

CLP: A Platform for Competitive Learning

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What is CLP?

- **CLP** is an online continuous improvement tool that provides feedback to students on continuous improvement tasks/problems.
- Engages students in active learning with their peers.
- Motivates students to do their best and improve their performance.

Experiment Setup

- Collected data from 18 courses @ 2 universities, 606 students, and 15782 CLP submission.
- Two different kinds of survey questions, open ended and closed ended (mixed positive and negative).
- Performed three different types of analysis:
 - Numerical Analysis
 - Sentiment Analysis
 - CLP Engagement

Table 1 : Classes and Student Distribution

Class	Subject	Session	Students	G/U	Survey	Engagement
1	Data Mining	Sp 17	29	G	Y	N
2	Data Mining	Fa 17	40	G	Y	N
3	Data Mining	Fa 17	29	U	Y	N
4	Data Mining	Sp 18	46	G	Y	Y
5	Data Mining	Sp 18	42	G	Y	Y
6	Large-Scale Analytics	Sp 18	46	G	N	N
7	Data Mining	Fa 18	47	G	Y	N
8	Data Mining	Fa 18	25	U	N	Y
9	Data Mining	Fa 18	42	G	N	Y
10	Large Scale Analytics	Sp 19	40	G	N	Y
11	Data Mining	Sp 19	45	G	N	Y
12	Data Mining	Wi 20	31	G	Y	Y
13	Machine Learning	Sp 20	28	G	Y	Y
14	Machine Learning	Fa 20	30	U	Y	Y
15	Data Mining	Wi 21	21	G	Y	Y
16	Deep Learning	Sp 21	31	G	Y	Y
17	Data mining	Sp 21	46	G	Y	Y
18	Data mining	Sp 21	41	G	Y	Y

Table 2 : Survey Questions

ID	Question	(+)/(−)
1	I would prefer to use a competitive learning platform for my homework assignments.	+
2	I found that the leader board function in CLP discouraged me from trying to improve.	−
3	I thought the CLP system was easy to use.	+
4	I hope I never have to compete in a homework assignment again.	−
5	The leader board function in the CLP motivated me to try my best.	+
6	I found the CLP system unnecessarily complex.	−
7	I would imagine that most people would learn to use the submission system in the CLP quickly.	+
8	I found the information provided by the CLP was insufficient.	−
9	The personal submissions table and graph summary were helpful to gauge my progress.	+
10	I found the personal submissions graph for a given assignment unhelpful.	−
11	What were the most useful features of the CLP? Why?	+
12	What were the downsides of using the CLP system? Why?	−
13	How, if at all, did you approach solving a CLP homework assignment in a different way than you would have approached a normal homework assignment?	+/-
14	Did you choose to display leaderboards before submission deadlines? If you could go back to the beginning of the semester and change your choice, would you? Why or why not?	+/-

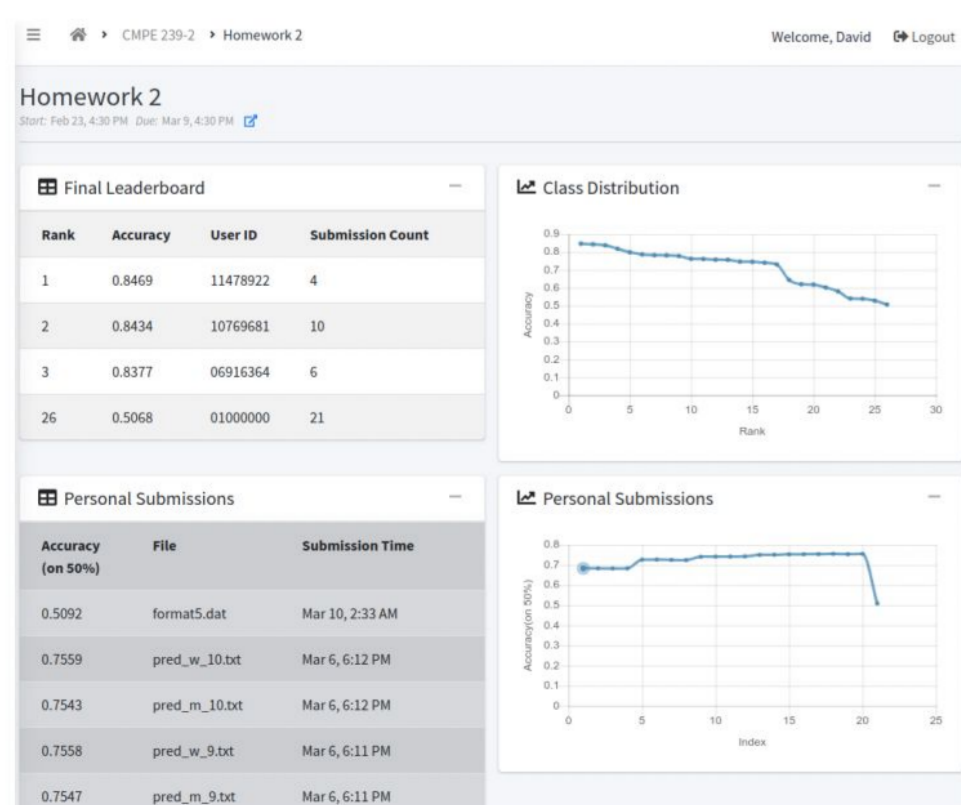


Figure 1 : The CLP leaderboard.

Do students believe CLP is a helpful tool in their learning in the classes that use it?

- When given the option to choose between CLP and Non CLP, the majority of students opted for CLP.
- 96.16% and 88.07% of graduate and undergraduate students opted in, respectively.
- Competition opt-in distribution for each class in the study can be seen in Figure 2.

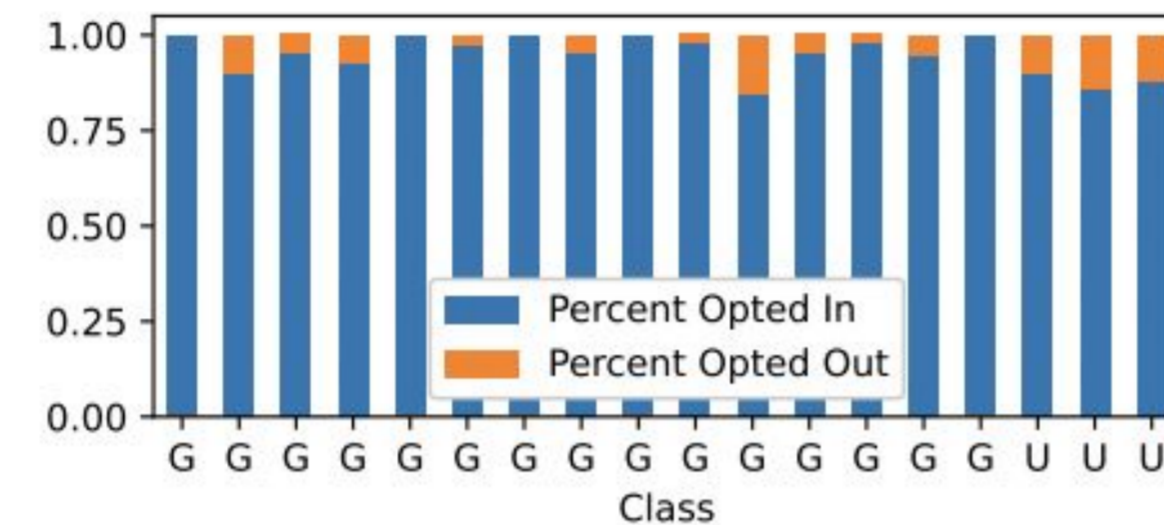


Figure 2 : Competition Opt-in Distribution

- Most students gave positive responses in the closed-ended questions.
- Figure 3 shows responses after inverting results for negative questions.

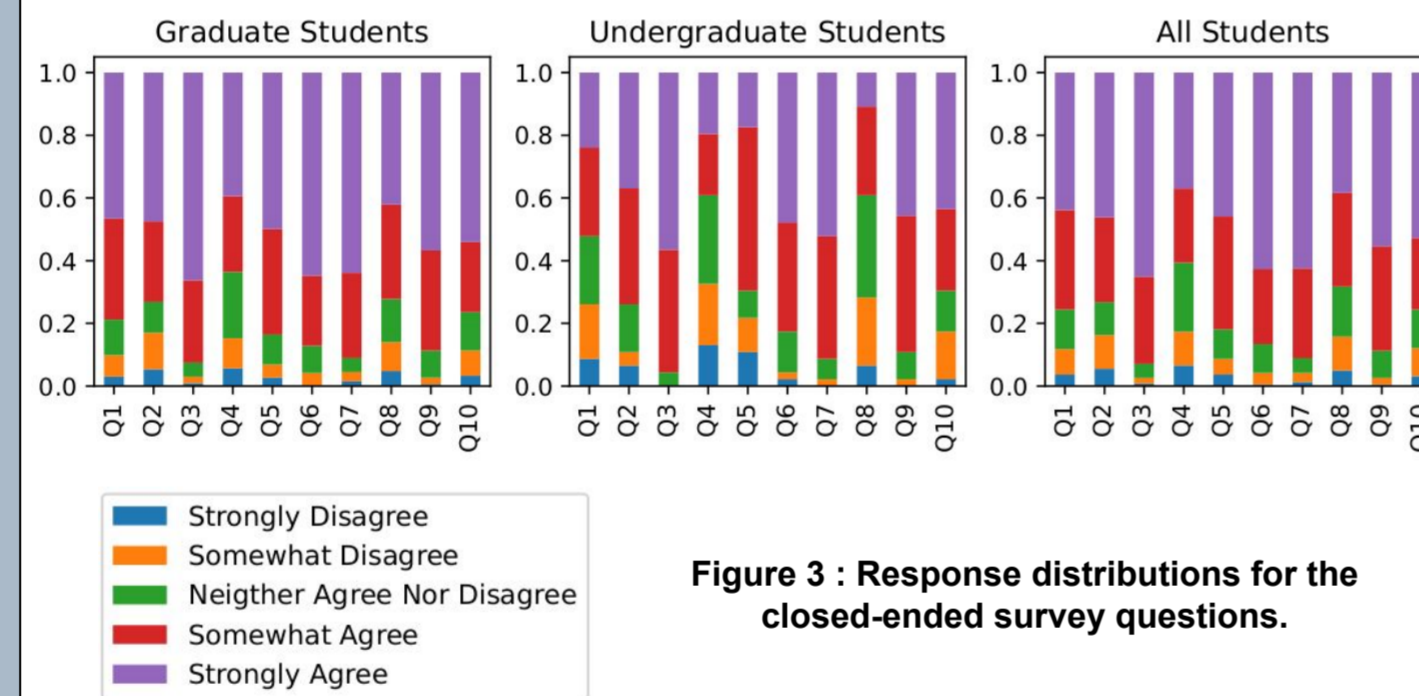


Figure 3 : Response distributions for the closed-ended survey questions.

- Sentiment analysis for the open-ended questions shows decisively positive responses, indicating students enjoyed the platform.

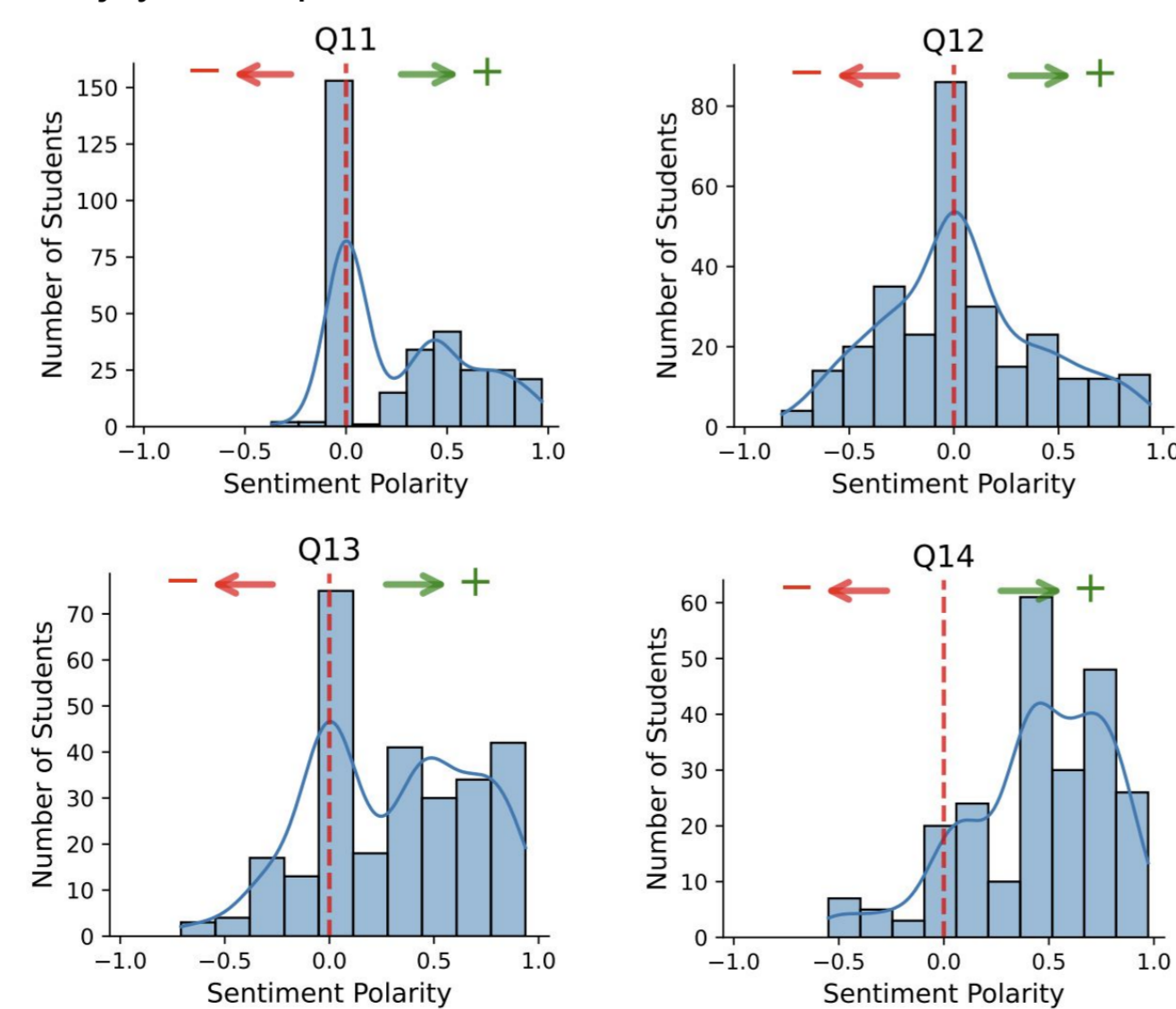


Figure 4 : Sentiment polarity distributions for open-ended survey questions.

Does CLP encourage students to try different solutions that they may have not considered previously?

- Survey Q13 addressed this question, but we also analyzed distribution of CLP submissions.
- Q13 responses indicate CLP promotes trying a different approach and encourage students think of new approaches for certain problems.

Table 3 : Per-Class Sentiment Polarity for the Open-Ended Survey Questions

Class	G/U	Q11	Q12	Q13	Q14	All
1	G	0.35	0.02	0.19		0.20
2	G	0.04	0.05	0.14	0.38	0.10
4	G	0.34	0.09	0.41	0.42	0.32
5	G	0.14	-0.10	0.22	0.34	0.14
7	G	0.31	-0.17	0.22	0.39	0.20
12	G	0.36	0.42	0.20	0.47	0.36
13	G	0.43	0.15	0.55	0.55	0.42
15	G	0.38	0.07	0.23	0.55	0.35
16	G	0.45	0.19	0.32	0.53	0.38
17	G	0.26	0.06	0.40	0.42	0.31
18	G	0.23	-0.04	0.29	0.23	0.18
3	U	0.04	-0.01	-0.02	0.31	0.01
14	U	0.32	-0.10	0.43	0.40	0.26

- On average, each student submitted more than 10 solutions for each problem.
- Increased number of submissions shows the willingness of students to try to improve their score.
- Similar results for later assignments in the quarter or semester.

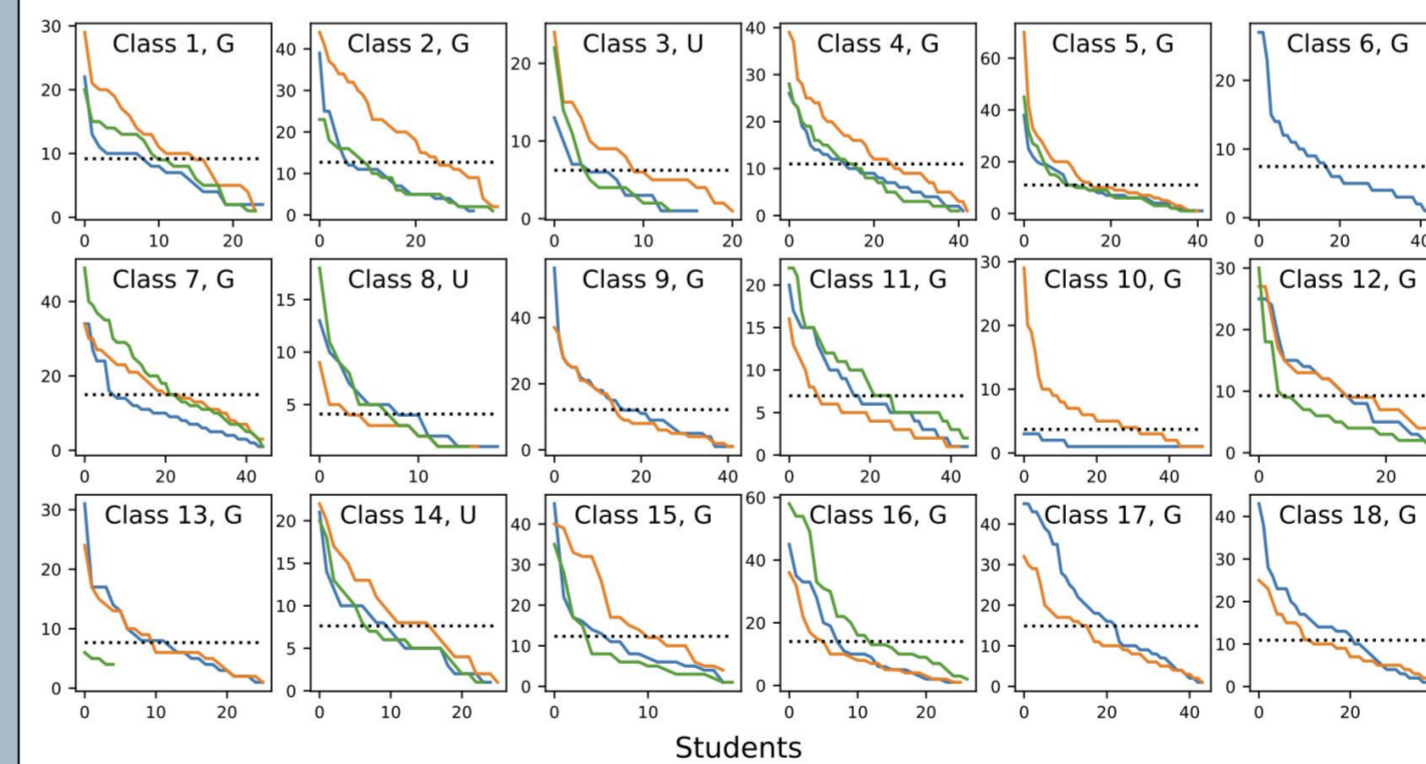


Figure 5 : Assignment submission count distribution for each class in the study.

What is the impact of using CLP on student performance?

- Correlation analysis shows strong correlation between mean assignment grades and the number of submissions, both for undergraduate and graduate courses
- Result indicates that student with good grades are the ones with higher numbers of submissions. Note that this is not a causal inference.
- There is also a strong correlation between score improvement and number of submissions, indicating that more submissions often lead to better performance
- Correlation between class engagement scores and number of submissions was mostly positive but not as strong as the other factors.

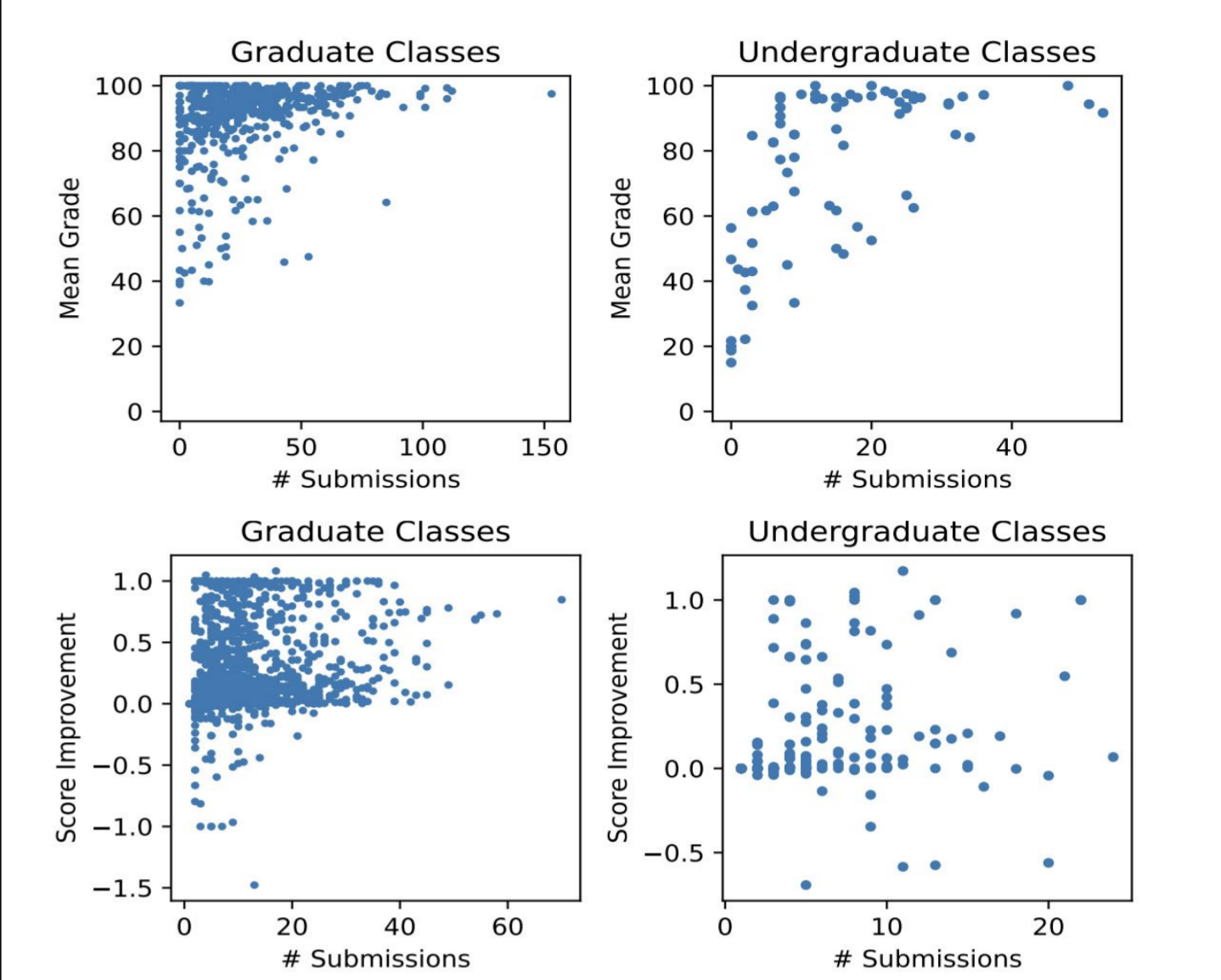


Figure 5 : Correlation between number of submissions and mean assignment grade and score improvement.

Table 4 : Correlation Analysis Between Number of Submissions and Other Factors

Class	G/U	Score	Improvement	Grade	Engagement
1	G	0.26	0.18	0.01	
2	G	0.36	0.37	0.30	
4	G	0.27	0.19	0.28	0.15
5	G	0.18	0.20	0.12	0.20
6	G	-0.27	0.43	0.11	
7	G	0.08	0.27	0.37	
9	G	0.23	0.33	0.33	0.18
10	G	-0.06	0.01		
11	G	-0.12	0.34	0.18	0.21
12	G	0.35	0.22	0.24	0.09
13	G	0.34	0.08	0.35	0.19
15	G	0.40	0.15	0.35	0.25
16	G	-0.09	0.31	0.34	-0.05
17	G	0.05	0.47	0.12	0.30
18	G	0.08	0.40	0.16	-0.20
3	U	0.08	0.32	0.03	
8	U	-0.00	0.07	0.26	0.22
14	U	0.20	0.22	0.23	-0.00

Discussion and Conclusions

- Formative feedback encourages students to improve their response and think about solutions they would not have thought of before.
- CLP encourages students to try different solutions to the same problem.
- CLP activity is correlated with improvements in the assignment objective scores and the assignment grades.
- CLP helps students achieve higher learning satisfaction as measures by end of the term survey.

Acknowledgements and Links

- Research supported by a grant from the Santa Clara University Faculty Collaborative for Teaching Innovation
- Read our paper...

