

Board 92: Work in Progress: Developing an Application to Optimize Student Group Formation for Enhancing Inclusivity and Collaborative Learning

Dr. Zulal Sevkli, Miami University

Mr. Hunter Jarrod Hicks, Miami University

Hunter Hicks is a Jr. Developer at Applied Research Associates. Hunter is an alumnus of Miami University where he completed his Bachelor's degree in Computer Science in December, 2023. Hunter's academic interests include computational electromagnetics, 3D computer graphics, data representation, backend development, and algorithm analysis/optimization.

John Brandabur, Miami University

Andrew Philibin, Miami University

WIP: Developing an Application to Optimize Student Group Formation for Enhancing Inclusivity and Collaborative Learning

Andrew Philibin*
philibaj@miamioh.edu

Hunter Hicks
hickshj3@miamioh.edu

Jack Brandabur*
brandajj@miamioh.edu

Connor Bischoff*
bischoc2@miamioh.edu

Sarah Lin*
lins29@miamioh.edu

Nathan Farrar*
farrarn@miamioh.edu

Zulal Sevkli*
sevkli@miamioh.edu

Computer Science and Software Engineering
Miami University
Oxford, OH

Introduction

In educational settings, collaborative learning has emerged as a cornerstone of teaching practice, emphasizing the importance of group work in fostering student engagement, critical thinking, and knowledge retention. Within engineering programs, where teamwork and interdisciplinary collaboration are integral components, the efficacy of group formation strategies directly influences the learning outcomes and overall educational experience of students. Recognizing the role of optimized group formation in enhancing inclusivity and promoting collaborative learning environments, our project aims to address this imperative need by developing an innovative application tailored for facilitating student grouping within the Canvas Learning Management System (LMS). Grounded in empirical research and informed by existing literature on effective group dynamics, our application, IntelliGroups, aims to streamline the group formation process, offering educators a customizable and efficient solution for creating diverse, balanced, and cohesive student groups. This paper provides an overview of the theoretical framework, methodology, and implementation by emphasizing its significance in advancing educational practices and fostering inclusive learning environments in engineering education.

In the subsequent sections, we'll delve into existing literature and applications addressing analogous challenges, elucidating our approach in light of these insights. Following that, we'll analyze our application in-depth, detailing its implementation, merits, drawbacks, and forthcoming enhancements. We will also touch on the progress made with our application and explain what improvements will be made. Lastly, we'll offer conclusive remarks with implications for our project and lay out the plan and necessary steps to finish the project on time.

Previous Studies

Building effective student groups for learning is a thoughtful process. Instructors should consider students' diverse skill levels and knowledge of the subject or should consider students' backgrounds and experiences. Groups with a mix of expertise can foster peer teaching and learning. Mixing students from different backgrounds can lead to richer discussions [1]. Furthermore, research has also shown that isolating minority students within groups increases the risk of these students dropping out [2]. So, educators should adapt their group formation strategies to the specific learning objectives of the course and the needs of their students. This highlights the strong need for a helpful tool to help form student groups.

Traditional methods of group formation, where professors manually create groups, offer high customizability but are exceedingly time-consuming and may not yield optimal group combinations. Application-based methods, such as the current grouping function in Canvas LMS, while providing some automation, still require significant manual effort and offer limited customizability based on criteria. Another approach within Canvas is random group creation, which disregards students' backgrounds and experiences.

Inspired by applications like CATME Team-Maker [4], which focuses on criterion-based team assignments, our application, IntelliGroups, shares a similar goal but is specifically designed for professors at Canvas-using universities. IntelliGroups automates the group formation process by assigning custom weights to students based on multiple criteria, including schedule, race/nationality, grade-point average (GPA), and software skills. Building upon this foundation, we have introduced additional criteria, such as international or domestic student classification and customizable preferences for professors.

The Application

Creating groups within the Canvas Learning Management System (LMS) using the provided tools is a straightforward process. To begin, navigate to the "People" tab, where users can initiate group creation by selecting "+ Group Set." This action prompts the user with several settings for configuring the group they wish to create. Users can specify the group name in an input field and choose whether students can self-enroll in a group or if enrollment is restricted to students in the same class section. Additionally, users can determine the group's structure using a drop-down menu.

For structuring groups based on the number of groups required, users input the desired number, and Canvas will distribute students into an equal number of groups to the best of its ability. Alternatively, users can specify the desired group size, and Canvas will allocate students into groups of that size as effectively as possible.

The primary objective of our project is to enhance the group formation tool within the Canvas LMS, addressing the limitations of the current grouping options. Canvas is widely utilized in North American higher education institutions, with approximately 36% adoption [3].

Our application is designed to empower faculty by offering a more customizable and efficient solution for student group formation.

Our theoretical framework revolves around the idea that optimized group formations foster inclusivity and positively impact learning environments. By integrating customizable algorithms into the Canvas LMS grouping tool, we aim to leverage existing research findings on effective group dynamics to enhance student collaboration and engagement.

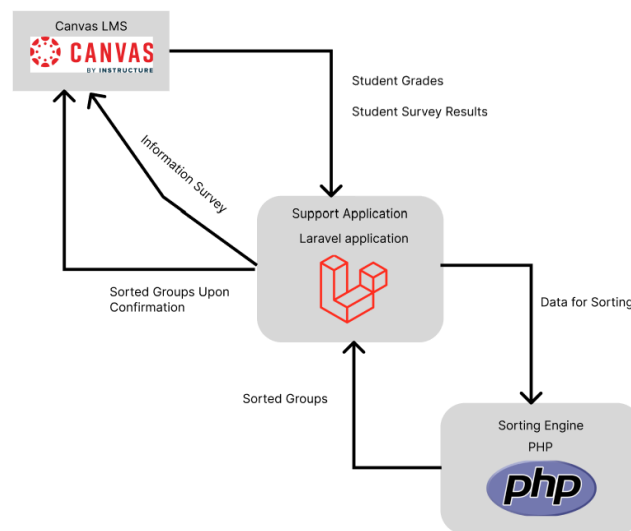
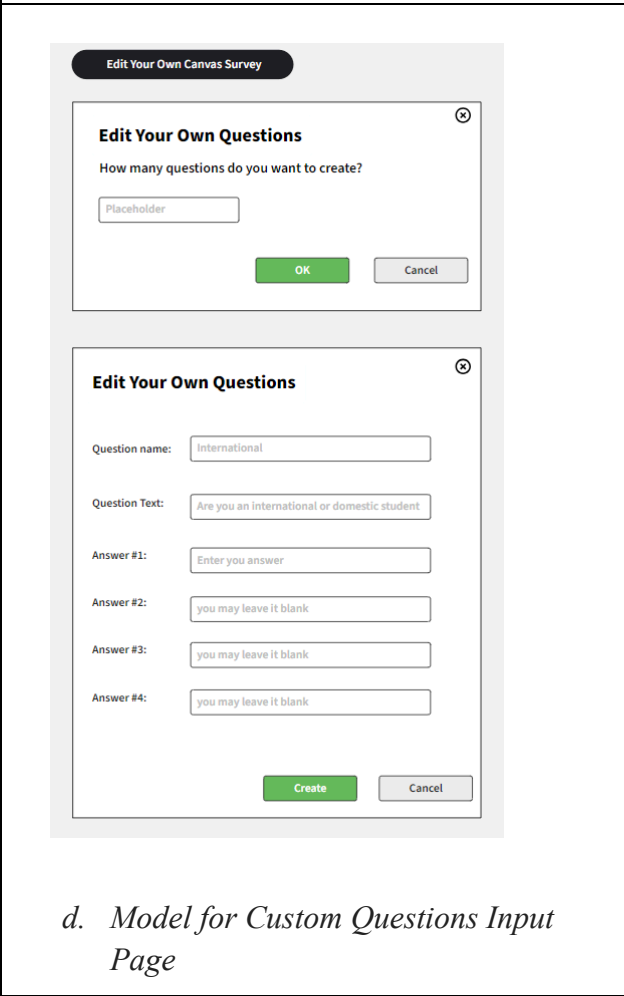
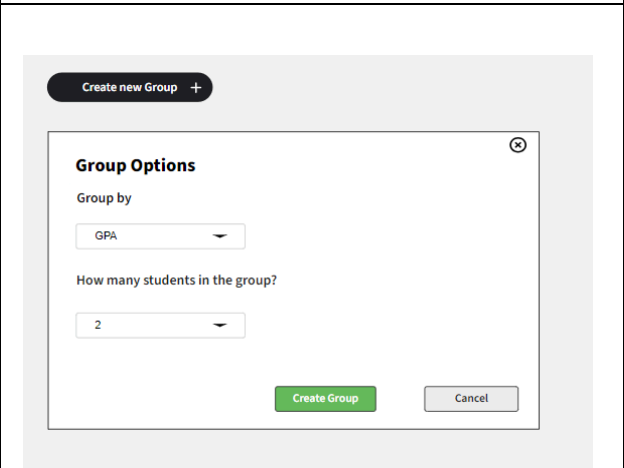
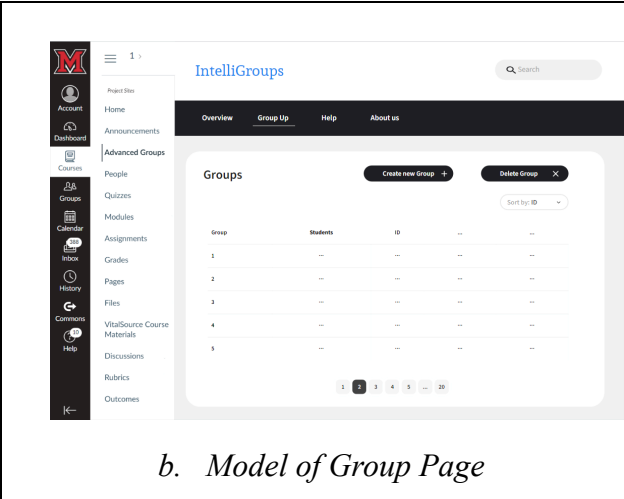
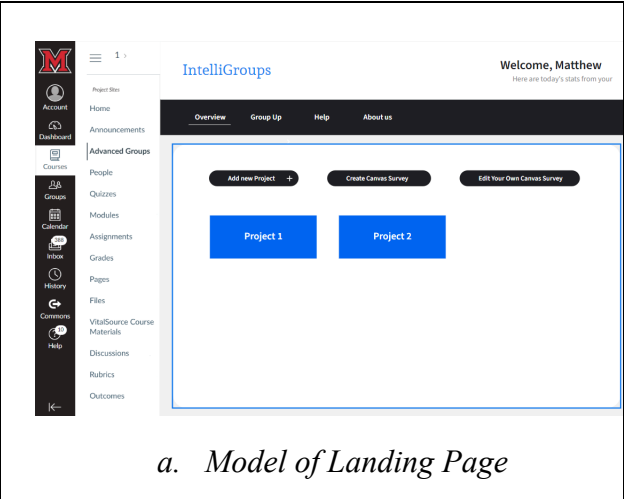


Figure 1. The framework of IntelliGroups

The implementation of our application involves utilizing the Canvas LMS API to extract relevant student information. The framework currently supports three grouping algorithms, including grade in the class, gender, major, and skill sets, allowing for flexibility in the selection of criteria. The application's architecture is designed to facilitate the integration of new and more advanced grouping algorithms in the near future.

Our design prioritizes a user-friendly and modern UI to ensure a seamless experience for professors navigating the application. Through intuitive navigation tools, swift data retrieval from the LMS, and easily accessible dropdown menus, our goal is to simplify the group formation process, making it as effortless as configuring any other option within Canvas.

To enhance convenience, our vision includes integrating our application into the Canvas platform itself. This integration eliminates the need for professors to access our application externally, allowing them to perform all necessary actions in a unified environment. This cohesive approach not only streamlines the user experience but also aligns with the workflow professors are accustomed to within Canvas, contributing to the overall efficiency of the educational management process. Figure 2 depicts the outline of the interfaces for IntelliGroups.



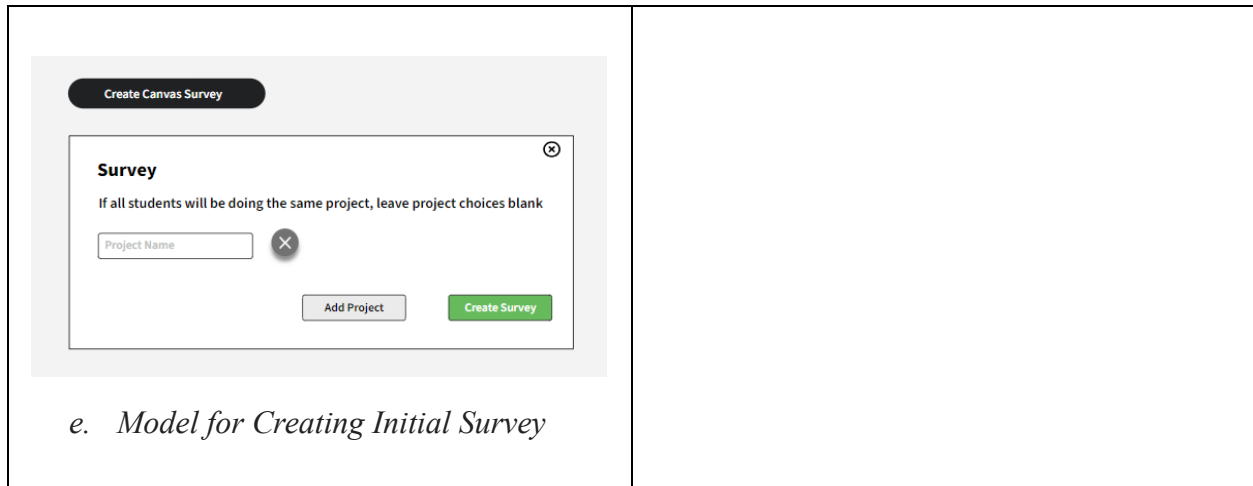


Figure 2. The outline of the interfaces for IntelliGroups

The initial version of IntelliGroup incorporated three grouping criteria: gender of students, students' grades in the class, and project preference. The application pulls the class roster from Canvas into an external application, groups the students, and then pushes those newly created groups back into Canvas. The initial version of our application was slow in splitting the students into their groups, often taking several minutes to complete. However, in our version, we plan to improve the speed of this process down to mere seconds by using an improved heuristic-based algorithm as described below.

Pseudo-code for Sorting and Grouping Algorithm:

1. Priorities:
 - Parameters selected by the teacher are scaled from 0 to 5, indicating least to highest importance.
 - Parameters assigned a priority of 0 won't influence the grouping.
2. Initial Group Sorting:
 - Divide class size by group size to distribute students evenly.
3. Calculating Group Diversity Score:
 - Assign scores based on diversity criteria.
 - Calculate the score for each group as the sum of diversity scores multiplied by parameter priorities.
 - Apply scalar if the group size exceeds the number of answers.
4. Calculation of Scores:
 - For diverse responses: count unique responses; if group size exceeds the answer set size, assess even distribution.
 - For similar responses: count repeated responses; if there is no similarity, the score reverts to 0.
5. Final Score Calculation:
 - Priority of parameter * evaluation of characteristic * scalar (if selections < group size).

6. Optimizing Group Scores:

- Utilize simulated annealing algorithm.
- Randomly swap two students from different groups.
- Evaluate average score; accept swap if improvement or revert if not.
- Accept worse states based on temperature (high temp favors worse states).
- Decrease temperature linearly to 99% each iteration.
- Terminate when the temperature reaches 0.

Preliminary Test Result:

Group size of 2

Test #1	Class size	Time to complete	Old Score	Score
	31	53ms	18.4	25.2
	72	78ms	19.06	24.72
	131	114ms	18.75	24.01

Test #2	Class size	Time to complete	Old Score	Score
	31	50ms	16.93	25.8
	72	78ms	18.25	24.83
	131	120ms	17.42	24.48

Test #3	Class size	Time to complete	Old Score	Score
	31	51ms	17.6	24.77
	72	73ms	18.22	24.33
	131	118ms	18.73	23.99

Test #4	Class size	Time to complete	Old Score	Score
	31	51ms	18.27	25.67
	72	82ms	17.47	24.61
	131	116ms	18.56	24.32

Test #5	Class size	Time to complete	Old Score	Score
	31	49ms	18.6	25.33
	72	80ms	18.36	24.56
	131	123ms	17.94	23.99

Group size of 5

Test #1	Class size	Time to complete	Old Score	Score
	31	47ms	43.48	64.66
	72	71ms	55.66	71.48
	131	102ms	56.67	72.39

Test #2	Class size	Time to complete	Old Score	Score
	31	49ms	42.21	65.1
	72	73ms	53.15	71.11
	131	98ms	52.91	72.79

Test #3	Class size	Time to complete	Old Score	Score
	31	41ms	47.33	63.62
	72	74ms	54.63	71.97
	131	100ms	53.91	73.45

Test #4	Class size	Time to complete	Old Score	Score
	31	49ms	47.68	64.27
	72	73ms	53.58	70.71
	131	105ms	56.1	71.7

Test #5	Class size	Time to complete	Old Score	Score
	31	48ms	49.67	62.86
	72	64ms	55.28	71.5
	131	100ms	56.42	72.66

Conclusion and Future Plans

This paper delves into the critical need for an optimized solution to student group formation, particularly within engineering education. We highlight the escalating emphasis on collaborative learning and the pressing requirement for tools that streamline group formation. Drawing from previous studies and existing applications, we dissect the literature surrounding group dynamics and the shortcomings of current grouping methods. Our project, IntelliGroups, fills this gap by offering a highly customizable and efficient approach to group formation, harnessing criteria like GPA, gender, and project preference.

Our group is taking the necessary steps to ensure that the application will be complete by the conference date. Our project plan focuses on key development milestones to ensure the timely completion of IntelliGroups. Starting with backend development and integration, we'll finish the remainder of the core infrastructure, including implementing the application into

Canvas. Following this, we will dedicate efforts towards front-end development and UI refinement, improving the current interface and ensuring optimal usability in Canvas. After that, we will build upon the testing already conducted to address any bugs or performance issues. Lastly, we'll focus on the remainder of documentation and finalization, preparing comprehensive documentation and conducting final testing to ensure the IntelliGroups application meets all specified requirements and is ready for submission.

Ensuring the success of our project involves several critical evaluation criteria. Firstly, we aim to achieve a project outcome free from technical errors, ensuring that the application operates smoothly and efficiently without disruptions. Additionally, we will measure the success rate of group formation, evaluating the effectiveness of our algorithms in creating diverse and balanced student groups. To gather comprehensive feedback, we plan to conduct testing sessions with faculty members, soliciting their opinions and insights on the usability, functionality, and overall performance of the IntelliGroups application. By systematically assessing these aspects, we can validate the project's success and identify any areas for improvement further to enhance the application's efficacy and user satisfaction. Once complete, IntelliGroups will contribute to student group formation, addressing the evolving demands of collaborative learning in higher education.

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