K-12th Teachers Have Hard Jobs

Joy Chu and Helen Li
Information Visualization and Presentation Final Report

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Project Summary

K-12th teachers have hard jobs. Especially in the United States, they experience high levels of burn-out and stress, leading them to quit their jobs. This has been especially impacted in light of the COVID-19 pandemic [1]. In an effort to educate people from outside the education sector about how difficult K-12th public school teachers' jobs are in the United States, we designed a website with informational visualizations that depict the different ways teachers experience difficulties throughout their careers. This writeup documents our work in building this website.

Project Goals

Our main goal for our project is to convey the overall idea that teachers have hard jobs, specifically to audiences outside of the K-12th education sector. We specifically chose an audience outside of the education sector because we felt that individuals from this population would be most unaware of the plight of K-12th teachers. We also chose this audience because we, ourselves, are not K-12th teachers – as a result, we could probably better empathize with audience members from outside the education sector.

As a result, the interface targets tasks for:

(a) Learning more about US public school teachers' lives in general
(b) **Comparison** of US public school teachers' jobs with other careers and with teachers in other countries
(c) Identifying how US public school teachers might sit at the **extrema** when compared against these other groups
(d) Identifying how the aforementioned factors contribute to **extreme** actions (ie. leaving one's job)
(e) Understanding **correlations** between data points (ie. student: teacher ratio) and the overall difficulty of teachers' jobs

We chose to focus on US public school teachers because this population has the most complete data we could find.

Related Works

This section documents related works to the subject of K-12th teachers in the United States.

MateriALL: Auto-generated Classroom Materials Link

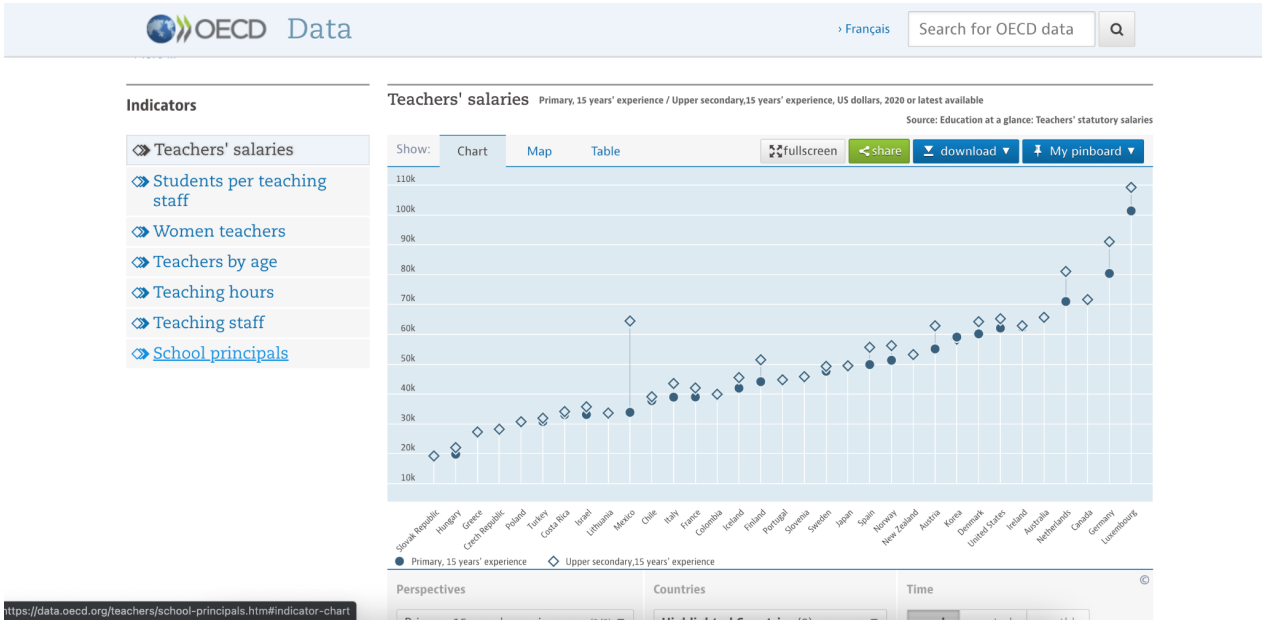
A final capstone project for the 2022 Master of Information Management & Systems program at the School of Information that the authors of this writeup were involved in. The qualitative interviews and survey data used for our website came from the research for this project. While our infoviz project demonstrates how teacher's jobs aren't easy, MateriALL is a potential solution for teachers to ease some of their job-related burdens (specifically, those related to creating classroom materials).

But What About The Teacher? Link

A paper written in Fall 2021 for another School of Information course, HCI Research. The preliminary research conducted for this paper included qualitative interviews with K-12th public school teachers, specifically about technology-based embodied learning (TBEL) tools. Despite having a narrower scope, this research revealed a lot of pain points and difficulties that teachers deal with, which contributed to the motivations for this project.

OECD Data Link

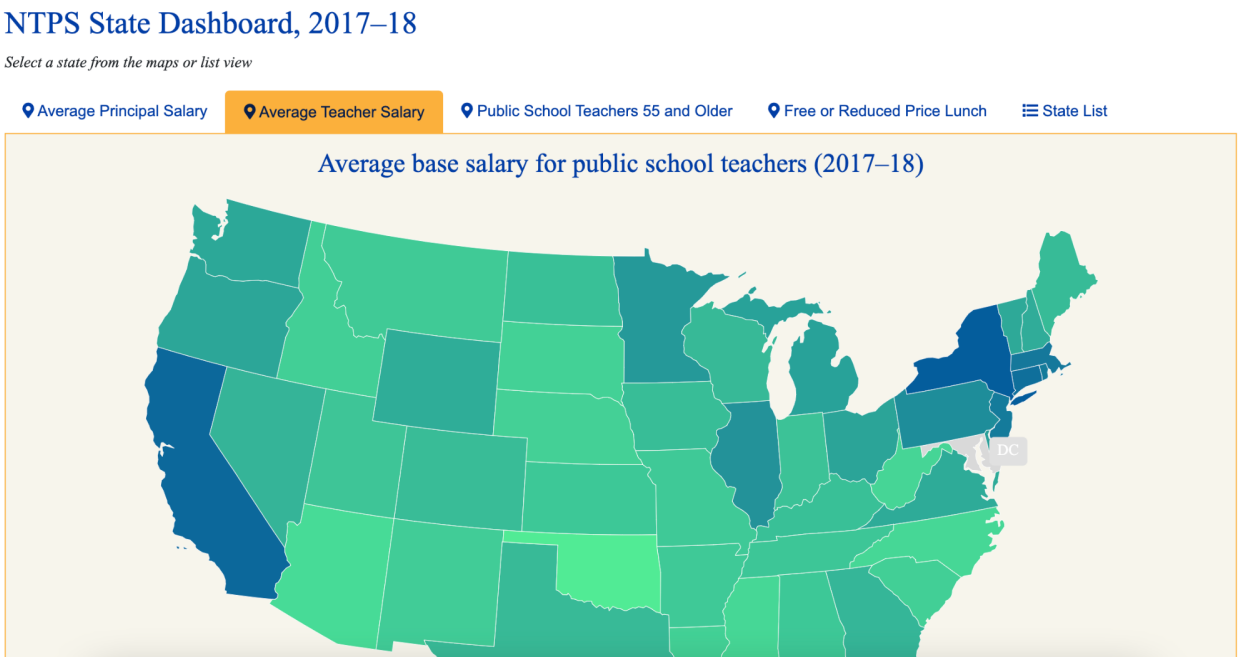
Data compiled about teachers on the international scale, with interactive information visualizations for topics like salary, work hours, etc. This site actually became a primary data source for us because it allows for raw data download. However, unlike our visualization, the OECD database compares teachers' data between countries. It also does not necessarily tell a story in an explicit way like our visualization does.



An example of a visualization on the OECD website

National Center for Education Statistics, National Teacher and Principal Survey Dashboard [Link]

A dashboard visualization for the results of the National Teacher and Principal Survey (NTPS). Data from these surveys were also used in our visualization because the NTPS results are available in their raw format. However, only the 2017-2018 results are available in a dashboard format, and similar to the OECD data, they do not tell a compelling overall story. NTPS survey results also focus partly on principals in the US.



NTPS State Dashboard

The National Education Association Resource Library [Link]

The National Education Association provides a library of online resources for teachers looking for assistance in their jobs and/or advocating for their rights. While this is meant for teachers instead of the general public, it contains a lot of helpful information that gave us a better contextual understanding of how teachers currently deal with their stressful jobs. We provide a link to one of the NEA's petitions in our website as an action item.

News Articles, Reddit Threads, and Other Firsthand Accounts

While we don't have an explicit link for all the firsthand accounts we read from teachers, we found these primary sources the most helpful in developing the story we wanted to tell. When talking about what topics to highlight, we found ourselves most inspired by firsthand accounts from teachers who were interviewed in news articles, posting on Reddit, and even making TikTok videos. Here are just a few examples of these kinds of sources:

- More Texas teachers consider quitting as pandemic wears on
- Today's teacher shortages are part of a longer pattern
- Burned-out teachers are sharing their Great Resignation stories on TikTok

- How Staff Shortages Are Crushing Schools
- Teachers subreddit
- Teacher's Viral Tiktok Recounting Her Day Shows Us Who the Real Heroes Are

Description of Data Used

Unfortunately, due to both the effects of the COVID-19 pandemic and the lack of support around K-12th teachers in general, there are not many sources with complete, recent data. As a result, we combined data sources the best we could, and we also stated this as a limitation on our website.

Bureau of Labor Statistics Occupational Employment and Wage Statistics Link

The Bureau of Labor Statistics, Occupational Employment and Wage Statistics (OEWS) section contains data about different sectors of employment, including education. We used this data for our exploratory data analysis, then waited until later in the year when recent data from 2021 came out. 2021 OEWS data was estimated from 2018 results. Data from the BLS's OEWS tables were especially handy for comparing between states. We used this data for our wage-related plots – the first three plots on our website.

OECD Data Link

The OECD website contains data about teachers at the international level, between different countries, and it allows for raw data download. We used this data for our visualizations that compared statistics between countries, but we filtered for data from developed countries. We did this because we realized that it would be disingenuous to compare a teacher's life in the United States to a teacher's life in a country with fewer resources. By just comparing within developed countries, we could demonstrate how US teachers compare to their counterparts living in similar situations. We used the data related to teacher hours and student-to-teacher ratio.

2015 - 2016 NTPS Survey Results Link

We used survey data, specifically about full-time public school teachers' hours, from the 2015-2016 NTPS survey conducted by the National Center for Education Statistics. This was the most recent survey conducted with this data that was also complete. It was conducted over the majority of US public school teachers at the time. It also focused on just teachers, as opposed to similar studies that also included principals, administrators, etc. We used all the data in this table.

2012 - 2013 Teacher Attrition and Mobility Survey, Follow Up Results Link

We used data from a follow-up survey conducted on teacher attrition and mobility, which focused a lot on how teachers move between jobs within and outside the education sector. Like the NTPS survey, this survey was conducted by the National Center for Education Statistics. It covers both private and public school teachers. We used the data from this survey to inform our final plot about what ex-teachers find better in their new jobs.

Description of Tools Used

To build our individual visualizations, we used a wide variety of tools. For the visualizations that could stand alone as commonplace plots, we used Tableau (ie. comparing work hours between teachers in different countries). We uploaded these plots to Tableau Public and used its sharing functionalities to insert them into our website.

For visualizations that required more interaction or animation (ie. teacher student loans to pay off, per year), we used D3.js for its animation functionalities. We used CSS for styling, to keep these consistent with the other visualizations in our website. We used a combination of inline D3 and inserted Observable notebooks.

For more visual, designed visualizations (ie. student ratio, shown in icons), we used a combination of Figma for our simple isotopes and online resources for more visual graphics. We exported them, then inserted them into our website. Credit for these online resources is included in our website.

To build our website, we used a combination of HTML, CSS, and JavaScript. We used a github.io site to host our work.

Design Process

Once we had defined our main goal for our visualization, we created an outline with the different visualizations, data points, key points, etc. that we'd want to cover in our website. We ordered these in a way that we felt would best tell the start-to-finish journey of a K-12th teacher in the United States, then set to designing the individual visualizations for each point.

In parallel, we also used Figma to create mid and high-fidelity screens of our overall website. Links to these different iterations can be found in our "Helpful Links" section, under "Figma Workspace." We used one of our high fidelity iterations to conduct usability testing, which we felt was appropriate, because we were testing more for our audience's overall education of and engagement with our content rather than individual interactions.

After usability testing, we made any design adjustments before building our website using the tools described in the previous section.

Usability Test Results

We conducted usability testing with the first version of our Figma high-fidelity prototype. The results are documented below.

Introduction

For this usability study, we were testing the effectiveness of a website that uses information visualization to depict why K-12th public school teachers in the United States are experiencing so much stress from their jobs. Specifically, we wanted to test the "story" of our visualization. There is a lot of disparate data on K-12th teachers, which means lots of ways of combining this information to tell a story. Our central research question was "Does this website help viewers better understand how difficult teachers' jobs are?" Therefore, for our research study, we sought to understand how viewers would perceive the overall message of the website, along how effectively each individual plot supported our overall message either implicitly or explicitly.

Method

We used a qualitative, open-ended usability study augmented with pre and post-questionnaires to help us answer our research question. All tests were conducted over Zoom. We used a Figma prototype due to time constraints, so some plots were not as interactive as they would be in the final product. We felt that this method would still be effective, because we were probing more for story meaning and comprehension rather than individual, fine-tuned interactions.

Participants

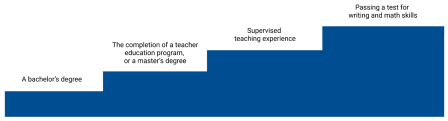
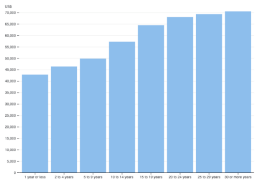
Our target audience of the final website is the general public, especially the people who don't understand or hold bias toward K-12th teachers' jobs. As a result, we recruited three participants from our immediate network accordingly. We made sure to recruit participants who represented a variety of different experiences with K-12th learning in the United States. For example, one participant had received all their K-12th education in the United States, one partially, and a third received the equivalent of their K-12th education totally outside the United States. We also collected demographic information about age because we felt that age could imply when someone received their K-12th education (or equivalent). We felt that these demographics, in combination, would accurately represent a participant's pre-existing experience with the United States K-12th schooling system, without having to ask leading questions. An overview of each individual participants' demographics can be found in the appendix.

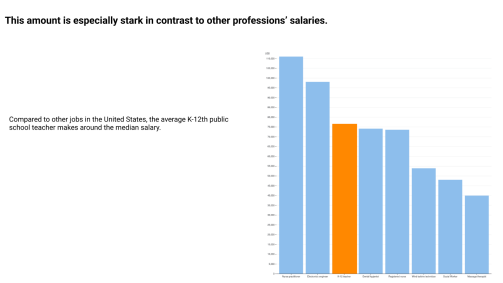
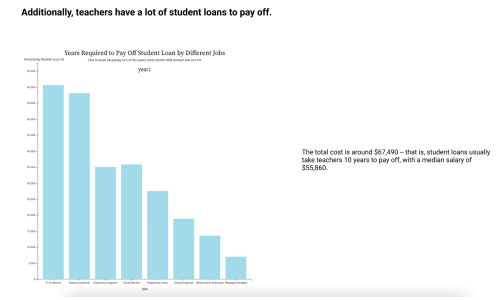
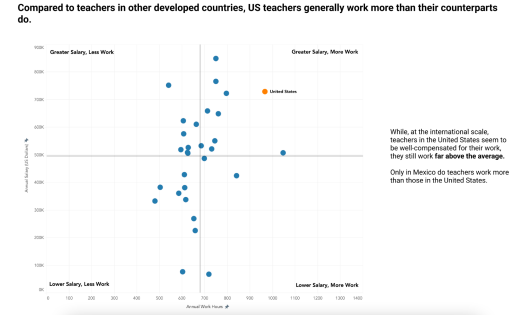
Scenarios/Tasks

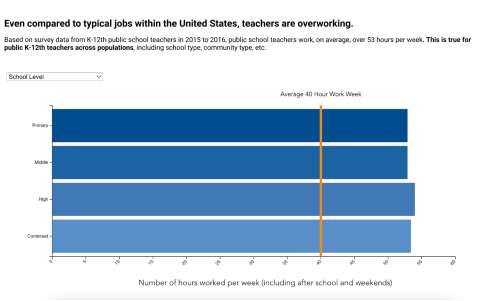
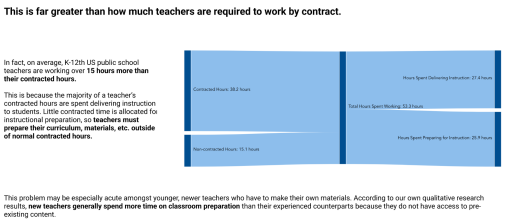
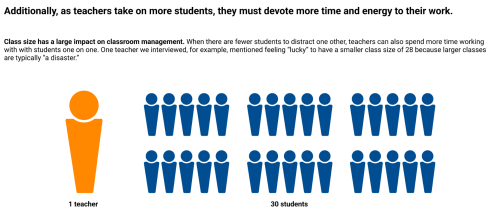
We started by asking participants to fill out the informed consent form, then a pre-test questionnaire. Both can be found in the appendix. The pre-test questionnaire combined demographic questions as well as questions that probed at participants' interest and knowledge of K-12th teachers in the United States.

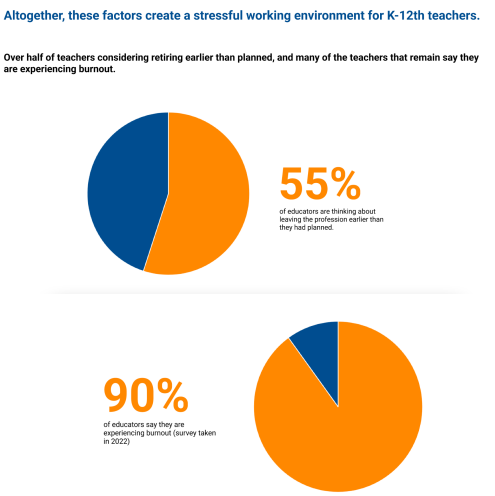
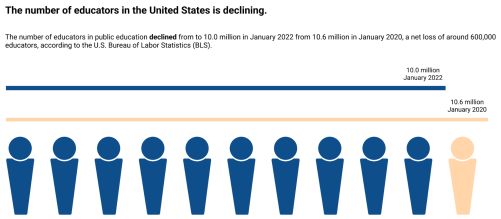
Next, we asked participants to conduct one or two tasks per individual visualization. A breakdown of the tasks that were asked of participants for each visualization is documented in the next page.

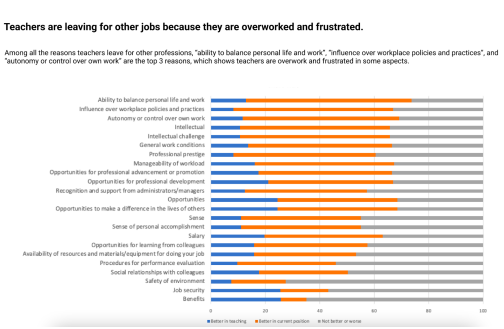
After completing the tasks, we asked participants to give their overall opinions about the webpage. We asked them to consider what they were surprised about, what they wished they could see more of, what information they wish they could know now, etc.
We finished the session by asking participants to fill out a post-test questionnaire.

Plot/Task Name	Screenshot	Participant Prompt(s)	Purpose(s)
Personal Teacher Story	In 2019, Sheena Graham received the Connecticut Teacher of the Year Award. Two years later, in January 2021, she retired five years earlier than she expected to. Her reason? A "**total lack of respect**" for educators, made clear by the effects of the COVID-19 pandemic. Like Sheena, K-12th teachers have been leaving their jobs in droves due to burn-out. While the COVID-19 pandemic brought this topic to the forefront, stress has always been the leading reason for teachers quitting. K-12th public school teachers in the United States have, and always have had, hard jobs. And there's lots of reasons why.	What are your main takeaways from this section? What are you expecting to see in the rest of the website?	To understand how a more personal story might impact people's perceptions at the start.
Many Requirements	**Teachers put in a lot just to make themselves qualified for their jobs.** **Teachers need to meet many requirements before meeting qualifications.** These requirements will usually vary by state, but most K-12th public school teachers in the United States must go through the following steps before they can become full-time teachers. 	What are your main takeaways from this section? How many steps do teachers have to go through to be qualified to teach?	To determine whether the "stair" visualization correctly conveys step-by-step procedure
Average Salary	**However, the average salary that teachers make is not that much.**  The average starting income for K-12th public school teachers in the United States is **$42,800 per year**. This amount will slowly increase with experience gained.	What are your main takeaways from this section? How long would a teacher have to work, on average, to reach over $60,000 per year in income?	To determine readability of bar chart

Average Salary Compared to Other Professions		What are your main takeaways from this section? Which job(s) make more than the average K-12th public school teacher per year?	To determine readability of bar chart
Student Loans		What are your main takeaways from this section? Suppose this section were a gif. What additional information would you expect to see?	To understand what additional information people might be expecting out of the animation
International Comparison Salary vs. Hours		What are your main takeaways from this section? What would you expect to see if you hovered over a blue dot?	To understand what additional information people might want about other countries.

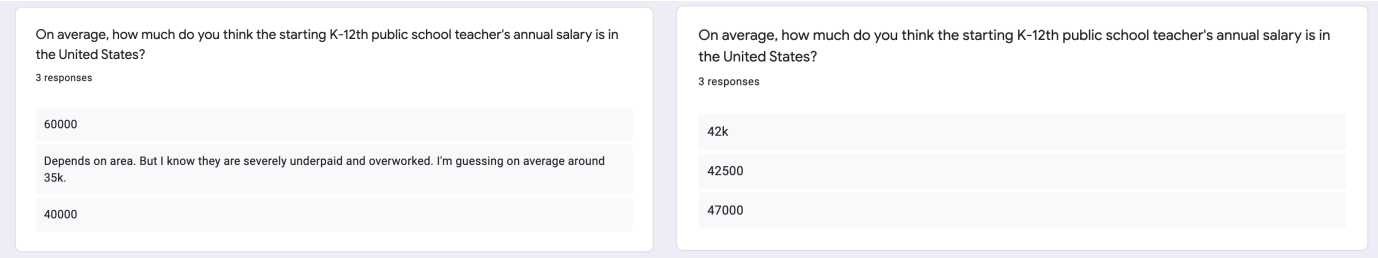
Hours per Week		What are your main takeaways from this section? How might you go about seeing how much teachers in rural schools work?	Usability of dropdown
Breakdown of Hours		What are your main takeaways from this section?	
Students to Teachers		What are your main takeaways from this section? What does the student-to-teacher ratio implicitly mean?	To see whether student-to-teacher ratio is meaningful to people outside the educational sector

Teachers' Current Situation		What are your main takeaways from this section?	
Amount of Teachers Decreased		What are your main takeaways from this section? How many teachers less from 2020 to 2022? How do you feel about the number?	To see if the number with the visualization can make audience realize there's a continuous loss in teachers

Reasons for Leaving		What are your main takeaways from this section? How would you interpret this chart? Is the data sorted?	To see if audience can see the reasons are sorted and whether the chart is easy to understand
Overall		What did you learn? What was surprising to you? What questions do you still have about K-12th teachers? What information did you feel was missing?	To see if the content/story as a whole is effective and complete, and if there's any general feedbacks

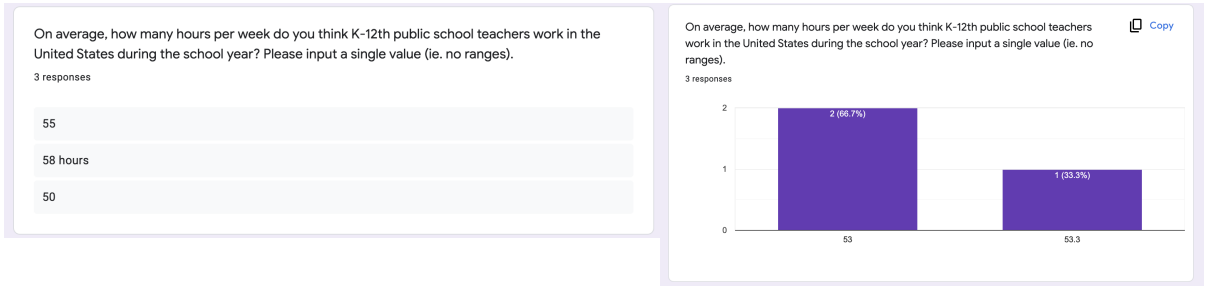
Test Measures

We used results from our pre and post-test questionnaires to measure our success in educating our participants about K-12th teachers. We asked them the same questions before and after the usability session. For example, we asked them how much they thought the starting K-12th public school teacher's annual salary is in the United States.

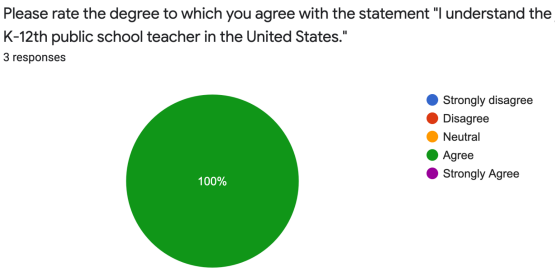


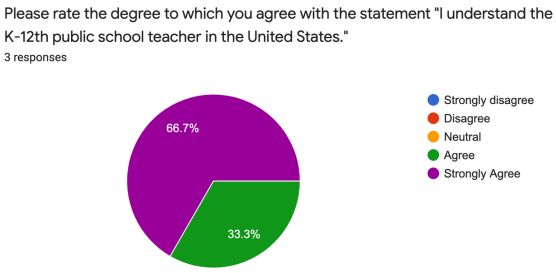
On the left, which depicts responses from the pre-test questionnaire, participants guessed both above and below the correct answer of $42,800. Only one participant was within $10,000 of being correct. On the right, which depicts responses from the post-test questionnaire, participants were closer to the correct answer. All three participants answered within $5,000 of the correct answer.

We also asked participants how many hours they thought K-12th public school teachers worked per week in the United States.



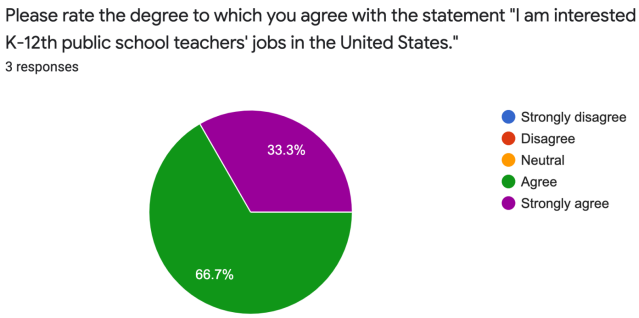
On the left, which depicts responses from the pre-test questionnaire, participants answered fairly close to the correct answer of 53.3 hours. However, as seen on the right, which depicts post-test questionnaire responses, participants were more accurate, with one individual even remembering the correct answer to the tenth. While this is a small sample size, these tests demonstrated that our visualizations had successfully taught participants new, numerical values related to K-12th teaching.
However, we did not feel that just education was enough to validate our design. We also wanted to determine whether participants also subjectively felt more interested in the plight of K-12th teachers after looking at our visualization. We used Likert scale "agree, disagree" questions to probe this. We first probed about pre-existing knowledge.
On the left, which depicts responses from the pre-test questionnaire, all participants responded "agree" to whether they agreed with the statement "I understand the job of a typical K-12th public school teacher in the United States." On the right, which depicts responses from the post-test questionnaire, two participants changed their response to





“strongly agree.” This demonstrates how participants not only were more educated, but also felt more educated about their knowledge of K-12th teachers.

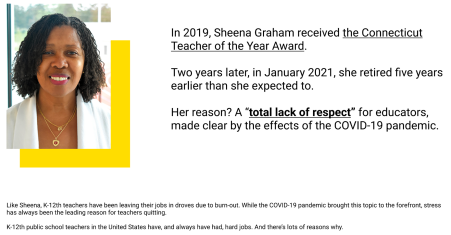
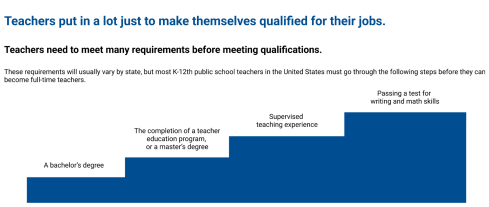
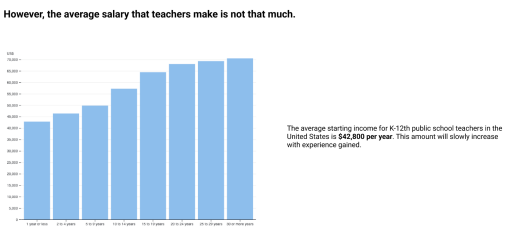
We also probed participants about their interest in K-12th teachers.

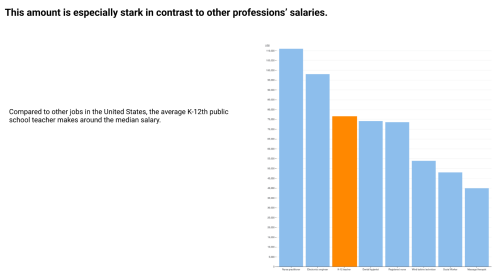


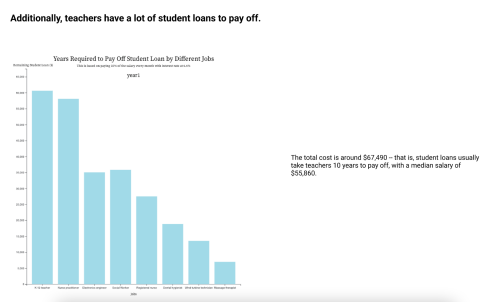
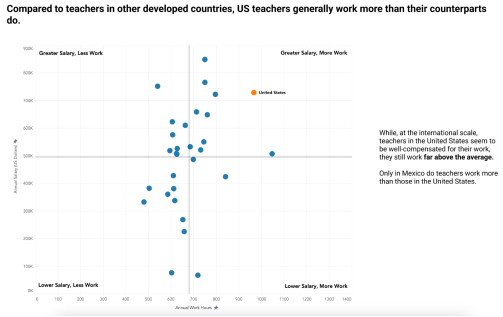
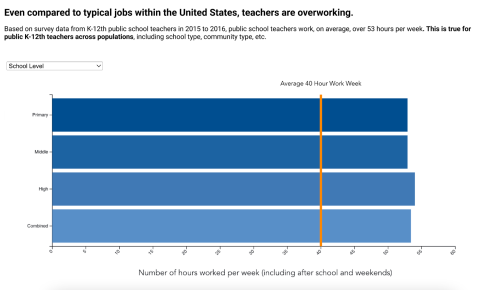
However, there was no change in sentiment about this statement between participants, which is why only one pie chart is shown. We did notably already start out with participants who exhibited interest in the state of K-12th public school teachers’ jobs, which may have been why we did not see a change in self-reported interest between tests.

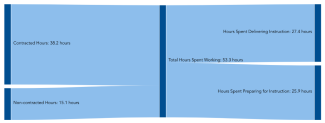
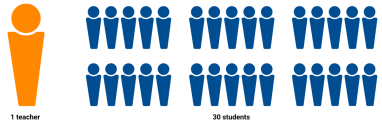
To measure more fine-grained usability details and the success of our visualization, we considered how successful participants were at conducting specific tasks for the majority of our plots (see above). In addition to success, we also considered the amount of time participants spent completing the task as well as any questions, concerns, etc. they voiced through the think-aloud process. Documentation of these observations, in addition to changes we plan on implementing based on their interpretation, are documented in the next section.

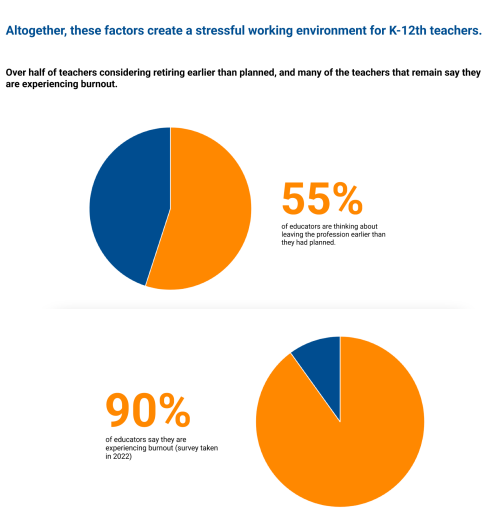
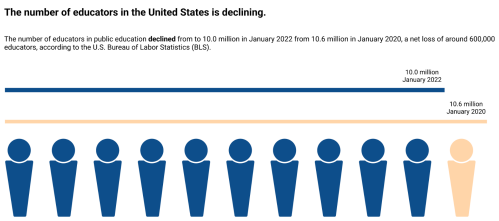
Results and Discussion

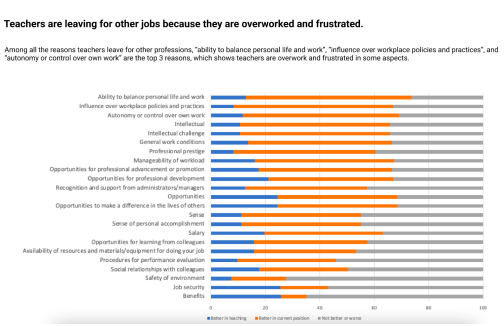
Plot/Task Name	Screenshot	Results & Discussion
Personal Teacher Story		All participants had no difficulty understanding the story and the issues — teachers are not happy at work and thus are leaving the job, especially during COVID-19 — we try to bring up. In addition, the story had successfully engaged the participants in wanting to learn more, including the reasons behind, current situation, differences among states, and potential solutions. Based on the results, we evaluated this "personal story" as effective enough, and doesn't need too much adjustment.
Many Requirements		All of the participants successfully got the idea of the "steps" required to become a teacher. However, the visualization made it a bit confusing, as some of the participants said it looked like a bar chart at first, and some steps seemed taller than the others. Furthermore, they would like to see how long, effort, and money each step required, and thus could make better judgment on if the requirements are reasonable. We will adjust this part into an arrow-like visual artifact with the length of each step indicating the years each step takes, and fee/tuition in text labels. This change should avoid the confusion the previous artifact brought.
Average Salary		All of the participants understood the information delivered by the plot, although some improvements could be done to improve the readability. For example, a participant was reconfirming to himself the salary is annual salary while thinking out loud, and another participant was reconfirming to herself that the x axis meant the years of experience

		instead of age. Adding more explicit text labels to the x and y-axes should avoid these confusions. In addition, this plot left an impression to them that the growth of the salary with experience is not steep enough. According to a participant, “It doesn’t seem rewarding at all.” We might consider adding the growth rate if there’s a way to add it without making the plot too complicated.
Average Salary Compared to Other Professions		All of the participants understood the idea of the bar chart, however, the message delivered seemed not straightforward. When compared with other occupations, participants were not sure whether it was indicating that K-12th teachers’ salary is good or not, as it seemed not the best but also not the worst. In addition, participants said they weren’t sure how to compare because they are not sure what are the requirements (efforts, time, money, etc.) for other occupations. Based on the results from the test, we have some ideas for improvements. The first is to only compare the jobs that require the same level of degree, time, and money, and explicitly indicate it. In addition, we were considering making a chart to show the annual salary comparison, and then switch (interaction) to salary per hour comparison to highlight that although K-12th teachers’ salary seem not the worst (it’s around the median amount of all occupations in the U.S.), it’s a lot worse when considered the total working hours. Furthermore, we will adjust the size of the labels and put all the text explanations in the left and graphs in the right to make it easier to read, (also apply to other plots).

Student Loans		Although this chart on the testing Figma is not with animation as the final version should be, all of the participants still could get the concept really quickly, and imagined what it would look like with the animation. Some improvements to be made are 1) adding the average salaries for each occupation, and make it clear if it's the starting salary or what other basis, 2) making the "year x" label bigger, 3) have a final view of how long each occupation needs to take to pay off the student loans in case viewers miss something during the animation, and 4) extracting the wording part in the plot to the text area to separate the texts and graph more clearly to make it easier to read.
International Comparison Salary vs. Hours		All participants were able to identify the United States as an outlier on this graph and interpret it, thanks to its dot's bright color and the labeled quadrants. Participants understood that US teachers work a lot. However, the additional information about payment was not as meaningful to participants. They wondered whether cost of living also affected teachers' pay, and how pay was related to work hours. We will improve this plot by eliminating the salary metric of the visualization and focusing more on hours.
Hours per Week		Although this plot was not interactive/animated, all participants successfully identified the dropdown as the main interaction point with which they could change filters on the visualization However, participants did show confusion with the label inside the dropdown because it insinuated that "School Level" is the least fine-grain filter. We will change the initial starting label on this dropdown to convey to users that "school level" is just one of many types of filters they can use.

Breakdown of Hours	**This is far greater than how much teachers are required to work by contract.** In fact, on average, K-12th US public school teachers are working over **15 hours more than their contracted hours.** This is because the majority of a teacher's contracted hours are spent delivering instruction to students. Little contracted time is allocated for instructional preparation, so **teachers must prepare their curriculum, materials, etc. outside of normal contracted hours.**  This problem may be especially acute amongst younger, newer teachers who have to make their own materials. According to our own qualitative research results, **new teachers generally spend more time on classroom preparation** than their experienced counterparts because they do not have access to pre-existing content.	This plot caused a lot of confusion amongst participants, as they needed to spend a lot of time to decipher its meaning. Participants were confused with the middle bar on the Sankey diagram. We will improve this visualization by eliminating the middle rectangle and adding more curvature to the links in the diagram.
Students to Teachers	**Additionally, as teachers take on more students, they must devote more time and energy to their work.** **Class size has a large impact on classroom management.** When there are fewer students to distract one other, teachers can also spend more time working with with students one on one. One teacher we interviewed, for example, mentioned feeling "lucky" to have a smaller class size of 28 because larger classes are typically "a disaster."  	This plot was quite effective to participants. They all effectively relayed back to us the importance of school-to-teacher ratio, and many exhibited surprise at the size of a 30-student classroom. However, we still believe there are improvements to be made. We will add more visual indicators for suggested class size so that users have something to compare against, and we will also use visual cues to indicate the impact of COVID on student-to-teacher ratio.

Teachers' Current Situation		Based on the test results, this part is quite effective and left participants with a strong impression that the current situation is very severe. There's no significant change to make here, but we will make the wording clearer. For example, one participant wasn't sure if leaving the job earlier than planned was retiring or quitting the job.
Amount of Teachers Decreased		Although all the participants got the idea that the amount of K-12th teachers decreased from 2020 to 2022 and by how many, the visualization might not be intuitive enough. First of all, as people usually read from top to bottom, they will read 2022's data first and then to 2020's. As a result, the timeline is reversed and the number increases in that order. We will thus have two layers of the icons, and display 2020's data first then to 2022's data. On the other hand, participants said they would like to also see the amount of students to have a better understanding of the situation and make better judgment whether the gap is large or not. Meanwhile, participants mentioned this visualization was powerful combining the teacher-to-student ratio they just saw.

Reasons for Leaving		This part took participants longer to fully understand the messages behind due to both the amount of the content and the way it was shown. Based on the feedbacks, we will adjust 1) the wording part to make it clear what each color represents, 2) the bar to make it showing only the percentages of "teaching" and "the new job after leaving teaching" to make the comparison more straightforward, and 3) the number of reasons shown by taking off some least important reasons, as currently there are more than 10 reasons and may make it hard for readers to comprehend all of them.
Overall		Overall feedback on our prototype was positive, as participants all felt the importance of this topic, learned some facts they didn't know before, and would like to see more information regarding this issue. A participant mentioned he/she would like to see some comparison among states, which we are still evaluating whether it will be good to include the information as we also want to focus on certain areas. Some overall improvements include the consistency of all the plots in style and figures, augmenting readability by adjusting the style, and providing more resources or action plan at the end of the page. We will also improve readability by having all paragraph text be on the left of the visualizations, as this came up with one of our participants.

We used the findings from our usability tests to inform our final iteration/submission. This is documented in detail in the next section

Final Website Description

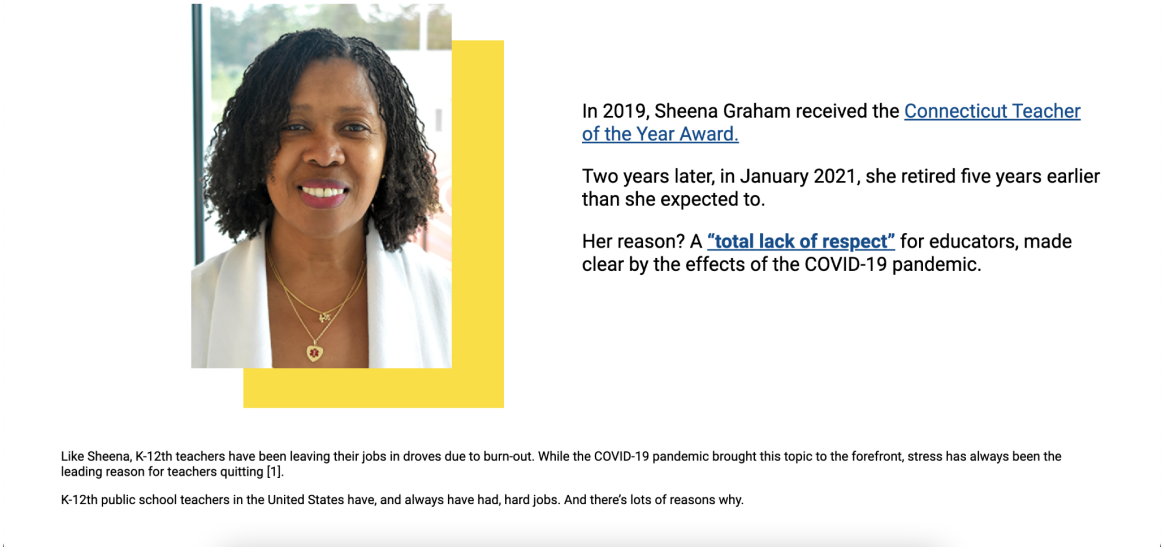
Our final website, "K-12th Teachers Have Hard Jobs," is a single-page website dedicated to educating audiences from outside the education sector about the difficulties that public K-12th teachers face in the United States. We use a storytelling approach for our website and break up our story into three main sections:

(a) Before the teacher enters employment
(b) While the teacher is employed
(c) After the teacher leaves employment

We use this chronological ordering to tell a compelling story about how K-12th public school teachers' difficulties from past, present, and future may combine to demonstrate the obstacles they face in their careers. In these next sub-sections, we will dive deeper into the different parts and visualizations of our website.

Sheena Graham's Story

Because we, as authors, are not K-12th teachers, we thought it would be more grounding to the audience to begin with an individual person's perspective. We presented the story of Sheena Graham, who was an excellent teacher who eventually left her profession early, to root the audience in a personal narrative before jumping into statistics and visualizations.

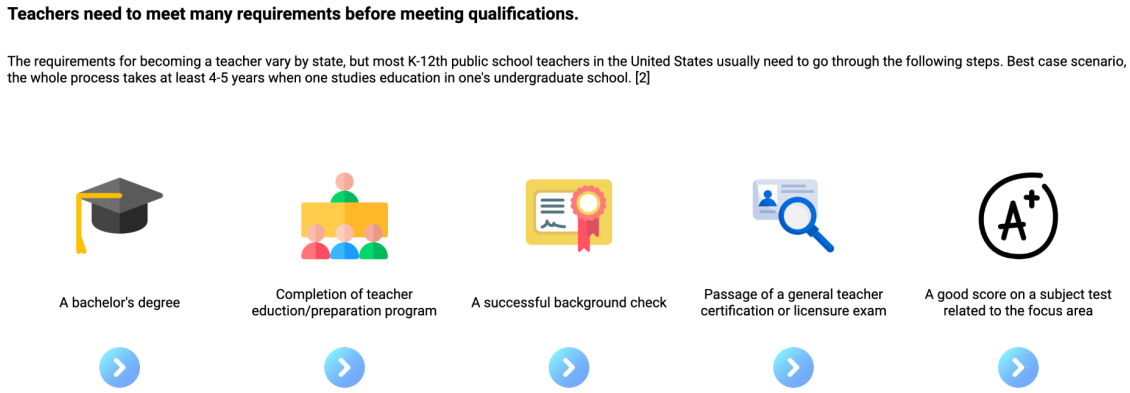


Sheena Graham's section on our website, with a picture of her and a few sentences about her story

We used a picture of Sheena Graham to create a more personal, humanized beginning to our website. Based on usability testing, audience members were often confused whether this story was "real," so we also included links to news articles within the text for users to confirm this story themselves.

Teacher Qualifications

Our next section introduces the different requirements teachers need to go through to meet qualifications. We use graphics, text, and icons to indicate these steps as they correlate to passage of time. This section aims to convey to the audience that teachers actually invest a lot of their time and efforts into their qualifications. There is not a simple route to becoming a teacher.



The different qualifications teachers need to meet, as conveyed with graphics, text, and icons

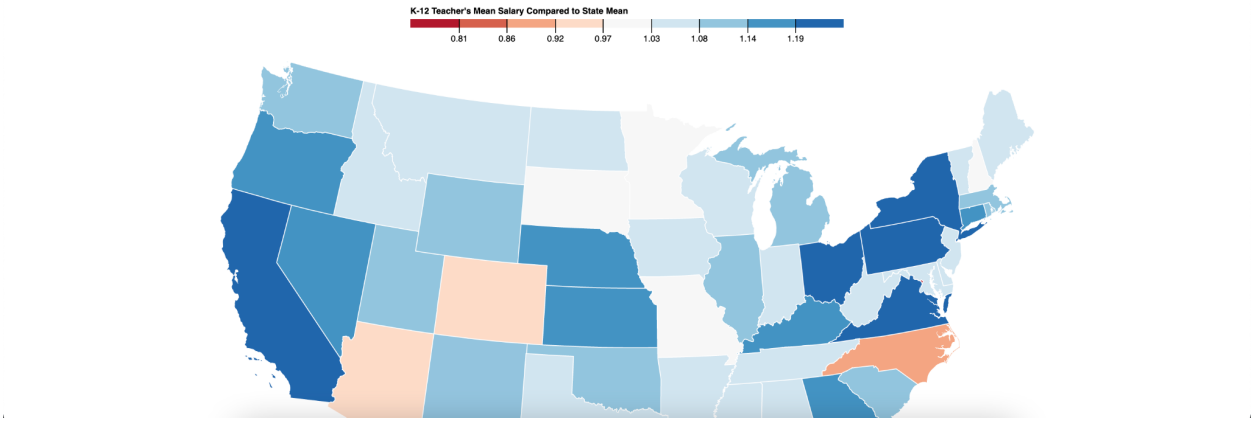
Some users during usability testing were confused with our initial visualization, and they also wanted to understand more about how much time was spent on each step. However, based on our own research, this can vary quite a bit across states. Therefore, we changed our visualization from the original “steps” idea to the graphics and icons, and we instead used a bit more detailed text to bring specifics into this section

Average Salary Between States

Our next section compares US states’ average salary of teachers to that state’s average mean. It uses a chloropleth with a color scale legend to indicate the mean teacher salary’s difference from the state’s mean.

However, the average salary that teachers make is not that much.

The average annual salary for K-12 teachers is **$64,336** among all states. Compared to the mean for all occupations in each state, in most of the states, K-12 teacher's mean salary is close to the mean for all (in the range of -10% and 10%), with some states a bit lower or higher. [3]

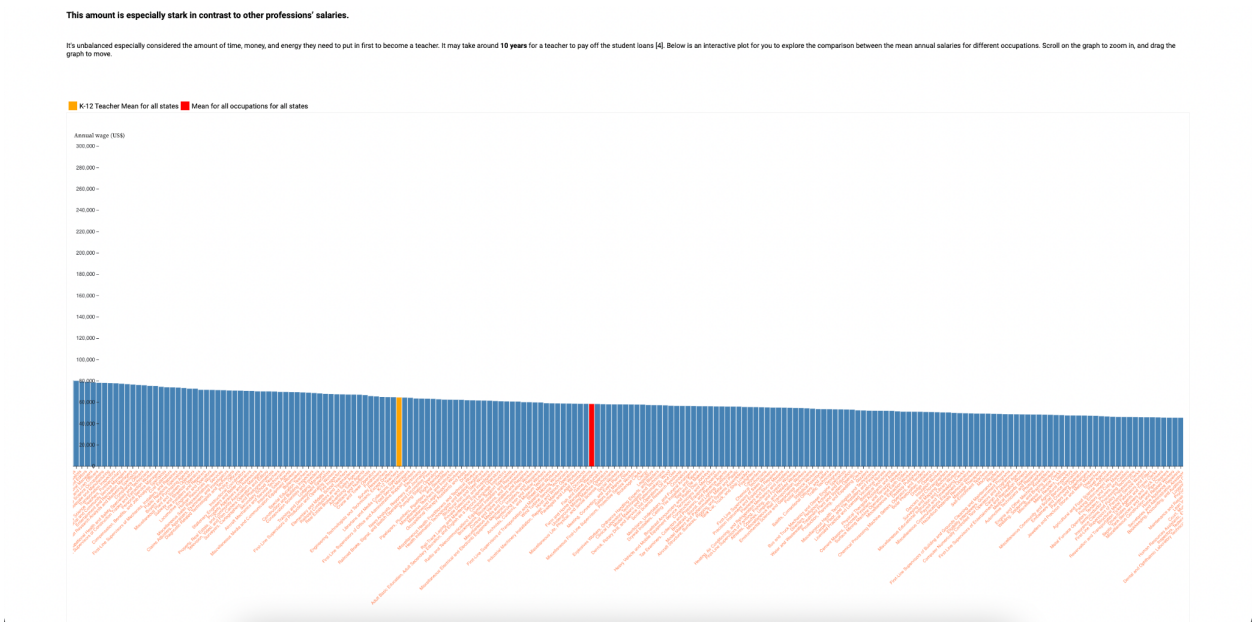


A chloropleth demonstrating how states' teacher salaries compare to that state's mean salary

This visualization changed quite a bit from the one we user-tested. Initially, we were comparing the difference in income between a first year teacher and a more experienced teacher using a bar chart. However, this was not meaningful to our audience, and many of our participants expressed more of a desire to consider salary in a way that was relevant to their own lived experiences – in other words, cost of living. We didn't want to just focus on one state, though, since California (our state) is very different from other states' statistics. Therefore, we used a chloropleth

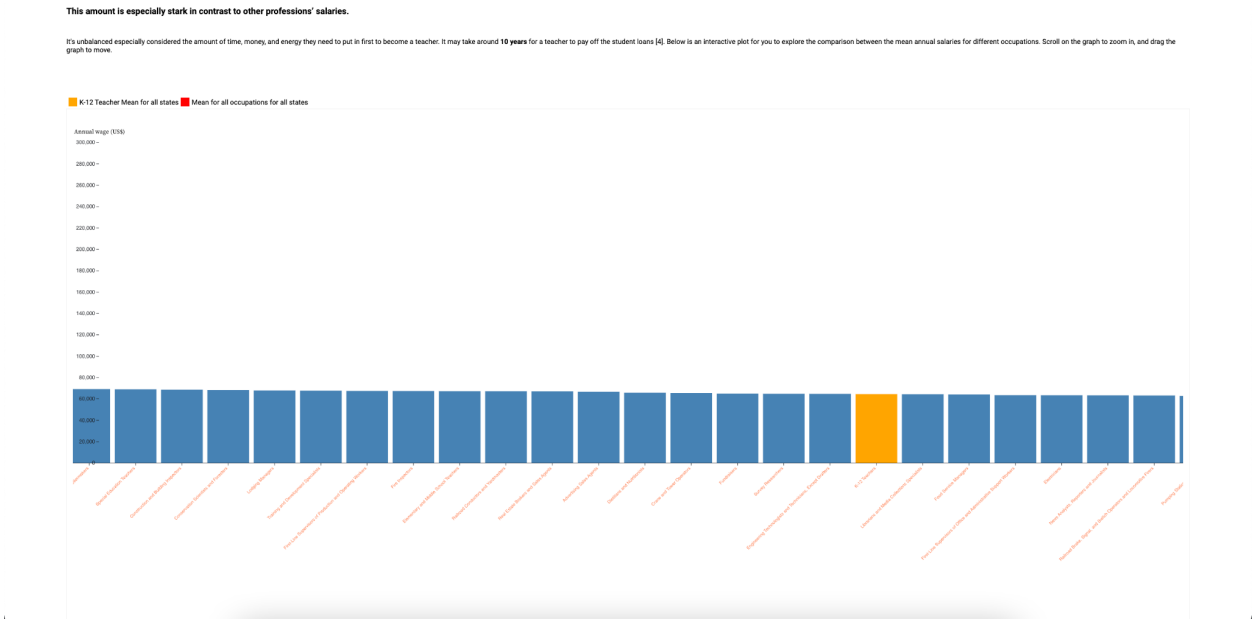
Teacher Salaries vs. Other Professions'

We then use visualization to compare US teachers' mean salary to other professions' salaries. Our visualization starts out with a large bar chart with the US teachers' mean salary and the US's overall mean salary highlighted with color.



Our large bar chart comparing teacher salary with other professions' salaries

Upon zooming in and interacting with one's mouse, a user can see the individual titles for all the professions as they relate to salary.



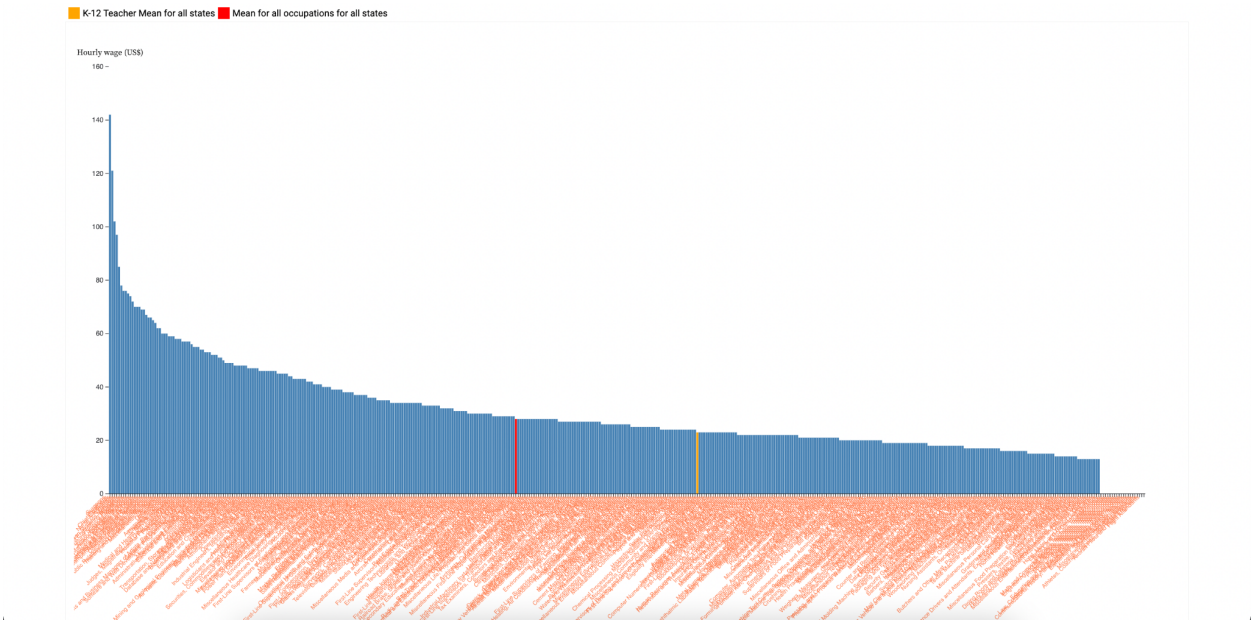
Our large bar chart, zoomed in

Our original visualization for this was a much smaller bar chart with just a few professions included. However, we personally felt that this was disingenuous because we weren't sure which professions could justifiably be comparable to a teacher's work. Additionally, our users didn't feel particularly connected to any of the professions that were included in the chart.

Therefore, we used a larger bar chart to incorporate more occupations, and to better visualize where teachers actually sit in comparison to all occupations in the nation.

Teachers' Hourly Wages vs. Other Professions'

However, we still felt that the previous visualization could use more nuance, especially considering the fact that teachers work long, difficult hours. Therefore, our next section includes a similar bar chart, this time broken down by hourly pay rather than overall salary. While teachers in the previous visualization were above average, they now sit below average when their salary is broken down into their hourly wages.

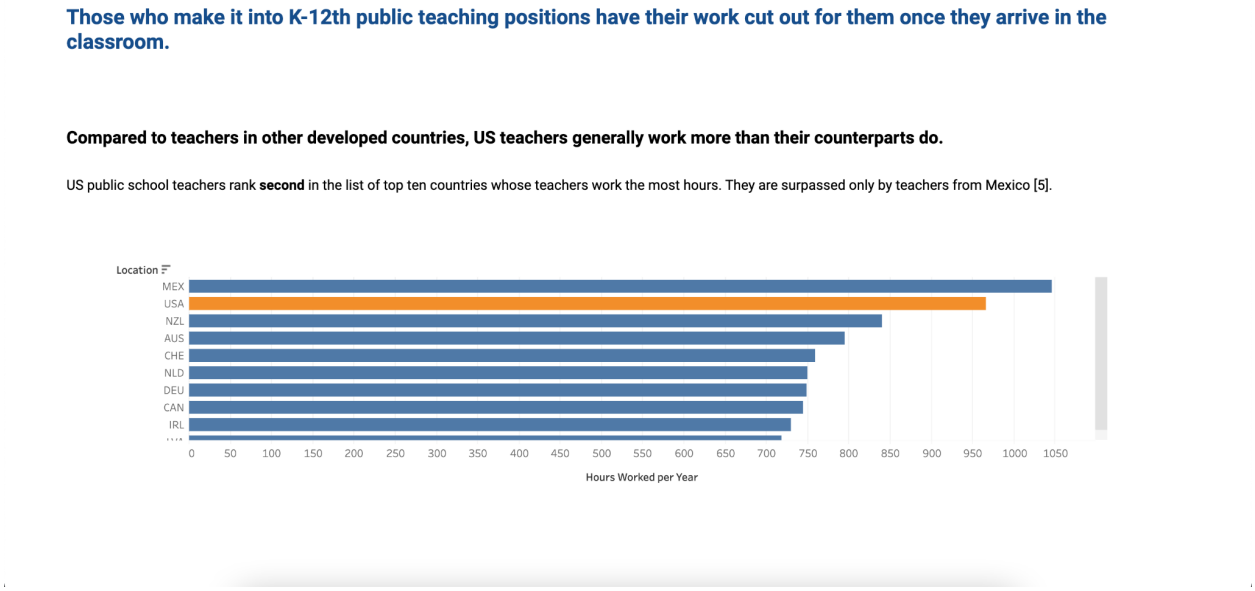


Hourly wage across professions in the US, with teachers' highlighted with color

We thought this visualization was especially important to include alongside the previous section.

US Teacher Work Hours vs. Other Countries

The previous section provides a nice segue into our next section, which covers now just work hours. For this section, we decided it would be interesting to compare teacher hours across different developed countries. We use a bar chart with the US teachers' hourly work highlighted with color.



A bar chart of teachers' work hours, compared across different countries

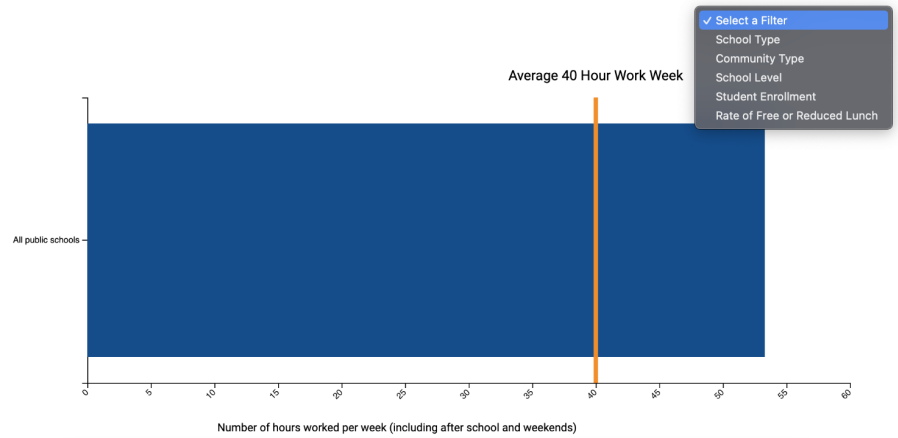
We decided to stick with just a simple bar chart because in our usability testing, which visualized both hours and wages at the same time for teachers in different countries, the extremes that US teachers experience was not very apparent. The bar chart visualizes how the US sits at second for most hours worked per year for teachers. Additionally, it nicely visualizes the distance between US and the next nation.

Teacher Hours, Broken Down

We next break down the hours that teachers in the US work, first by teacher population. We use an interactive drop down and a bar chart with the 40 hour work week highlighted on the x-axis. Users can use the drop down to see how much different subsets of teachers work per week. The catch is that no matter what subset they choose, teachers will always consistently work above 40 hours per week.

Even compared to typical jobs within the United States, teachers are overworking.

Based on survey data from K-12th public school teachers in 2015 to 2016, public school teachers work, on average, over 53 hours per week. **This is true for public K-12th teachers across populations, including school type, community type, etc.** Use the dropdown to explore how different breakdowns of teacher still reveal this trend.



How much different subsets of teachers work per week, with the dropdown toggled open

We made this visualization interactive in order to facilitate the act of discovery. This way, users can try to look for something that will never exist: a subset of teachers who perhaps work at or below the 40 hour work week. Through this interaction, we can better convey how all teachers are overworked, even when filtered for things like region, school level, etc.

Contracted vs. Non-Contracted Hours

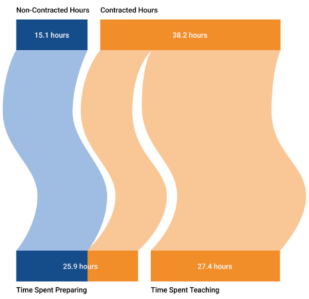
In our next section, we explain why teachers need to work so many hours, even ones that they're not required to work. We use an up-down Sankey diagram with color to demonstrate how a teacher's contracted and non-contracted hours are distributed between instruction and preparation. A notable amount of non-contracted time is devoted to classroom preparation. We augment this with text that uses some qualitative research we conducted to explain why so much time must be devoted to preparation.

This is far greater than how much teachers are required to work by contract.

In fact, on average, K-12th US public school teachers are working over **15 hours more than** their contracted hours [6].

This is because the majority of a teacher's contracted hours are spent delivering instruction to students. Little contracted time is allocated for instructional preparation, so **teachers must prepare their curriculum, materials, etc. outside of normal contracted hours.**

This problem may be especially acute amongst younger, newer teachers who have to make their own materials. According to our own qualitative research results, new teachers generally spend more time on classroom preparation than their experienced counterparts because they do not have access to pre-existing content [7].

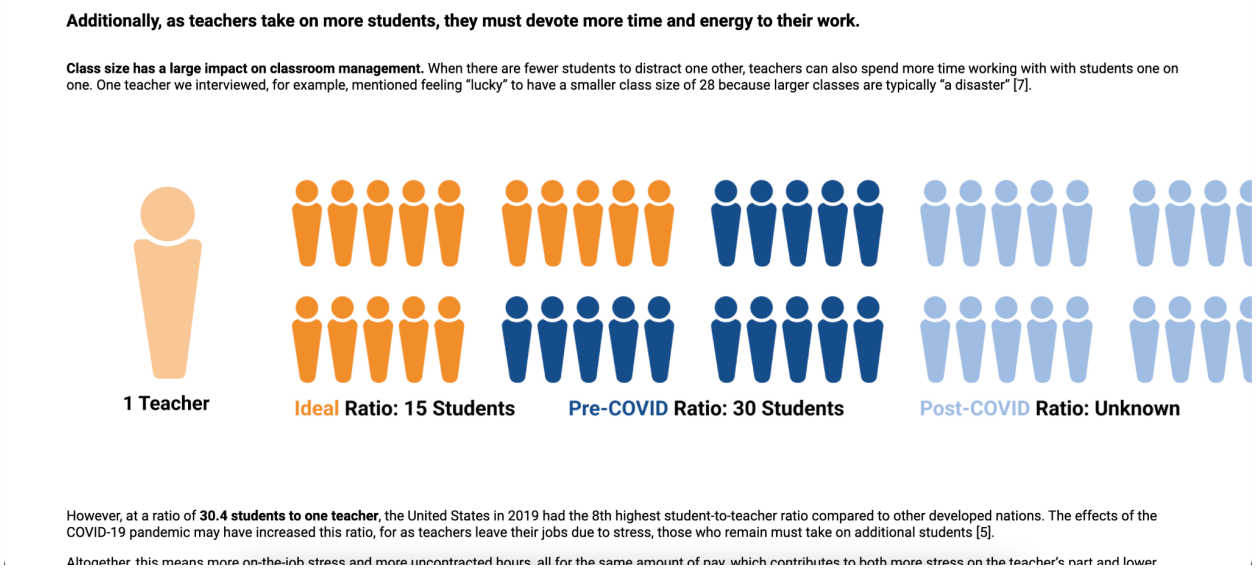


An up-down Sankey Diagram demonstrating the breakdown of teachers' contracted and non-contracted hours

We included this because we wanted to give our audience a reason *why* teachers have to spend so much extra time on their work. We believe that this may especially be surprising to users who assume that teachers spend the majority of their time teaching.

Student: Teacher Ratio

We next use isotopes to demonstrate student: teacher ratio. First, though, we use text to explain why student: teacher ratio impacts classroom management and, therefore, teachers lives. We then use isotopes to indicate what an optimal ratio is, what the ratio was in the US when survey results were collected, and how COVID might have even impacted this ratio further. For COVID results, the isotopes purposefully run off the screen to convey both an unknown value and, therefore, the possible exponential growth in ratio.

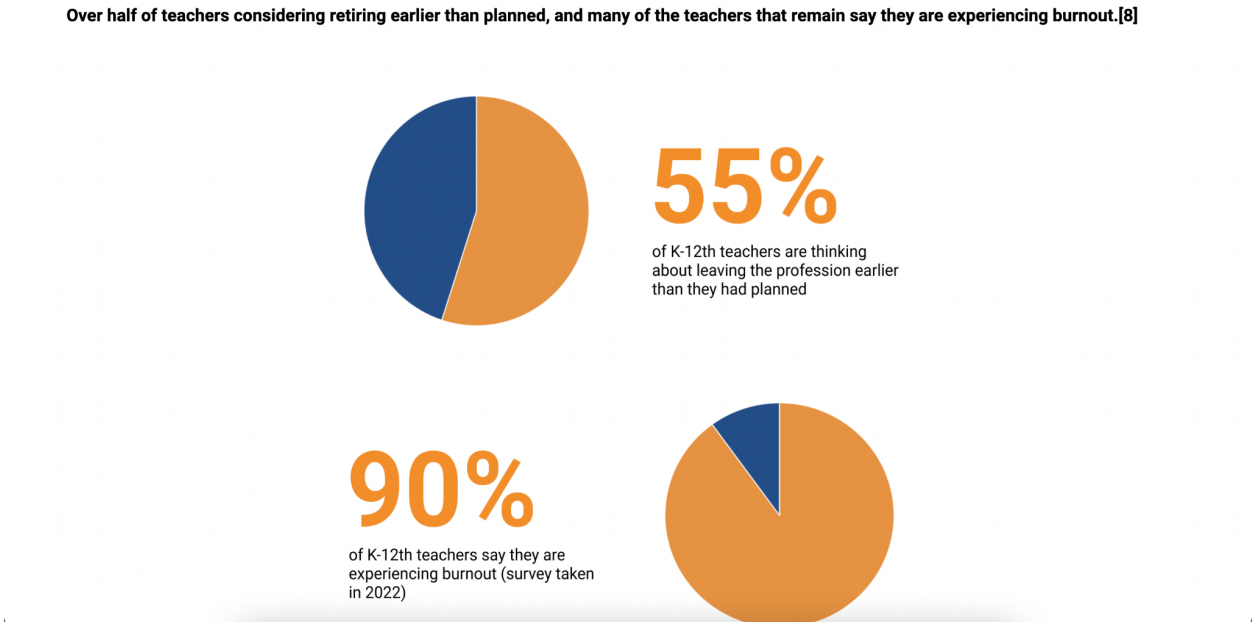


Isotopes denoting different ratios, with post-COVID isotopes running off screen

While usability testing revealed that users understood this visualization well, we felt that the use of isotopes could be iterated on to also indicate where the ratio would *ideally* be. Our original visualization also did not convey the ambiguity of post-COVID calculations as well, which we wanted to include in our final submission.

Teacher Burnout

We next move onto what happens when teachers leave their jobs, starting with feelings of burnout and frustration. Despite the range of opinions that exist regarding pie charts, we felt that it would be prudent to include a pie chart in this section because (a) we are only comparing two parts of a whole, and (b) we include the numerical values in large font as well to ease any confusion. This section includes two pie charts, one indicating what percentage of teachers are thinking of leaving their profession, and another how many teachers are experiencing burnout.

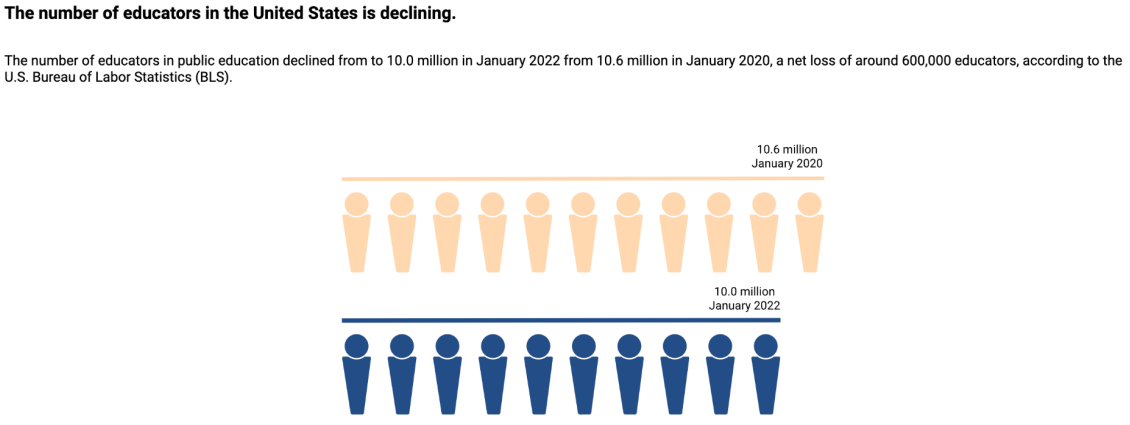


Two pie charts with their corresponding percentages next to them, showing teachers thinking of leaving and teachers experiencing burnout

These visualizations had positive feedback, even from participants who had prior experience in information visualization. Thus, we felt that our use of pie charts was valid and decided to keep them largely unchanged.

Declining Number of Teachers

We next showed how the number of teachers was declining, again using isotopes. We use two rows of isotopes, one representing the number of teachers in 2020, and then another row representing the number of teachers in 2022. This goes from top down, and the figures from 2020 are also a lighter orange, all to signify the passage of time, which caused confusion in earlier iterations during usability testing.

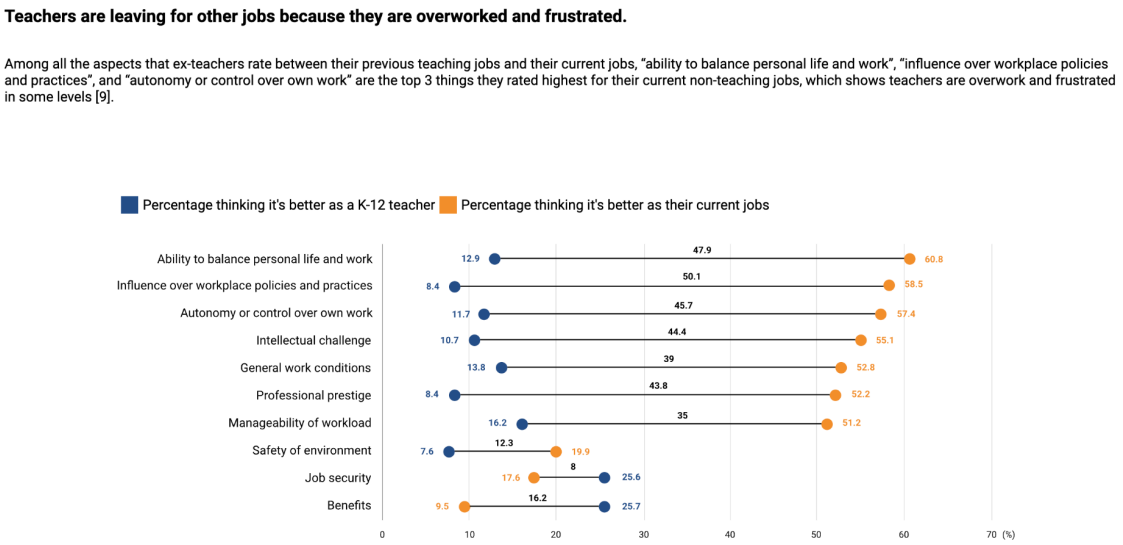


The decline of the teacher population, shown with isotopes

Usability testing results largely informed how we iterated on this visualization. We use now a second row of isotopes and also go from top-down rather than bottom-up to indicate the passage of time.

Reasons for Leaving

We wanted to end with very clear reasons why teachers were living. We used a connected dot plot indicating the different “benefits” of jobs, comparing how many ex-teachers thought these benefits were better at their teaching positions, and how many ex-teachers thought these benefits are now better at their current jobs. We elected only to include the values that were job-related and that had a large difference between the two aforementioned populations. We did not include marks for users who thought that these benefits were similar before and after their teaching positions.



A connected dot plot indicating ex-teachers’ experiences of benefits during and after their teaching experiences

Our usability tests revealed to us what values were meaningful to users, and why. This helped us cut out certain parts of the raw data.

Calls to Action

We ended our website with different calls to action. They are ordered in least personal to most personal, with the least personal call to action being signing a petition, the middle being donating to a school district, and the most personal being recommending a tool (our capstone project) to a teacher friend.

always have had, hard jobs, for a vast number of reasons related to financial impact, job stresses, and more. These create feelings of burnout for teachers and, eventually, make them leave their jobs.

We need to do more to improve the working conditions for K-12th teachers.

How can you help?

Contact your local representative

Urge them to support the Public Service Freedom to Negotiate Act.

Link

Donate to your school district

Many school districts, like the Oakland Unified School District, accept donations online

Link

Tell your teachers about MateriALL

MateriALL is a free tool that helps automate the lesson-planning process for teachers.

Link

Different calls to action, with relevant links, at the end of our website

We decided to add this section because, during usability testing, one of our participants wanted to know what to do next and had expected to do something with their newfound knowledge. We decided to use calls to action that had a wide range of personal requirements, to address the needs of users who may or may not have gotten a lot out of our visualization.

Helpful Links

Final Website

GitHub Repository

Figma Workspace

Team Contribution Breakdown

Project Phase	Task	Joy	Helen
Initial Ideation	Project Proposal	50%	50%
	Gathering Data	50%	50%
	EDA	50%	50%
Visualizations	Teacher Qualifications	90%	10%
	Teacher Salary across States	90%	10%
	Teacher Salary vs. Other Professions' (Income)	90%	10%
	Teacher Salary vs. Other Professions' (Hourly)	90%	10%
	Teacher Work Hours across Countries	10%	90%
	Breakdown of Work Hours amongst Teachers	10%	90%
	Contracted vs. Un-Contracted Hours	10%	90%
	Teacher: Student Ratio	10%	90%
	Teacher Burnout Pie Charts	90%	10%
	Educators Leaving Jobs	90%	10%
	Teachers' Reasons for Leaving	90%	10%
Website Design	Mid-Fidelity Mockup	25%	75%
	First High-Fidelity Mockup	25%	75%

Usability Testing	Testing Script and Plan	25%	75%
	Conducting Sessions	50%	50%
	Synthesizing Findings	50%	50%
	Writeup	50%	50%
Final Submission	Coding Website	75%	25%
	Writeup	25%	75%

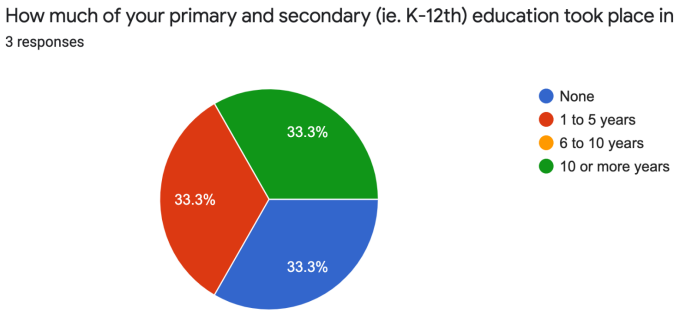
Works Cited

[1] Diliberti, Melissa Kay & Schwartz, Heather L. (2021). Stress Was Leading Reason Teachers Quit Before Pandemic, and COVID-19 Has Made Matters Worse. https://www.rand.org/news/press/2021/02/22.html

Appendix

Participant Demographics for Usability Testing

Our participants consisted of two 25 year-olds and one 30 year-old. Based on our pre-test questionnaire, one of our participants did not complete any of their primary/secondary education in the United States, one completed 1-5 years in the United States, and another completed 10 or more years in the United States. For a larger study, we would ask for the actual number of years.



We elected not to ask for further demographic information, simply because we knew we would have a small sample size, and we wanted to keep our entire usability session within 30 minutes.

Informed Consent Form for Usability Testing

Viewable Link

We asked all participants to fill out this form prior to beginning video recording

Pre-Test Questionnaire

Viewable Link

We asked participants to fill out this form after receiving their informed consent. It includes demographic questions and questions about their experience with K-12th education in the United States.

Post-Test Questionnaire

Viewable Link

We asked participants to fill out this form after they completed the tasks for the website. Its questions are the same as those on the pre-test asking about K-12th education. In the future, we would like to change our questions a bit between pre and post-tests to make sure we were not priming our participants to find the correct answers after their pre-test.

Usability Test Script

Intro

Hello, my name is [Session Leader Name], and this is my project partner [Note Taker Name], who will be joining us for note-taking purposes. Thank you for joining us today. Before we begin, we'd like to ask you to fill out this informed consent form. Participation in our session today is completely voluntary.

[Send link to form in Zoom chat]

Thank you! Now, to start, I'd like to ask you to first fill out this pre-test questionnaire. Please fill it out to the best of your ability, and do not use the Internet or any other sources to answer the questions.

[Send link to questionnaire in Zoom chat]

Thank you! We will now begin the usability test portion of this session. We are testing the effectiveness of this design, not you. There are no wrong answers to any of our questions, and your honest feedback will be most valuable.

Throughout this session, I will ask you to "think aloud" as you go through the website. Please verbally say what you are thinking so that we can go through your thought process.

I will now send you a link to the prototype. Please open it and wait for it to load. Once it's loaded, please share your screen with me.

[Send link to prototype in Zoom chat]

Task: Personal Teacher Story

Let's start by looking at the story about Sheena Graham. Take a moment to read it, then let me know your thoughts.

- What are your main takeaways from this section?
- What are you expecting to see in the rest of the website?
    - Purpose: To understand how a more personal story might impact people's perceptions at the start.

Task: Many Requirements

Let's look at the first plot.

- What are your main takeaways from this section?
- How many steps do teachers have to go through to be qualified to teach?
    - Purpose: To determine whether the "stair" visualization correctly conveys step-by-step procedure

Task: Average Salary

Let's go to the next plot.

- What are your main takeaways from this section?
- How long would a teacher have to work, on average, to reach over $60,000 per year in income?
    - Purpose: To determine readability of bar chart

Task: Average Salary Compared to Other Professions

Let's go to the next plot.

- What are your main takeaways from this section?
- Which job(s) make more than the average K-12th public school teacher per year?
    - Purpose: To determine readability of bar chart

Task: Student Loans

Let's go to the next plot.

- What are your main takeaways from this section?
- Suppose this section were a gif. What additional information would you expect to see?
    - Purpose: To understand what additional information people might be expecting out of the animation

Task: International Comparison Salary vs. Hours

Let's go to the next plot.

- What are your main takeaways from this section?
- What would you expect to see if you hovered over a blue dot?
    - Purpose: To understand what additional information people might want about other countries.

Task: Hours per Week

Let's go to the next plot.

- What are your main takeaways from this section?
- How might you go about seeing how much teachers in rural schools work?
    - Purpose: Usability of dropdown

Task: Breakdown of Hours

Let's go to the next plot.

- What are your main takeaways from this section?

Task: Students to Teachers

Let's go to the next plot.

- What are your main takeaways from this section?
- What does the student-to-teacher ratio implicitly mean?
    - Purpose: To see whether student-to-teacher ratio is meaningful to people outside the educational sector

Task: Teachers' current situation
Let's go to the next plot.

- What are your main takeaways from this section?

Task: Amount of teachers decreased
Let's go to the next plot.

- What are your main takeaways from this section?
- How many teachers less from 2020 to 2022? How do you feel about the number?
    - Purpose: To see if the number with the visualization can make audience realize there's a continuous loss in teachers

Task: Reasons for leaving
Let's go to the next plot.

- What are your main takeaways from this section?
- How would you interpret this chart? Is the data sorted?
    - Purpose: To see if audience can see the reasons are sorted and whether the chart is easy to understand

Task: Teachers leaving for other occupations
Let's go to the next plot.

- What are your main takeaways from this section?

Conclusion
That was the last task I had for you today. What are some of your thoughts about the website we just had you look at?

- What did you learn? What was surprising to you?
- What questions do you still have about K-12th teachers? What information did you feel was missing?

Finally, I'll ask you to fill out this post-test questionnaire.

[Send link to post-test questionnaire in Zoom chat]

Thanks for taking the time to sit down with us for this session today.