Supporting Documentation for TransferMaster

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Our Team

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Subject Matter Experts

Debbie Little | Interim Director, Enrollment Performance Management Team | World Campus | Penn State | dxm16@psu.edu

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Date: (03/15/2023)

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1 Overview

1.1 Problem Description

In the 2021-22 academic year, Penn State welcomed 2381 transfer students, while approximately 2 million college students across the country transferred to other higher education institutions. However, the current process for evaluating transfer credits is cumbersome and arduous. It involves numerous interactions between students and the transfer credit team, who must ensure that faculty reviewers provide timely responses. After students submit their syllabi, the transfer credit team sends them to committees consisting of professors and instructors who manually compare them to Penn State syllabi. Once a decision is made, it is sent back to the transfer team. The faculty typically reviews around 1350 courses each month, usually taking 4-8 weeks to conclude a course. This process takes up a lot of time and can leave both students and faculty frustrated, while also detracting from the faculty's capacity to attend to other pressing academic concerns. For Admissions, this results in increased workload, decreased efficiency and student satisfaction, and potentially increased turnover.

The root cause of this bottleneck is the manual comparison of syllabi, which requires human experts to spend significant time reviewing each course. While this is a critical step, it also contributes to delays in the process. As a result, students at Penn State and hundreds of thousands of others across the country must wait weeks for their credit evaluations. This delay can have several negative impacts on students, including:

1. **Delayed progress toward degree completion**: Students may be unable to enroll in required courses until their transfer credits are evaluated, which can delay their progress toward degree completion. This can also cause scheduling conflicts and result in students taking courses out of sequence, which can affect their ability to graduate on time.

2. **Financial Burden**: Delayed credit evaluations can result in students paying for courses that they have already completed at another institution. This can result in a financial burden for students who may have to pay for courses they don't need or have already taken.

3. **Frustration and Stress**: The uncertainty of not knowing which credits will transfer and how long the evaluation process will take can cause frustration and stress for students. This can be especially challenging for students who are already adjusting to a new school environment and may need to navigate additional administrative procedures.

4. **Limited Access to Resources**: Students who have yet to receive a transfer credit evaluation may not have access to resources such as academic advisors, career services, and financial aid. This can limit their ability to make informed decisions about their academic and career goals.

1.2 Proposed Solution Description

To streamline this process and benefit all parties involved, we propose an AI-powered assistive tool - TransferMaster, that is dedicated to prioritizing and simplifying the transfer credit process by providing a comprehensive platform for students, admissions, and faculty. Our solution is centered around leveraging AI to extract key data from two syllabi (such as course name, institution name, course objectives, textbook, etc.), segmenting it into relevant sections, and comparing them to determine a match likelihood. It will also provide an analysis report explaining the equivalency between the two courses.

The previous attempts in this space were aimed at introducing an entirely new system to aid with the pre-evaluation of transfer courses for prospective transfer students. This meant bringing about a significant change in a relatively short time period, thereby greatly altering the existing process. However, we envision a gradual process, in which we first introduce an assistive tool that provides reviewers with comparison metrics that will help them make data-driven decisions. Ultimately, if this tool is positively received, it could be incorporated as a part of a unified system that allows the complete evaluation process to occur on a singular platform. In addition, we are utilizing existing methods and resources, such as Penn State's transfer credit tool already in place, to develop our system.
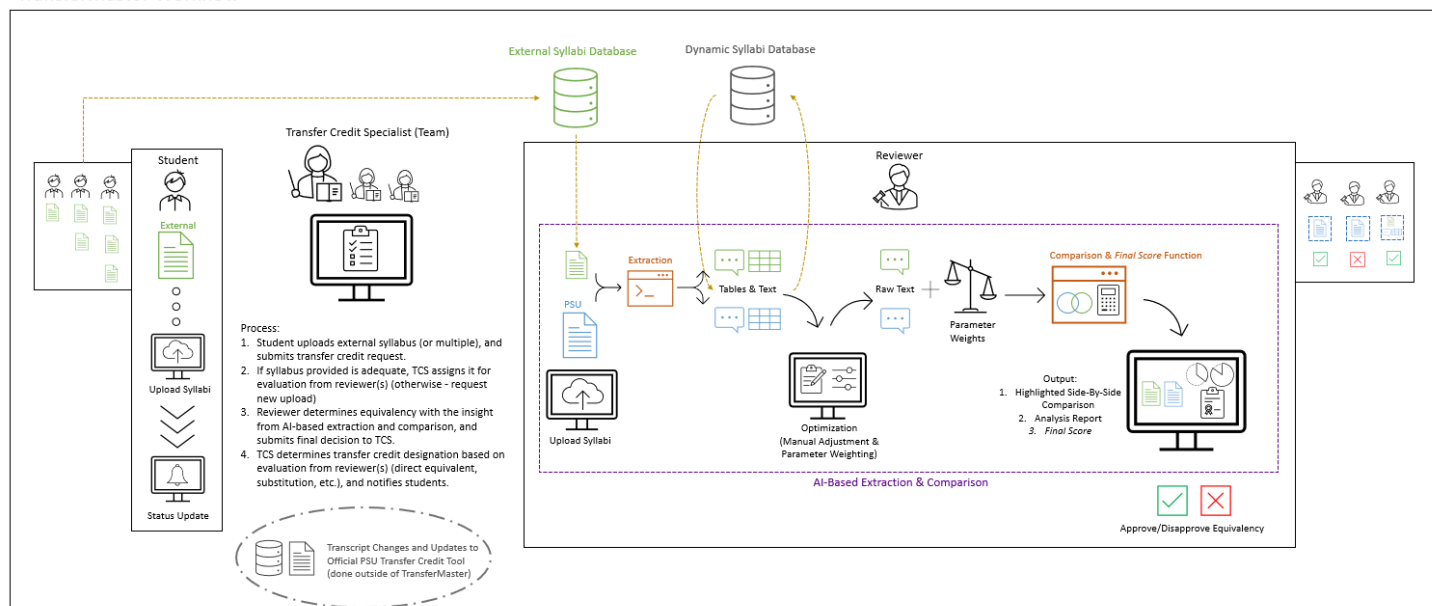
TransferMaster Workflow

Figure 1.2 TransferMaster Workflow Diagram

2 Use Case

In the long term, TransferMaster will offer three roles to access the platform: **Student, Transfer Credit Specialist, and Reviewer.** By maintaining a unified, robust environment for the entire transfer credit evaluation process to occur, the strain of this critical procedure would be significantly reduced.
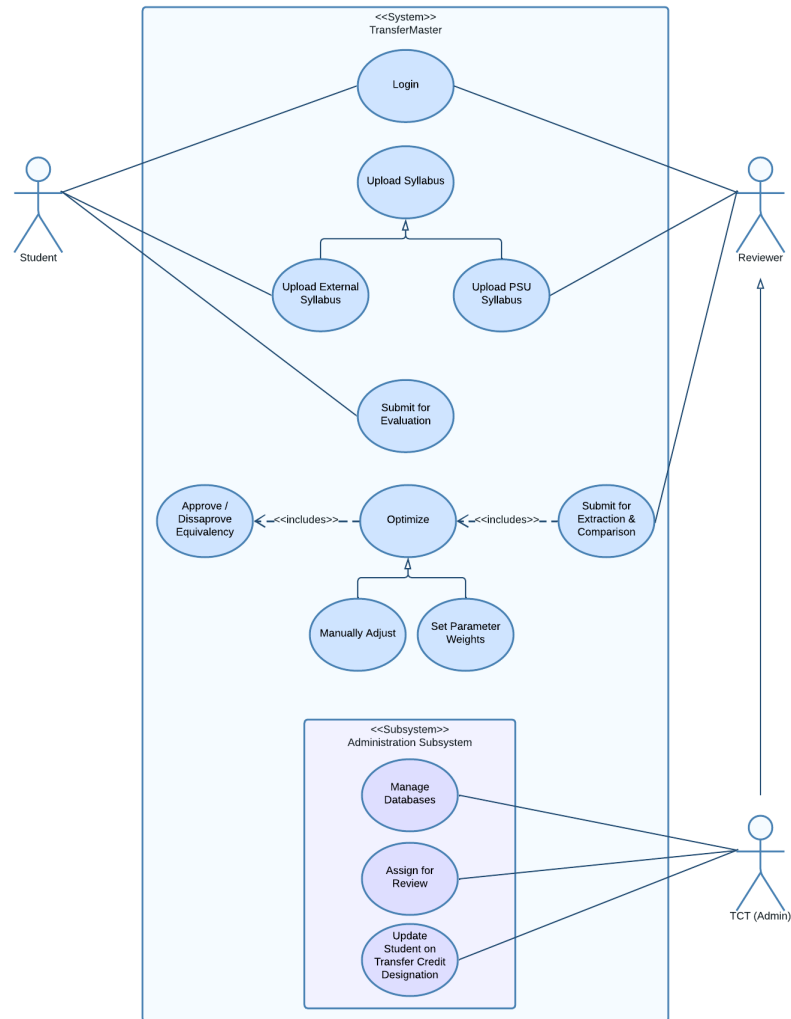

Figure 2.1 TransferMaster Use Case Diagram

Below, we discuss how these three users will use TransferMaster and benefit from it:

- **Students** will simply log in to upload external syllabi for the classes they wish to receive credit for and receive timely updates on the status of their transfer requests.
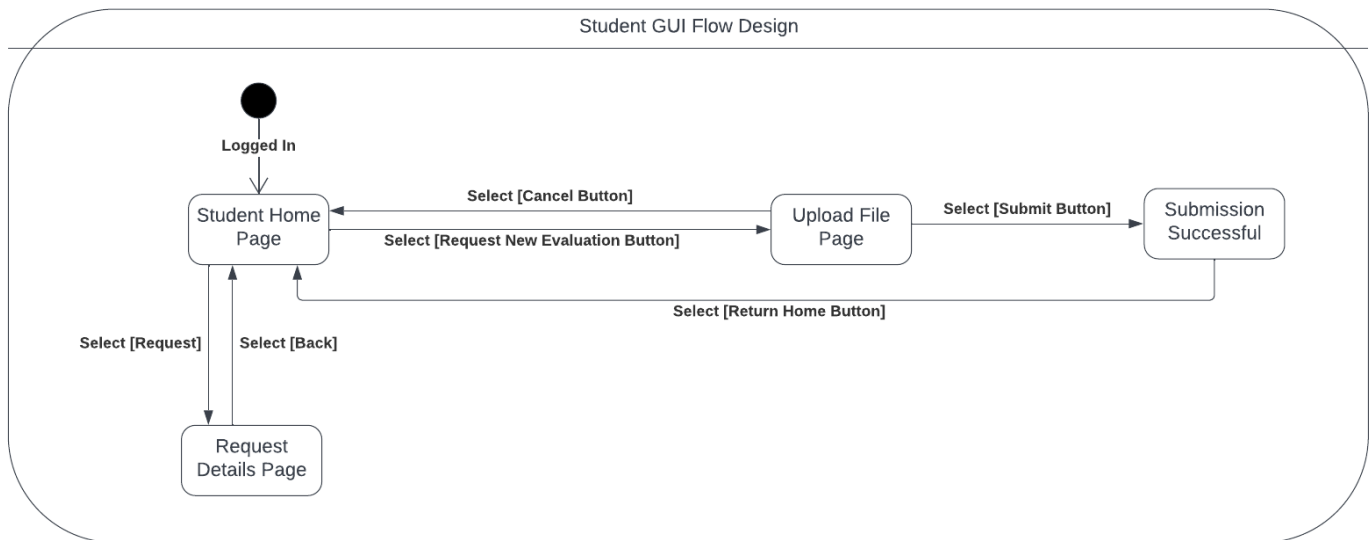

Figure 2.1.1 TransferMaster - Student GUI Flow Design

- **Reviewers** will be faculty members responsible for evaluating courses for equivalency using TransferMaster's AI comparison tool.
    - On logging in, the reviewer will see a list of requests they've been assigned. They will select a request to view the student-uploaded external syllabus; and upload the corresponding PSU syllabus. Then they will use TransferMaster's AI features to view a side-by-side comparison of the extracted sections of the two syllabi, followed by a final score and a summary report, and some data visualizations analyzing the equivalency. They will also have the option to adjust any parameter weightings as per their requirement. They can then either approve or disapprove the match, which the transfer credit team will be notified of.
    - Being the faculty experts in that respective subject area, the final decision on whether a course is transferable rests solely with them.
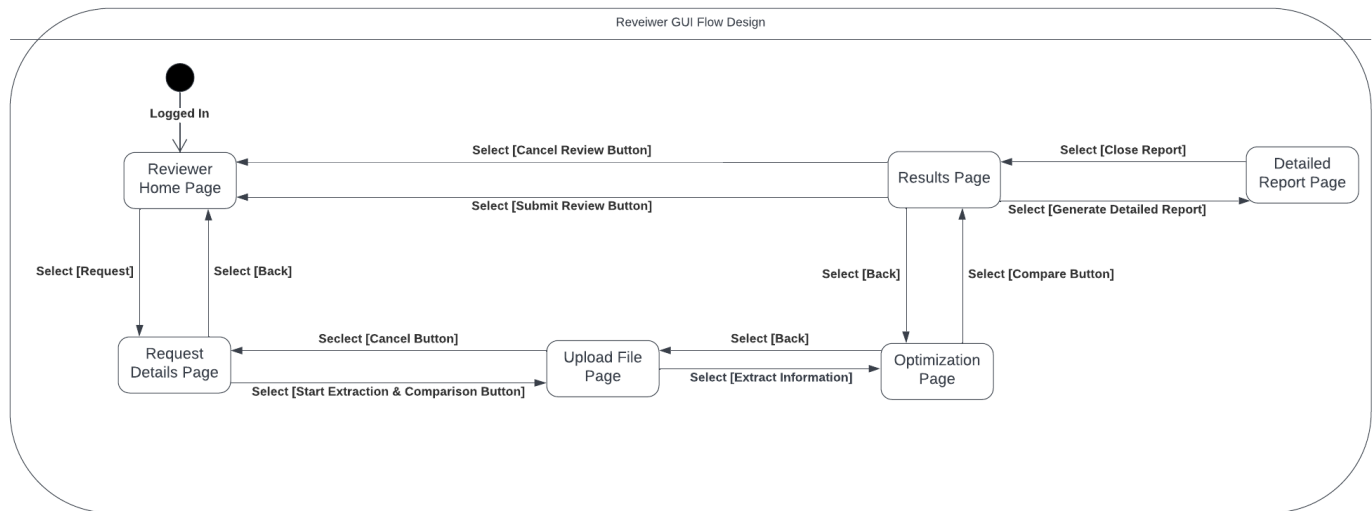
Figure 2.1.1 TransferMaster - Reviewer GUI Flow Design

- The **Transfer Credit Team** will act as the intermediary, assigning reviewers to a request and making credit designations based on evaluations received. In addition, they would also have the ability to evaluate courses themselves, if need be.

  - On logging in, their dashboard will display a list of all requests and their statuses (assigned, review pending, approved, etc.) They can assign reviewers to requests, view the decisions given by the reviewers and accordingly notify the concerned students.
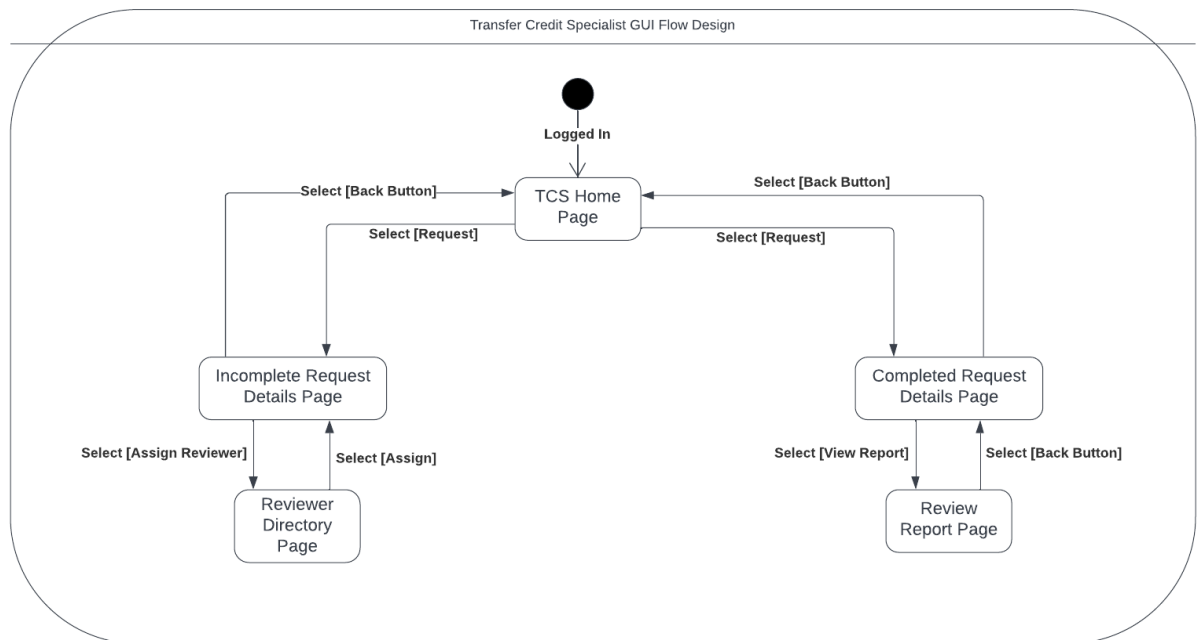

Figure 2.1.2: TransferMaster - Transfer Credit TeamGUI Flow Design

3 Technology

3.1 AI Technologies

TransferMaster will have two main fronts where AI is used:

1. Extraction and categorization of data from pdfs or images of syllabi.

2. Comparison between the extracted data of two syllabi.

In broad terms, Optical Character Recognition (OCR) will be used for extraction from scanned images of syllabi, while Natural Language Processing (NLP) will play a primary role in extraction from PDF syllabi and the comparison between the extracted data. To achieve these objectives, we are delegating to different services as explained below:

3.1.1 Data Extraction

Upon uploading a syllabus, it must undergo a parsing process to extract vital information such as the institution name, number of credits, textbook, course objectives, and other essential data. To accomplish this, we have utilized the Open Syllabus Document Parser API, a service that we have thoroughly researched and selected for its efficacy.

Open Syllabus is a non-profit research organization that aggregates and analyzes millions of syllabi to facilitate novel teaching and learning applications. They have developed an end-to-end document parser that efficiently transforms unstructured documents (such as syllabi) into well-organized metadata, including course code, title, institution, learning outcomes, and more. By utilizing their parser and syllabus schema, we can effectively segment uploaded syllabi into relevant sections and expedite the parsing process, reducing the need for manual intervention. This, in turn, saves time and resources while improving the overall efficiency and effectiveness of the syllabus parsing process.

3.1.2 Data Comparison

After extracting the desired information, corresponding attributes from the two syllabi will be compared. For this, we are primarily relying on semantic textual similarity. Leveraging the power of sentence transformers, we can determine how similar the sentences are according to their literal meaning. This method of comparison is crucial for syllabi elements such as course objectives. For more straightforward items, such as the number of credits or the course title, simpler methods will be deployed, such as fuzzy string matching and direct numerical comparison.

Our current algorithm involves using the *paraphrase-multilingual-mpnet-base-v2* sentence transformer model that maps sentences and paragraphs to a 768-dimensional vector space. We pass a source sentence (PSU course objective) from a PSU syllabus along with other sentences to compare (external course objectives) to the model, and

it returns a similarity score for each pair of sentences. We repeat this process for all the remaining course objectives. Then, through a systematic approach to calculating averages, we compute a final score that quantifies the equivalency between the 2 given syllabi. Before returning the final score, we allow the users to adjust the parameter weightings (such as weighing the course objectives more than the textbook) as desired; which is then accounted for in our final computation.

To enhance our solution, we are exploring the integration of cutting-edge technology, specifically ChatGPT. Incorporating the recently released API, we generate an analysis report explaining the final score and elaborating on the equivalency between the 2 courses.

Our goal is to empower reviewers to make more informed decisions by providing robust comparison metrics. We hope these metrics will serve as a valuable tool for reviewers and facilitate better decision-making across the transfer credit evaluation process.

3.2 Other Technologies

The system offers a user-friendly Web App, which has undergone meticulous design to ensure a seamless experience. Further details regarding its UI/UX are available in the User Interface section. The system operates under a role-based model, and for secure data storage and easy access, essential information like user credentials and syllabi are stored in a SQL Database. We have established guidelines that govern our database, and the relationships between various tables are illustrated through the Entity Relationship Diagram below.
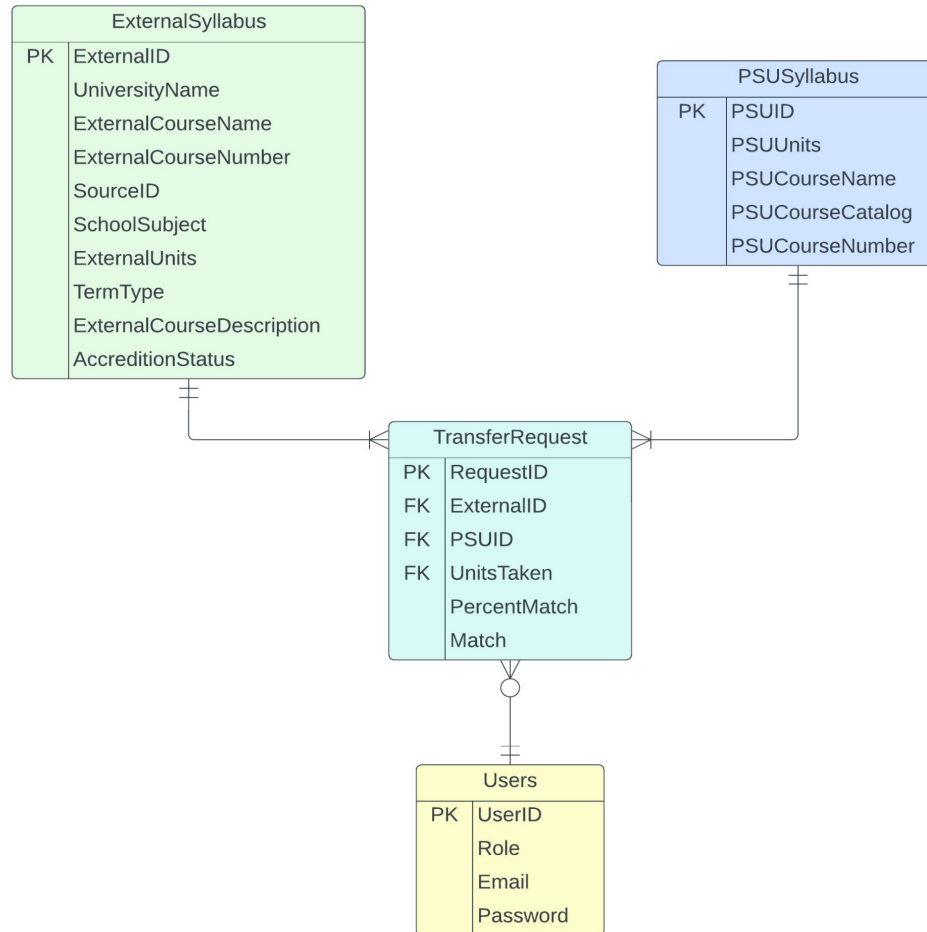
Figure 3.1 TransferMaster - Entity Relationship Diagram

Our database has been designed to adhere to the articulation rule data provided by the Transfer Credit Team at Penn State World Campus. The database aims to store all the relevant information extracted from PSU and external syllabi while minimizing data redundancy. This approach will facilitate the creation of mappings between PSU and external courses.

Furthermore, to maintain the integrity of the original content, we plan to store both PSU and external syllabi in their raw form (e.g., PDFs) until our tool is fully tested and verified. We understand the importance of storage management, and therefore, the transfer credit team will have the option to purge the documents on a semesterly basis as syllabi are updated regularly.

4 Data Sources

Open Syllabus's Parser API has been trained on a hand-labeled dataset; most of the schema fields have been trained on the vicinity of 10,000 to 20,000 documents. Once the documents come in and are converted to text, the parser analyzes the full document to identify spans that correspond to the dozen or so fields of interest. The costs to process some thousands of syllabi are minimal — and Open Syllabus will decide when eventual applications come into focus down the road, through licensing. Open Syllabus currently has a corpus of nine million English-language syllabi from 140 countries. It uses machine learning and other techniques to extract citations, dates, fields, and other metadata from these documents. The resulting data is made freely available via the Open Syllabus Explorer and for academic research. The first step in the Open Syllabus data pipeline is to separate syllabi from other documents collected in Open Syllabus's internet crawls. The second step is to deduplicate these documents. As of August 2021, around 10 million documents passed these duplication tests. The Open Syllabus Explorer currently displays the roughly 7.2 million syllabi collected through 2018. We are collaborating with Open Syllabus to obtain a research use agreement that permits us to utilize all the Penn State associated syllabi that they have scraped. This will serve as testing data to enhance our comparison process.

The PSU transfer credit related statistics have been validated by transfer credit specialists at World Campus, and they have generously provided us with a collection of external syllabi. However, this data set is quite small with only around 208 syllabi: we've been using it for initial testing. Additionally, we have been granted access to the transfer course mapping data that powers the backend of the current transfer credit tool. This database contains articulation rule data on courses submitted to the university for transfer credit evaluation, including the equivalent PSU course and its status. As of March 2023, there are over 570,000 records, of which around 200,000 contain course mappings. Incorporating this data into TransferMaster's syllabi comparison will ensure that it accurately aligns with the existing evaluation standards. With this, we aim to establish a legacy connection that will allow our tool to integrate with the current system.

5 User Interface

TransferMaster will be a web-based application and does not need installation on a local machine. The application user interface (UI) is divided into 3 categories, Student, Reviewers, and Transfer Credit Specialists. To see more details, see Appendix. Initially, users will log in (existing users) or sign up (new users). As shown in Figure 5.1 below
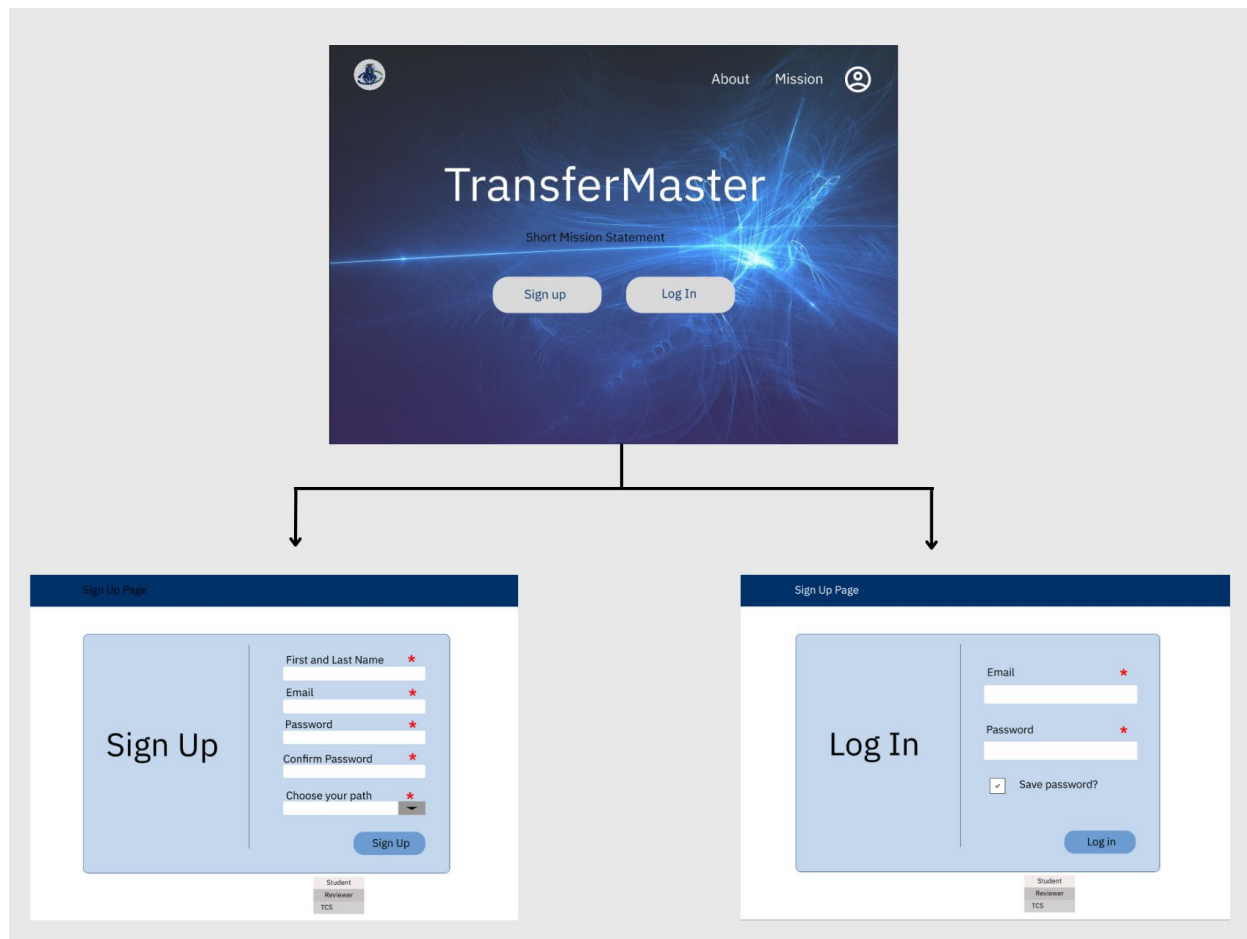

Figure 5.1 Landing page and user signup and login page

5.1 Student Interface

The student user interface allows users to request syllabus evaluation by uploading their syllabus as well as the ability to see their activity histories. Figure 5.2 shows the page flow of the student user interface.
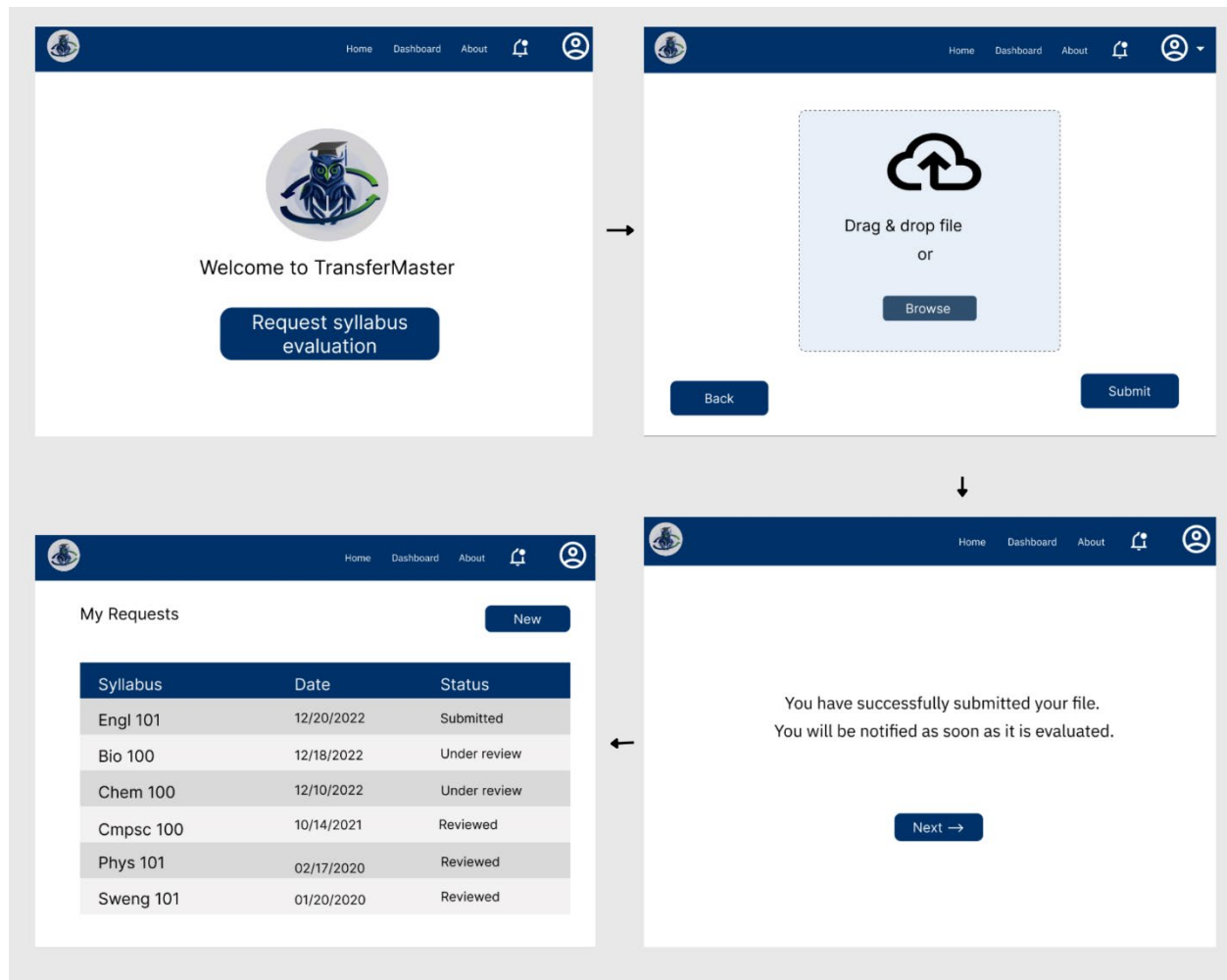
Figure 5.2 Student User Interface Interaction

5.2 Reviewer Interface

The reviewer interface allows the reviewer to evaluate an assigned request. The reviewer has 2 options to choose from. They can either evaluate an assigned request or create a new request. The reviewer evaluates an assigned request by uploading their Penn State syllabus and have TransferMaster's tool to compare and generate summary. The reviewer can create a new request by uploading an external and Penn State syllabi and then compare the two syllabi.
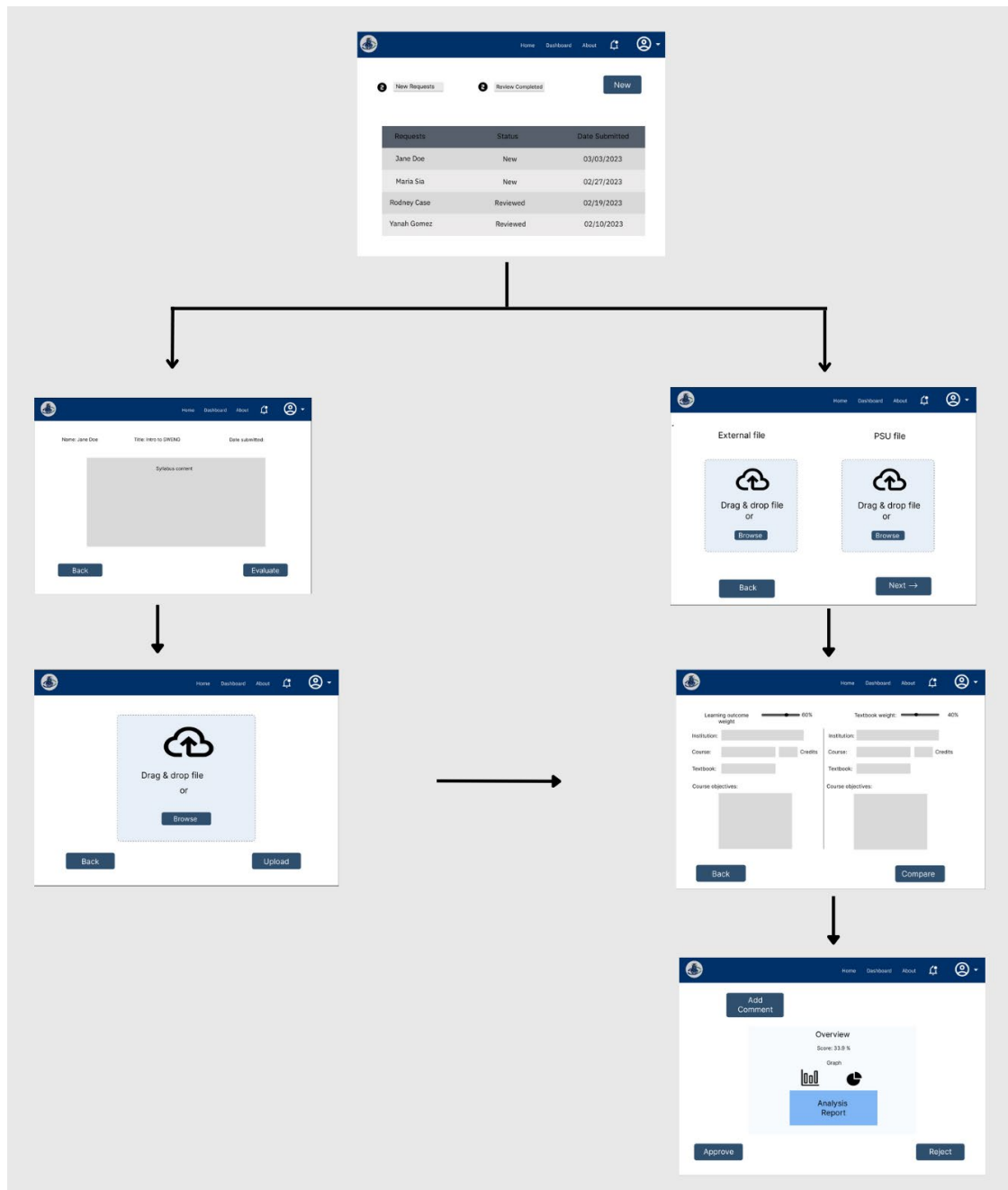
Figure 5.3 Transfer Credits Reviewer User Interface Interaction

5.3 Transfer Credit Specialist Interface

The transfer credit specialist interface allows the transfer credit specialist to have access to all requests. They can assign a request to a reviewer and/or perform the evaluation process themselves. The transfer credit specialist has the ability to change their role to the other two roles: students and reviewers.

Figure 5.4 Transfer Credit Specialist User Interface Interaction

6 Development Timeline

Currently, we have a functioning feature demo showcasing TransferMaster's core AI functionality in the prototype phase. This serves as the backend for our MVP and is written in Python. Additionally, we have our Figma prototype.

PROTOTYPE PHASE

CREATE SQL DATABASE & WRITE PYTHON CODE FOR WEB APP

After setting up the VM, we'll create the database with SQL Server. A robust backend for the MVP relies heavily on the database. We'll develop both the database and the web- app code in tandem.
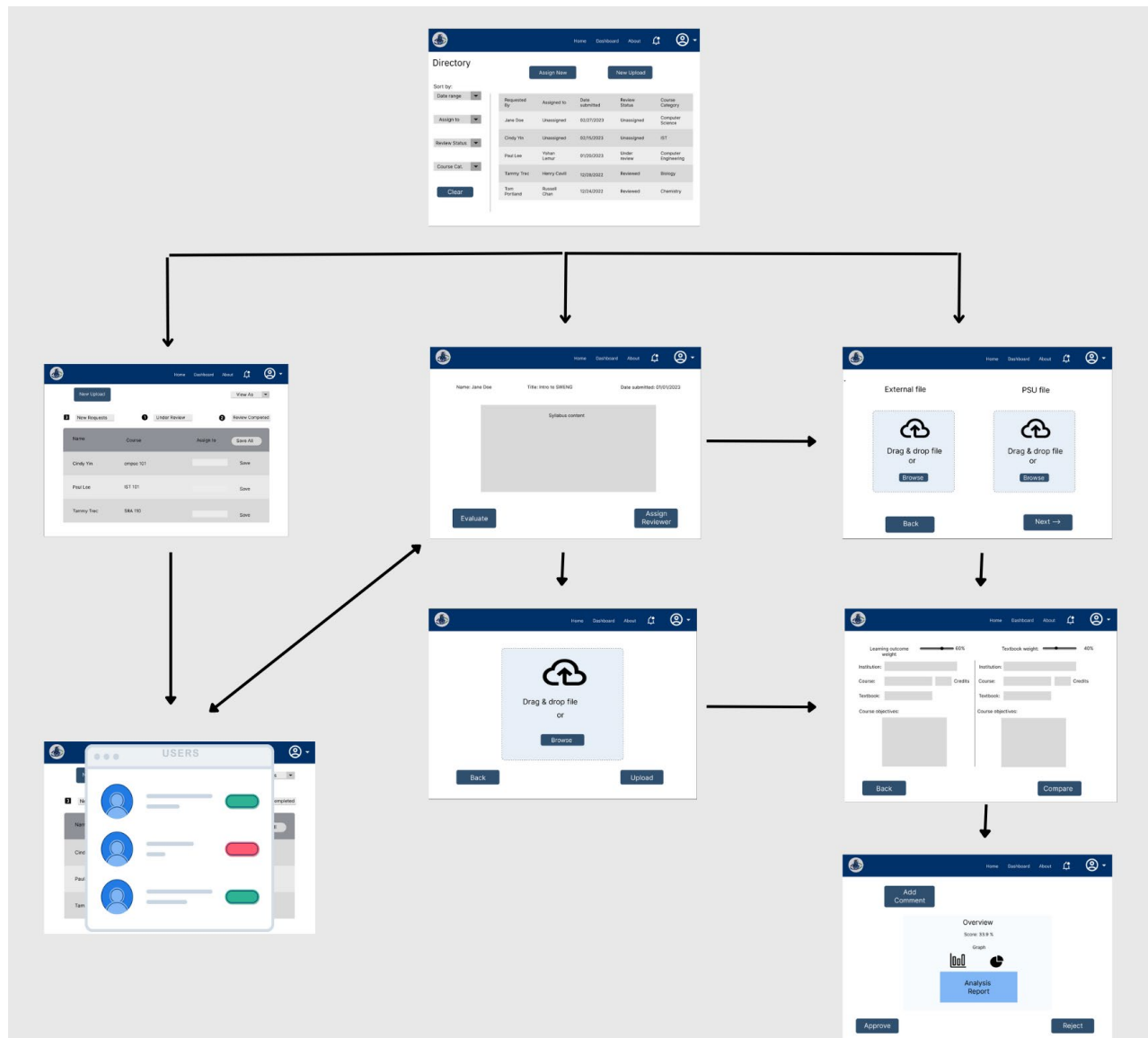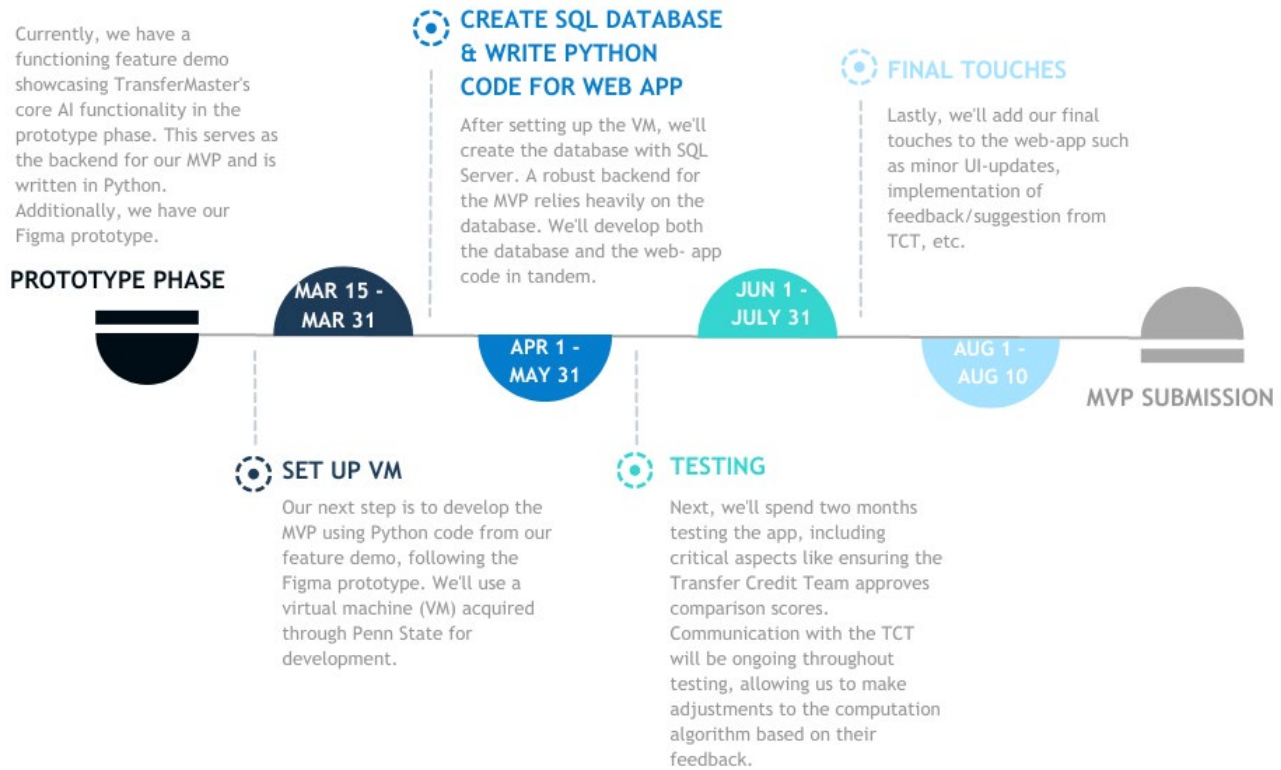
FINAL TOUCHES

Lastly, we'll add our final touches to the web-app such as minor UI-updates, implementation of feedback/suggestion from TCT, etc.

MAR 15 - MAR 31

APR 1 - MAY 31

JUN 1 - JULY 31

AUG 1 - AUG 10

MVP SUBMISSION

SET UP VM

Our next step is to develop the MVP using Python code from our feature demo, following the Figma prototype. We'll use a virtual machine (VM) acquired through Penn State for development.

TESTING

Next, we'll spend two months testing the app, including critical aspects like ensuring the Transfer Credit Team approves comparison scores. Communication with the TCT will be ongoing throughout testing, allowing us to make adjustments to the computation algorithm based on their feedback.

**Figure 6.1 TransferMaster Development Timeline**

7 Team Capabilities

Elizabeth Morvey

Elizabeth, our *Team Lead,* is a junior at Penn State Harrisburg majoring in Information Sciences and Technology, with a focus on Integration and Application. She is the President of Cyber Lions at PSU Harrisburg and is currently taking an IT project management class, which has allowed her to explore leadership and management models. Having a keen interest in UI/UX and experience with HTML/CSS (Tailwind), Next.js, React, and a variety of prototyping tools such as Figma, she is also our *Design Lead.*

Andrew Klawa

A junior at Penn State World Campus majoring in Software Engineering, Andy is currently working as a Computer Aided Design Technician at Bingham & Taylor. He will soon be starting a new position at Riverside Research as a Machine Learning Intern for the summer. With a passion for ML, and knowledge in various domains of software development he is our *Machine Learning Lead*.
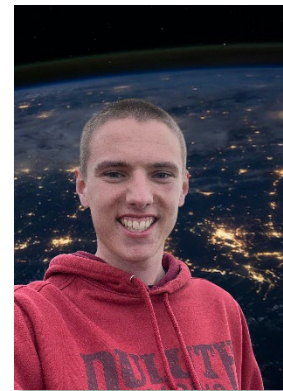
As transfer students themselves, Andy and Elizabeth are aware of the tedious process of transfer credit evaluation and are therefore, personally invested in this project. Our team shares this sentiment of speeding up this process to reduce the time overhead associated with all concerned parties.

Jared Daniel

Jared is also a Software Engineering Junior at Penn State World Campus. He has previously worked with NAVSEA as a Naval Research Enterprise Intern (NREIP - Software Engineering Focus) and with Knodemy as an Information Technology Intern. He will be returning as an NREIP for the upcoming summer. With a strong foundation in software development and invaluable internship experience, he is one of our *Technical Lead*s.

Manasi Patil

A Computer Science Junior at Penn State Behrend, Manasi is currently interning as a Software Engineer at an AI start-up – Mirro.ai. Being the Vice President of the Software Development Organization World Campus, she is well-versed in team delegation and management. With a strong interest and knowledge in backend and data science, she is also contributing to the role of *Technical Lead* for our team.

Neha Pandit

Also interning with Mirro.ai, Neha is a Software Engineering Junior at Penn State Behrend. Serving as the President of the Software Development Organization World Campus, she has a diverse set of skills ranging from team collaboration and coordination to experience with various core software technologies. She is contributing as the third *Technical Lead* to the team.

Our team is well aware of the time commitment that this project demands and has been actively putting in the necessary efforts to ensure that we see this project through.

8 Letters of Support

1. [Letter of Support from Penn State World Campus Transfer Credit Team](#)
2. [Letter of Support from Open Syllabus](#)

9 References

Undergraduate admissions. Data Digest. (2021). Retrieved January 12, 2023, from https://datadigest.psu.edu/admissions/

Karaganis, J. (2023). *About open syllabus*. The Open Syllabus Project. Retrieved January 12, 2023, from https://blog.opensyllabus.org/about-the-open-syllabus-project/

Appendix

Letter of Support from Penn State World Campus Transfer Credit Team

PennState
World Campus

Transfer Credit Services
The Pennsylvania State University
128 Outreach Building
University Park, PA 16802

814-867-4163
1-800-252-3592
Fax: 814-865-6727

December 2, 2022

Nittany AI Challenge
Nittany AI Alliance
313 Shirley M. Malcom Building
University Park, PA 16802

To Whom It May Concern,

I am writing in support of TransferMaster, an artificial intelligence powered transfer credit tool that will aid in the transfer credit evaluation process, as part of the 2023 Nittany AI Challenge.

I have had the opportunity to work with the team of students collaborating on this project and believe they have the ability to create a tool that can utilize technology to assist in what is currently a very manual and time-consuming process. Through a virtual meeting and email correspondence it is clear this team is taking the necessary steps to research the current transfer credit evaluation process and collect data so they can take an innovative approach to improve the process through artificial intelligence.

The Nittany AI Challenge encourages students from various educational backgrounds to identify pressing issues and use artificial intelligence to build solutions. I know first-hand how important enhancing the transfer course evaluation process is to Penn State prospective and current students as well as staff. I believe the TransferMaster team has the capability to transform the evaluation process and I am in full support of their work in this area.

Respectfully,

Tasha Rockey

Tasha Rockey
Acting Director
Transfer Credit Services
Penn State World Campus

Letter of Support from Open Syllabus

OPEN SYLLABUS

January 23, 2023

Nittany AI Challenge
Nittany AI Alliance
313 Shirley M. Malcom Building
University Park, PA 16802

To Whom It May Concern,

I write to express strong support for the work being done by the TransferMaster team in the Nittany AI Challenge. I am the CTO of Open Syllabus, a non-profit organization that collects and analyzes college course syllabi and uses this data to build tools to support teaching and learning. Over the course of the last 18 months, we have become increasingly interested in how machine learning can be used to build decision-support tools to help make credit transfer more efficient and equitable.

TransferMaster is a perfect example of work in this direction, and we think that the product they are envisioning has the potential to significantly improve the credit transfer workflow at PSU. And, if scaled up across many institutions, it could have wide-ranging impacts on post-secondary educational outcomes in the US – making credit transfer more efficient is one of the highest-leverage ways to reduce costs and increase graduation rates.

We have been delighted to work with the TransferMaster team over the last couple months as they have experimented with integrating the Open Syllabus document parsing models into their product, and we're excited to continue to contribute in any way we can as the work progresses.

Sincerely,

David McClure
CTO

Open Syllabus
306 W 100th St. Suite 61
New York, NY 10025

Figma Wireframe

Students: https://www.figma.com/proto/ExAEflrm2T1XrTM0Ro3EXC/prototype?page-id=254%3A880&node-id=256%3A995&viewport=417%2C389%2C0.13&scaling=contain&starting-point-node-id=256%3A1008

Transfer Credit Specialist:
https://www.figma.com/proto/ExAEflrm2T1XrTM0Ro3EXC/prototype?page-id=102%3A43&node-id=310%3A1590&viewport=1436%2C188%2C0.13&scaling=scale-down&starting-point-node-id=168%3A844

Reviewer: https://www.figma.com/proto/ExAEflrm2T1XrTM0Ro3EXC/prototype?page-id=102%3A44&node-id=310%3A987&viewport=252%2C198%2C0.06&scaling=contain&starting-point-node-id=310%3A932

TransferMaster Prototype GitHub Page Link

https://jaredd-sweng.github.io/TransferMaster/