



WORCESTER POLYTECHNIC INSTITUTE

A MAJOR QUALIFYING PROJECT SUBMITTED TO THE FACULTY OF THE
WORCESTER POLYTECHNIC INSTITUTE IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE ON
MARCH 17, 2016

MATTERS. Data Mining

Bogotov, Dmytro dbogotov@wpi.edu

Hennessy, Jillian jrhennessy@wpi.edu

supervised by

Professor Elke Rudensteiner

Abstract

ABSTRACT HERE!!!111

Executive Summary

IT GOES HERE!!!111

Acknowledgements

HERE!!!

Contents

List of Figures	6
List of Tables	7
1 Introduction	8
2 Background and Related Work	11
2.1 System Architecture	12
2.2 Requirements	12
2.2.1 API and Documentation	12
2.2.2 Metric Builder	14
3 Methodology	17
3.1 Metric Builder	17
3.1.1 Back End	17
3.1.2 Front End	18
3.2 API	20
3.2.1 Authentication	20

CONTENTS	5
3.2.2 Methods	21
3.2.3 Query string and output format	22
3.2.4 Documentation	23
3.2.4.1 Overview	24
3.2.4.2 API Key	24
3.2.4.3 States	24
3.2.4.4 Metrics	25
3.2.4.5 Years	25
3.2.4.6 Examples	25
3.3 Changes to the database	25
4 Testing	27
4.1 User Testing Procedure	27
4.1.1 User Tasks	28
4.2 Results	29
4.3 Changes made	32
5 Conclusion	35
5.1 Recommendations	35
References	36

List of Figures

3.1	Data Explorer page	19
4.1	Initial location of the API Documentation link	31
4.2	Footer	32
4.3	Metric Builder's Edit menu	33
4.4	Metric Builder	33
4.5	Metric Builder's canvas	34
4.6	"Save" menu	34
4.7	API Documentation page	34

List of Tables

3.1	API User database relation	26
3.2	User Metric database relation	26
4.1	Average ratings for the user study on the Metric Builder	30
4.2	Average ratings for the user study on the API Documentation	30

Introduction

With the total amount of data in the world growing steadily at a fast rate, the need to analyze large amounts of data in datasets, or big data, is a major key to productivity growth, and innovation [10]. With this increase in information and the detail of the information available across the web, the internet will continue to provide a basis for the continued growth of data in the future. Data is a part of every industry and business in today's world, from retail to government. Big data and analysis can help to create value in these industries by making information more usable, showing more accurate performance measures, and providing detailed analytics that lead to better decision making.

In this data-driven time, it is important to be able to make decisions quickly using the data that is available. Big data visualization is an effective way to present the important information amongst the large amount of data used and helps to drive complex analysis [11]. With the use of big data analysis, it can make otherwise too large amounts of data meaningful to those who are looking to interpret significance from it.

The Massachusetts High Technology Council, or MHTC, is a group of technological, professional and higher education executives across the state of Massachusetts. They are comprised of higher education CEOs, senior executives from Massachusetts and more. For

over thirty-eight years, MHTC has advocated for various policies and programs to create and keep both a healthy and competitive business climate. Their goal is to establish and keep Massachusetts as a competitive place for successful business and talent building, including a specific focus within the technology sectors. In part because of the MHTC and its members, who are regarded as the regions most venerable technology association, Massachusetts is regarded as one of the top competitive areas for businesses that are high tech [12].

MATTERS, the Massachusetts Technology, Talent, and Economic Reporting System, was developed by MHTC along with Worcester Polytechnic Institute (WPI) and other institutions as a collaborative effort designed to aid users in understanding a variety of public data in an effort to help make Massachusetts the top location for high technology businesses. MATTERS uses this data collected to both measure and evaluate the current state of Massachusetts compared to other states in the country and provides policy makers and advocates with easily accessible and searchable dynamic data to assist in their efforts regarding decisions to help retain and grow business in the state. MATTERS is able to provide a way to centralize a wide range of talent, cost, and economic metrics and state rankings from federal and state government sources, non-profit organizations and media outlets into one location for its users [13].

Previously to our project, WPI IQP, MQP and graduate student teams worked to develop the MATTERS dashboard as it was when we began working. The goal of our Major Qualifying Project (MQP) is to provide additional features to the MATTERS website that will give our users additional ways to interact with the data and metrics found within the site. The idea for the metric builder was presented by the MHTC members as a means for the MHTC to be able to visualize their own indicator that they were in the process of creat-

ing. Users will be able to create an account on the MATTERS site and be able to build and display the results of their own unique metric formulas for ranking states. Users will also be able to retrieve any of the data points found throughout the site for their own personal use through the creation of our own API. These new features will provide authorized users an opportunity to use and share the data in even more innovative ways, aiding in the MHTCs goal toward making Massachusetts a leading state for high technology business. These two features create further access to the sites data and additional ways to manipulate and visualize the data to interpret it in new ways. These features also create an expanded user base for MATTERS and different privileges for different types of users, such as the already existing administrative users, and general users who also would like to create their own indicators.

Background and Related Work

The creation of a metric builder page and an API for the MATTERS site is a result of two prior project groups and additional efforts by WPI students who worked to establish the initial features and the design framework for MATTERS to exist. The initial development of MATTERS came from a team of students completing their Interactive Qualifying Project (IQP) with the aid of other WPI graduate student teams. This team of IQP students researched and came to the resulting decisions regarding the front-end visualization for the MATTERS dashboard [1]. This includes the inclusion of decisions regarding colors, and visualization types such as charts and tables, that would be used to represent the data within the system in a manner that was both intuitive for the users and a quick way to show analytics. In parallel, the graduate student teams worked to develop the back-end for MATTERS. They made it possible to extract the data wanted from various sites and then parse and clean this retrieved data, before then uploading it to a database. This data would be called upon to be shown in the various visual methods for the users [2].

Following this initial front-end and back-end design and implementation of the MATTERS dashboard, a team of students working on their Major Qualifying Project (MQP) for WPI then worked to improve the administration center and the data integration for the

dashboard. This involved the data integration pipeline manager as well as the Administration Centers development to allow for MHTC and other administrators who had access to be able to easily upload their desired data and metrics, as well as an easy way to view this data on the administrative end. This MQP team was able to integrate 20 new data sources for the MATTERS dashboard, make the Administration Center useable for non-technical users, and improve upon the look and feel of the MATTERS dashboard as a whole [2].

2.1 System Architecture

2.2 Requirements

The main goal of creating an API for MATTERS as well as creating the Metric Buidler page for the site and what it would entail, required looking into other similar features of different sites and making decisions regarding implementation, design and security features for these aspects of the MATTERS site.

2.2.1 API and Documentation

An API is an Application Programming Interface. APIs are tools that allow other programs to interact with the software program that the API belongs to without having to give someone complete access to your codebase. In a sense they expose some of the internal workings of software to the public but in a way that is limited by what the API chooses to provide. APIs aid in providing a way to share a potentially large amount of data in an efficient way. According to the chief data officer of Philadelphia, Mark Headd, APIs allow a specific audi-

ence to use data more quickly, easily, and efficiently when they are looking to do something specific with the information. APIs are beneficial for not only keeping certain aspects of code private, but also for saving users time. Even in cases of open source programs where all of the code for a program is visible, the number of code can be so large that it is inefficient to search through the whole code base for specific data [3].

APIs will be beneficial from both a business aspect and for programs that aim share information and research with many people. An advantage of an API being an automated tool is that it can process a large number requests without any added cost and work from the developers. APIs also present the data requested in a manner that is useful and easily manipulated for the users purposes. For APIs whose goals are to share certain data across systems there is a great benefit efficiency wise, as many manual procedures are cut out by the APIs automatic generation. When these tasks are done manually, they waste time and are both laborious and repetitive, as well as being more prone to error; all of these things being costly on the developer end. While it is more time consuming and costly to develop an API initially, the overall benefit once it is developed is very clear [3].

Additionally, APIs not only encourage innovation and the ability to manipulate and extrapolate data by external collaborators, they provide a means to do so that is more secure for the group creating the API. They reduce the risk of how and what data is obtains and encourage good practice for how to properly manage the data available [4].

One important step to gaining the full benefits from an API is making sure that the API is secure. This can be achieved through requiring authentication and authorization of users before they gain access to the APIs features. It is good practice to ensure that the users are who they say they are and that they are given permission before using data or parts of a

developers program. This also allows for a record of who exactly is accessing the data, in the event that there is an issue so that a specific user can be tracked down [5].

In addition to creating the API for a site, it is necessary to create good documentation to accompany the API, to make the API as user friendly and simplistic as possible. API documentation provides developers with everything that they need to know in a concise manner in order to use the APIs features with other applications. The API documentation needs to contain the classes, functions and other important aspects of the API [6]. The documentation guide allows developers to easily interact with a sites API and their own code, as many developers style their code in their own unique way.

2.2.2 Metric Builder

The main feature that is to be developed is the metric builder page which will be available for the registered users on the MATTERS website only. A user will be able to select any number of the metrics already available in the MATTERS database and combine their data to create their own personal formula or indicator. The user can then use their created formula to display the states' rankings based on this indicator. This will allow users to see and evaluate states based on what they think is most important as a whole or combination of various factors, and interpret the data in their own way, simply. By allowing users to create their own data set from all the metrics available and then provide their own weights to each of these data values, we are allowing users to see the value that each state has based on how important they find a large number of metrics.

It is important to ensure that many different data types are able to be combined to create one final value. It is also important to consider the effects that certain data types

will have on the final value received from the users indicator. For example, the MATTERS database contains rankings, percentages, nominal values, and other data types. Certain data types could end up dominating in a user created indicator when combined with significantly smaller value data types. There are also complexities involved with certain data types that are represented in the reverse of the majority of the data types. For example, both rankings and some other data types use numerical values in which a lower value indicates a better performance by the state, versus the majority of other metrics in which the larger the value is, the better a state is performing in that area.

Finally, there are many metrics that do not contain a value for every single year that other metrics contain. Situations where one metric being used in the users metric builder equation does not contain values for years that another metric being used in the same equation need to be considered. There needs to be a uniform solution for what to do in these instances in a way that does not deceive the users of the indicator, as this would affect the calculations and following visualizations across years where these issues exist.

These factors need to be taken into consideration in order to provide accurate and understandable visualizations and results when users create their own indicator in the metric builder. It is for this reason good to consider special handling or removal of certain data types, as well as potential ways to normalize the final numerical values received from the formulas the users have created in the metric builder.

We looked at various economic indicators to come up with an idea for how to allow our users to combine sets of data to use for comparisons. One common approach in economic indicators is to use weighted averages [7]. For example, one of the most popular economic indicators, CPI, or the Consumer Price Index, uses weighted averages of data from hundreds

of different consumer goods and services to measure inflation and deflation. Each of the goods considered by the CPI is weighted based on its importance [8].

Weighted averages work by taking each number in a given data set, and multiplying the value by its given weight. This will give you a new value reflecting the product of the data and its weight. Add all of these products together from the data set to get the total value. Then, add up the total of all the weights. Finally divide the total value by the total weight in order to receive the weighted average of your data set. The weights are used to show the importance that each specific item in a data set has in order to calculate an overall value of all the data together [9].

Methodology

3.1 Metric Builder

3.1.1 Back End

Implementing a Metric Builder the core question was how to store and compute a user metric. We have come to these two options

1. Store a user metric data in the database
 - Pros
 - Fast to retrieve; no computation needed
 - Cons
 - Waste of space in the database
 - User metric data remains static; update in the underlying data does not cause an update in the user metric
2. Store a user metric as a metadata only and compute values on-the-fly (on-demand)
 - Pros

- Efficient use of the database space
- User metric data is always in sync with underlying data
- Cons
 - Might be time-consuming to compute

Looking at the cons of each option, we attempted to approximate how bad they are. Having n users each creating m user metrics each of which has data for k years we have $m \cdot n \cdot k \cdot 50$ entries in the database. This data would be a snapshot. If any data point in the metrics changes, user metrics remain out of sync.

For the second option, it was difficult to approximate time it takes to compute a user metric as it depends on the server load and the number of metrics involved in the user metric. We implemented the second option and benchmarked it with 3 users trying to compute largest possible user metric (all metrics with all states selected). It took around 1.5 seconds to load all 3 user metrics. This drove our design decision towards the second option - computing metrics on-the-fly.

3.1.2 Front End

The main goals for the front end of the metric builder feature was to design a webpage that was easy to use, easily accessible, intuitive, and consistent with the design of other pages on the MATTERS site. The metric builder feature needed to be a tool that allowed users with any level of technological background to easily build their metric formula from preexisting metrics, assign weights to their chosen metrics, and be able to make changes to their metric formula at any time.

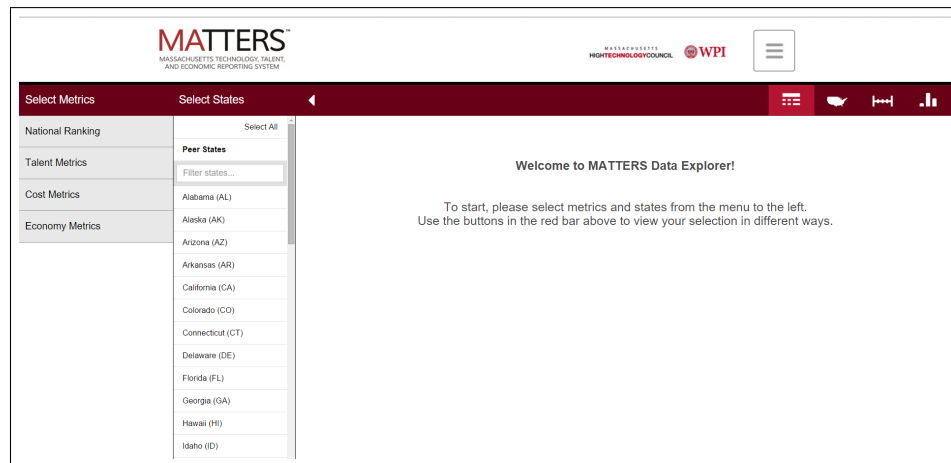


Figure 3.1: Data Explorer page

The front end for the metric builder page was created through the use of HTML, CSS and JavaScript. To make the page consistent with the rest of the site, code was reused from the Data Explorer page. The Data Explorer page, as seen in Figure 1, within MATTERS allows users to select preexisting metrics to visualize the data on the site in multiple different ways, including a bar chart, line graph, heat map, or table. The framework for the Data Explorer was the page most similar to how we wanted the metric builder to look, and we were able to reuse and modify code from that page to create our new feature.

Reference somewhere here Figure 3.1.

The Data Explorer page allows users to select metrics and states that they would like to view through the use of the sidebar. Because the intended users for the metric builder feature are meant to be authorized users with experience using the MATTERS Data Explorer, we used the sidebar from the Data Explorer as the basis for how the users would select their metrics on the metric builder page as well.

3.2 API

Implementing an API, there are 2 problems to consider

- Do we implement a closed API or open API? If closed one, how do we implement authentication.
- Which methods do we put in the API?
- How our query string will look like? What is the output format?

3.2.1 Authentication

Although MATTERS system is a public resource, we wanted to at least track who uses our API, how and how often. This requirement made us chose a closed API option. Thinking of authentication we had a few options

- Bind to user
- Simple *API key* (token) authentication
- Complex *handshake* mechanism
- *Handshake* mechanism with random value

Binding to API user t regular user would allow any registered user to access API. Although this kind of authentication is the easiest one to implement we wanted a separate API users.

Simple *API key* authentication is the one when API users are given unique token (long random string) which they need to provide with each request. Based on this token system is able to accept or deny connection and track individual users.

Handshake mechanism with random value involves the following steps

- Client sends in username (not password)
- Server responds by sending back unique random number
- Client encrypts using user's password plus number as key
- Client sends hashed or encrypted value back to server
- Server encrypts using the user's same password plus number as key
- Server compares two hashed or encrypted values, if same then grant access

Provided that the main purpose of the API being closed is tracking an activity for statistical purposes, *API key* authentication was implemented.

3.2.2 Methods

Main method implemented in the API is `api/data?`. This method returns all data points for given metrics, states and years.

Since `api/data?` needs specific IDs as arguments, there is a need for supporting methods which show information about metrics and states. So we also implemented `api/metrics?` and `api/states?`.

3.2.3 Query string and output format

There are two options for constructing a query string.

- `api/method?argument1=value1&argument2=value2&...`
- `api/method/value1/value2/...`

To make out API user friendly we implemented the first option since it clearly shows which value corresponds to which arguments and these argument-value pairs may be in any order.

The final query strings are given in Listing. 3.1

Listing 3.1: API methods examples

```
1      /* method */
2      /api/data?metric=&state=&year=&apiKey=
3      /* example */
4      /api/data?metric={16,32}&state=MA&year=*&apiKey=key
5
6      /* method */
7      /api/metrics?apiKey=
8      /* example */
9      /api/metrics?apiKey=key
10
11     /* method */
12     /api/states?apiKey=
```

```
13      /* example */  
14      /api/states?apiKey=key
```

The output format JSON (JavaScript Object Notation) was chosen as it both compact and human and computer readable.

3.2.4 Documentation

In order for the developers to know how to make proper API calls, it was necessary to create the API Documentation page for MATTERS. The documentation provides users with full information on the MATTERS API and how to use it, as well as examples of valid API calls and the output that they would return. It is important to ensure that the API documentation is free of both natural language and code sample errors, as this tool is what developers unfamiliar with using the API rely on to understand how to properly access and extract data [10].

In order to make the documentation easy to follow, the documentation was divided into sections. The main sections of the API documentation were: an overview, the methods, the parameters, and examples. The layout of the MATTERS API documentation was based on the API Documentation of Tradestation, which had been very simple and easy to follow [11]. The Tradestation documentation provided a summary, path, parameters, and examples of both an API call and what it would return. An example of their documentation can be found at: <http://tradestation.github.io/webapi-docs/en/users/accounts/>. For the MATTERS API, it was necessary to include information on where to access a user's API key, as well as the proper format to get the data desired for different years, states, and

metrics. The API Documentation sections are explained in the following sections. The full API Documentation can be found in Appendix 1.

3.2.4.1 Overview

The API Documentation begins with a summary about what the MATTERS API is and what data points the API tool gives users access to. This section also includes an interactive table of contents which allows users to quickly navigate to a specific section of the documentation to look for information. This allows users to easily find what they are looking for without having to scroll through the entire documentation page and provides a brief overview of everything that follows.

3.2.4.2 API Key

Developers without authorization do not have the ability to use the MATTERS API until they have been given an API key. These users are directed to the Contact Us page in order to send an email request to become an authorized user with their own key. This section also explains that the API key is used in all API calls in order to validate the user's request.

3.2.4.3 States

Users are instructed on the proper format needed to retrieve a single state, list of states, or all states. If a user does not know any other information regarding the states in the MATTERS system, they are shown where to find any other information needed via an API request.

3.2.4.4 Metrics

Users are given the proper format in order to request data for a single metric, list of metrics or all metrics in the MATTERS database. The documentation explains that in order to access data from metrics, the metric parameter values must be the proper metrics ID number. The user is also given the path to all information regarding the metrics, which will give the user the metric names, ID numbers and details.

3.2.4.5 Years

Users are given the proper format to request data from specific years. Users may request data for a single year, range of years or all years in the database.

3.2.4.6 Examples

Following the parameters and methods of the MATTERS API, the documentation provides the users with two examples of valid API requests and the data which they would return. The example requests include the proper format of the parameter values and the various different types of calls the users can make to request specific data. Under the path name showing an API request the option to display the return value of that specific example. Users can view this to see the return data as well as the JSON format it would be given in.

3.3 Changes to the database

We had to add two tables to the database - **APIUser** and **User Metric**. See Table. 3.1 and Table. 3.2.

Name	<i>Type</i>	Comment	Reference
Id	<i>INT</i>	Unigue aoutoincremented identifier	none
Name	<i>VARCHAR</i>	API user's name	none
ApiKey	<i>VARCHAR(160)</i>	Unique random string; used for authentication	none

Table 3.1: **API User** database relation

Name	<i>Type</i>	Comment	Reference
Id	<i>INT</i>	Unigue aoutoincremented identifier	none
Name	<i>VARCHAR</i>	User metric's title	none
Value	<i>TEXT</i>	JSON formatted list of metric id - coefficient	none
UserID	<i>INT</i>	Id of a user - author of the user metric	Id in User relation

Table 3.2: **User Metric** database relation

Testing

After the backend code and the initial front end of the Metric Builder, API and API Documentation features were complete, our team decided to receive user feedback to see where we could improve our design. We created a two part user study to first test the usability, intuitiveness, and simplicity of the Metric Builders user interface and finally to test the clarity and completeness of API Documentation and to make sure there are no errors in the code samples or the natural language text within the documentation.

4.1 User Testing Procedure

All of the users were students from WPI and were asked to complete the user tasks on a laptop provided by our team. Even though the users in our study are not the typical expected users of the MATTERS site, we believe that their input is valuable. If the features of the site are easy to use for users inexperienced with the MATTERS site, then we should expect the features to be easy for the authorized users in the future as they are more experienced with the MATTERS site or with developing APIs. After completing the tasks for each part of the user study, the users filled out a survey asking them to rate the easiness of different aspects of the tasks on a scale of one to five. While the users were completing their tasks, our team

was also there observing their actions in order to get better insight on their clicking behavior and thought process while navigating the site. We also recorded the operating system and browser the users were doing the study on to note any important differences this may bring about.

4.1.1 User Tasks

The user tasks given to the users in the following order and were printed on a sheet of paper so that the users could reference the task details at any time:

User Study Tasks: Part 1, Metric Builder feature

1. *Navigate to the Metric Builder feature*
2. *Please create your own metric formula, which includes Unemployment Rate, Corporate Income Tax Rate and Median Household Income, with weights 10, 5, and 22 respectively.*
3. *Name your new metric "My Metric" and save it.*
4. *Please find and select your created metric on the data explorer page.*
5. *Edit your metric formula so that Unemployment Rate is no longer a part of the metric and Median Household Income has a weight of 15.*
6. *Save your changes to My Metric.*
7. *Please delete My Metric*
8. *You will now receive a short survey about your experience using the Metric Builder.*

User Study Tasks: Part 2, API feature and Documentation

- 1. Navigate to the API Documentation page*
- 2. Your API Key is "secret"*
- 3. Please get the data for the metric Unemployment Rate for Massachusetts and Florida for the year 2012 using the API tool and the documentation as a guide*
- 4. You will now receive a short survey to complete about your experience using the API and API Documentation.*

The survey that the users completed at the end of each part of the user study can be found in Appendix 2.

4.2 Results

Thirteen users completed the user study and filled out the subsequent surveys. Most users performed the tasks on Google Chrome or Safari and all users performed the tasks on either a Mac Operating System or Windows Operating System. All of the data collected from the user studies can be found in Appendix 2. Table 4.1 shows the average of the users ratings on a scale of one to five for each question on the survey regarding the Metric Builder feature.

Table 4.2 shows the average of the users' ratings on a scale of one to five for each question on the survey regarding the API Documentation.

Our team considered an average rating of above four to be a good score, meaning that the specific task was easy to perform with our user interface. The only tasks that did not score above our desired rating was for How easy was it to edit My Metric to make the appropriate changes? and How easy was it to find the API Documentation?. User feedback on the open ended survey responses, as well as observations made by our team during the user studies

Survey Question	Average User Rating
How easy was it to find the Metric Builder?	4.385
How easy was it to select the metrics "Unemployment Rate", "Corporate Income Tax Rate", and "Median Household Income" in the metric builder?	4.308
How easy was it to weigh the metrics accordingly?	4.615
How easy was it to name and save your metric?	5.000
How easy was it to find My Metric on the data explorer page?	4.231
How easy was it to edit My Metric to make the appropriate changes?	3.846
How easy was it to remove My Metric?	5

Table 4.1: Average ratings for the user study on the Metric Builder

Survey Question	Average User Rating
How easy was it to find the API Documentation?	3.250
How useful is the API Documentation?	4.167

Table 4.2: Average ratings for the user study on the API Documentation

were able to confirm that these two tasks were the most difficult or confusing and provided insight as to how to improve it.

For the metric builder, users noted that they wanted an option to allow them to edit their metric from the Data Explorer page. Our observations confirmed that while on the Data Explorer page, users were actively searching for an edit button while they were viewing their custom made metric. Many times the users would find the "Create new metric link quickly, which if clicked would bring the user to the Metric Builder page where they could also edit their metric, but were hesitant to click the link because they were not interested in starting over with a new metric.

For the API documentation, many users commented on their difficulty finding the link

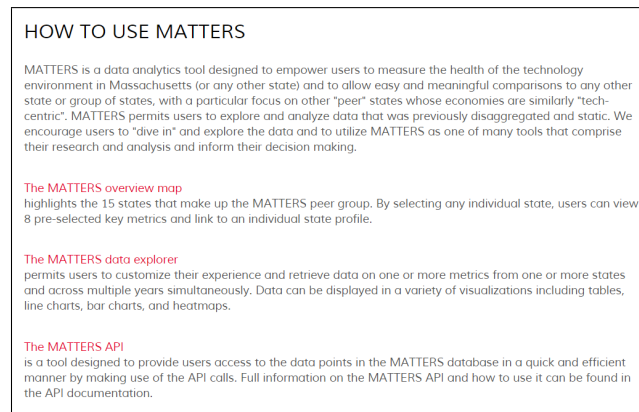


Figure 4.1: Initial location of the API Documentation link

for the API Documentation page. Ultimately, twelve out of the thirteen users did not have much of an issue eventually navigating to the API Documentation link found on the How to use MATTERS page as seen in figure 2; however, it was more time consuming than it should have been and many users clicked on multiple other links before navigating to the correct page. The users who stated that they did not know what an API was mainly looked for the API Documentation link in the main dropdown menu of the site before navigating to the About page, followed by clicking on the link to How to use MATTERS and finally finding the API section which led them to the documentation. Most of the users who were aware of what an API was, ultimately navigated to the API Documentation page the same way; however, many of them scrolled to the bottom of the home page of the site looking for a link similar to the Developers links found at the bottom of many webpages.

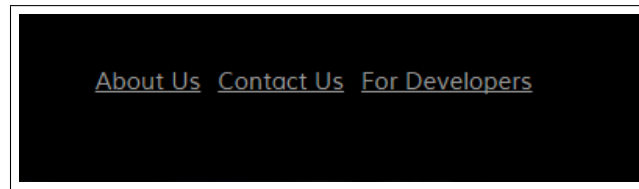


Figure 4.2: Footer

4.3 Changes made

As a result of the user ratings, comments and our observations made while completing the user study tasks, we made a few front end changes to make our features easier to use and easier to find. This included adding a link to the API Documentation in the footer of the site in addition to the link on the "How to use MATTERS" page, as seen in figure 3, and as shown in figure 4, changing the Create new metric link on the Data Explorer page to mention that the link would also allow users to edit their metric.

These changes led to the final design of the front end of the Metric Builder and API Documentation which can be seen in figures 5 through 8 below:

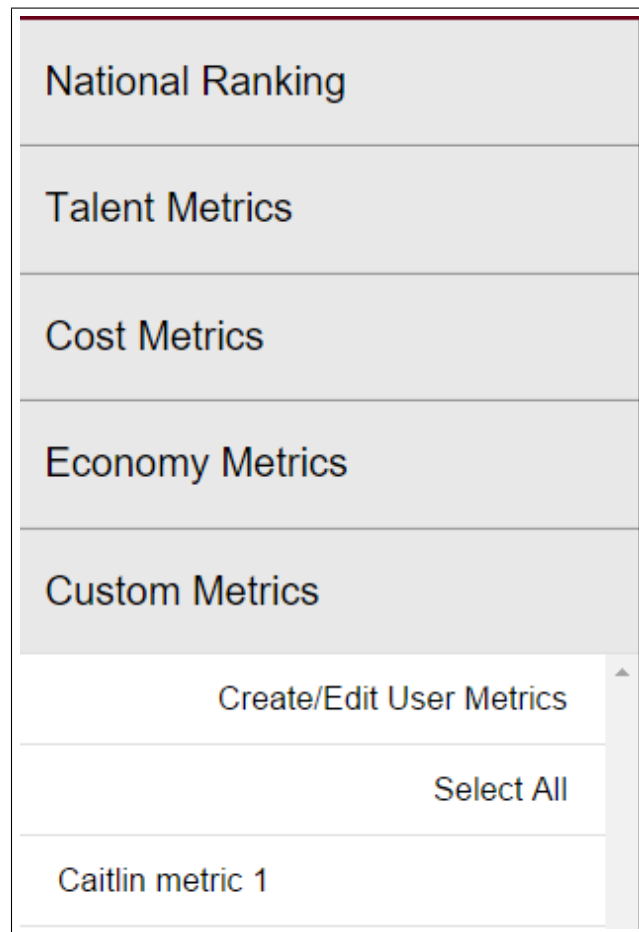


Figure 4.3: Metric Builder's Edit menu

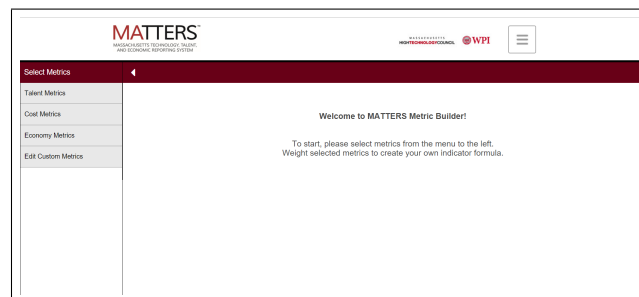


Figure 4.4: Metric Builder

The Metric Builder's canvas displays a formula in a dashed box: $(\text{Hiring Difficulty for Technology Industries}) * 67 + (\text{Bachelors Degree Holders in Workforce}) * 19 + (\text{Corporate Income Tax-Appportionment Method}) * 50$. Below the formula, the result is shown as $67 + 19 + 50 = 136$. Three sliders are visible, each with a 'Remove' button and a weight value: 'Hiring Difficulty for Technology Industries - Remove' with weight 67, 'Bachelors Degree Holders in Workforce - Remove' with weight 19, and 'Corporate Income Tax-Appportionment Method - Remove' with weight 50. At the bottom, there is a text input field labeled 'Metric name' and a 'Save' button.

Figure 4.5: Metric Builder's canvas

The 'Save' menu is displayed with a text input field containing 'Caitlin metric 1'. To the right of the input field is an 'Update' button. Below the input field are two buttons: 'Remove' and 'Cancel'.

Figure 4.6: "Save" menu

The API Documentation page for the MATTERS system is shown. The header includes the MATTERS logo (MASSACHUSETTS TECHNOLOGY 'Talent' AND ECONOMIC REPORTING SYSTEM) and the WPI logo. The main content area is titled 'API DOCUMENTATION' and contains the following text: 'The MATTERS site contains data collected from a number of sources stored in one convenient database. To help users make the most of all of this data, MATTERS has provided an API. This tool is designed to provide users access to the data points in the MATTERS database in a quick and efficient manner by making use of the API calls. This documentation will show you how to use the MATTERS API in order to properly access these data points. All data returned will be in a JSON format.' Below this text, it states: 'To start, a valid request for accessing the API will look like the following: `{website}/api/{method}/{parameter1}/{parameter2}/{parameter3}/{parameter4}`'. It then says: 'Below we will explain the methods and parameters that can be used to get data from the site, and valid format for the parameter values'. A list of contents is provided at the bottom: 1. Methods, 2. Data, 3. Parameter Names, 4. API Key, 5. Status, 6. Metric, 7. Year, 8. Examples.

Figure 4.7: API Documentation page

Conclusion

5.1 Recommendations

References

- [1] Alex Fortier, Long Hoang Nguyen Duc, Kevin Mee, and Westley Russell. Advancing massachusetts technology, talent and economy reporting system (matters). http://www.wpi.edu/Pubs/E-project/Available/E-project-042915-094249/unrestricted/Advancing_MATTERS.pdf.
- [2] Nilesh Patel, Stefan Gvozdenovic, and Ted Meyer. State cost competitiveness dashboard. http://www.wpi.edu/Pubs/E-project/Available/E-project-050814-222635/unrestricted/Final_report_5.6.2014_FINAL-revisions.pdf.
- [3] Greg Sleter. What's an api and why do you need one?
- [4] Brian Proffitt. What apis are and why they're important.
- [5] Andy McGregor, David Flanders, and Malcolm Ramsey. The advantage of apis.
- [6] Gregory Koberger. The importance of good api documentation: Creating meaningful partnerships for businesses.
- [7] Weighted average.

- [8] Consumer price index - cpi.
- [9] The top 10 economic indicators: What to watch and why.
- [10] Hao Zhong and Zhendong Su. Detecting api documentation errors.
- [11] Get user accounts.