00:07

I didn't always think the mathematics

00:11

and the responsible citizenship were

00:13

really tightly connected and that

00:14

changed for me that changed for me back

00:17

in 2008 that was the election between

00:20

Barack Obama and John McCain it was one

00:24

of during one of their debates that the

00:26

king said something like this he said

00:29

what senator Obama's not telling you is

00:31

there his tax plan half of all small

00:34

business profits will be taxed at a

00:36

higher rate he went on to talk about how

00:38

that would be bad for the economy bad

00:40

for jobs

00:41

a few minutes later Obama came back and

00:44

he said the vast majority of small

00:47

businesses don't make one $250,000 in

00:50

fact 98 percent of small businesses

00:52

won't see their taxes go up but if you

01:04

think through it if you think more

01:06

deeply than these you know 50 sound

01:08

bites something deeper is going on and

01:11

it's possible that they're both telling

01:13

the truth here you see if we think about

01:15

all these small businesses you might

01:17

have a lot of small businesses making

01:18

very little money and then occasionally

01:21

some small business does really well it

01:23

makes a lot of money some other small

01:25

business just breaks it in and if you

01:30

think through it might be that if you

01:32

look at the number of small businesses a

01:34

huge portion of 98 percent are making

01:37

less than Twitter

01:39

but if you're looking after the numbers

01:40

of dollars it might be that half of

01:43

those dollars are going to - just a few

01:45

small businesses it might be them both

01:48

of those need to understand you need

02:16

[Music]

02:26

2000 students mathematics this is the

02:29

map that they needed to be responsible

02:31

citizens it's not inner college Brittany

02:34

it's not the k-12 curriculum you know

02:37

Jefferson knew that we needed an

02:39

informal to sustain our democracy a

02:42

democratic republic and part of that is

02:44

mathematical knowledge where are we

02:47

giving our students the math that they

02:49

need to be informed citizens and so I

02:53

started thinking differently and I

02:56

started teaching differently and I would

02:58

give you a sense of what that looks like

03:00

examples for the first one imagine

03:03

you're at a hospital of their year in

03:05

report and there's an administrator of

03:07

Trump talking about public they've done

03:09

the administrator might say you know one

03:11

of our goals is to get people out of the

03:13

hospital recuperating in their own homes

03:15

and we've done a great job in fact

03:17

ninety five person for the patient's who

03:19

spent the night last year they checked

03:21

out with the no we baked up and in the

03:25

back maybe the nurses are sort of

03:27

mumbling about

03:28

finally I don't see how that's possibly

03:32

true we worked on Christmas we remember

03:35

all the patients who were given hospital

03:37

that day and eighty percent of those

03:39

patients in better the whole year what

03:43

how is it possible that somehow ninety

03:46

five percent of the patients are

03:47

short-term patients and at the same kind

03:49

of eighty percent of the patients are

03:51

long-term residents in the hospital that

03:53

seems completely contradictory but if

03:56

you start to think about it these two

03:59

people are talking about different

04:00

groups the administrator is talking

04:01

about a very large hospital the nurses

04:05

are talking about a fairly small group

04:06

just the ones where they're in one

04:08

particular name if you want to think

04:10

about possible that both of these are

04:12

true imagine a hospital with just ten

04:14

bags where 80% of them eight of them are

04:18

long-term residents those last two beds

04:21

you can have a lot of people cycling

04:23

through those last two minutes even in

04:26

just two weeks it's probable that the

04:28

majority of people who spent the night

04:30

or in those last two beds if you extend

04:33

this over a year it might be

04:35

5% for second through those last two

04:38

dozen short-term states no well they

04:42

come about this with my students they

04:44

think this is just a quirky strange

04:46

mathematical example until we start

04:49

talking about how similar statistics

04:51

flow for people who are getting food

04:53

stamps for people who are on

04:55

unemployment for those from getting

04:57

causing matches and if a politician is

05:00

talking to you and wants you to believe

05:02

that the people on welfare are on and

05:05

they're just reaching for years and

05:08

years

05:08

feels like the statistic at one time and

05:11

then a huge portion of those people and

05:14

if a different politician wants you to

05:16

believe that people are just on welfare

05:18

for short periods you know in between

05:21

jobs or recovering from an illness does

05:23

like the statistic over a year or two or

05:25

three and then a huge portion of those

05:27

people will be short time uses of these

05:29

programs their agenda the current switch

05:33

statistic based survey and these sort of

05:35

statistics are well known in social

05:37

sciences is the staff in the flow and

05:39

it's one thing to hear these two numbers

05:41

and think through like oh they might

05:44

both be true but the hard work of being

05:47

an informed citizen requires that

05:48

appeared just one of those numbers and

05:50

imagine what the other one is that's

05:53

what it takes to be an informed citizen

05:56

these are the sorts of things that are

05:58

taught with my students about for the

06:01

second example I want you to think back

06:03

to the financial crisis

06:05

okay back then people started talking

06:08

about inequality a little bit more and

06:11

some of their spoken some of their signs

06:13

had fairly complicated statistics and

06:15

they said things like the top one

06:18

hundred percent control 30 percent 38

06:20

percent of the wealth or maybe the

06:23

bottom 50 50 percent or just 13 percent

06:25

of the income I don't know about you but

06:28

I heard any statistics and I found them

06:31

very confusing it's a couple of

06:33

different percentages they're talking

06:35

about things that I don't think about

06:36

that much I don't want to compare to

06:38

other people other countries and I

06:41

didn't understand them until I learned a

06:42

little bit more mathematics that's what

06:44

I share with my students and I'm sure

06:45

between today

06:46

to understand this we have to think

06:49

about asking the question repeatedly

06:51

what percent of the total income of the

06:53

country to the bottom a percent of

06:55

people girl now if we're talking about

06:58

just the bottom the zero percent we're

07:01

gonna grab them the people if we're

07:06

looking at the bottom zero percent

07:08

bigger than zero percent of the income

07:10

so we're going to put zero comma zero on

07:12

that graph if we're looking at the

07:14

bottom hundred percent that's everybody

07:16

and so we can go ahead and put the point

07:17

one hundred one hundred they all the ink

07:20

collector in between if we know that say

07:24

the bottom 50% or thirteen percent of

07:26

the income that puts up the point fifty

07:29

concert

07:30

there was actually the statistic for the

07:32

u.s. in 2014 occasionally when you hear

07:36

one of these statistics you have to

07:38

pause a little bit if we have to do the

07:44

subtraction figure out the bottom 99%

07:47

earned the rest 80% of the income and so

07:50

ninety nine eighty goes on in each one

07:54

of these each of those statistics is

07:55

just one point on this graph but we can

07:57

draw the entire graph and if we do we

08:00

get what economists call the Lorenz

08:02

curve this gives us a much greater a

08:04

much fuller picture of what the

08:05

inequality looks like in the United

08:07

States but we can go further we can

08:11

calculate a single number to measure how

08:14

equally really something is distributed

08:16

and to do that let's look at the extreme

08:19

cases if we all aren't exactly the same

08:22

this because you know seventy percent of

08:27

the people would earn 70 percent of the

08:31

other extremely before one person in

08:39

that case look here he's only going

08:50

if we look at these extreme cases they

08:53

form this triangle and I look at the

08:55

areas you see the actual arrests curved

08:57

cuts that up to two pieces and if we

08:59

shade the area above that curve we can

09:02

take the ratio of the yellow region

09:04

above the curve to the entire triangle

09:05

and that is what we call the Gini index

09:09

we look at that ratio in the US and 2014

09:12

it was 0.48 to get a sense of how this

09:15

Genie and that index can change in the

09:18

case of equal distribution of wealth the

09:20

curve goes along with that

09:21

there's no period and we get a teeny

09:23

index of zero and then the Jeff Bezos

09:26

takes the entire time goes above the

09:28

curve for unity and I want to give you

09:50

the tools I want to give them the tools

09:52

to better understand the to make

09:55

informed choices to be informed citizens

09:58

and if you're like them and these are

10:18

the questions we get into we talk about

10:24

we talk about

10:26

income taxes for the marginal tax is we

10:29

talk about the pros and cons of each we

10:33

talk about the other is four times six

11:31

twenty four I think that moment has

11:36

important implications in terms of her

11:38

future as a citizen I give that woman

11:46

the whole plan let me explain let me

11:49

the last you seen years have seen as

11:52

rise of people believing things that are

11:55

not true

11:56

arising people believing lives whether

11:59

it's social media or some people are

12:10

[Music]

12:26

[Applause]

12:33

pointing fingers at this politician or

12:36

that media but if I'm from math teachers

12:41

are cartography you see what we're sort

12:44

of our classes while we're teaching our

12:46

students are not learning just

12:48

multiplication or factoring polynomials

12:50

they're also building up over here's a

12:53

sense of what it means for something to

12:54

be true what makes a fact a fact what

12:58

knowledge itself is are things true

13:03

because of you know decades and

13:05

centuries of sifting and winnowing

13:07

they're figuring things out of reason

13:10

and evidence or things true just because

13:12

so many

13:13

[Music]

13:15

if I stand in front of my class and I

13:18

sell them give it at the right triangle

13:20

a squared plus B squared equals C

13:21

squared they went here with the second

13:24

theorem you passed the test of young but

13:27

they're also pushed a little bit in the

13:29

direction of knowledge as being about

13:31

Authority and if I'm teaching them to

13:34

unquestioning the movies when I said

13:36

what are they going to do what there is

13:39

a television screen and two candidates

13:41

talking about small business taxes

13:43

tell them two seemingly contradictory

13:45

things they're going to believe whoever

13:48

they see is the authority whoever they

13:50

trust more and maybe not hear your side

13:54

we get lucky take the swing sticks in

13:56

the election or maybe that you're gonna

13:58

do the other side's turn to win either

14:00

way the loser will be cleared our

14:03

democracy which requires people who are

14:06

willing to stand up call out what's true

14:09

and what's not and demand honest answers

14:12

from their politicians and teachers have

14:16

a role to play in creating that electric

14:18

and informed electorate instead of just

14:22

telling people about telling our

14:24

students what the answers are we can

14:26

talk about all the processes the king

14:28

did that came to make that knowledge we

14:31

can put our students in positions where

14:33

they're they discover the same facts

14:36

that we're figuring it out and they

14:37

discovered everything themselves they

14:39

have ownership over that knowledge they

14:41

have intellectual autonomy we can go

14:44

further we can turn our classrooms over

14:46

to our students so that instead of

14:47

answering our questions they're asking

14:50

their own questions and we can guide

14:52

them in

14:54

now I'm far from the first to argue for

14:58

the sort of student-centered teaching

14:59

there are hours of fantastic TED Talks

15:03

out there about how we should

15:04

concentrate on the process more than the

15:07

product we should turn our classes over

15:09

to our students we should leverage their

15:10

leverage their creativity and all the

15:15

educational research suggests that our

15:16

students would be better off if we did

15:18

that they would understand things more

15:19

they would remember things more but I

15:22

think there's no more important

15:23

implication of that that there would be

15:25

better informed citizens and this can't

15:31

stop with teachers and math teachers and

15:34

that's maybe the most important

15:36

connection I want to make for you today

15:37

this has to involve you if it's your kid

15:43

is 4 times 6 equal to 24 what are you

15:48

going to do if you just say yes

15:51

you're pushing that hip a little bit

15:54

more in the direction of thinking of

15:55

knowledge as about authority you have an

15:59

opportunity to push them in the other

16:01

direction you could say how'd you get 24

16:04

can you draw me a picture

16:06

the convinces you that that's right and

16:08

when the questions get harder are they

16:12

going to be just the answer book are you

16:15

Oh being honest really good to know the

16:18

answer if you do you're pushing them in

16:22

that direction if instead you can sit

16:26

next to them and help explore these

16:28

these questions with we do them and when

16:32

that hardware will that work of

16:34

exploration involves going online we

16:37

treat Google like it's some sort of

16:39

vending machine to sort of topic out

16:41

some sort of a piece of candy and

16:42

knowledge you click on the first link in

16:44

believing or able to do the hard work to

16:47

question that - there - questioning

17:15

citizens who don't just accept what's in

17:17

front of them people who are ready to

17:24

not just be workers or consumers people

17:27

who are ready to be active active

17:31

participants in our democracy so I hope

17:35

you join me in treating our students our

17:38

children like the informed citizens we

17:41

need them to be both in terms of what we

17:43

teach and in terms of how we teach

17:45

because the future of our democracy

17:47

might well depend on it

17:51

[Applause]