

WeBWork Leaderboards: From Experiment to Feature

In the spring semester of 2018, six math sections were targeted for experimentation at City Tech, CUNY - three sections of standard College Algebra and Trigonometry and three sections of College Algebra and Trigonometry with a co-requisite component consisting of additional review topics from Algebra and an extra instructional session each week. All participating sections were assigned WeBWork problem sets authored as part of the Opening Gateways Title V Collaborative Grant.¹ Both courses were expected to achieve the same level of understanding by the end of the semester, and outcomes for each course were measured using the same final assessment.

	Standard	Co-Requisite
Maximum	≈ 1750 XP	≈ 2000 XP
Level 10	> 1575 XP	> 1800 XP
Level 9	> 1400 XP	> 1600 XP
Level 8	> 1225 XP	> 1400 XP
Level 7	> 1050 XP	> 1200 XP
Level 6	> 875 XP	> 1000 XP
Level 5	> 600 XP	> 800 XP
Level 4	> 425 XP	> 600 XP
Level 3	> 350 XP	> 400 XP
Level 2	> 175 XP	> 200 XP

Table 1 XP model for the two courses

Our experiment was made possible by the work of G. Goehle², who created the framework for the leveling and achievement features in WeBWork.

Fundamentally, the XP system works by awarding a fixed number of experience points for every successfully-completed WeBWork problem. On its own, however, this would be no different than a student's grade. But, in addition to the experience points awarded for successful problem completion, achievements recognize other, often overlooked, aspects of student-homework interactions and further contribute to students' experience point totals.

Our six experimental sections utilized game-like features: achievements, badges and leaderboards. Since leaderboards were not (at the time) a feature built into WeBWork, we exported achievement data and generated sectional and cross-sectional leaderboards in Google Sheets, which we updated weekly.




Students who participated in the leaderboards experiment, on average, outperformed their peers for every single problem on the final exam assessment. This difference in means was statistically significant for all but two of the 14 problems. The two problems that failed to show a significant difference were assessing content that could be considered "review" for the context of these courses. This distinction from the rest of the exam might have contributed to the lack of impact.

MAT 1275EN WeBWork Leaderboard			
Gamer	Level	Achievements	WeBWork Completed
Manika	10_level_ten	1970	98.5%
102784	10_level_ten	1960	97.5%
K.Boozly	10_level_ten	1925	96.25%
TainaN	10_level_ten	1925	96.25%
BD71	10_level_ten	1915	95.75%
mikeisback0999	10_level_ten	1910	95.5%
teddy	10_level_ten	1905	95.25%
kingjr1590	10_level_ten	1885	94.25%
Fundamentals	10_level_ten	1870	93.5%
RN0111	10_level_ten	1870	93.5%
M14	10_level_ten	1860	93.25%

Fig. 1 Individual student leaderboard for WeBWork achievement scores

¹ <https://openlab.citytech.cuny.edu/openinggateways/>

² Goehle, Geo., Gameification and Web-based Homework, PRIM (2013)

WebWork Leader Board	TOTAL POINTS	AVG/STUDENT	CLASS LEVEL	SECRET ACHIEVEMENTS
MAT 1275EN/ [redacted]	24815	1,306.05	 7	72
MAT 1275EN/ [redacted]	36210	1,248.62	 7	111
MAT 1275EN/ [redacted]	48755	1,101.49	 6	137

Moreover, six of the 158 students in the experiment achieved a perfect score on the final exam. Only two of the 459 control group students managed the same feat. This suggests that students who might have otherwise settled for knowing “enough” of the curriculum may have been pushed to excel by the achievements or the competitive nature of the leaderboards. It is also expected that the exacting nature of WeBWork answer-grading, in combination with achievements recognizing consecutive correct answers submitted without error, contributed to students’ ability to solve problems with precision on their first attempt.

Beyond the formal assessment gains realized by the participating students, their responses to the new features were overwhelmingly positive (according to survey results). Students’ comments reflected an awareness of how their study skills were positively impacted by the achievements and the leaderboards. Even those who admittedly did not strongly engage with the experiment noted their desire to do better in the future.

Leaderboards

Username	Achievements Earned	Achievement Points Collected
mbonanome	22	100%
blm	22	100%
ceess	20	71.4%
...

In summer of 2018, we received funding from the City Tech Foundation which allowed our team to code a leaderboard feature into WeBWork and create brand-new level and special achievement badges. Our team consisted of 3 City Tech students: a communication design student and two experienced student coders.

With these improvements, WeBWork leaderboard usage at City Tech continues

to grow - with 19 sections participating in Fall 2019. Ongoing analysis has consistently shown a significant impact on student engagement with WeBWork, increasing measures of completion and persistence, while simultaneously decreasing the frequency of incorrect attempts.



MAT 1375 WeBWork Level Achievement Badges

If you would like to learn more about our work, please contact us.

Respectfully,
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