most people underestimate the esthetic appeal of mathematics, which he likens more to literature than to accounting.

Battling B.C.'s math crisis

Educators have devised new approaches to engage kids in a subject that's crucial to the economic future of the province

in B.C. anymore. "The universities and colleges, without dissent, wanted them to be continued for mathematics," Bluman insisted to the *Straight*.

He cited research conducted at UBC showing that students who had written the optional tests performed much better in first-year calculus courses. And according to a survey he conducted, public-school math teachers want the Grade 12 exams reinstated; UBC student senators echoed this view in a separate survey.

Moreover, Bluman noted that B.C., unlike most other jurisdictions, allows secondary-school educators to teach math regardless of their qualifications in this area. "You don't have to be knowledgeable in the subject," he said. "It's a real problem."

Meanwhile, the Educational Quest Society of Canada (EQSC) has published a report chronicling how B.C. students' performance in math has deteriorated in the 21st century. The Pan-Canadian Assessment Program testing of Grade 8 students in 2010 showed that B.C. registered a score of 481, which was well below the Canadian average of 500 and significantly behind the top three provinces: Quebec (515), Ontario (507), and Alberta (495). "Moreover," the report notes, "BC students performed below the Canadian average on all four of the mathematics sub-domains: numbers and operations, geometry and measurement, patterns and relationships, and data management and probability."

B.C. also fell behind the Canadian average in the 2009 math-test results of 15-year-olds, according to Program of International Student Assessment results. B.C.'s score of 523 was four points below the national average and 11 points below the score achieved in 2000. This decline followed the B.C. government's decision to halt reevaluation of the math curriculum shortly after the B.C. Liberals took power.

One member of EQSC, Pi Yuan, told the *Straight* by phone from Burnaby that he teaches math and science at a private educational centre. He rattled off nine major concerns about math education in B.C., including the elimination of the requirement to include calculus in Grade 12 mathematics. He claimed that a reduction in standards has diminished the value of a B.C. diploma.

"If you compare the mathematics textbooks the students are using now and the textbooks that were used 10 or 20 years ago, you can see that the content is getting less and less [difficult]," Yuan said.

He also claimed that the elimination of the Grade 12 math exam can undermine a student's chance of getting accepted to university. "A lot of students have concerns about the fairness of the marking," Yuan maintained. "If the students have a very nice, fair teacher and a good marker, maybe the mark is high. But if the student is taught by a strict teacher or a callous teacher, maybe the mark is low."

SITTING IN HER office at UBC's Point Grey campus, UBC math-department outreach coordinator Melania Alvarez bluntly told the *Straight* that there's a "crisis" in math education in B.C. Alvarez, winner of this year's Canadian Mathematical Society award for promoting math learning, travels across the province to support schools and teachers in their math education.

"I think we really need to change some things, because otherwise, I don't see us moving forward," she said.

Foremost is the culture around mathematics. She noted that people don't routinely announce that they don't know how to write or that they

hate reading books. But parents will often tell their kids how much they hate math, even though most young children love the subject. "Being math phobic is culturally acceptable," Alvarez said. "I'm sorry to say, the media promotes this."

Alvarez is education coordinator at the Pacific Institute for the Mathematical Sciences, a consortium created by eight universities. It puts on two summer camps: one for kids making the transition from elementary school to secondary school, and another for high-school students. And for the past 15 years, the institute has hosted a free educational event called "Math Mania" several times a year in school gymnasiums that includes games, puzzles, kaleidoscopes, and various interactive events.

On October 27, the UBC faculty of education invited families to attend a math fair, which featured numerous activities for children. In one Clue-like game, participants had to figure out which tourist stole a priceless ruby from the tomb of King Ramses. Students also learned how math is integral to Coast Salish weaving.

Two UBC education professors who attended the fair, Cynthia Nicol and Jo-ann Archibald, explained to the *Straight* how they worked with aboriginal residents of Haida Gwaii on a program to connect math to the community and local culture. Nicol mentioned that they worked with carvers and elders to learn how mathematics influenced the Haida Nation, then incorporated what they learned into lessons. "Some of it was taking the kids outside to the beach, to the land, helping them imagine other possibilities to studying math in a textbook," Nicol said.

Archibald described how this emphasis on linking to the land could better engage aboriginal students. As an example, she said it's possible to base a lesson on the number of logs that have been cut and removed, and then equate that to the impact on the local environment. "You're connecting math with social issues," Archibald stated.

Alvarez often emphasizes that just as it takes time to excel in sports or in music, it also takes considerable effort to do well in math. "Most kids believe that if they cannot solve a problem in five minutes—or in two minutes or in 30 seconds—then they are no good in math," she commented. "We need to change that."

She pointed out that students feel empowered when they excel in math. And she said it's important for teachers to set expectations high and not pigeonhole students as slow learners because they will not perform as well as they can. Alvarez also acknowledged that many teachers don't feel comfortable with their level of math knowledge—and she pointed out that they must be supported with professional-development opportunities.

"Many of them have told me that they tried to avoid math when they were student teachers but that they really regret that," she stated. "Unfortunately, the institutions allowed for that."

One thing is clear: knowledge of math is increasingly important in the 21st-century economy. UBC math professor Arvind Gupta is the CEO and scientific director of Mitacs Inc., a national nonprofit organization funded by federal and provincial governments and the private sector. It encourages graduate students to work with companies to understand their problems and propose solutions, which then become the students' thesis projects.

Gupta told the *Straight* by phone that the program began with math students but has since expanded to include people in everything from anthropology to zoology. Nowadays, occupations

ranging from architecture to medicine to journalism to engineering all require significant math skills. Gupta pointed out that the genomic revolution is really about the application of mathematics to life sciences and that math is even becoming more important in the social sciences.

He noted that former U.S. president Bill Clinton's speech at the most recent Democratic national convention was loaded with arithmetic, winning rave reviews from the public and giving Barack Obama a boost in the polls. "If you go back to that movie *A Beautiful Mind*, who would have thought that a movie about a mathematician would win so many awards?" he stated. "I think there's actually a hunger for this kind of thing."

To stimulate kids' interest in the subject, Mitacs is backing a stage production called *Math Out Loud*, which recently played in Vancouver and Surrey. Written and directed by Vancouver actor Mackenzie Gray, the zany show features two students who time-travel. In various vignettes, they encounter characters ranging from Cleopatra to Christopher Columbus and learn how math influences everything from art to game shows to the sounds coming out of the radio.

"What we want to do is figure out a way to re-engage kids," Gupta said. "It's great to have your music on your iPhone, but what you're really doing is carrying around a very sophisticated piece of mathematics."

ONE OF THE NEWER members of the UBC math department, Prof. Fok-Shuen Leung, has also learned some things about how to make mathematics more engaging for students. In an interview in his office at UBC, the winner of a 2011-12 Killam Teaching Prize (science) told the *Straight* that people are missing the mark when they see mathematics as "only a tool that you use and not a subject that you study".

"I think it's closer to literature than it is to accounting," Leung stated.

He quickly added that there's nothing wrong with accounting before saying that people underestimate the aesthetic appeal of math. "I think it's [Godfrey H.] Hardy who said: 'There is no place in the world for an ugly proof.' So, in fact, I think one of the biggest misconceptions is that it is this kind of austere, useful thing—and not a rich, beautiful thing."

As an undergraduate studying physics at Queen's University, Leung was keenly interested in music. He discovered that math combined the aesthetics of music and the rigour of the physical sciences, which led him to obtain a PhD. In 2009, he was hired at UBC.

He said another misconception about math is that the answer to a problem is simply a number. "This is not true," he declared. "An answer to a mathematical problem is a story. It's an explanation, a description. Not only does mathematics require grammar the way any other description would require grammar, it also requires an economy of language. It requires imagination, creativity, and communication skills."

Leung often hears students tell him that they enjoyed their high-school English classes but disliked studying math, even if they were good at it. He said that this is because in English, students get to read great writers like Shakespeare, whereas math education often focuses primarily on the "grammar".

He emphasized that he admires teachers, saying they are the experts in running classrooms in the elementary and secondary system and he

see next page

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B.C.'s math crisis

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wouldn't dream of telling them how to do their jobs. But when it comes to math, he pointed out that there are more than 100 proofs of the Pythagorean theorem.

"To me, that is a formula that sits on the surface of an enormous body of mathematics, philosophy, and ways of looking at the world," Leung said. "I think it would be worthwhile for students to see more than one proof of this theorem. I think it would be worthwhile for them to talk about why you would need more than one proof."

Later this year, Leung will find out if he will obtain tenure at UBC. Down the road, he hopes to have a greater impact on "the teaching mission" of Canadian universities.

A KEY PART of the teaching mission in math is the curriculum. Under the last NDP government to hold power in B.C., the deputy minister of education, Charles Ungerleider, began exploring why Quebec students consistently outperformed B.C. students in math. But Ungerleider, a veteran UBC education professor, was replaced after the B.C. Liberal government got elected in 2001. And according to a paper published in 2006 in the *Canadian Journal of Educational Administration and Policy* by two University of Victoria professors, the curriculum-reform initiative stalled under the new regime. The education minister at the time was Christy Clark, now B.C.'s premier, who changed the ministry's focus to overall school accountability.

"One final, tragic event sealed the fate of mathematics reform in B.C.," authors Helen Raptis and Laurie Baxter wrote in their paper, *Analysis of an Abandoned Reform Initiative: The Case of Mathematics in British Columbia*. "In January 2002, the director of the Curriculum Branch, under whose direction research was conducted, passed away. Within weeks of his passing, his office was cleaned out and most of his files and reports were relegated to the dustbin. Without the support of the deputy minister or the curriculum branch director to sustain the reform efforts, B.C.'s brief courtship with mathematics curricular reform was aborted soon after its conception."

The authors pointed out that the math curricula in Quebec and B.C. differed in key areas, including: the number of topics and objectives covered, the degree of abstraction versus concreteness, learning theories and the role of problem-solving, the role of mental calculation, and the use of curricular differentiation.

"For example, B.C.'s grade four curriculum included 130 objectives, whereas Quebec's had 23 terminal and 68 sub-objectives," Raptis and Baxter wrote. "This difference is exemplified in the study of *measurement* whereby Quebec's curriculum dealt with *length, area and volume* while B.C.'s students covered *length, area, capacity, mass, time, temperature and money* with *time, temperature and money* being repeated from previous years' curricula. This repetition

occurred again in grade eight, where 43% of B.C.'s *Numbers/Operations* objectives had appeared in grades five, six, and seven. By grade 11, 60% of instructional time was earmarked for Algebra, with 33% of objectives repeated from prior years."

The researchers claimed that the math curriculum in Quebec "also appeared to be more unified and coherent than B.C.'s", with directives advising teachers to relate material to previously learned content.

Many mathematicians, including UBC's George Bluman, defend the "spiral curriculum", which was pioneered by Harvard cognitive psychologist Jerome Bruner in his 1960 book, *The Process of Education*. Under this approach, topics are regularly repeated to reinforce concepts for students. However, the paper by Raptis and Baxter cited researchers with concerns about this approach.

One of the harshest critics of the spiral curriculum is U.S. "direct instruction" advocate Siegfried Engelmann, whose 1992 book, *War Against the Schools' Academic Child Abuse*, tore it to shreds: "The decision makers are blind to basic instructional constraints: an activity must be effective with different kids; it must be *time efficient*; and it must be related both to what comes before it in the instructional sequence and what comes after it."

The B.C. Ministry of Education would not make anyone available for an interview for this article. A revised math curriculum for grades 10 to 12 has been instituted over the past three years. It diminishes the amount of repetition and sets out three pathways—apprenticeship and workplace mathematics, foundations of mathematics, and precalculus. They arose out of a collaborative process that includes four western provinces and three northern territories.

In its report, the Educational Quest Society of Canada did not address the spiral curriculum or the failure of B.C.'s reform initiative more than a decade ago. And it emphasized that Chinese methods should not simply be transplanted onto Canadian society: "The superiority of western education rests in its emphasis on developing intellectual potential... We agree that an education system ignoring students' differences should be changed. But if differences were over emphasized to negate regularity, and if traditional classroom lectures were replaced with 'personalized teaching', the consequences on fundamental knowledge and skills would be disastrous."

That's one reason why the society views the restoration of the Grade 12 provincial examinations, including in mathematics, as a "top priority".

Whether or not this becomes an issue in the 2013 provincial election remains an open question. But one thing is indisputable: an initiative to reform the math curriculum stalled under the leadership of the premier when she was education minister.

And since then, B.C. students have not fared nearly as well in this subject as those in Alberta, Ontario, and Quebec. ♦

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