

# AB LA NIT

METALS CAPSTONE SUMMER REPORT 2019  
COALESCE



Carnegie  
Mellon  
University



Human-  
Computer  
Interaction  
Institute



# Acknowledgments

We made a lot of progress in a very short span of time, but we were not alone in this journey. A lot of people sharing our enthusiasm for this idea helped bring about this report and all the progress the KLab team has made these past few months. It is at this point that we would like to thank all of these people for helping us make the progress we did.

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Lastly, we wish to thank K12 in general for allowing us the opportunity to work with them on such an engaging project. For an organization this large and ubiquitous, we were really caught by surprise about their openness with their internal resources, the amount of time spent on ensuring we received the right kind guidance, and how consistent they were in engaging with our group, showing how much they value and trust us. It was truly a memorable experience.

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# OVERVIEW

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METALS is a one-year, interdisciplinary master's program that trains graduate students to become **learning engineers, programmers and LX (learning experience) designers**.

In these roles we apply learning science principles, evidence-based research, and large-scale data analysis to design, create, and improve educational resources and technologies that enable students and instructors to succeed. The second and third semester of this program culminates with a seven-month capstone project for an external client.

Our program lies at the intersection of Learning Science and Computer Science and finds ways to effectively deliver quality education through online mediums.

# EXECUTIVE SUMMARY

K12 students often report having less social, collaborative learning opportunities than their brick-and-mortar counterparts. K12 believes that project based learning (PBL) is an approach that can address this problem. K12 approached CMU MET-ALS, and the KLab team was assigned to investigate the unique problem space of online PBL. After finding a variety of problem areas, referred to in the report as breakpoints, KLab classified the areas into two major categories, those specific to K12's unique situation and those that are found in any PBL environment.

KLab is proud to use this report to introduce their work over the period of May to July 2019: Coalesce. Coalesce is the result of KLab brainstorming an educational tool to help combat as many problem areas specific to K12 as possible. The working prototype of Coalesce contains 5 features focused on assessing, visualizing, and utilizing students' professional skills including an initial self evaluation, a benchmark self and peer evaluation, a dashboard, an in depth student profile, and a grouping tool to help teachers form groups using the data our system provides.

This report is split into two halves. The first half introduces our final product and an explanation of its features and designs, and how they address the problems we found during the Spring Semester. It also includes areas where the product could be developed further and where there are still areas of possible improvement that have not yet been addressed by KLab. The second half details the process of Coalesce's creation, including a case study of how the presentation of the grouping tool evolved from an idea to current incarnation in the working prototype.

# HUNT STATEMENT

We will research Project Based Learning (PBL) principles, specifically focusing on those concerning collaboration. We will compare these principles and theoretical ideals to K12's particular context through analyzing K12 students' and teachers' needs and pain points on collaboration. This will inform our prototype which will both augment the teacher's ability to personalize PBL instruction and mitigates some of the barriers that make it difficult to achieve High Quality PBL (HQPBL) in K12 virtual classrooms.

# ABOUT THE CLIENT

K12 is an education management organization that offers both fully functional online public school systems as well as individual courses for students from Kindergarten to 12th grade. K12 operates no physical schools, catering mainly to homeschooled children and selling its services to charter schools.

In general, students and parents turn to K12 because they deal with constraints and requirements that brick and mortar schools typically cannot accommodate. These students work with certified teachers and complete both asynchronous self-paced coursework and attend synchronous learning sessions throughout the week.

On the surface level, the organizational structure of K12 schools resembles that of a brick and mortar school, with **teachers** teaching **students** with the help and supervision of their **learning coaches** (i.e. usually parents). Teachers are supported and supervised by **department chairs** and **administrators** of their school.

What K12 needs in addition to the brick and mortar organization are the employees that keep the online system and curriculum running: **FAST Liaisons** are in charge of being the actual physical presence of the school in a student's online learning career and will visit students' homes, usually for absenteeism or behavioral issues. Curriculum is written up and presented in a way easy for online dissemination by the **instructional design team**, and it is here where the **PBL specialists** are helping advise development of new PBL curriculums. The system is constantly going through updates and design retooling by the **product design team**. The **teacher trainers** then help bring schools up to date on these changes.

# ABOUT METALS & CAPSTONE

## METALS OVERVIEW

The Masters of Education Technology and Applied Learning Science (METALS) is a one-year professional Masters degree at Carnegie Mellon University's Human-Computer Interaction Institute. The program is situated between design, computer science, and psychology, drawing on areas of all three to inform better design, creation and evaluation of learning technologies. METALS graduates apply learning science principles, evidence-based research, and large-scale data analysis to design, create, and improve educational resources and technologies that enable students, instructors, and educational leaders to succeed.

## CAPSTONE OVERVIEW

The METALS program culminates in a seven-month capstone project for an external client. Guided by industry and faculty mentors, students form interdisciplinary teams and follow a product development life-cycle, from exploratory research to ideation to prototyping. Through the capstone project, students learn to combine the skills they have learned throughout METALS, communicate with a corporate client, meet the needs of various stakeholder groups, and develop a novel educational product.

# ABOUT THE KLAB TEAM



Project Coordinator

## Harley Chang

Harley received his master's degree in Technology, Innovation and Education from the Harvard Graduate School of Education in 2013 and has taught high school mathematics for the past 5 years. He wishes to use his knowledge and experience to help develop and improve the lives of the next generation of educators.



Content and Creative Lead

## Xiaofei Zhou

Xiaofei has a background in Industrial Engineering with a specialization in Human Factors from Tsinghua University in China. Her design passion and research interests lie in creating embodied and intelligent interfaces that can improve the learning, communication and wellbeing for people of diverse abilities and backgrounds.



## Rishi Pisipati

### Development Lead

Rishi holds a bachelor's degree in Computer Science and Engineering from NIIT University in India. He is fascinated by the developments being made in both Computer Science and Educational Technology and hopes to become a Learning Engineer focused on developing open source frameworks that will aid educators.



## Xiaoyan Song

### Research Lead

Xiaoyan holds a bachelor's degree in Psychology from Durham University in the UK and has interned as a teaching assistant in a local primary school. She aspires to understand learners' and educators' needs through a psychological lens to help improve the learning experience for all students, especially underserved ones.



## Sasha (Zhuolin) Meng

### Design Lead

Sasha holds two bachelor's degrees, one in Educational Sciences and another in Psychology and Social Behavior from the University of California, Irvine. She wants to use her skills in interactive design and the field of digital education as a UX designer and learning engineer to offer a better experience to users, especially those who are in the educational field.

## OVERVIEW



Shoot on May 5th, 2019 at CMU

# PRODUCT WALKTHROUGH

The Problem

The Solution: Coalesce

Main Features Walkthrough

Feature 1: Initial Self Evaluation

Feature 2: Benchmark Self/Peer Evaluation

Feature 3: Class Dashboard

Feature 4: Student Profile

Feature 5: Grouping Tool

Use Cases



# THE PROBLEM (SPRING SUMMARY)

KLab identified 21 different causes preventing efficiency and effectiveness, referred from here on out as breakpoints, for PBL in K12's online setting. These breakpoints can be categorized into 3 major categories: ones exacerbated by K12's unique situation (either by their unique student body or the online environment), ones inherent to PBL, or ones that don't easily fit into the two previous categories (mainly systemic problems). These 21 breakpoints, in turn, resulted in 6 major problematic areas preventing High Quality PBL (HQPBL).<sup>1</sup>

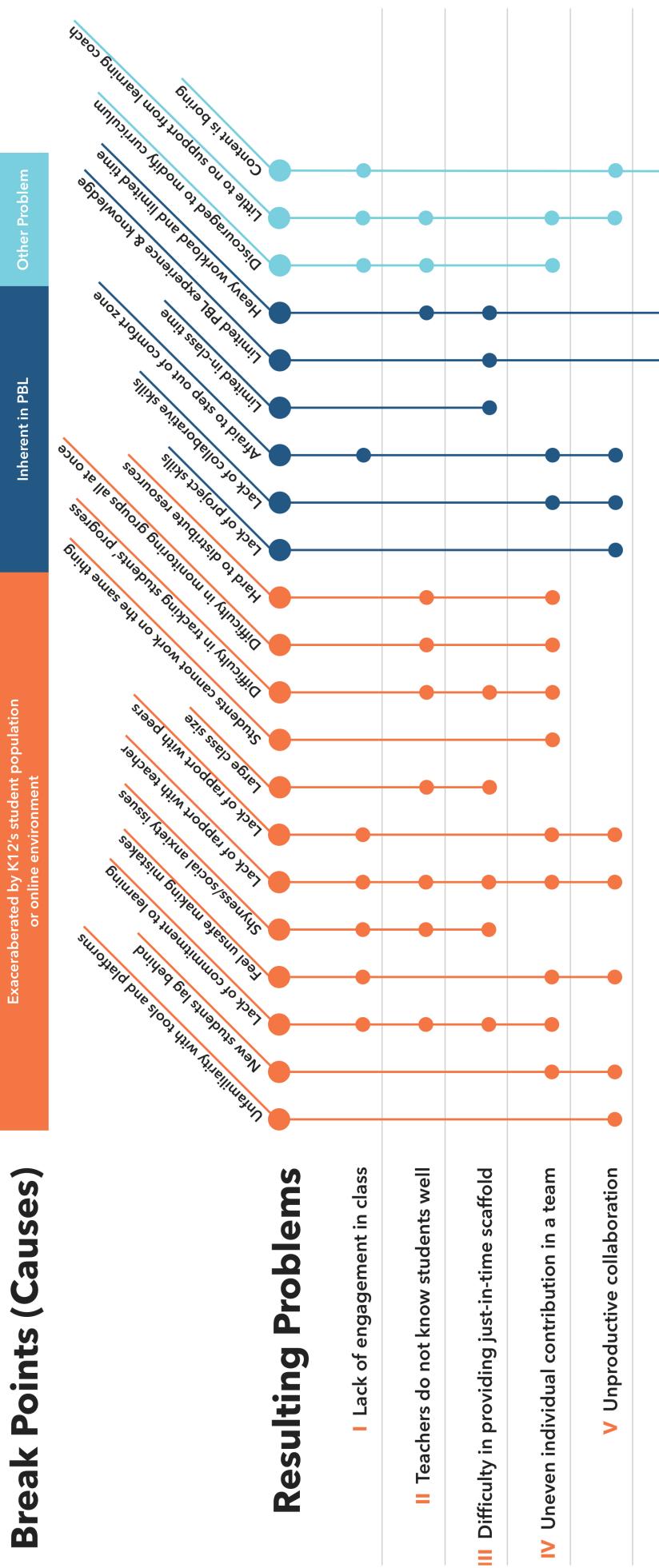
## BREAKPOINT MAP →

These 6 major areas, in turn, led to 7 guiding design problems for us to tackle:

1. How might we build rapport among students and between students and the teacher in PBL?
2. How might we help teachers to better understand students in order to tailor to different student needs in PBL?
3. How might we make it possible for teachers to monitor and track students' learning activity in PBL in order to provide just-in-time support?
4. How might we help students without prior PBL experience adapt to PBL without being overwhelmed by the heavy workload?
5. How might we facilitate positive interdependence and individual accountability in online PBL?
6. How might we support productive group collaboration that works for all types of learners?
7. How might we help novice teachers to plan a good PBL curriculum that meets the criteria of HQPBL and tailor to students' needs?

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<sup>1</sup> Break points and subcategories of each problem can be read in fuller detail in Appendix C, Relevant Spring Report pages.

**Breakpoints Map**

Spring report findings

# THE SOLUTION: COALESCE

Coalesce is a tool that empowers teachers through assessing by visualizing and utilizing students' spring report findings professional skills in Project-based learning.

## SCOPE OF PROTOTYPE

1. An **initial self assessment** for students to self report their skill and comfort level with various professional skills to create the initial profile and data in the system.
2. A **self assessment and peer assessment** of various professional skills to be given at benchmarks.
3. A **dashboard** which summarizes students' data being **pulled from evaluations and interactions for the class**.
4. An **individual student's profile page**, showing his or her current level of professional skills as well as their growth over time.
5. A **grouping tool** that can automatically create groups.

The dashboard displays student evaluations for History 2A. It includes a navigation bar with 'Class dashboard', 'Grouping', 'Notes', 'Setting', 'Help', and a user icon. Below the navigation is a search bar with 'Reminder' and 'Evaluation' buttons. The main area shows three groups of students with their evaluation status (Exemplary, Accomplished, Developing, Exemplary, Accomplished) for each skill. A 'Group average' icon is present for each group.

The profile for Ariana Campbell includes an 'Attention' sidebar with a list of students and their evaluation status. The 'Overview' section shows cumulative evaluations for each skill. The 'Participation' section includes a 'Teams' chart showing active time in-class and out-class over time, and a 'Single evaluation summary' timeline from Feb 26 to May 14. The 'Evaluation' section shows a grid of skills and their average levels (Exemplary, Accomplished, Developing) across four categories: Public speaking, Writing, Creative, and Critical thinking.

## Class Dashboard

The grouping tool allows for random or smart assignment of students to teams. It features a 'Table' or 'Chart' view, a sorting dropdown, and a 'Save' button. The chart view shows students assigned to teams A through G, with each team having a 'Save' and 'Confirm' button.

The cumulative evaluation summary provides a detailed look at student performance across skills like Collaboration, Communication, Problem solving, and Project management. It includes line charts for peer and self-assessments, and a 'Download' button for the data.

## Grouping Tool

## Student Profile

## WHAT IT SOLVES, AT A GLANCE →

Coalesce mitigates or augments the teacher's ability to address the majority of breakpoints we have discovered. Clearly missing from the problems addressed are the three breakpoints in the Other category, which are more systemic in nature and cannot be solved through ed-tech alone.

## THE BREAKPOINTS SOLVED IN DETAIL

Please read each of the statements below, and decide how much it is like you. There are no right or wrong answers. Please be as honest as you possibly can.

I work well with other members of the team to accomplish the job.

I always give my best when I am working to solve a problem.

I always respect other people's opinion, even when I disagree.

I actively communicate my ideas and opinions with other people.

I'm comfortable giving presentation in front of my classmates.

**Student initial survey**

### ● New Students Lag Behind

It is hard for a K12 teacher to know what new students' prior knowledge, personality or work habits are like. Coalesce helps overcome this problem by getting students to take an initial self evaluation at the beginning of a new semester. This gives both the system and teachers actionable data to work immediately with, without having to figure out such information through several weeks worth of interactions.

**Breakpoints Map**

What Coalesce solves

Last evaluation
Cumulative
Sort by **First name**

Display
Select all
Communication
Public speaking
Writing
Problem solving
Group discussion

		Ariana Campbell	Exemplary	Exemplary	Exemplary	Exemplary	Exemplary
<input type="checkbox"/> Collaboration			Evaluation Jun 13	↑ Exemplary	Exemplary	Exemplary	Exemplary
<input type="checkbox"/> Cooperative							
<input type="checkbox"/> Commitment							
<input type="checkbox"/> Respectful							
<input checked="" type="checkbox"/> Communication			Evaluation Jun 15	↑ Exemplary	↓ Accomplished	↑ Exemplary	↑ Exemplary
<input type="checkbox"/> Communicative			Evaluation Jun 13	↓ Accomplished	Exemplary	Developing	Accomplished
<input checked="" type="checkbox"/> Public speaking			Evaluation Jun 15	↓ Accomplished	Exemplary	Accomplished	Exemplary
<input checked="" type="checkbox"/> Writing			Evaluation Jun 17	↑ Developing	Exemplary	Developing	Exemplary
<input checked="" type="checkbox"/> Problem solving			Evaluation Jun 10	Exemplary	↓ Exemplary	Exemplary	Exemplary
<input type="checkbox"/> Creative			Evaluation Jun 13	↑ Exemplary	Exemplary	Exemplary	Exemplary
<input type="checkbox"/> Critical thinking			Evaluation Jun 13	↓ Accomplished	Exemplary	↓ Accomplished	Exemplary
<input type="checkbox"/> Grit			Evaluation Jun 13	Exemplary	↓ Exemplary	Exemplary	Accomplished
<input type="checkbox"/> Reflective thinking			Evaluation Jun 17	↑ Developing	↓ Accomplished	Exemplary	Exemplary
<input type="checkbox"/> Project management			Evaluation Jun 15	↑ Exemplary	↑ Exemplary	Exemplary	Exemplary
<input type="checkbox"/> Leadership			Evaluation Jun 16	↓ Developing	Exemplary	Developing	Developing
<input type="checkbox"/> Organization							
<input type="checkbox"/> Group discussion							
<input type="checkbox"/> Active time in-class							
<input checked="" type="checkbox"/> Discussion evaluation							
<input type="checkbox"/> Production in group							
<input type="checkbox"/> Time spent out-class							

**Class dashboard**

Ariana Campbell
Notes

Ariana Campbell
Notes

Evaluation Jun 13
Low group discussion engagement
X

Evaluation Jun 13
Big drop on project management
X

Overview

Collaboration
Communication
Project management
Problem solving
Group discussion

Latest evaluation
Exemplary
↑ Exemplary
Developing
↑ Exemplary
↓ Exemplary

Cumulative
Accomplished
Exemplary
Accomplished
Exemplary
Exemplary

**Student profile**

### ● Difficulty in Tracking Students' Progress

#### & Lack of Teacher-Student Rapport

Coalesce's student profile can be viewed either in terms of the latest evaluation's scores or in cumulative terms, allowing teachers to individually look through the history of evaluations and to see the patterns and growth among them. Best of all, these data points on every student's professional skills are pulled and analyzed starting from the first day with the initial self evaluation, giving teachers relevant talking points with students long before they would be able to otherwise. In this case, teachers can know what sort of help the student needs and make the student comfortable to ask for help from a teacher.

- **Lack of Project, Collaborative or Social Skills & Commitment to Learning**

To achieve HQPBL, Project Based Learning requires its learners to have multiple categories of essential skills to succeed. While PBL will inherently teach these skills, giving a project that requires more professional skills than its learners have will result in an ineffective learning environment. For example, many K12 students have social anxiety issues, feeling intimidated to talk or write in front of a large group they are unfamiliar with. This poses a challenge for PBL, where students must communicate with each other regularly and are encouraged to present their product in a public setting.

In the Coalesce student profile and class dashboard, the three categories of project management, collaboration, and communication skills are shown, calculated from self and peer evaluations. Having the knowledge of which students are strong and which students are weak in these areas helps teachers provide more personalized scaffolding and feedback, and having all the actionable data organized in one place allows teachers to easily refer to it.

Coalesce also has another category dedicated to participation, which is calculated based on automatic pulling and analysis of group activity data. As teachers can't be supporting all students at all times, it pays to have the system be able to monitor and report when a student is not doing his or her work, or is otherwise disengaged from team activities.

**Student profile**

Student	Performance	Exemplary	Accomplished	Exemplary	Accomplished	Accomplished
Ariana Campbell	Exemplary	Exemplary	Exemplary	Exemplary	Exemplary	Exemplary
Dan Voss	Accomplished	Exemplary	Accomplished	Exemplary	Exemplary	Accomplished
Max Johnson	Exemplary	Exemplary	Exemplary	Accomplished	Accomplished	Accomplished
Paige Smith	Developing	Accomplished	Exemplary	Exemplary	Exemplary	Accomplished
Group average						

**Grouping tool**

Sort by: Collaboration

Team	Students
A	Sam Strong, Isabell Rich
B	Sawyer Smiley, Ariana Campbell, Paige Smith
C	Sam Strong, Darby Grandk
D	Isabell Rich, Darby Grandk

### ● Heavy Workload and Limited Time

#### & Large Class Size

PBL, being a more messy and open ended type of instruction compared with lecture, can often lead each team dealing with its own types of problems that aren't easily applicable to other teams. Thus, teachers must deal with each problem individually, which requires a great deal of time. However, outside of the usual preparation needed for classes, much of teachers' time outside of class is occupied by attempting to reach out to disconnected students or providing support to new students or students with special needs. Coupled with the large class sizes, it is hard for teachers to find time to do much else.

Coalesce is organized in a way to help teachers get the knowledge they need as quickly as possible. The class dashboard has a variety of features such as flagging, sorting and filtering and growth or regression arrows that help bring important information to the forefront. Coalesce's grouping tool also has a smart grouping feature that automatically creates intentional groups for teachers, removing the tedious and timely task of doing it themselves.

- **Limited PBL Experience and Knowledge  
& Difficulty in Monitoring All Groups**

PBL is a complex way of delivering subject matter, requiring teachers that use this method to not only be subject matter experts, but also experts in their students and experts in facilitating discovery as opposed to telling students the answer. With K12 only beginning its foray into this pedagogical method, most interested teachers are still relatively new in facilitating PBL in an online environment.

Coalesce, while generally unable to help bridge the experience gap, is able to bring the good practices of experienced teachers to group formation. With each group formed through the press of the smart group formation button comes an underlying algorithm created from the advice and rules of many experienced teachers' interviews. Coalesce's class dashboard also includes a group view, allowing teachers to see the dashboard information with respect to the current groups of the project. Additionally, within the student profiles are visualizations that compare the student with his or her teammates both for work in and outside of class, allowing teachers to monitor the group without having to physically be a part of it.

# Feature I

## Initial self evaluation

“

*This is a really good idea; I wish we had something like this now.*

T3

### WHAT IT DOES

A self assessment of professional skills to give the system and teachers something to immediately work with instead of being left to figure out it for each student over the course of many weeks.

“

*I love the initial assessment, it tells me which students are being more reluctant and which student wants to take up being a leader. Looking at this would be helpful to us.*

T4

### MAIN BREAKPOINTS COVERED

New students lag behind

Lack of teacher-student rapport

### HOW ARE BREAKPOINTS COVERED BY THE FEATURE

- **Breakpoint covered: New students lag behind**

By the end of the new student's first week in the class, he or she will have filled out the initial survey and the teacher will have a better sense of the student's professional skills, as opposed to having to figure things out over the course of many weeks, in which the class may already be over if the student joined particularly late in the semester. This allows the teacher to help integrate the new student into the PBL curriculum much faster and with less trial and error.

- **Breakpoint covered: Lack of teacher-student rapport**

The initial survey gives the teacher something they can connect with the student both on a personal level and an academic level. This will allow the teacher to confidently talk to the student at the beginning of the course, establishing a relationship that can continue to grow throughout the semester.

“

*Students will like the survey because they like to talk about themselves, they won't mind answering the questions once.*

T7

Please read each of the statements below, and decide how much it is like you. There are no right or wrong answers. Please be as honest as you possibly can.

I work well with other members of the team to accomplish the job.



I always give my best when I am working to solve a problem.



I always respect other people's opinion, even when I disagree.



I actively communicate my ideas and opinions with other people.



I'm comfortable giving presentation in front of my classmates.



I'm confident in my writing skill.



Submit

Screenshot of several survey questions

“

*I think most of the questions  
are very good and are important  
questions to ask.*

T8

“

*This is all great stuff, nothing  
negative, it's very thorough.*

T12

#### FEATURE SPOTLIGHT:

CAN WE TRUST RESULTS OF THE SURVEY?  
A TRIANGULATION OF EVIDENCE

- **A look into crafting the survey questions**

The comprehensive version of the alignment table can be found in the Appendix A, including the alternative versions of the initial self evaluation and benchmark evaluation questions, and the alignment with PBL rubrics from the Buck Institute for Education.

To show how we crafted questions for our own survey, this sub-section shows some questions under the category of collaboration, along with the references we have found to support our question design. The rest of the question design can be found in the Appendix A.

Category & Subcategories	Self Report Questions	Self/Peer Evaluation Questions	Alignment with K12 PBL rubric	Alignment with ESS
Cooperative	I work well with other members of the team to accomplish the job.	Works well with teammates and willingly provides help to teammates to forward group goals	Working well with teammates on a group task and willingly providing help to teammates in support of group goals.	ESS07.03 (04,05,10,11) ESS07.04 (02) ESS07.05 (05)
	Commitment	I always give my best when I am working to solve a problem.	Submitting quality work on time and constantly contributes to group goals	ESS07.02 (05) ESS07.03 (07,08) ESS07.05 (03,05)
Communication	Respectful	I always respect other people's opinions, even when I disagree.	Listens attentively to others and respects other perspectives, especially different opinions.	ESS09.01.03
	Communicative	I actively communicate my ideas and opinions with other people.	Communicates with the team actively about deadlines, goals and ideas.	ESS07.03 (05) ESS07.04 (04,05,06)
	Public Speaking	I'm comfortable giving presentations in front of my classmates.	Orally presents information, findings, and ideas to the class with confidence, in a clear and logical way.	ESS03.03 (04) ESS07.03 (11) ESS07.05 (06)
Writing	Writing	I'm confident in my writing skills.	Expresses written information, findings and ideas in a clear and logical way.	N/A
	Grit	I always finish my tasks even if they are hard for me.	Resolves project challenges and failures with perseverance.	N/A
Problem Solving	Creativity	I often come up with different ways of solving problems.	Helps the group develop creative and realistic solutions.	ESS02.05 (01-03)
	Critical Thinking	I evaluate arguments by assessing whether reasoning is valid and the evidence is relevant and sufficient	Evaluates reasoning and evidence of given conclusions, instead of taking conclusions at face value.	ESS03.01 (01,02,03,05,08,09,10,11) ESS09.03.07
	Reflective Thinking	After I have solved a problem, I analyze what went right or what went wrong.	Reflects frequently to see what went right and wrong in the project to improve future processes	N/A
Project Management	Leadership	I am good at leading a group to work towards a common goal.	Leads the group effort to accomplish group goals and helps promote collaboration between group members.	ESS07.01 ESS07.02 (04,06,07) ESS07.03 (02,03,09) ESS07.05 (01,02) ESS07.06
	Organization	I am able to use my time, energy and resources in an effective way to achieve my goal in my studies.	Manages time and resources effectively to complete tasks.	N/A
				ESS09.01 (06,08)

### Evaluation question alignment with K12 Standards

Category & Subcategories	Self Report Questions	Self/Peer Evaluation Questions	Original Question Reference
<b>Collaboration</b>	I work well with other members of the team to accomplish the job.	Works well with teammates and willingly provides help to teammates to forward group goals	<p>Government Employability [1] This means: You work with other members of the team to accomplish the job - no matter what. M-PARS [2]</p> <p>This student had a positive influence on the group. This student promoted collaboration between group members. This student was willing to share his/her information.SSIS SEL Rating Forms [3]</p> <p>I try to think about how others feel. I work well with my classmates. I help my friends when they are having a problem.WCSD-SECA Long Form [4]</p> <p>Getting along with my classmates. Knowing when someone needs help.</p>
	I always give my best when I am working to solve a problem.		<p>VIA [5]</p> <p>I don't give less than 100% when I am working on something.M-PARS [2]</p> <p>This student was committed to the group. This student felt responsible for the group. This student participated well. This student actively participated during the brainstorm sessions This student contributed to a better understanding of the subject matter. This student contributed more than other group members.SSIS SEL Rating Forms [3]</p> <p>I do my homework on time. I do what the teacher asks me to do. I keep my promises.</p> <p>WCSD-SECA Long Form [4]</p> <p>Doing my schoolwork even when I do not feel like it. Planning ahead so I can turn a project in on time. Finishing my schoolwork without reminders.</p>
	I always respect other people's opinions, even when I disagree.	Submits quality work on time and constantly contributes to group goals	<p>VIA [5]</p> <p>I respect the opinions of my teammates, even when I disagree.SSIS SEL Rating Forms [3]</p> <p>I pay attention when others present their ideas. I stay calm when I disagree with others. I try to find a good way to end a disagreement.WCSD-SECA Long Form [4]</p> <p>Learning from people with different opinions than me. Respecting a classmate's opinions during a disagreement.</p>
		Listens attentively to others and respects other perspectives, especially different opinions.	

### Evaluation question references

Criteria	Why this criteria	Example
Simple and easier to understand All statements phrased positively	To get students' answer more reliably; to make it easier for students to complete.	<p><b>Grit:</b> I always finish my tasks even if they are hard for me. [simple] Sometimes I get so charged up emotionally that I am unable to consider many ways of dealing with my problems. [complex]</p> <p><b>Reflective Thinking:</b> After I have solved a problem, I analyze what went right or what went wrong. [phrased positively] When a solution to a problem was unsuccessful, I do not examine why it didn't work. [phrased passively]</p>
Central to the category measured (common across different measurement + subjective judgement)	To lower the cognitive load in switching between agreeing with positive and negative or passive statements.	<p><b>Respectful:</b> I always respect other people's opinions, even when I disagree. [central] I take turns when I talk with others. [less central]</p>
Item described closely related to PBL setting	To ensure validity of the survey  To help teachers better predict students' performance in learning	<p><b>Leadership:</b> I am good at leading a group to work towards a common goal. [related to PBL setting] My friends get my opinion before they make important decisions. [unrelated to PBL setting]</p> <p><b>Cooperative:</b> I work with other members of the team to accomplish the job. [concrete] I am very cooperative when I work in groups. [not concrete]</p>
Concrete description Emphasize disposition/attitude rather than skill/ability	To help students evaluate themselves more objectively; describing a desired state to help students know what to aim for (desired by teachers)  Teachers care more about attitudes than ability of students; (To promote a growth mindset)	<p><b>Creativity:</b> I often come up with different ways of solving problems. [concrete] I see myself as a very creative person. [not concrete]</p> <p><b>Communicative:</b> I actively communicate my ideas and opinions with other people. [disposition] Demonstrate effective communication skills in meetings. [skill]</p>

Criteria used for selecting evaluation questions

- **Testing external validity**

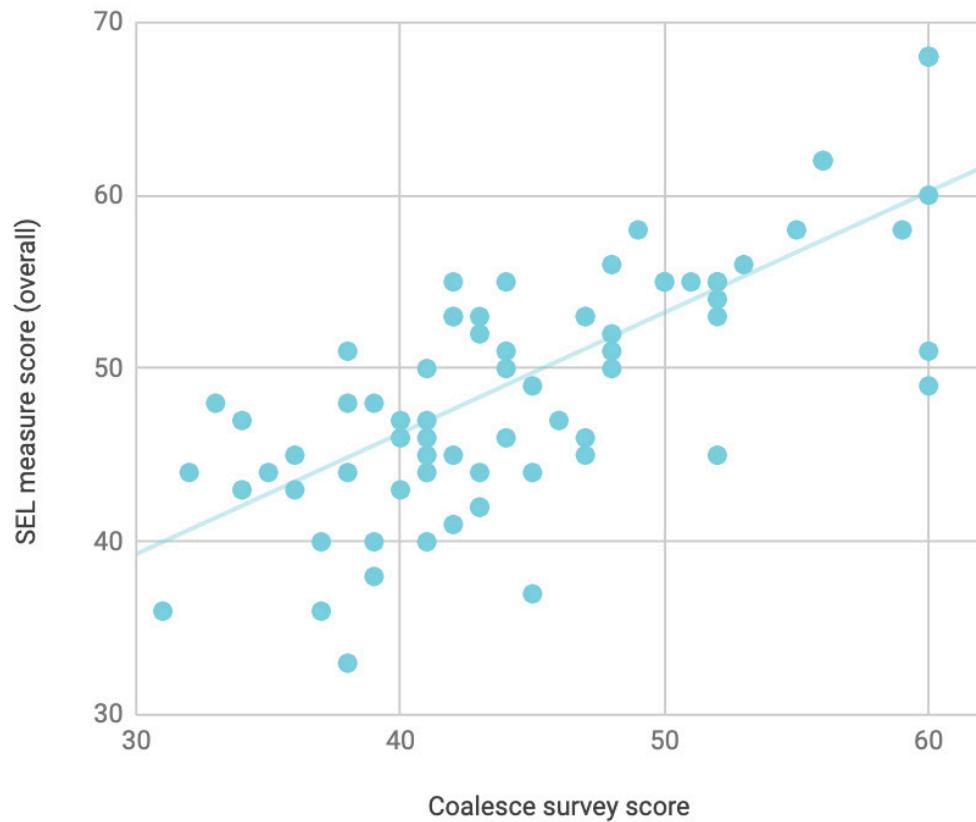
To establish the external validity of the survey items, we tested the survey with 18- and 19-year-old MTurk workers ( $N=77$ ) as a proxy to high-schoolers. Along with the items, participants also completed the WCSD Social and Emotional Competency Short-Form Assessment [4]. Since SEL is a goal closely aligned with PBL and a desirable state for K12 students, we deemed the measurement is a proper one to test the external validity.

The results revealed a trend of positive correlation between participants' scores in our survey and the overall score in WCSD measurement (left), and between participants' scores in our survey and partial score in WCSD measurement that only include items in categories relevant to collaboration<sup>2</sup> (right). This correlation indicates our survey is going in the right direction in describing students' level of success skills.

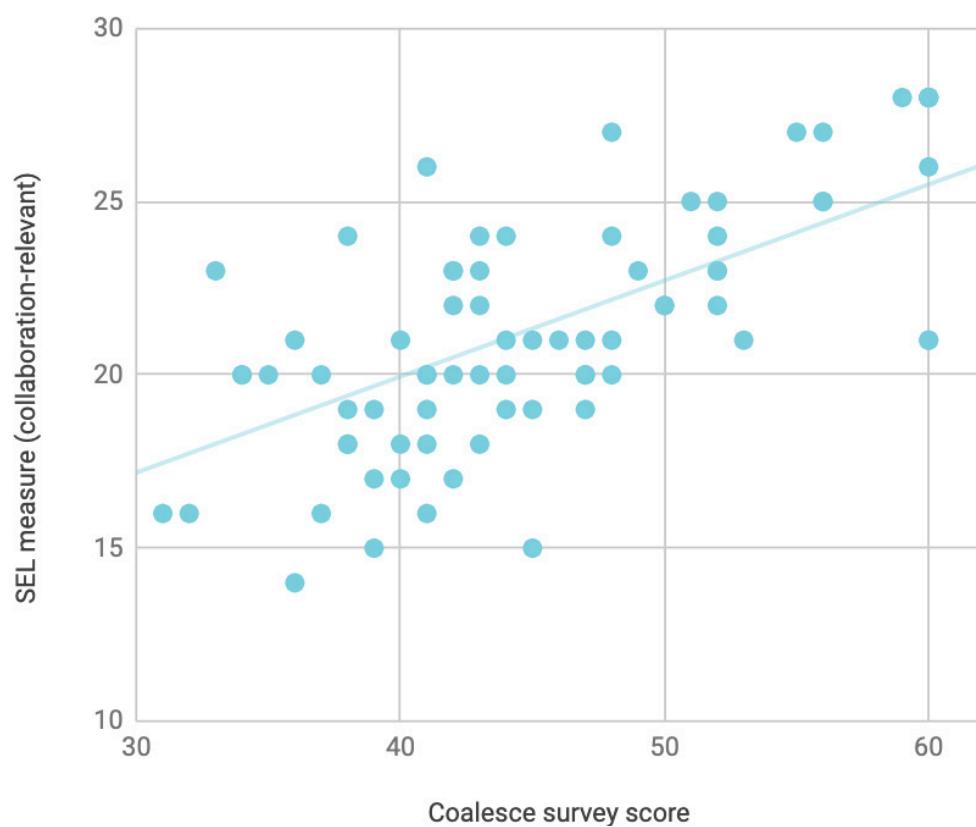
---

<sup>2</sup> Including items in: Social Awareness; Relationship Skills; Responsible Decision-Making. Excluding items in: Self-Awareness; Self-Concept; Self-Awareness: Emotion Knowledge; Self-Management: Emotion Regulation; Self-Management: Goal Management; Self-Management: School Work.

### Coalesce survey score - SEL measure score (overall)



### Coalesce survey - SEL measure (collaboration-relevant)



- **What teachers think**

When asked about whether students can reliably and honestly report their own ability in success skills, teachers generally did not express much concern. One teacher explicitly told us “my online students are quite honest”.

We have considered the use of situational judgement tests as an alternative way of gathering initial data. However, teachers believed that students will not be willing to read the lengthy texts required to set up the situation and then answer questions about it. For that reason, teachers felt that surveys are a more reliable way to gather initial data.

## FAQ

### ***How will the survey be distributed?***

Currently, it will be manually distributed by the teacher, but we hope that future developments can have it be automated by a button somewhere in our system. Ideally, the initial survey will be distributed uniformly by K12 at the beginning of a new semester. For the peer evaluation and self-evaluation, the surveys will be distributed by teachers through our system by a button on the class dashboard.

### ***Will students do this carefully?***

Teachers have expressed concerns about students' willingness to complete the survey carefully when we had around 20 questions. Following teachers' feedback, we cut down the number of questions to make it easier for students to complete. After the trim, teachers felt more optimistic about students completing the survey. On the optimistic side, one teacher indicated that “students will like the survey because they like to talk about themselves”.

 UNANSWERED QUESTIONS***Should this survey be taken at the beginning of every semester? Or perhaps multiple times in a semester?***

Several teachers mentioned the need of checking students' progress in essential skills more comprehensively and frequently than the current design and suggested the full survey be assigned more than once. However, other teachers have noted students' workload. Thus, a trade-off between the quantity of comprehensive data points and students' workload has to be made.

## Feature II

# Benchmark Self/ Peer Evaluation

“

*This is really good! What I like about it is that this is very brief.*

T3

“

*This is really useful for self reflection.*

T13

### WHAT IT DOES

An assessment given to each team member at benchmark times, where every team member evaluates both their own performance as well as their teammates' performance in the project so far. Every evaluation contains six questions and students can rate all teammates at the same time by dragging and dropping both their own and their teammates' names to different boxes. This data is then uploaded to the system and students' professional skills scores are updated accordingly.

### MAIN BREAKPOINTS COVERED

- Lack of project skills
- Lack of collaboration skills
- Lack of commitment to learning
- Shyness/social anxiety issues
- Lack of student-teacher rapport
- Difficulty in tracking student progress

### HOW ARE BREAKPOINTS COVERED BY THE FEATURE

- **Breakpoint covered: Lack of project/collaboration skills**

Although the initial survey gives both the system and teacher something to immediately work with, novices are known to be poor at evaluating themselves. Thus, benchmark evaluations by peers can help give a more complete picture of a student's project and collaboration skills. A consistent difference between self and peer evaluations can also lead to productive talks between the teacher and student.

Please rate you and your teammates on the item below:

1. Works well with teammates and willingly provides help to teammates to forward group goals.

Exemplary    Competent    Developing    Not Applicable

Save    >

Items for students to self and peer evaluate on.

Teammates' names for students to drag and drop while doing the evaluation.

Names of people who haven't been evaluated.

Open-ended feedback that has already been provided for Anne through the previous text boxes.

A text box as a scaffolding for students to provide other feedback for teammates.

To help your teammates improve, please leave some constructive feedback for them - praise them for what they have done well and tell them how they could do better.

**Feedback for Anne**

I think how Anne can improve on working well with teammates: try to be more open to different opinions. I think Anne did well on communicating with the team actively about deadlines, goals and ideas because: she created a google doc to organize everyone's task.

Plus, ...  
I wonder if ...

**Feedback for Bill**

I think how Bill did well on working well with teammates because: he is good at solving conflicts between teammates. I think Bill did well on communicating with the team actively about deadlines, goals and ideas because: he helped Anne creating the google doc.

Plus, ...  
I wonder if ...

**Feedback for Cathy**

I think how Cathy can improve on working well with teammates: be more patient while others are sharing ideas.

Plus, ...  
I wonder if ...

**Feedback for Myself**

I think how I can improve on communicating with the team actively about deadlines, goals and ideas: check the task management google doc more frequently.

Plus, ...  
I wonder if ...

<    6/7    >

Save    Submit

- **Breakpoint covered: Lack of commitment to learning**

While students who fail to show up to class can be easily seen and the problem rectified, poor or non-participation can be harder to detect, especially if it is harder to observe aspects, such as collaboration for a paper, or a meeting outside of class. Peer evaluations can point these out to teachers, allowing them to talk to students accordingly.

- **Breakpoint covered: Shyness/social anxiety issues**

Sometimes, poor or non-participatory behavior is simply due to a social anxiety issue. By triangulating data from the initial survey and self and peer evaluations, teachers can see that the student works hard, but does not communicate well, and thus can not only react accordingly, but perhaps also view this student's grade differently than another student with the same grade but due more to a lack of effort as a whole.

- **Breakpoint covered: Lack of student-teacher rapport**

Benchmark evaluations are done regularly (ideally once every two weeks), allowing teachers to stay up to date with students' thoughts about their own and teammates' progress in the project. This, in turn, allows teachers to have timely material to talk about whenever they need to contact a student, helping form a more trusting relationship between the two.

- **Breakpoint covered: Difficulty in tracking student progress**

With regular benchmark evaluations, teachers have a way to stay on top of students' progress both in terms of the project and throughout the course.

**FEATURE SPOTLIGHT:**

WHY NOT KEEP USING THE LIKERT SCALE?

USE DRAG AND DROP TO KEEP THE EVALUATION QUICK AND ENGAGING

One piece of feedback we got from teachers is that using Likert scale in all evaluations will bore students easily and they may start taking it less seriously or otherwise game the system by clicking through all the Likert scale questions without thinking. As the self evaluation and peer evaluation come up throughout the course compared with the one-time initial evaluation, it's important to avoid the boredom or gaming situation as much as possible.

Thus, we cut down the number of questions and also designed the drag and drop interaction to make the process of filling out the survey more interesting and efficient. Besides the novelty and efficiency factors, considering all the team members at the same time for one question can help students compare the performances of the different members, allowing for a more standardized evaluation [6].

In addition to the drag and drop method of evaluation, we also added an open-ended feedback text box. The end goal of evaluations should be to emphasize growth and encourage improvement [7]. To help students provide more constructive feedback, we added sentence stems into the open-ended feedback textbox as scaffolding. With such techniques, students can learn to give praise or criticism in a balanced and effective way.

- **High-schoolers can complete the evaluation reliably**

We tested the feature with 18- and 19-year-old MTurk workers (N=24) as a proxy for K12 high-school students by asking them to watch a group collaboration video [8] and complete our benchmark evaluation form.

- Reliable rating

- Reliable rating
  - Students are able to rate themselves and peers fairly reliably. Scores for both self and peer evaluation given by the participants closely agreed with a heuristic rating given by us (based on the PBL knowledge of the team members).

- Generally good open feedback, but more scaffold will be needed

- Generally good open feedback, but more scaffold will be needed
  - K12's rubric requires students to be able to give specific, reasonable, and supportive feedback. The result shows most participants' open feedback meeting at least one or two criteria. More scaffolding will be helpful to get students leave better constructive feedback.

*“I like that Alice thinks a lot and doesn’t jump into conclusions. She is a great value to the team. Her thoughts were so sensible and conclusive.”* (lacking actionable suggestions)

*“Alice is too easily bullied by stronger personalities. She needs to improve her confidence and focus on her strengths.”* (lacking evidence)

- A couple of instances of inappropriately blunt feedback detected, which suggested a need for better scaffold

*“I wonder if Kirk will be as aggressive next time as well.”*

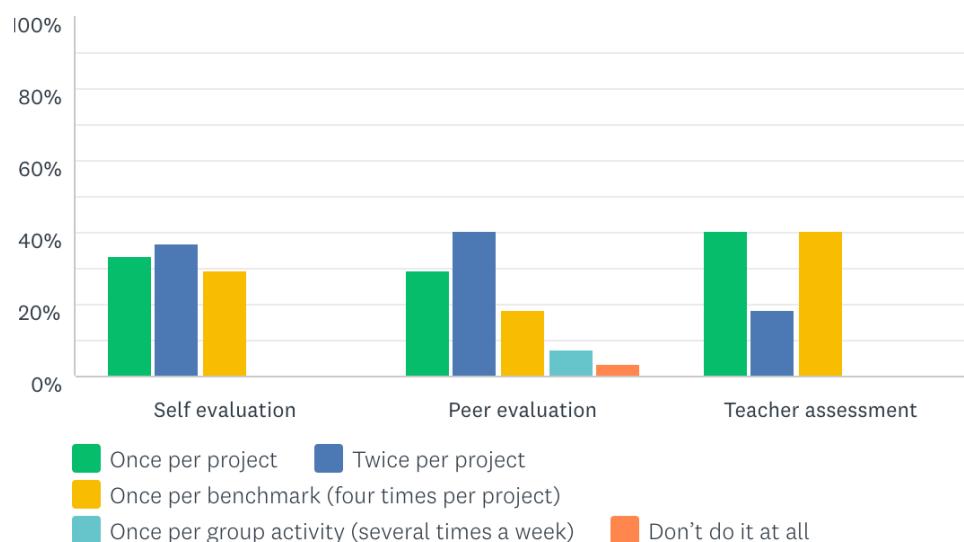
- Around 20% participants gave open feedback that was too brief and thus, not useful, such as: “nice thought” or “over creativity”.

- Students feel positive about receiving feedback from peers
  - 88% participants think they received fair feedback from their peers
  - 92% participants think receiving feedback from teammates will help them improve.
- “*Nobody likes to hear criticism but it helps for self-improvement.*”
- Students feel generally positive about giving feedback, with a slight concern of “being judgmental”
  - “*I felt good about evaluating everyone. It was clear what to do.*”
  - “*Evaluating my team members is difficult because I do not want to sound judgmental. However it was a great experience to do so.*”
- Students do not feel uncomfortable letting teammates see the feedback they wrote to them

## FAQ

### ***Can students be trusted to evaluate others accurately?***

Not always, there will definitely be students who, whether due to immaturity or bias, will try to skew scores in a particular direction. However, the individual student profile page (Feature 4) will at least allow teachers to spot these individuals. Open ended responses will also help in seeing if there is evidence that warrants the low or high score. Having several peers give the evaluation can also help balance out any skewing from an individual outlier.



### ***How often should students do the benchmark evaluation?***

From survey responses we collected (N=27), most teachers (40%) think the benchmark evaluation should happen twice per project. With the design of a “Evaluation” button in teachers’ interface, we leave the flexibility to teachers to decide when students should do the evaluation.

### ***How many questions should students complete in each benchmark evaluation?***

Considering students’ high workload, we attempted to minimize the extra burden of doing both a self-evaluation and several peer evaluations that would be required in a benchmark evaluation. Thus, we cut down the number of questions from 12 to 6 (see the result above), which will be randomly chosen from all the questions for the entire class. In the future, we imagine incorporating a feature to allow teachers to pick questions for different student groups.

“

***Completion of the reflection is where the learning takes place. Plus, it's important for students to understand that being talked to by the teacher is not a bad thing.***

*K12 Instructional Methods Advisor*

### ***Should completion of this be for a grade?***

Teachers expressed that students will not do the evaluation without a grade. From K12’s Instructional Methods Advisor, a completion grade is recommended to incentivize students to complete the evaluation.

### ***Should the scores received in the evaluation be part of students' score?***

All teachers responded to the survey (N=27) indicated that students' benchmark self and peer evaluation should be reflected in their project grades. Most teachers stated they would make the evaluation score be worth anywhere between 10% to 30% of students' final project grade.

However, one teacher expressed concern about how the grade will affect the evaluation. This is a problem that requires further exploration in the future.

### ***Won't the sheer amount of evaluations overwhelm the teacher?***

That's what our dashboard is for! To specifically provide summary information without overwhelming teachers. See Feature 3 for more information.

### **UNANSWERED QUESTION**

### ***Should the open responses be optional or not?***

We have received mixed responses on this question from teachers. Making it mandatory will increase unwillingness, but have the benefits of increasing students' reflective skills and writing skills for those who are poor at giving evidence for their arguments.

“

*If the other member's grades affect your own at all, then there is an incentive to simply say everyone did well. Plus, giving yourself a low grade might mean a talk from the teacher.*

T2

“

*Consider all the classes that a student takes. If all of them give a benchmark evaluation, how many will the student be doing? They'll eventually stop taking them seriously.*

T1

# Feature III Class Dashboard

“

*I'd like to know if I haven't given any comments or feedback to a student in a while.*

T3

“

*I really like the check in timer, this will allow me to get to anyone I haven't talked to in a while.*

T3

## WHAT IT DOES

A dashboard that summarizes and shortens the individual student profiles (See Feature 4) to just the important high level information and organizes the information in several desirable ways for teachers to easily focus their attention to where they are needed most.

## MAIN BREAKPOINTS COVERED

Lack of project skills  
Lack of collaboration skills  
Lack of teacher-student rapport  
Large class size  
Heavy workload and limited time  
Difficulty in tracking student progress  
Difficulty in monitoring groups

## HOW ARE BREAKPOINTS COVERED BY THE FEATURE

### ● Breakpoint covered: Large class size/heavy workload and limited time

The dashboard's primary purpose is organizing students' professional skills data all in one place, helping teachers manage their large class sizes and limited time by allowing them to first know and then focus their attention on those who need it most.


Last evaluation
Cumulative

Sort by — Attention needed ▾

**Display** Select all

- Collaboration
- Cooperative
- Commitment
- Respectful
- Communication
- Communicative
- Public speaking
- Writing
- Problem solving
- Creative
- Critical thinking
- Grit
- Reflective thinking
- Project management
- Leadership
- Organization
- Group discussion
- Active time in-class
- Discussion evaluation
- Production in group
- Time spent out-class

		Communication	Public speaking	Writing	Problem solving	Group
Darby Granok		Developing	Exemplary	Developing	Exemplary	
Sam Strong		Developing	Exemplary	Developing	Developing	
Max Johnson		Exemplary	Exemplary	Exemplary	Accomplished	
Paige Smith		Developing	Accomplished	Exemplary	Exemplary	
Sawyer Smiley		Exemplary	Exemplary	Exemplary	Exemplary	
Ariana Campbell		Exemplary	Exemplary	Exemplary	Exemplary	
Angie Xie		Exemplary	Accomplished	Exemplary	Exemplary	
Chris Wentz		Accomplished	Exemplary	Developing	Accomplished	
Dan Voss		Accomplished	Exemplary	Accomplished	Exemplary	
Eadric Gilett		Exemplary	Exemplary	Exemplary	Exemplary	
Erika Benson		Exemplary	Exemplary	Exemplary	Exemplary	
Isabell Rich		Accomplished	Exemplary	Accomplished	Exemplary	

### Sorting & Selective Display

#### Breakpoint covered: Lack of project skills/lack of collaboration skills

The dashboard can be used to sort any particular category or individual professional skills from highest to lowest or lowest to highest for easy discernment on who is doing well or poorly. Teachers can also choose to hide or show any categories or individual skills they wish, allowing them to focus on the skills they want to see.

### Growth/Regression Alert

#### Breakpoint covered: Difficulty in tracking student progress

The dashboard has arrows besides the rankings, which gives teachers an easy way to detect whether a student is growing, regressing, or staying the same in any particular skill.

### Flagging System

#### Breakpoint covered: Large class size/heavy workload and limited time

An alert system tells teachers of particularly large growths or drops so that they do not need to comb through the data of every student before knowing who to focus on and can take the necessary interventions.

## History 2A

Reminder Evaluation

Last evaluation
Cumulative
Sort by — Check-in date

Display		Communication	Public speaking	Writing	Problem solving	Group
<input type="checkbox"/> Collaboration	Eadric Gilett ! Evaluation Jun 10	Accomplished	Exemplary	Exemplary	Accomplished	
<input type="checkbox"/> Cooperative	Max Johnson ✓ Evaluation Jun 13	Exemplary	Accomplished	Exemplary	Accomplished	
<input type="checkbox"/> Commitment	Ariana Campbell ! Evaluation Jun 13	Exemplary	Exemplary	Accomplished	Exemplary	
<input checked="" type="checkbox"/> Respectful	Chris Wentz ! Evaluation Jun 13	Accomplished	Exemplary	Developing	Accomplished	
<input checked="" type="checkbox"/> Communication	Erika Benson ✓ Evaluation Jun 13	Exemplary	Accomplished	Exemplary	Accomplished	
<input type="checkbox"/> Communicative	Isabell Rich ✓ Evaluation Jun 13	Accomplished	Exemplary	Accomplished	Exemplary	
<input checked="" type="checkbox"/> Public speaking	Sawyer Smiley ✓ Evaluation Jun 15	Exemplary	Exemplary	Exemplary	Exemplary	
<input checked="" type="checkbox"/> Writing	Angie Xie ✓ Evaluation Jun 15	Exemplary	Accomplished	Exemplary	Accomplished	
<input checked="" type="checkbox"/> Problem solving	Dan Voss ✓ Evaluation Jun 15	Accomplished	Exemplary	Accomplished	Exemplary	
<input type="checkbox"/> Creative	Sam Strong ✓ Evaluation Jun 16	Developing	Accomplished	Developing	Accomplished	
<input type="checkbox"/> Critical thinking	Darby Granok ✓ Evaluation Jun 17	Developing	Exemplary	Accomplished	Accomplished	
<input type="checkbox"/> Grit						
<input type="checkbox"/> Reflective thinking						
<input type="checkbox"/> Project management						
<input type="checkbox"/> Leadership						
<input type="checkbox"/> Organization						
<input type="checkbox"/> Group discussion						
<input type="checkbox"/> Active time in-class						
<input checked="" type="checkbox"/> Discussion evaluation						
<input type="checkbox"/> Production in group						
<input type="checkbox"/> Time spent out-class						

**Cumulative View****Breakpoint covered: Difficulty in tracking student progress**

The dashboard includes a cumulative score view, where teachers can see the average of students' scores, with a heavier weight towards more recent scores to better showcase their growth.

**Last Check-in****Breakpoint covered: Lack of teacher-student rapport**

The dashboard is able to sort the roster by check in date as well. This allows teachers to make sure they can have a connection to even those who do not require direct interventions, and make students who are in the middle of the pack to feel like they matter in the class.



## Group View

### Breakpoint covered: Difficulty in monitoring groups

Once students are assigned to groups, teachers can use the sort by group function to see the student roster grouped together in their assigned groups with their group averages.

## FEATURE SPOTLIGHT:

### WHAT REQUIRES TEACHERS' ATTENTION?

#### A DIVE INTO THE FLAGGING SYSTEM

The flagging feature is designed to alleviate teachers' workload by allowing teachers to quickly identify which students need their attention. In designing the rules of flagging, we first interviewed teachers regarding their current practice of deciding when to have one-to-one conversation with students. From there, we designed the following rules for flagging:

Data	Criteria for flagging
Last check-in data (when the teacher last check in with the student)	Over 2 weeks
Scores in the four professional skill categories (Collaboration, Communication, Problem Solving, Project Management), or individual skills	Developing level OR decrease by over 30% from last cumulative score
Participation - Active time in class	Under 30% for the latest class session / average score for the project
Participation - Discussion evaluation rating	Under 1.5 stars received for the latest score / cumulative score
Participation - Production in group	15% above or below $(100/n)\%$ , where n is number of people in a team. (Assumes groups of 3-5)

Since the flagging rules are largely dependent on the actual evaluation scores students give and receive in the benchmark evaluation, testing in an authentic class setting is needed in iterating the rules outlined here. We also imagine that in the future, teachers can be allowed to customize the rules and thresholds for their classes to better suit their needs.

# Feature IV

## Student Profile

---

“

*I like the individual progress overview, it allows me to see how the student is progressing.*

T4

### WHAT IT DOES

The student profile is where a teacher can see both the most recent and previous benchmark evaluations as well as the initial self-evaluation of any particular student (see how the levels and scores are calculated in Appendix B).

“

*I like how (the participation data) is automated, the teacher won't feel overwhelmed by this.*

T5

### MAIN BREAKPOINTS COVERED

- Lack of project skills
- Lack of collaboration skills
- Lack of commitment to learning
- Lack of teacher-student rapport
- Difficulty in tracking student progress
- Difficulty in monitoring groups

### HOW ARE BREAKPOINTS COVERED BY THE FEATURE

- **Breakpoint covered: Lack of teacher-student rapport**

The student profile not only allows the teacher to have timely material to talk about with the student's professional skills, but also helps in remembering the student's history, allowing the teacher to refer back to previous benchmarks and comment on the student's improvement and performance.

**Student Roster Sorting**

The student roster can be sorted in several beneficial ways, including by first name, last name, attention flags, and by groups.

**Overview**

This area displays an overview of students' success skills, and flags issues that requires teachers' attention.

**Participation Signals**

This area displays data indicating students' participation level.

**Single Evaluation Summary**

This area displays the benchmark self and peer evaluation students received from different date. By default, the latest evaluation result is displayed.

**Cumulative Evaluation Summary**

This area displays cumulative scores students received from all evaluations and initial survey.

The screenshot shows a user interface for evaluating students across various professional skills. At the top right, there are two buttons: "Evaluation overview" (gray) and "Evaluation detail" (orange). Below this, a row of four student profiles is displayed with their names: Ariana Campbell, Max Goldstein, Paige Voss, and Eadric Granok.

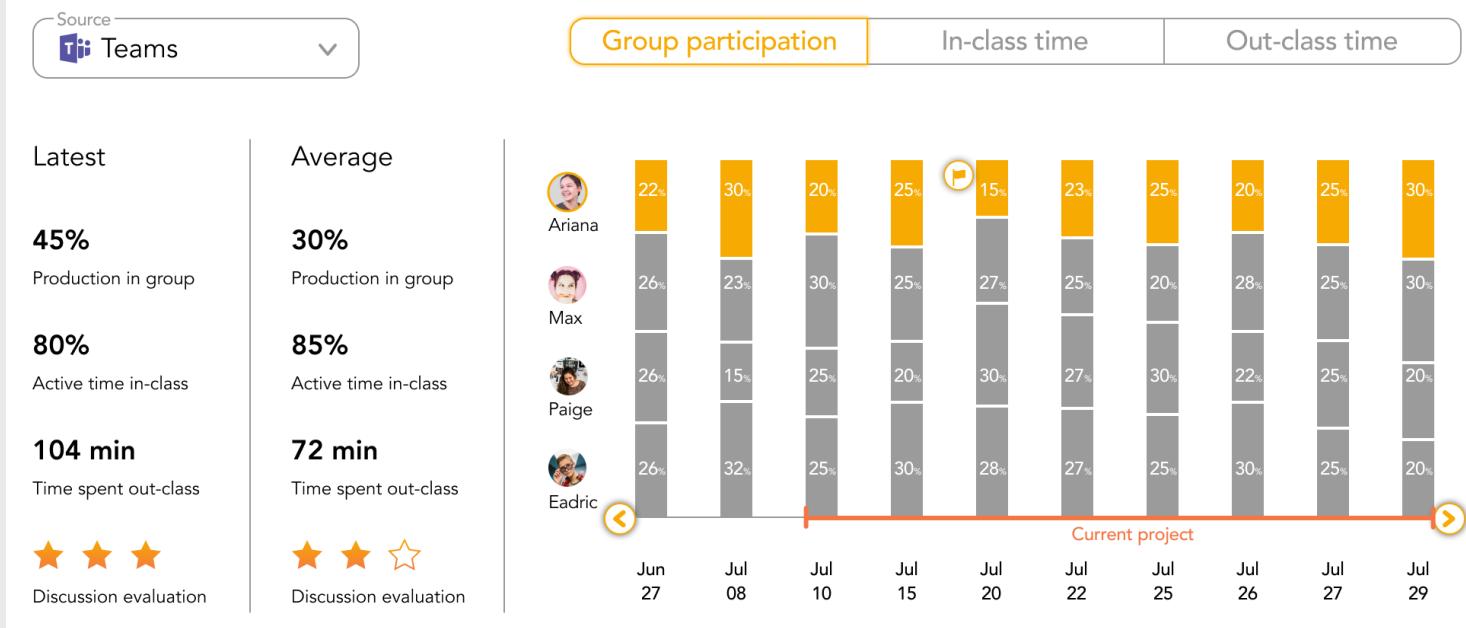
Category	Skill	Average	Ariana Campbell	Max Goldstein	Paige Voss	Eadric Granok
	Public speaking	Exemplary	Exemplary	Accomplished	Exemplary	Accomplished
	Writing	Exemplary	Exemplary	Accomplished	Exemplary	Accomplished
	Creative	Accomplished	Accomplished	Exemplary	Accomplished	Exemplary
	Critical thinking	Exemplary	Exemplary	Accomplished	Exemplary	Accomplished
	Leadership	Accomplished	Accomplished	Developing	Accomplished	Developing
	Organization	Exemplary	Exemplary	Accomplished	Exemplary	Accomplished

### Self & Peer Evaluation Ratings

#### **Breakpoint covered: Lack of project skills/lack of collaboration skills**

Teachers can see how peers have rated a student from any given benchmark evaluation and figure out if there is a general consensus amongst teammates if a student is weak in particular professional skills. This also helps teachers realize when a student is not evaluating him or herself correctly.

## Participation

[Download](#)

## Participation Signals

Participation signals from the various data sources are compiled into a couple helpful aggregates in this image.

### Quick self&peer evaluation after each group discussion

The average of stars the student received from the group members (including him-/herself) at each of the class sessions.

How did everyone in your team contribute in today's group discussion?

Max  
☆ ☆ ☆

Say something about what you think Anne did well and how she can improve

Eadric  
☆ ☆ ☆

Say something about what you think Bill did well and how he can improve

Paige  
☆ ☆ ☆

Say something about what you think Cathy did well and how she can improve

You (Ariana)  
☆ ☆ ☆

Say something about what you think you did well and how you can improve

Submit

### Percentage of project contribution

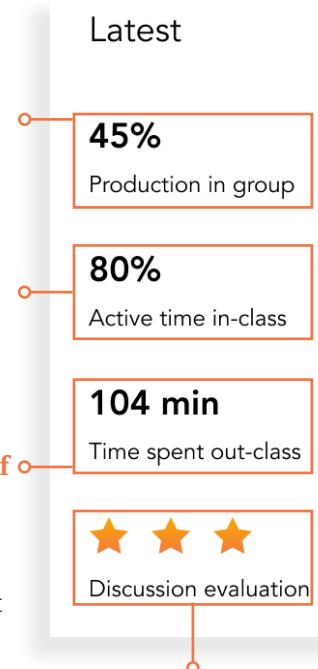
The percentage of the student contribution in the group, measured by the number of words produced.

### Percentage of active in-class time

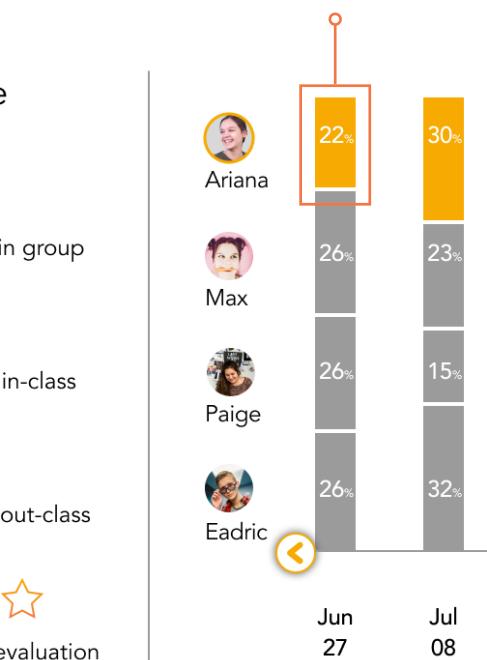
The proportion of time the student is active on any project tool in a class session (100% being the time allotted to the group work).

### Time spent on the project outside of class

The time the student spent on the project tool since last class session out of the class.



### Proportion of the words sent in a group discussion



### Quick self&peer evaluation after each group discussion

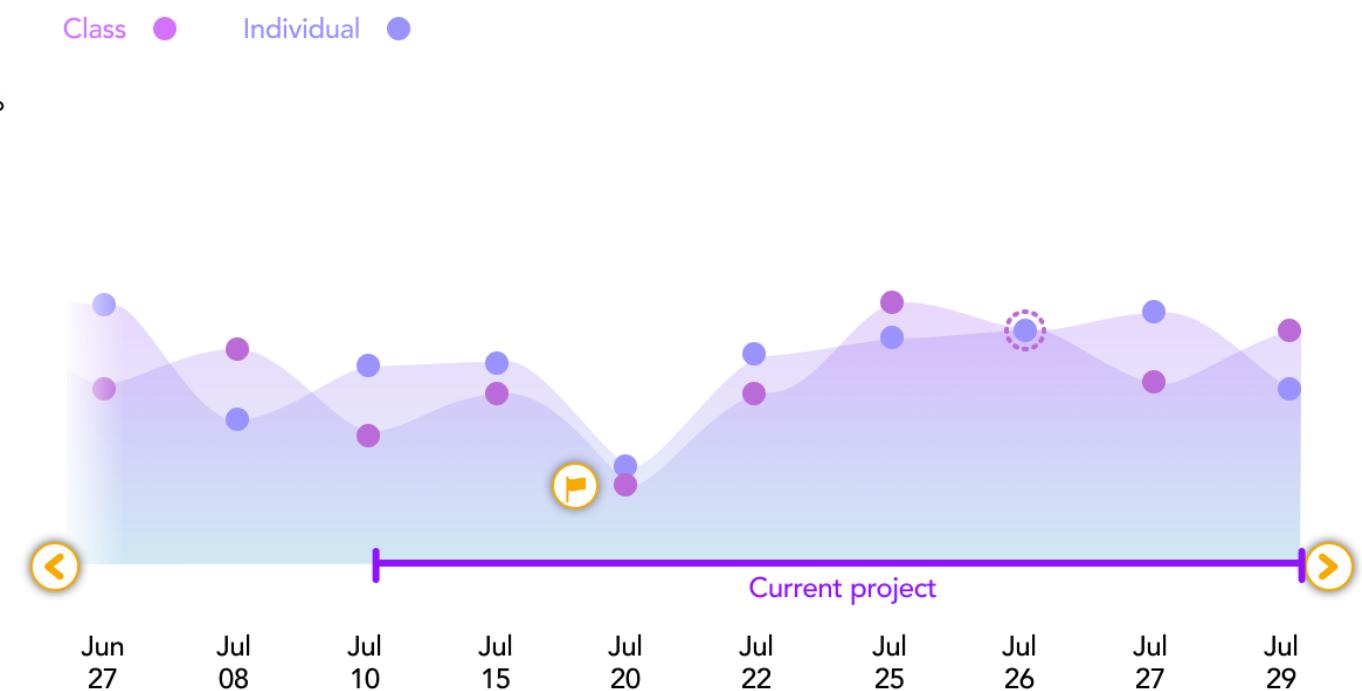
# Participation

[!\[\]\(d5289ce63862c554731d6a7befec07e4\_img.jpg\) Download](#)

Group participation

In-class time

Out-class time

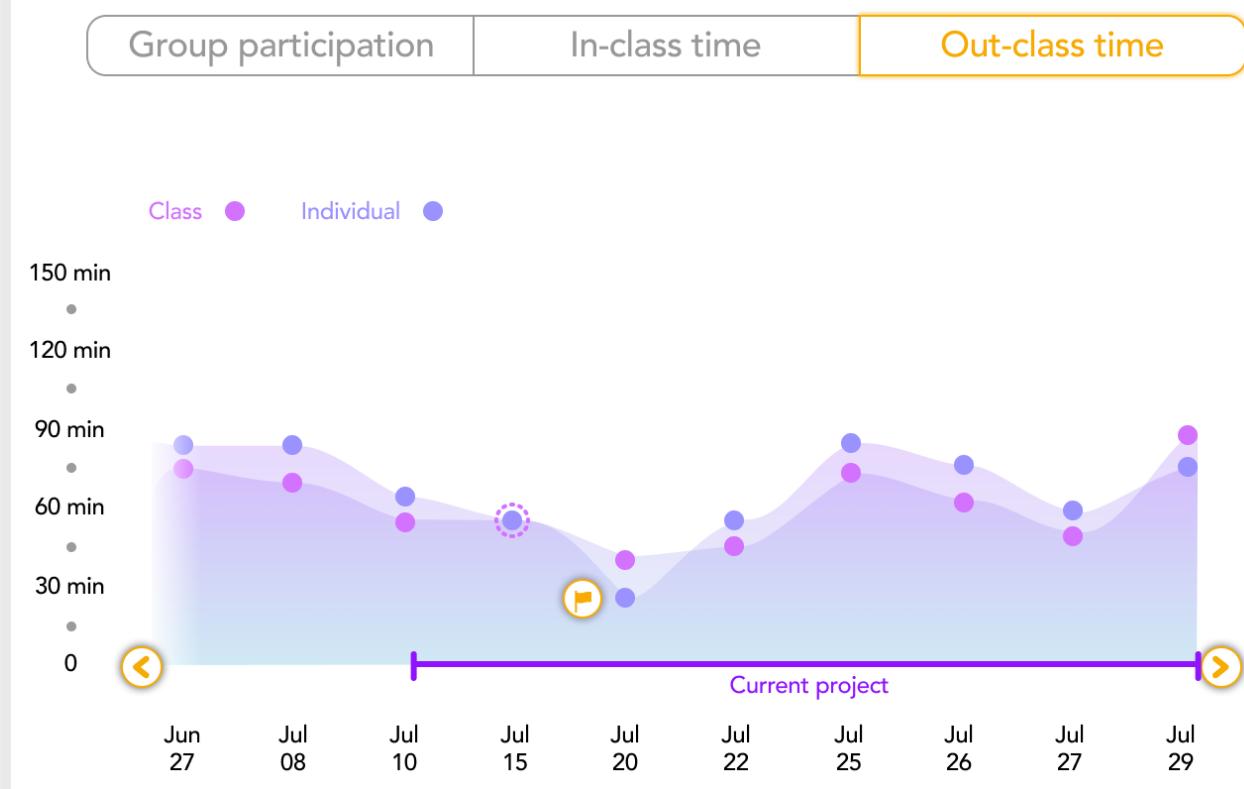


## Compare with Class Average

### Breakpoint covered: Difficulty in monitoring groups

Compared with each other, a group may seem to be doing fine, speaking in equal amounts. However, a percentage can perhaps hide the truth, and the group might as a whole be speaking relatively little. With a comparison with the class average, a clearer picture can be seen.

# Participation

[Download](#)


## Participation Signals

An alternative view to show the discussion contribution compared with class average

## Participation Signals

### Breakpoint covered: Lack of commitment to learning

The various participation percentages with respect to the students' teammates can show if the student is actively participating both overall or in a particular group activity, in this case, chatting in Microsoft Teams. Participation that falls below a certain threshold will be flagged.

### Breakpoint covered: Difficulty in monitoring groups

Although the individual student in question is always at the forefront of any particular student profile, an added benefit is seeing how the group is interacting with respect to participation. At least in regards to participation, it is easy for the teacher to see who is participating how much in the activity with the "Compare with Group View" and how much each group is engaging with the material with the "Compare with Class Average View".

## Cumulative evaluation summary

[Download](#)


### Cumulative View

**Breakpoint covered: Lack of project skills/lack of collaboration skills**

As the course progresses, the cumulative view gives a weighted average of where students are at for each professional category and skill, with more weight being given to more recent evaluations. Thus, categories or skills remaining at Developing can show a lack of improvement on these weak areas.

### Timeline

**Breakpoint covered: Difficulty in tracking student progress**

As the student profile stores all previous benchmark evaluations and the initial self-evaluation, teachers can see a student's growth in any particular category or skill over the course of the semester.

## FEATURE SPOTLIGHT:

WHAT DOES 25% REALLY MEAN?

HOW PARTICIPATION DATA SIGNALS ARE CALCULATED?

Currently, the participation percentage is calculated as the proportion of words a student has sent in a group discussion platform, such as Microsoft Teams. In the future, we envision a complete list of places where students collaborate online to pull data from, such as productivity applications such as Google Docs, telecommunications applications such as Zoom and other discussion forums such as the one built into the K12 LMS. In this way, teachers can not only view signals from individual sources, to see which medium a student may favor his or her communications in, but also have an aggregate participation score, which can be more representative to show how much a student participates in online group collaborations, taking all forms of group work into account.

## FAQ

*Can the participation score be gamed? And measuring participation by just words typed doesn't do those who talk on the microphone justice.*

As it is now, measuring just the amount of words a student has typed, yes. However, future iterations would draw on other sources of data as well as different ways of measuring (see Future Work). This will allow for a more trustworthy and fair participation score.

***Isn't an update every two weeks already too sparse to be able to see gradual growth? What if the teacher wants to do a benchmark only once a month?***

With just your own class' data, quite possibly. We could make it so that the system will remind teachers that the suggested time to give benchmarks is every two weeks, but certainly teachers might conscientiously not want to do it for a variety of reasons. However, we believe that by using the data from other classes would help mitigate this problem, as it would allow the inclusion of several more sets of data to create a more complete aggregate.

 UNANSWERED QUESTION

***How much should students see for their individual profile?***

We believe in making a student facing individual profile for each student, where the student would see a less detailed version of the profile. Teachers generally agree allowing students to see their levels in different categories would be helpful for students' learning. There was a mixed response over whether students should see a "moderated" or the original version of their peers' open feedback, but all teachers agree it should be kept anonymous for students. A "moderated" version of peers' open feedback would be an ideal case. However, the extra workload it will bring to teachers is a big concern. Further exploration is necessary in making the design decision.

# Feature V Grouping Tool

“

*I like the grouping tool, I can see it decreasing my own biases and favoritism.*

T2

“

*The grouping tool is so fabulous. It will help me disseminate the natural leaders to other groups.*

T4

## WHAT IT DOES

Utilizes the data gained from the various sources to help teachers create intentional teams quickly.

## MAIN BREAKPOINTS COVERED

New students lag behind

Lack of project skills

Lack of collaboration skills

Lack of commitment to learning

Large class size

Heavy workload and limited time

Limited PBL experience and knowledge

## HOW ARE BREAKPOINTS COVERED BY THE FEATURE

### ● Breakpoint covered: New students lag behind

With the data gained from the initial survey, teachers can find a group where new students can complement the other members' skills, allowing new students to jump right into the project and content without having to wait until the current project finishes, missing out on key learning opportunities the particular project would have provided.

The screenshot shows the KLAB Grouping Tool interface. On the left, a grid of student profiles is displayed, each with a name, profile picture, and a color-coded bar chart for five skills: Collaboration, Communication, Prob. Solving, Proj. Mgmt, and Participation. The students are categorized into three levels: Exemplary (top row), Accomplished (second row), and Developing (third row). On the right, a 'Student / Team' section shows four groups labeled A, B, C, D, E, F, and G. Each group has a flower icon and a list of student names. A dashed box highlights group G, which contains one student. Buttons for 'Save' and 'Confirm' are at the bottom.

Category	Name	Collaboration	Communication	Prob. Solving	Proj. Mgmt	Participation
Exemplary	Lauren Mikol	High	Medium	High	Medium	High
	Ariana Campbell	High	Medium	High	Medium	High
	Paige Smith	High	Medium	High	Medium	High
Accomplished	Sawyer Smiley	Medium	High	Medium	High	Medium
	Sam Strong	Medium	Low	Medium	High	Medium
	Darby Granok	Medium	High	Medium	High	Medium
Developing	Dan Voss	Low	Medium	Medium	High	Medium
	Chris Wentz	Low	Low	Medium	High	Medium
	Angie Xie	Low	Low	Medium	High	Medium
Developing	Erica Benson	Low	Medium	Medium	High	Medium
	Max Johnson	Low	Medium	Medium	High	Medium
	Ryan Zimmerman	Low	Medium	Medium	High	Medium

### Grouping Tool, pregrouping state

### Ungrouped Students

This area displays information of students that have not been assigned to a group.

### Formed Group

This area shows groups that have been made.

### Sorting by Category & Manual Drag and Drop Grouping

#### Breakpoint covered: Lack of project skills/ lack of collaboration skills/commitment to learning

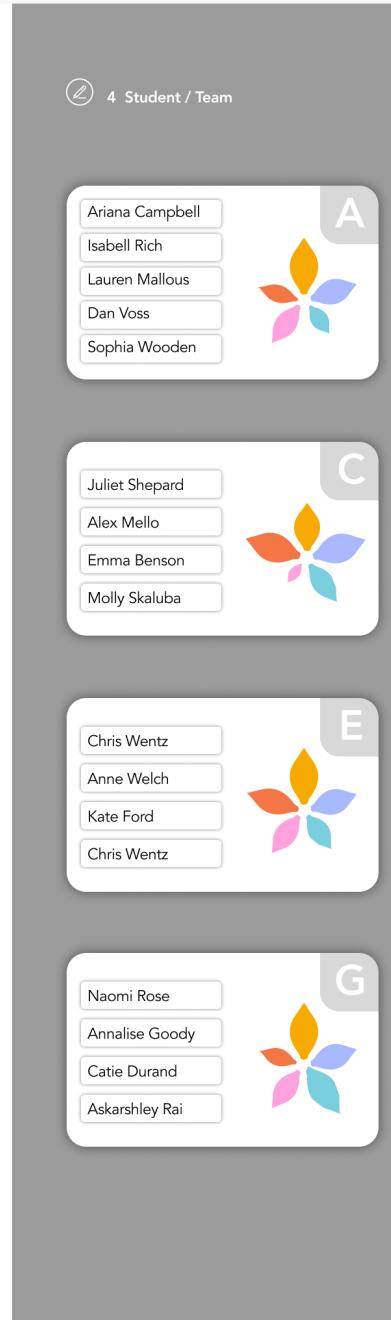
Sometimes, a student's lack of a particular skill can be supplemented by another student's strength in it. Both low and high scores are clearly visualized in the grouping tool's interface, allowing teachers to make an informed decision about how to group students in this way. Manual adjustments to the groups can be made through dragging and dropping, either to move the student out of a team to work alone or into another team.

## History 2A

Randomly a:

Table

Chart

Sort by  
Collaboration

## Grouping Tool, postgrouping state

## Petal Distribution Graph

**Breakpoint covered: Large class size/heavy workload and limited time**

A simple visualization of the team's scores in the five categories. Numbers are too detailed and do not fit in with the rest of the system's style, which has always stuck with the 3 level word ranking. However, the visualization is just right in describing the distribution of skills and can immediately inform teachers where a group's members are collectively lacking in a particular category.

Create balanced project groups based on the following factors (in order of priority):

- #1 Project management
- #2 Communication
- #3 Collaboration
- #4 Problem solving
- #5 Group discussion

**Customize**      **Apply**

**Balance the following**

- #1 Project management ×
- #2 Communication ×
- #3 Collaboration ×
- #4 Problem solving ×
- #5 Group discussion ×

**Randomize the following**

**Clear**      **Apply**

**Randomize the following**

- Group discussion +

**Clear**      **Apply**

## Smart Grouping

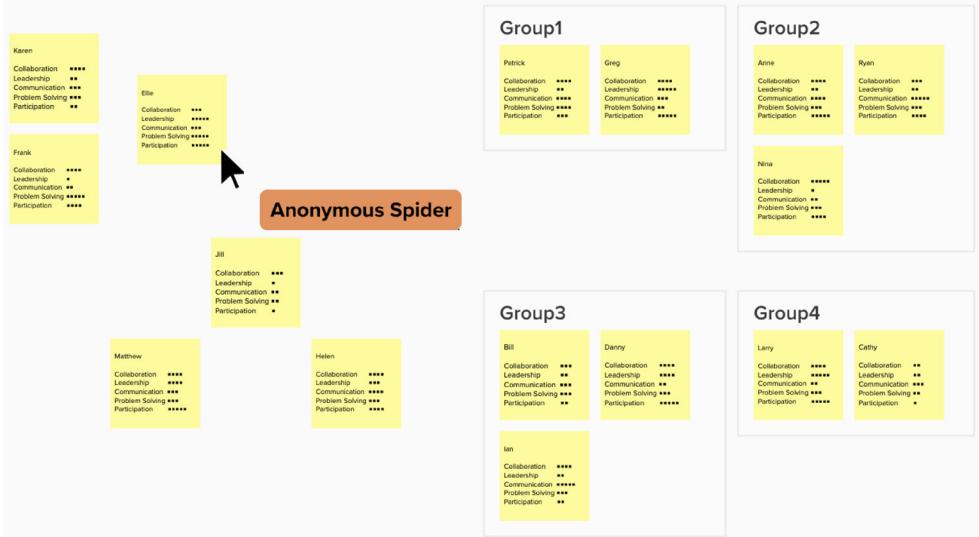
### Breakpoint covered: Large class size/heavy workload and limited time

While knowledge of students' abilities in various professional skills is a great boon for creating effective teams, it is a daunting task to do it for 60 or far more students. The smart grouping function is meant to automatically create teams using good grouping practices.

### Breakpoint covered: limited PBL experience and knowledge

Teachers with limited PBL experience and knowledge may not even realize the importance that good grouping has to the success of the project, much less know how to make such good groups. The default smart grouping algorithm separates strong students into separate groups so that they may help lead the team and is a method many experienced PBL teachers use to group students. The algorithm can be customized to focus on which category to split up first, and thus be the most successful at (Project Management is a favorite), ignoring a particular category, or a purely random grouping.

Please put students into project groups by drag-and-drop



### Task analysis with teachers on grouping students

#### FEATURE SPOTLIGHT:

#### SMART GROUPING: A DEEPER DIVE INTO THE ALGORITHM

The smart grouping intends to help teachers create student groups which are more likely to work well with only one click. Our algorithm is designed to make sure every skill is balanced across all the groups.

The algorithm utilizes the scores assigned for project management initially to assign group leaders. For each category, the student scores are sorted according to their respective categories, which results in 4 pools of the same set of students arranged differently. Then, the algorithm cycles through each of these pools and picks the best candidate for that given category. Since the pool of students is shared among all of these pools, the chosen student is filtered out of other groups before proceeding to the next. This assignment continues until one iteration of the groups is done (from  $G_1$  to  $G_n$ ). At this point, the algorithm reverses and begins round 2 from all the way to where  $_1$  and  $_n$  should be subscript 1 and n. This avoids the issue of imbalance where groups at the end consistently get the worst picks.

***How was the default algorithm developed?***

To find common considerations teachers have in making project groups, we did task analyses with teachers where we asked teachers to describe the way they group students, or asked them to do groupings given a bunch of students. Out of 9 teachers interviewed, 3 had the leadership skill as the top consideration - they want to make sure each group had a strong leader (though there were opposing opinions offered by another 3 teachers who believed leaders would naturally evolve from a group where there were none). Since teachers' responses to other skills were relatively diverse, we decided to prioritize leadership skills while leaving teachers ability to customize their priority.

Another common theme was teachers' desire to make balanced groups - putting students who are strong in at least one of the categories with those who are less strong. A balanced grouping mechanism was also recommended by the expert we interviewed.

Therefore, the default algorithm in smart grouping takes Project Management, where the leadership skill resides, as the first consideration, while trying to balance all the other categories in the way described above.

# PUTTING IT TOGETHER: USE CASES

## ■ USE CASE 1: USING THE GROUPING TOOL

Travis is four weeks into his History class and has been using PBL to great effect. However, he has been notified that two new students, Chris Wentz and Ryan Zimmerman, are joining the class.

Thankfully, the new project just started, so Travis feels comfortable in integrating both new students into preexisting groups. Both students have completed their initial self evaluation, so their data appears in the grouping tool.

Travis sees Chris lacking in collaboration skills, although well rounded in the other professional skills, and finds a group with a large communication petal. Once Chris has been slotted into a group, Travis sees the petals now and notices that while the communication petal has shrunk a little, the overall petal composition is still well balanced.

Meanwhile, Ryan is adamant that he does not wish to work in any group, citing a lack of trust with others. Travis attempts to convince Ryan that both his group mates would benefit from his high communication skills and that he would benefit from learning how to collaborate with a group who already know how. However, Ryan does not budge. Travis acquiesces to Ryan's request and moves him out of the group he initially put Ryan in, letting him work alone for this project, hoping that the fun other groups have during their group work and presentations during this project might convince Ryan to try and work with a group for the next project.

K COALESCE

Class dashboard Grouping Notes Setting Help

History 2A Randomly assign Smart grouping

Table Chart Sort by Communication

Exemplary Lauren Mikol Derby Granok Ryan Zimmerman...  
Communication Collaboration Prob. Solving Proj. Mgmt Participation

Exemplary Sawyer Smiley Angie Xie Erica Benson  
Communication Collaboration Prob. Solving Proj. Mgmt Participation

Accomplished Paige Smith Dan Voss Max Johnson  
Communication Collaboration Prob. Solving Proj. Mgmt Participation

Accomplished Ariana Campbell Eadric Gillett Chris Wentz  
Communication Collaboration Prob. Solving Proj. Mgmt Participation

Developing Exemplary

4 Student / Team Save Confirm

A Sam Strong Isabell Rich B C D E F G +

**Developing**

Chris Wentz

Communication  
Collaboration  
Prob. Solving  
Proj. Mgmt  
Participation

**Exemplary**

Ryan Zimmerman...

Communication  
Collaboration  
Prob. Solving  
Proj. Mgmt  
Participation

Chris Wentz  
Anne Welch  
Kate Ford  
Chris Wentz

E

## USE CASE 2: COMPARING SELF AND PEER EVALUATIONS

During one of the projects in his History class, Travis notices that Ariana's score in the communication category has been very low for a while. Travis is surprised because based on his own in-class observations, Ariana is doing a good job in communicating in her group.

After clicking into Ariana's individual profile, Travis realizes that Ariana's low score in the communication category is because she has consistently given herself much lower self-evaluation scores than how her peers have evaluated her. With the comparison between Ariana's self and peer evaluation, Travis knows that Ariana actually does have a good performance in terms of communication in a group project. Travis can now plan a way to talk to Ariana about having more confidence in herself and how to make a more accurate and objective self-assessment.



## Ariana Campbell

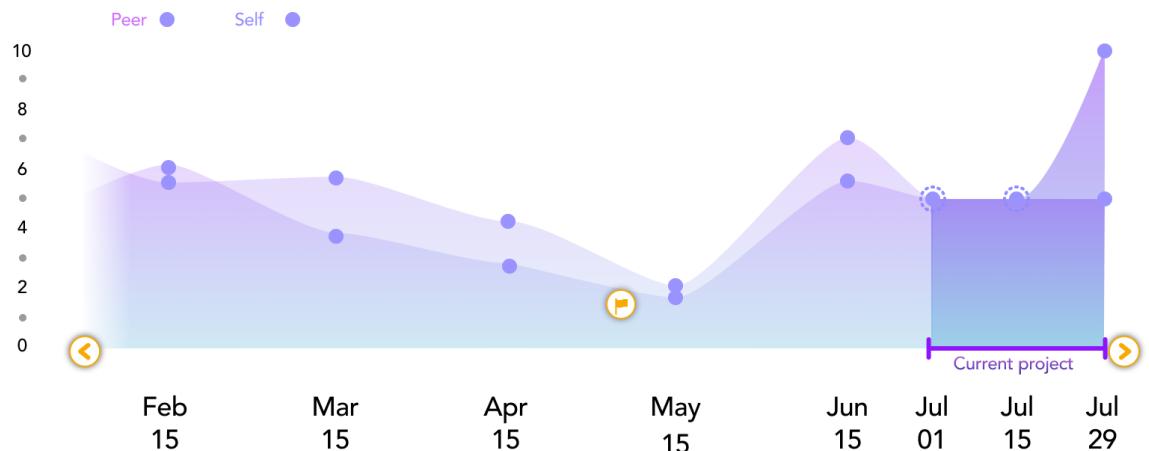
! Evaluation

L Jun 13

Low group discussion engagement

Big drop on project management

Peer Avg. ● Self Avg. ● Developing Accomplished Exemplary



## OTHER USE CASES

*“I’d like to use this to identify who is good at what, and then have them teach each other these skills, because you listen to peers far more than you listen to adults.”*

- T12

*“I can see benchmark evaluations occurring on Fridays and then having the groups meet on Monday to discuss the evaluations together.”*

- T5

*“It would be great to have a talk with a student if his or her self perception is vastly different from his or her peer’s perception of him or her.”*

- T1

*“The data may be useful for counselors and advisors as well.”*

- K12 PBL expert

# PROCESS CASE STUDY: GROUPING TOOL UX

---

Intro: Our Methods

Stage 1: What information to present

Stage 2: How to present the information



# INTRO: OUR METHODS

We interviewed 18 teachers as well as relevant K12 personnel, sometimes directly asking for feedback and suggestions, and other times teasing it out through setting scenarios for our interviewees or doing co-designing sessions.

Depending on our interview method, we sometimes got direct suggestions on how to change our product for the better, other times, with no clear suggestions, we had to simply try something new in hopes it would clear up a misunderstanding or confusion. As often as possible, we would try to take the interviewee's suggestions and improve our design accordingly. However, suggestions sometimes were out of scope and we had to ignore them. Later in development, many suggestions, as good and relevant as they were, simply had no time to be implemented. These suggestions are found in the Future Work section.

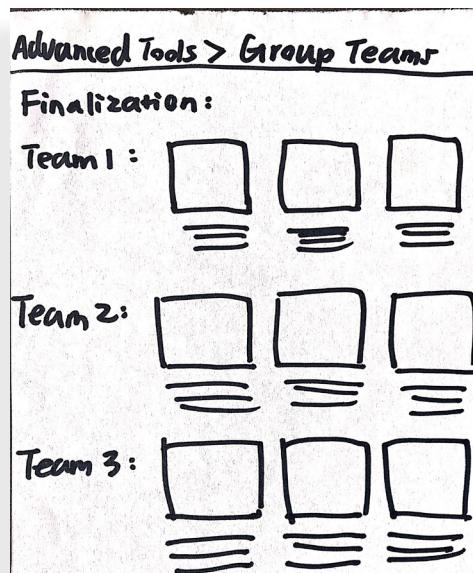
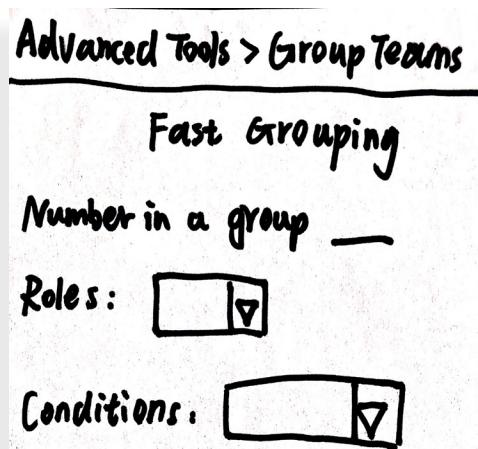
In the interest of time and space, we will showcase how our UI for our grouping tool evolved from its paper prototype to its current high fidelity incarnation. This deep dive into the process of how the grouping tool's UI was created is exemplary of the processes we used to reiterate and develop all the features and sub-features of our product. Throughout the whole process, we kept iterating on two things: what information to present, and how to present them.

# STAGE 1: WHAT INFORMATION TO PRESENT

Before making the product beautiful, we wanted to make sure it is useful to teachers. So we explored what was the important information teachers felt they had to see in the grouping tool.

## V1.0: SETTING YOUR CONDITIONS, AND BANG!

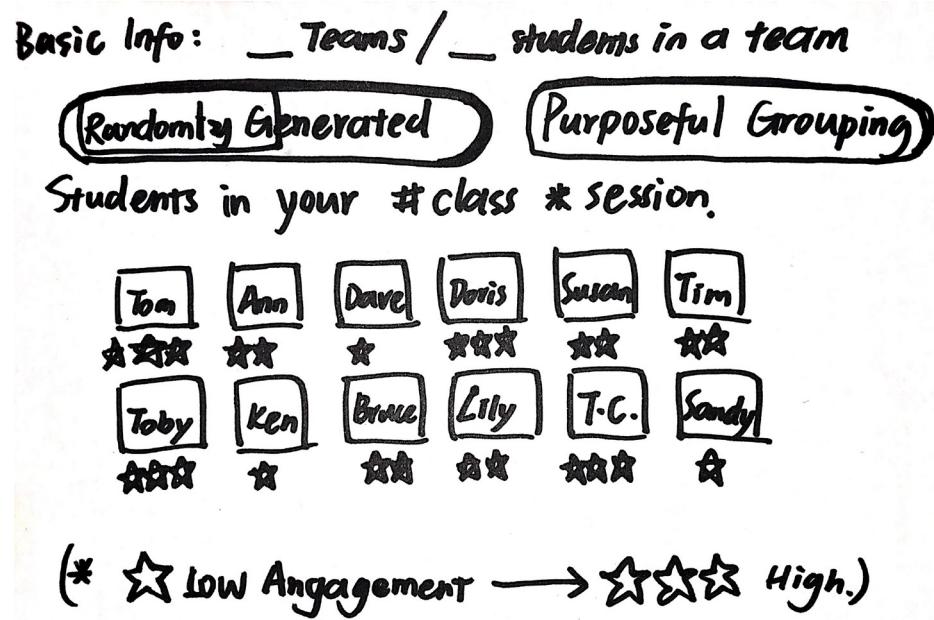
At first, we imagined the grouping tool to be a completely automated one, so we did not show students' information before the grouping happens.



### V1.1 INCREASED TRANSPARENCY WITH DISPLAY OF STUDENT DATA

Through our own heuristic evaluation, we realized our violation of the transparency design principle - we need to show teachers how the grouping happens even if it happens automatically.

We decided to present students' participation data, as teachers indicated that students' participation in class is an important consideration when putting students into groups. (Side note: Teachers have different opinions on whether to put all disengaged students into one group or putting them into different groups.)



V1.1

## V1.2: GIVE TEACHERS MORE CONTROL

We made the first draft of the digital prototype.

### Grouping Students

**Group students into project teams** ★ Low participation level ★★★ High participation level

Tom	Tim	Danny	Anne	Andy	Bob	Ben	Barney	Chris	Cindy	David	Draco
★★	★	★★★	★★★	★	★★★	★★	★★★	★★	★	★	★
Harry	Ross	Bella	Tony	Frank	Fiona	Ella	Crystal	Rose	Emma	Emily	Vince
★★	★★★	★	★	★	★★	★★	★★	★★	★★★	★★	★★

Group 24 students in your Senior History class into \_\_\_ teams.

**Random Grouping**      **Purposeful Grouping**

### Grouping Students

**Group students into project teams - Random Grouping**

Tom	Tim	Danny	Anne		Cris	Cindy	David	Draco
★★	★	★★★	★★★		★★	★	★	★
Andy	Bob	Ben	Barney		Rose	Emma	Emily	Vince
★★	★★★	★	★★★		★★	★★★	★★	★★
Harry	Ross	Bella	Tony					
★★	★★★	★	★					
Frank	Fiona	Ella	Crystal					
★	★★	★	★★					

**Modify**      **Shuffle**

**V 1.2**

### V1.3: SHOW RELEVANT DATA TO TEACHERS

Learning that teachers have different priority considerations in making student groups, we decided to make the interface to only show the data that the teacher cares about. For example, if teachers wanted to select the moderators for each group, the individual data relevant to the moderation skill will be shown.

#### Grouping Students

##### Group students into project teams - Purposeful Grouping

###### Step #1: Select moderators for teams (5 teams)

<input checked="" type="checkbox"/> Tom	Individual data related to moderation ★★	<input type="checkbox"/> Tim	Individual data related to moderation ★	<input type="checkbox"/> Danny	Individual data related to moderation ★★	<input checked="" type="checkbox"/> Anne	Individual data related to moderation ★★★
<input type="checkbox"/> Andy	Individual data related to moderation ★★	<input checked="" type="checkbox"/> Bob	Individual data related to moderation ★★★	<input type="checkbox"/> Ben	Individual data related to moderation ★★	<input type="checkbox"/> Barney	Individual data related to moderation ★★★
<input checked="" type="checkbox"/> Harry	Individual data related to moderation ★★	<input type="checkbox"/> Ross	Individual data related to moderation ★★★	<input checked="" type="checkbox"/> Bella	Individual data related to moderation ★★	<input type="checkbox"/> Tony	Individual data related to moderation ★★
<input type="checkbox"/> Frank	Individual data related to moderation —	<input type="checkbox"/> Fiona	Individual data related to moderation —	<input type="checkbox"/> Ella	Individual data related to moderation —	<input type="checkbox"/> Crystal	Individual data related to moderation —

Done

#### Grouping Students

##### Group students into project teams - Purposeful Grouping

Group #1	Tom	Tim	Danny	Anne	
	★★	*	★★★	★★★	
Group #2	Andy	Bob	Ben	Barney	
	★★	★★★	★★	★★★	
Group #3	Harry	Ross	Bella	Tony	
	★★	★★★	★★★	★★★	
Group #4	Frank	Fiona	Ella	Crystal	
	★★	★★★	★★★	★★★	
Group #5	Cris	Cindy	David	Draco	
	★★	*	*	*	
Group #6	Rose	Emma	Emily	Vince	
	★★	★★★	★★★	★★★	

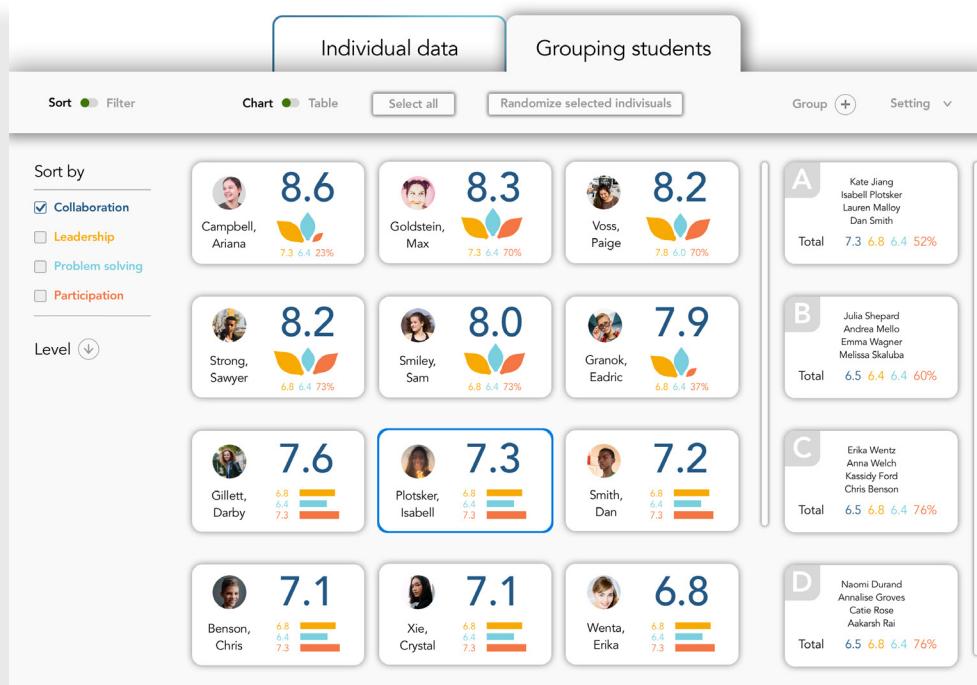
! Some groups don't meet all the conditions

V 1.3

## V1.4: GROUPING WITHIN ONE SCREEN

An important piece of feedback we got from K12's UX expert was the complexity of the last version of grouping - teachers had to go through multiple steps to put students into groups. Thus, we decided to show both students' data and finished group data on one screen. This new presentation was well received by teachers.

With that, we changed to show students' level of different skill categories altogether. Considering teachers' cognitive load, only the categories of skills were shown, instead of the breakdown of each skill.



V1.4

# STAGE 2: HOW TO PRESENT THE INFORMATION?

After version 1.4, the “what” question had its basic shape, although iteration on it continued. We started considering the next question: how do we present the information so that teachers would not feel overwhelmed.

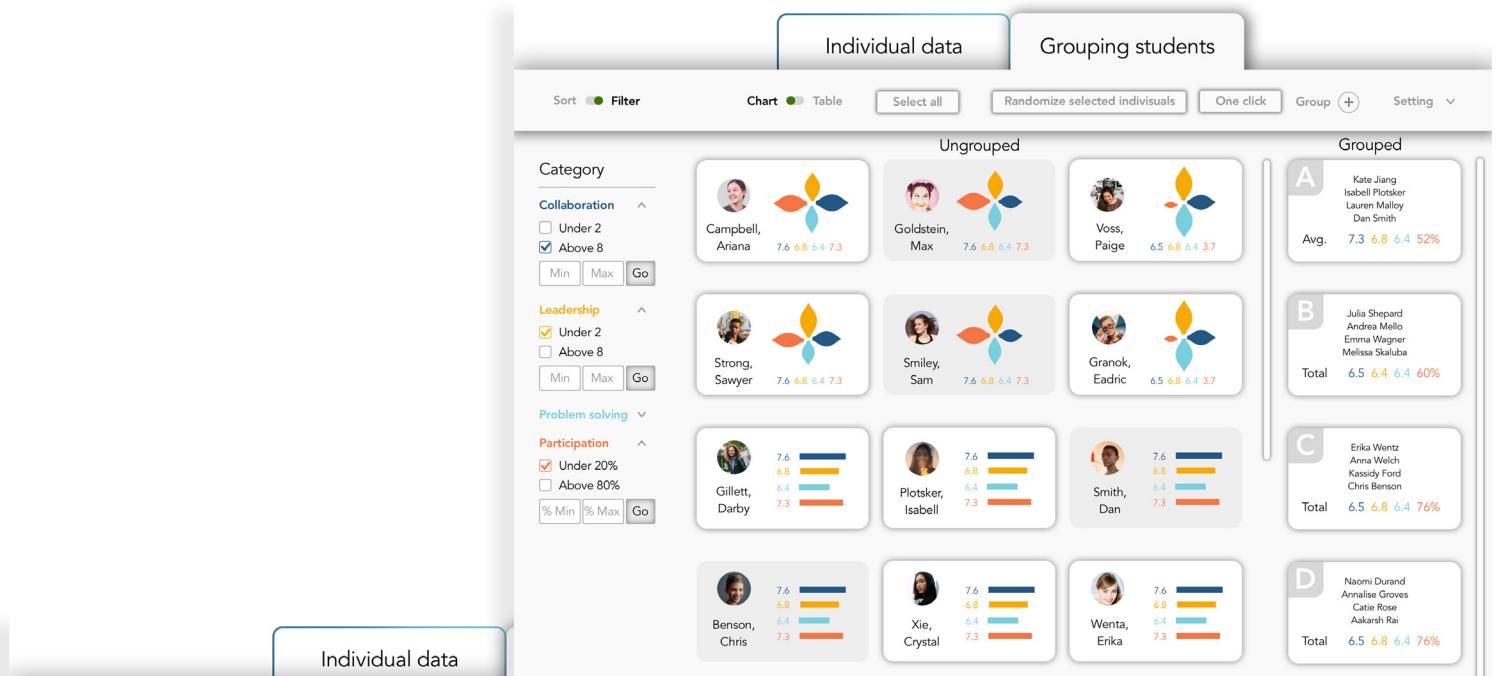
## V2.1 (V1.4 ALTERNATIVE DESIGN): PETALS VS BARS VS TABLES

Students’ data can be displayed in either visual chart or a table.

In the visual display, students’ data could be visualized in two ways: petals or bars.

Sorting and filtering features were designed to allow teachers to pick students meeting specific criteria. Students’ scores on different skill categories were shown in numbers to align with the concept of sorting and filtering.

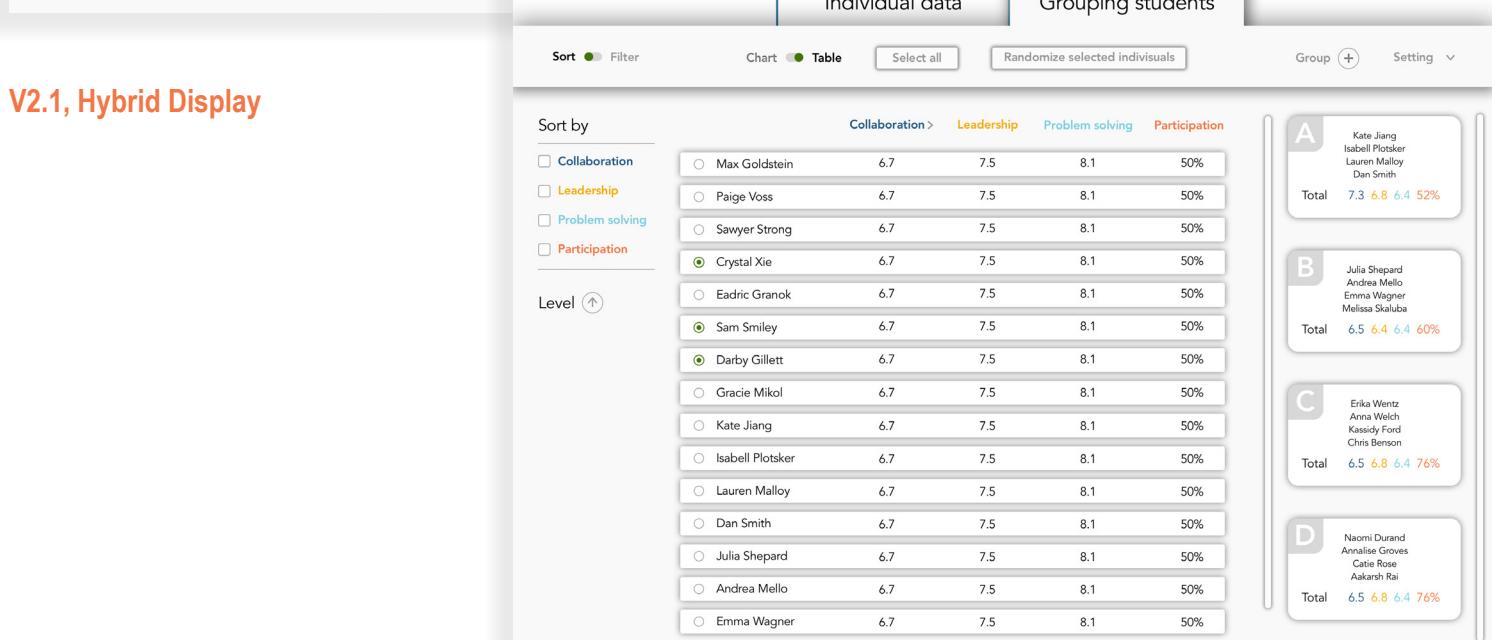
- Feedback
  - 2.1.1 For the pre-grouping section, bars make the most sense, as it allows
    - for easier comparisons of skills (by K12’s UX experts)
  - 2.1.2 Use data visualization to present group average information (by
    - K12’s UX experts)
  - 2.1.3 Teachers may want to use skills, as opposed to skill categories in
    - grouping (by K12’s PBL experts)



### V2.1, Visual Display



### V2.1, Table Display



### V2.1, Hybrid Display

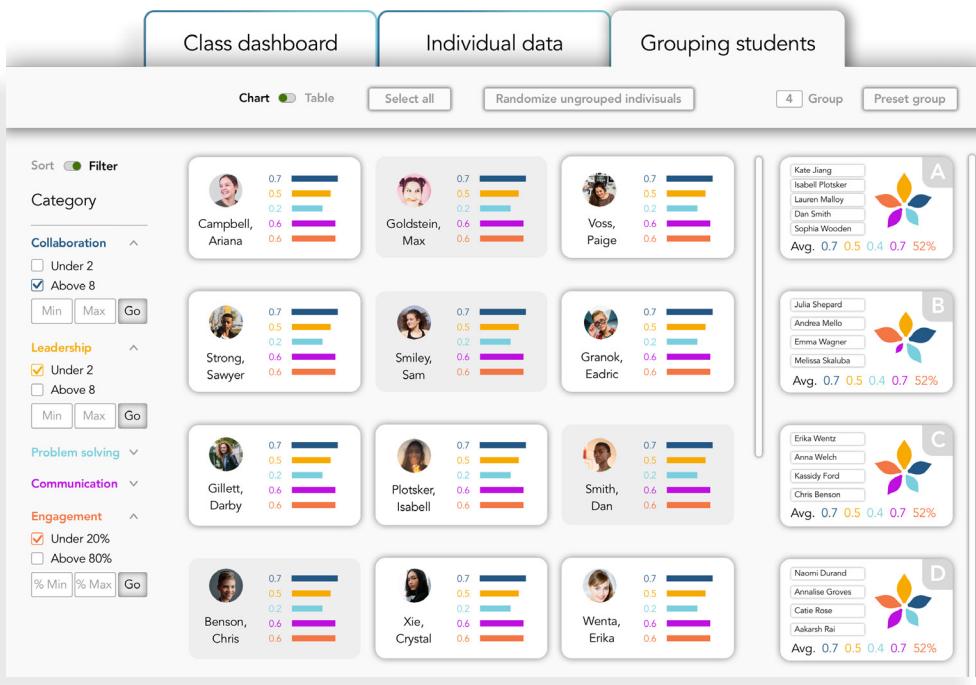
## V2.2 DIFFERENTIATE VISUAL LANGUAGE FOR INDIVIDUALS AND GROUPS

We followed the suggestion and used bars to represent individual scores. [based on feedback 2.1.1]

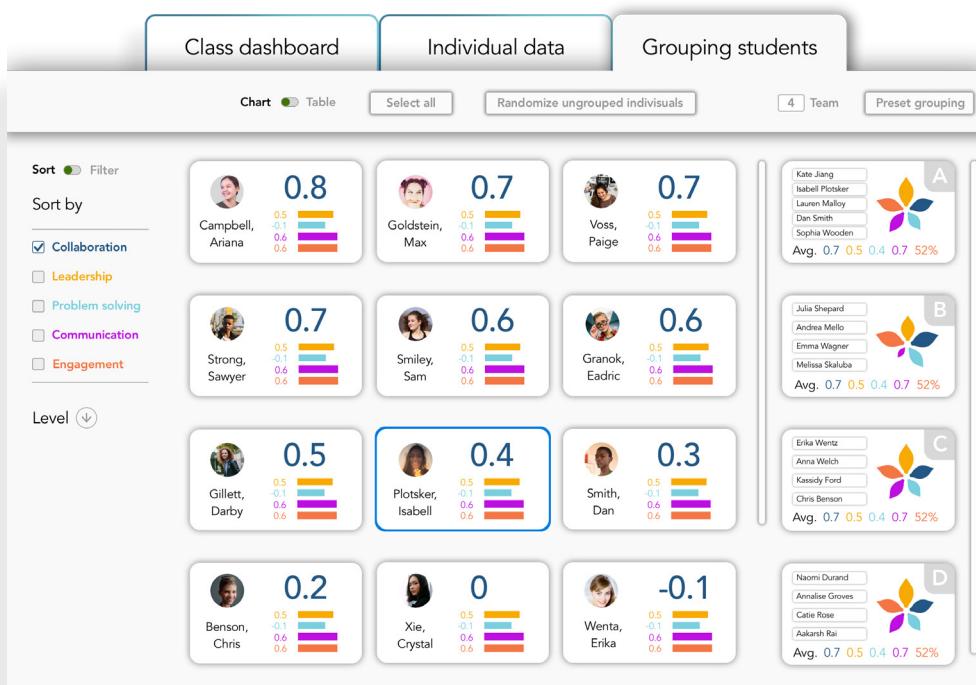
When trying to visualize the group average score, we decided to make the visual language different between individual data and group data to avoid confusion. [based on feedback 2.1.2]

In the table view, we changed the filter/sort options into “display” and added in the individual skills for each category, to allow teachers to view students’ performance on individual skills. [based on feedback 2.1.3]

- Feedback
  - 2.2.1: The detailed scores of students’ professional skills are unimportant for teachers to make student groups. A fair balance between teams, with no particular skill visibly lacking, is all that a teacher really needs to know. (by K12’s PBL and UX experts)
  - 2.2.2: The display of group average score is unnecessary when the petals convey the information (by K12’s UX experts)



## V2.2, Visual Display



## V2.2, Hybrid Display

## V2.3 AVOID COGNITIVE OVERLOAD BY USING LEVELS

A major change was the replacement of numeric scores with three levels: Exemplary, Accomplished, and Developing (from K12 PBL rubric). [based on feedback 2.2.1]

With the above change, we also removed the filter feature since it is less useful when the exact score is hidden.

We removed the display of group average scores [based on feedback 2.2.2]

The screenshot shows the 'Smart grouping' feature in the application. At the top, there are tabs for 'Chart' and 'Table', with 'Chart' selected. Below this, a section titled 'Sort students by' includes a radio button for 'Collaboration' (selected) and checkboxes for 'Communication', 'Problem solving', 'Project management', and 'Group discussion'. The main area displays student profiles in a grid format. Each profile card shows a student's name, a level indicator (Exm, Acc, Dvlp), and a bar chart representing their performance across four categories: Acc, Dvlp, Exm, and Evm. To the right of the grid, there is a legend for 'Smart grouping' showing eight groups labeled A through H, each represented by a flower icon and a list of student names. Group A: Ariana Campbell, Paige Smith, Sophia Wooden. Group B: Kate Liang, Reley Plotker, Lauren Mikol, Cassidy Smith. Group C: Juliet Shepard, Alex Mello, Emma Benson, Molly Skaluba. Group D: Hope Driver, Harley Polman, Will Cannon, Meghan Bowman. Group E: Chris Wentz, Anne Welch, Kate Ford, Chris Wentz. Group F: Lucas Ding, Stanley Icaza, Ryan Zhou, Kelly Kimisu. Group G: Naomi Rose, Annalise Goody, Katie Durand, Askarshey Rai. Group H: Trisha Pulos, Sally Durand, Emily Bhattachar...Eadric Gillett.

## V2.3

## V2.4 FURTHER REDUCING COGNITIVE LOAD

Based on intuition, we decided to add text to make the connection between categories and the corresponding visual elements, instead of just using color codes.

We replaced the levels before each bar in students' card with the skill categories. We also made a visual distinguishing line between the three levels not only to give teachers a sense of where students are within the level, but also to make the comparison easier for teachers.

- Feedback
  - The newer version reduces the cognitive load for teachers, as memorizing the three levels is much easier than memorizing the colors for each category (K12's UX expert).

The screenshot shows the KLAB software interface. On the left, there is a grid of student profiles. Each profile card includes a student's name, a circular profile picture, and a level indicator (Exemplary, Accomplished, Developing). Below each name is a bar chart showing performance across five categories: Collaboration, Communication, Problem Solving, Proj. Mgmt., and Participation. The bars are color-coded in blue, orange, red, green, and pink respectively. On the right, there is a 'Grouping' feature window. It shows a list of four students: Sam Strong and Isabell Rich under group A, and Darby Granok and Angie Xie under group B. Each group has a large flower icon. There are buttons for 'Save' and 'Confirm'. At the top of the grouping window, it says '4 Student / Team'.

“

*The petal design indicates that every student is like a flower. It's really conveying the idea of growing as well as variety.*

K12 stakeholders

V2.4 (Current Working Version)

## V2.5 UI DESIGN (IN DEVELOPING)

While the current working version embeds the style of Material Design and Ant Design as much as possible, to bring the product to next level, we plan to add more UI design, mainly focus on animations.

The feedback we got from potential users are in general positive. However, consider the fact that most of the testers do not have a design background and the limited number of test, we would say that there is still room for V2.4 to go beyond and meet all requirement from various user groups in different conditions. Responsive design will also be added to the product because we believe users should not be limited by their device while accessing the platform.

# Future Work

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What It Does, Ideally  
Further Development on Features



# WHAT IT DOES, IDEALLY

We envision Coalesce being a LMS add-on geared towards PBL that measures and visualizes students' professional skills as they develop throughout the course and through their high school career. The system then uses this data to help augment teachers' ability to personalize the instruction for the student in a variety of ways, such as grouping them with peers that can complement their abilities, giving focused praise/feedback on their strong/weak points, and assigning them tasks specifically meant to enhance their strengths or work on their weaknesses. In addition, by seeing their own individual profiles, students can figure out what professional skills they need to improve on, and how.

## CONSIDERING IEP/504 STUDENTS' NEEDS

As a minimal viable product, the current version of Coalesce does not specifically address IEP or 504 students' needs. As these students will be a part of PBL courses, we recommend consideration of the issue when constructing the student profile feature and putting such students into project groups. Some ways to address the problem might include:

- **Highlighting:** Use visual elements to help teachers see which students have an IEP or 504
- **Smart grouping rule:** Put students with IEPs or 504s into different groups, ideally so there is no more than one in any particular group

 STUDENT-FACING PRODUCT

Our current work has mainly focused on the teacher side of the product. To make a fully fledged product, the student-facing side needs to be designed. Based on teachers' feedback and experts' suggestions, here are some recommendations for designing the student product:

- **Understand Yourself**

Allow students to see their own scores and progress. One specific approach recommended in the literature is a strengths-based approach [9], which shows students what strengths they already have and what skills they are able to further develop.

- **View Peer Feedback**

Allow students to see an anonymous, teacher-moderated version of their peers' feedback.

- **Communicate with Teacher**

Make it possible for students to communicate special circumstances (e.g., family move, special event, sickness, etc.) with the teacher.

- **Gamification**

The student-facing product can incorporate some motivating/gamified elements to encourage students to improve on skills.

While we have fleshed out an initial version of the student interface for students to take the initial evaluation and benchmark self and peer evaluation, testing specifically with K12 students has not occurred and is needed. We consider the following as potential areas for improvement:

- **Additional Engagement Features**

Further explore the content and UX design to help students engage in this initial and thus crucial touchpoint. Use of more fun interactions (e.g., sliders, swipe) and inclusion of a more engaging look-and-feel by increasing UI design may be directions to explore.

- **Scaffold for Constructive Criticism**

While the current scaffold prompts comes from expert recommendations, more research on scaffolding on how to give constructive feedback, especially constructive criticism could potentially yield better results.

## INTEGRATION WITH K12 LMS

Although the prototype is designed as a stand-alone website, we vision that it will eventually be integrated as a module in K12's learning management system (LMS).

The integration will have multiple benefits:

- It reduces teachers' workload by allowing teachers to complete their job within one system. In particular, teacher can grade students' performance on the project with reference to students' self and peer evaluations.
- It allows teachers to compare and contrast students' professional skills, content knowledge and skills (reflected by grades, for example), and completion of assignments all at once, to develop a more holistic teaching approach tailored to different students. It allows teachers to take into consideration of students' content knowledge as a factor when putting students into different project groups.
- When the self and peer evaluation task is delivered to students' in the same way as other assignments with a reasonable frequency, students are more likely to take it seriously and voluntarily.

Potential design features that can be added on to Coalesce when it is incorporated into K12 LMS:

- **Grade Reference**

When teachers grade students' assignments, show students' self and peer evaluation as a reference.

- **LMS as a data source**

LMS has rich data about students' completion of assignments, which can be a good data source to include into the student profile in Coalesce. We imagine this will be helpful for teachers to understand how groups divide their work to finish project tasks.

# FURTHER DEVELOPMENT ON FEATURES

While we tried our best to incorporate teachers' needs and domain experts' recommendations into Coalesce, there are places where future work is needed to fully address those needs. We summarized these unmet needs and recommendations below as suggestions for K12's future work:

## FEATURE 1: INITIAL SELF EVALUATION

**Question Pool:** Having backup questions for each skill measured to allow students to answer different sets of questions each semester, in order to get more reliable results.

**Incorporate Developmental Perspective:** CASEL recommends taking into consideration students' development trajectory when designing measurements for Social Emotional Learning. In user testing, teachers also considered 9th-grade and 12th-grade students differently when responding to our questions related to survey design. It would be beneficial if the survey items are differentiated when given to different age levels.

## FEATURE 2: BENCHMARK SELF/PEER EVALUATION

**Customizable Questions:** Since the benchmark evaluation only gives a subset of questions that the initial survey asks for, a way to customize the subset each time a benchmark evaluation is given is extremely important. Additionally, being able to customize the subset for individual groups may also be helpful as each group may have different professional skills they should be focusing on. Feedback was given by K12 PBL experts that customization should not go as far as the individual, as this may lead to just one or two peers evaluating the student, making it more susceptible to skewing due to an outlier.

 FEATURE 3: CLASS DASHBOARD

**Customizable Flagging System:** Allow teachers to define and customize the criteria for flagging. One teacher mentioned that he would want to download the data in order to play with the data collected in a more flexible way.

 FEATURE 4: STUDENT PROFILE

**Student Profiles in Other Courses:** Some teachers expressed a desire to see students' performance in other classes, to understand how to better help students in the current course. For example, one teacher mentioned that if she identified a problem with a student, she would go to other teachers who teach the class where the student performs well to get advice on how to help or motivate the student.

**Fuller Use of Automated Data:** The current version of the product calculates the proportion of talking in a group discussion by analyzing the amount of words the student typed vs the amount of words his or her teammates typed, a method easily gamable and imprecise. In the future, natural language processing (NLP) technology can be used to further analyze students' performance in group discussion. Since a few teachers expressed that relevance to the topic is a basic thing to ensure quality discussion, an analysis on the relevance may be a proper measurement to start.

**More Personal Information:** Teachers have expressed desire to understand students on a more personal level, including students' personal interests and hobbies. More relevant to learning, teachers would want to understand if students' absence to class is excused or unexcused. This can be potential information to incorporate in the system, or as part of the LMS if appropriate.

**Validation on Cumulative Score Formula:** The current way of calculating cumulative scores was based on the feedback from experts that more recent scores should take on more weight to foster the sense of growth mindset. Based on this, the team used heuristics to design the formula. More testing and validation is recommended before using it in the real product.

**Flagging Outliers:** Although our algorithms attempt to ensure outliers do not affect the ultimate score and level given to the student, it would still be good to know if a student or his or her teammate is attempting to skew the score given so that teachers can take the appropriate action.

#### ■ FEATURE 5: GROUPING TOOL

**Flexible Grouping Rules:** Develop algorithms and rules for easier and more flexible grouping, to allow grouping based on students' weaknesses, grouping students with teammates that they have never worked with, grouping students to achieve maximal gender balance in groups, etc. All the above examples have been mentioned as information to consider when grouping students by at least one teacher in our testing. In particular, gender balance has been emphasized by two teachers as a critical consideration in making student groups.

**Reuse Groups:** Allow teachers to reuse or partially reuse previously formed groups. This has been mentioned as desirable by several K12 stakeholders to both save teachers time as well as allow them to plan future groupings.

**Richer Information:** Incorporate richer information to inform the grouping, such as students' attendance data or students progress in their assignments (e.g., to identify who is ahead in the material)

#### NEW FEATURE: TASK RECOMMENDATIONS

One potential use of the student profile is to identify students' skill gap and recommend specific learning units for the student to complete. K12's PBL team has imagined that student will learn project skills by watching video instructions. The profile can be a good assessment of students' application on the skills learned, in addition to quizzes testing pure understanding of the concepts.

# APPENDIX: DATA SOURCES AND USES

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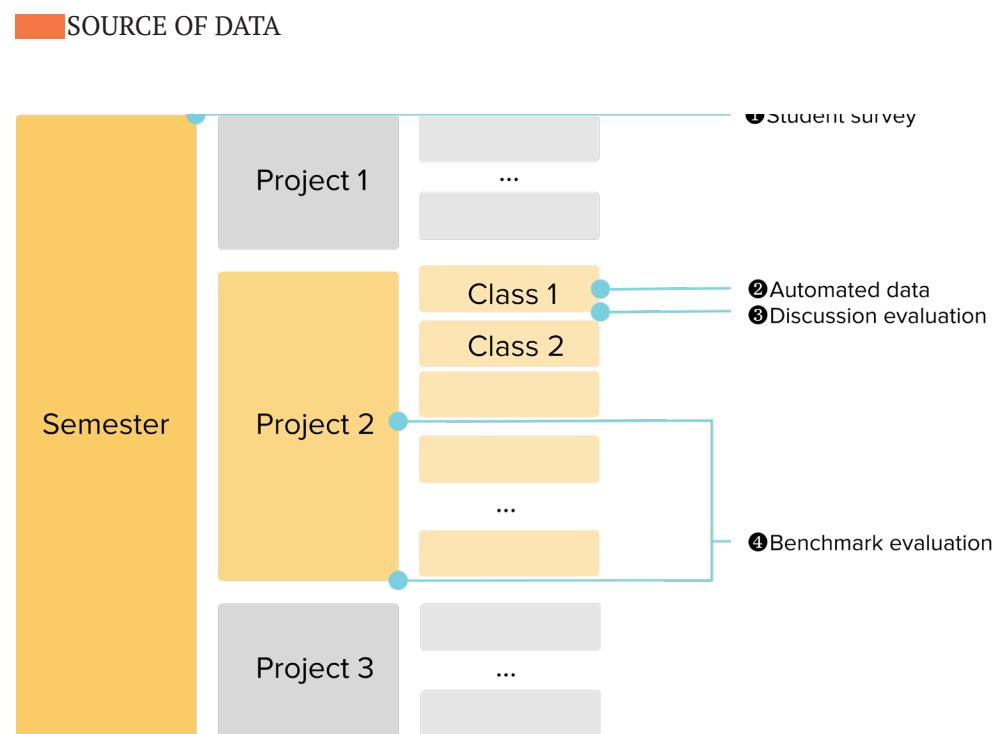
Summary

How are the scores/levels calculated?

Examples



# SUMMARY



Category	Source of data
Collaboration	
Communication	
Problem Solving	Initial self evaluation (self)
Project Management	Benchmark evaluation (self + peer)
Participation	Discussion evaluation (self + peer) Automated data [future work]

### Type of data

Single-time score; Cumulative Score (explained in detail next page)

### Transformation of different measurements

Data is displayed in numeric format (in Student profile - Cumulative score section), in stars (in Participation rating) and as categorical levels elsewhere. The relationship among them is shown below:

Type of Transformation	Equivalent Values
Initial survey (categorical) -> Numeric scores	Not like me at all → 0 A little like me → 2.5 Somewhat like me → 5 Mostly like me → 7.5 Very much like me → 10
Benchmark self and peer evaluation (categorical) -> Numeric scores	Exemplary → 10 Accomplished → 5 Developing → 0
Average score (numeric) -> Level (categorical)	Above 6.67 → Exemplary 3.33-6.67 → Accomplished Below 3.33 → Developing
Average participation rating (stars) -> Level (categorical)	2.34-3 stars → Exemplary 1.67-2.33 stars → Accomplished 1-1.67 stars → Developing

# HOW ARE THE SCORES/ LEVELS CALCULATED?

Ariana Campbell

! Evaluation Jun 13

Notes

Low group discussion engagement ×  
Big drop on project management ×

Overview

	Collaboration	Communication	Project management	Problem solving	Group discussion
Latest evaluation	Exemplary	Exemplary	Developing	Exemplary	Exemplary
Cumulative	Accomplished	Exemplary	Accomplished	Exemplary	Exemplary

## Student profile - Overview

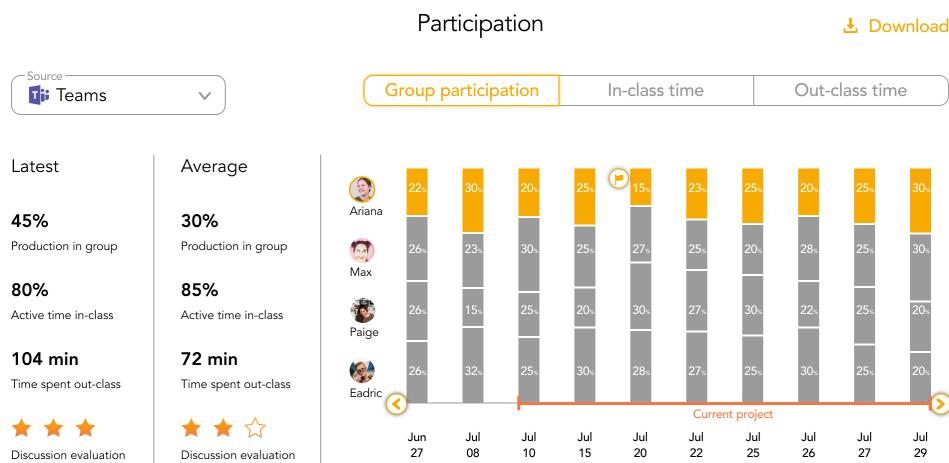
(Same information as displayed on the Class dashboard)

Latest evaluation = 50% score from last self evaluation + 50% score from last peer evaluation

Cumulative score = 50% cumulative self score + 50% cumulative peer score

Only the level of the cumulative score is displayed, a more detailed view of where exactly the student is in the level can be accessed from Student profile - Evaluation - Cumulative view

(Also see Student profile - Evaluation - Cumulative view for calculation of cumulative self and peer scores)



### Student profile - Group discussion data signal

Production in group: The percentage of the student contribution in the group, measured by the number of words written during the time period in question

Active time in-class: The proportion of time the student is active on the selected project tool in a class session (100% being the entire time allotted group work during class)

Time spent out-class: The time the student spent on the selected project tool since last class session out of the class

Discussion evaluation: The average amount of stars the student received from the group members (including him or herself) for each of the group sessions

Latest: Only the last class session's data is used for calculating Production in group, Active time in-class and Discussion evaluation. Time spent out-class is calculated from data gained since the end of the last class session.

Average: A simple average of the above data within the current project.

# HOW ARE THE SCORES/ LEVELS CALCULATED?



## Student profile - Evaluation - Cumulative view

For both self and peer evaluation scores,

Cumulative score =  $50\% * (\text{most recent evaluation score}) + 25\% * (\text{second most recent evaluation score}) + 12.5\% * (\text{third most recent evaluation score}) + \dots$  (the scores from the two most distant evaluations take on the same weight to ensure the total weight equals 100%)

Scores for each category takes the average from the scores from all of its skills.

## Student profile - Evaluation - Cumulative view - Evaluation progress chart

Within the current project, each data point shows the self and peer evaluations of that particular benchmark.

For previous data, each data point shows the average within the period of time (e.g., average score across a month).

For the self score, the first data point comes from students' self-report survey.

For peer score, the first data point comes from the average from the last semester, given it is available; if not, the data point will not appear.

**Summary Evaluation**

Download

Timeline: May 14, Acc; May 26, Acc; Jun 03, Dvlp; Jun 17, Acc; Jul 01, Exm; Jul 15, Exm; Jul 29, Exemplary

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**Ariana Campbell**

I really like this project because I love to work with my team. It was a great experience learning from my peers and get feedback from them. I wish I had more time developing my project.

---

Category	Skill	Self rating	Peer rating Avg.	Peer ratings
Communication	Public speaking	Exemplary	Accomplished	● ● ●
	Writing	Exemplary	Exemplary	● ● ●
Problem solving	Creative	Exemplary	Accomplished	● ● ●
	Critical thinking	Exemplary	Accomplished	● ● ●
Project management	Leadership	Accomplished	Accomplished	● ● ●
	Organization	Exemplary	Accomplished	● ● ●

### Student profile - Evaluation - Timeline

The average score of all the categories combining both self (50%) and peer evaluation (50%) is shown for each date.

### Student profile - Evaluation - Single Evaluation

To calculate the average peer evaluation score, first, the peer ratings are transformed into scores:

Exemplary = 10

Accomplished = 5

Developing = 0

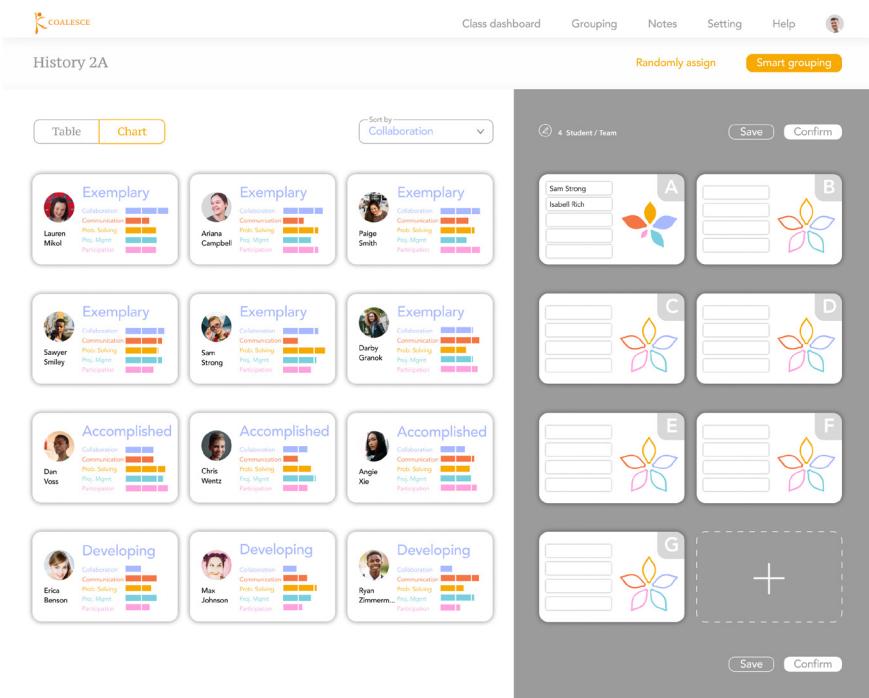
The score is then averaged. Next, this average score will be transformed back to one of the three levels:

Above 6.67 = Exemplary;

3.34-6.66 = Accomplished;

Below 3.34 = Developing

(This calculation method and grading scale have not been tested, and is open to future change.)



### Grouping Tool - Student area

The data shown in the grouping tool reflects the average cumulative score of both self and peers (see Student profile - Evaluation - Cumulative view for details). The bar reflects the actual score while the text describes the level the score falls in.

### Grouping Tool - Group area

The petals shows the average of the group members' individual cumulative scores for each category. Numeric scores in individual cumulative scores are used to calculate the group averages, not just the level.

# EXAMPLE

## WHERE DOES A LEVEL COME FROM FOR A LATEST EVALUATION?

Let's say these were the scores that Juliet and her teammates rated her for her communication subcategories

Skill	Rater	Juliet (Self)	Alex	Emma	Molly	Teammate Average	Average
Communicative	Accomplished (5)	Developing (0)	Developing (0)	Accomplished (5)	(0+0+5)/3 = 1.66	(5+1.66)/2=3.33 (Accomplished)	
Public Speaking	Question Not Asked	Question Not Asked	Question Not Asked	Question Not Asked	/	/	
Writing	Exemplary (10)	Exemplary (10)	Accomplished (5)	Accomplished (5)	(10+5+5)/3 = 6.67	(10+6.67)/2=8.34 (Exemplary)	
Communication Total	(5+10)/2=7.5 (Exemplary)	(0+10)/2=5 (Accomplished)	(0+5)/2=2.5 (Developing)	(5+5)/2=5 (Developing)	(5+2.5+5)/3 = 4.16	(7.5+4.16)/2=5.83 (Accomplished)	

\*All scores are first converted to a 10 point scale to accommodate the initial self evaluation, explained below

For any particular skill, the teammates' scores are averaged together. This is to make sure they do not take an unfair amount of weight in the final score, especially if groups are larger. It also helps to smooth out any potential outliers or biased evaluations. The teammate average score is then averaged with the self evaluation score to produce the final level that appears on the dashboard.

Range: 0-3.33=Developing, 3.34-6.66=Accomplished, 6.67-10=Exemplary  
The category ranking for any one person is calculated by averaging up the individual skill scores. The total category level can be calculated either in the same way a skill is calculated or by averaging the skill scores together.

 WHERE DOES A RANKING COME FROM FOR A CUMULATIVE EVALUATION?

Rater Data Source	Juliet (Self)	Alex	Emma	Molly	Teammate Average	Average
Initial Self Evaluation	Mostly like me, 7.5	N/A	N/A	N/A	N/A	7.5 (Exemplary)
Benchmark 1	Accomplished (5)	Developing (0)	Developing (0)	Accomplished (5)	$(0+0+5)/3 = 1.66$	$(5+1.66)/2=3.33$ (Accomplished)
Benchmark 2	Exemplary (10)	Exemplary (10)	Accomplished (5)	Exemplary (10)	$(10+10+5)/3 = 8.33$	$(10+8.33)/2=9.16$ (Exemplary)
Benchmark 3	Exemplary (10)	Accomplished (5)	Accomplished (5)	Exemplary (10)	$(5+5+10)/3 = 6.67$	$(10+6.67)/2=8.34$ (Exemplary)

Any particular benchmark's ranking follows the formula described above. However, the cumulative level is calculated with more recent evaluations being weighted more. Our current algorithm has the most recent one weighted 50%, the second most recent 25%, the third 12.5% and so on. To prevent this series from never equaling 1, the two evaluations in the most distant past have equal percentages. After everything is calculated, the score is reinterpreted back into a level.

Range: 0-3.33=Developing, 3.34-6.66=Accomplished, 6.67-10=Exemplary

The reason why we have weighed the cumulative level is because we feel this will not only ensure a better chance of reaching the Exemplary rank for those who started in the Developing area, since initial poor performances will be weighed less, but we also hope it can increase accuracy of the scores as the student's self perception gets influenced by his or her peers' aggregate evaluations as the course continues, and these evaluations are weighted more.

The QR code links to our website, which contains an archive of digital report and more appendix. Scan the code, and follow the URL that shows up. Alternatively, you can access our site at <https://k12-capstone.github.io>



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