



# Gamification of Research Experience in a Large Academic Laboratory

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**Abstract:** This paper examines the deployment and effects of gamification strategies within the Sensors, Energy, and Automation Laboratory (SEAL) at the University of Washington, introducing a gamified project management system aimed at boosting engagement and productivity among a diverse cohort of about 80 participants. Incorporating gamification elements such as points, badges, and rankings, SEAL Clan Life seeks to revitalize the research and educational landscape, creating an interactive and dynamic learning environment. This initiative underscores the pedagogical value of gamification in engineering education, highlighting its role in enhancing active participation, inclusivity, and learning outcomes. By leveraging the motivational power of game-like mechanics, the paper illustrates the potential of such strategies to cultivate a competitive yet cooperative environment conducive to both academic and professional advancement, particularly among Gen-Z influenced by iconic games during their formative years.

**Keywords:** : *Gamification in education, project management in research labs, student engagement strategies, learning*

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*outcomes improvement, interactive learning environments.*

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## I. INTRODUCTION

Gamification's utility in boosting engagement among students and faculty in research activities is increasingly recognized. Elements such as points, badges, and rankings have been shown to significantly uplift motivation and learning outcomes, offering a compelling narrative on the pedagogical value of gamification in fostering an inclusive, dynamic learning environment. An experimental study utilizing the gamified platform Feeper highlighted the positive impact of gamification on engagement and performance, evidencing its efficacy in educational contexts [1]. This paper delves into implementing a gamified project management system within the Sensors, Energy, and Automation Laboratory (SEAL) at the University of Washington. The laboratory's diverse cohort, comprising about 80 individuals from varied disciplines, age groups, and cultural backgrounds, underscores the need for innovative educational strategies that promote active participation, enhance learning outcomes, and respect and embrace the richness of diversity. By leveraging gamification, SEAL Clan Life endeavors to create a research and educational setting that is both inclusive and engaging, highlighting the potential of gamification to revolutionize educational pedagogies and outcomes.

## II. BACKGROUND AND RATIONALE

### A. Overall Approach

SEAL Clan Life, a gamification strategy implemented within the Sensors, Energy, Automation Laboratory (SEAL), integrates game-like mechanics into the academic and research framework. SEAL Clan Life aims to enhance learning, collaboration, and innovation among lab members by structuring the lab similarly to a video game's progression system. This system assigns members various ranks and statuses, encouraging progression through a structured system of quests, tasks, and projects. The methodology draws parallels with popular gaming concepts involving clans or guilds, such as those found in World of Warcraft, Clash of Clans, Eve Online, Final Fantasy XIV, and Destiny 2, to foster a competitive yet collaborative environment conducive to academic and professional growth [2]; [3].

The advent of gamification in educational and professional settings has introduced novel approaches to engagement and motivation. Millennials and Gen-Z, with their

innate affinity for gamification and interactive learning, are particularly well-suited to thrive in environments like SEAL Clan Life, where game-like elements transform traditional academic and research tasks into engaging and rewarding quests [4]; [5]; [6]. Games like Final Fantasy XIV and Guild Wars 2, released between 2003 and 2017, captured the imaginations of Millennials during their formative teen years, and SEAL Clan Life aims to replicate the engaging and immersive experiences of these games. With the introduction of gamification, SEAL Clan Life harnessed the power of game elements to enhance engagement and productivity in educational and professional settings, a direction of thought pursued actively in many groups [7]. SEAL Clan Life represents an application of these principles within a research laboratory context, leveraging the inherent appeal of gaming to foster a productive and dynamic learning environment.

Gamification in SEAL Clan Life relies on the insights from neuroscience on how engaging, game-like environments can positively influence neural pathways and enhance learning and motivation. This approach mirrors how gamified tasks and quests stimulate the brain, fostering neural plasticity and engaging cognitive processes [8]. By integrating tasks that mimic the quest systems of popular games, SEAL Clan Life captures the engaging essence of these games and taps into the neural underpinnings of learning and motivation, making the lab's work not just productive but also deeply satisfying on a psychological level.

Gamification, as utilized in Space World™, has been used to engage underrepresented demographics in Science, Technology, Engineering, and Mathematics (STEM) by making complex subjects appealing and accessible [9]. SEAL Clan Life follows the principles of gamification to foster an inclusive, engaging learning environment that increases motivation and educational outcomes for diverse groups.

As seen in Fig. 1, SEAL Clan Life operationalizes gamification through a points-based ranking system, rewarding members for contributions across five core areas: Lab Citizenship, Leadership, SEAL Certification, Products and Deliverables, and Academic Development. Students' SEAL rank, based on the total points across these categories, establishes a progression system within the lab. As students accumulate points and increase in rank, it becomes a tangible indicator of their professional growth

and contributions to the lab. This system encourages a holistic approach to professional development, emphasizing technical skills, leadership, and collaborative abilities.

The methodology of SEAL Clan Life mirrors the clan or guild systems prevalent in multiplayer online games. Members undertake quests, manage tasks, and contribute to projects in a collaborative effort to advance their status within the lab. The Yellow Brick Road (YBR) system is a project, task, and performance management tool designed to guide associates step-by-step through their tasks within a quest. SEAL Clan Life draws inspiration from mechanisms found in popular video games, incorporating elements of gamification to enhance motivation and engagement in academic research settings. By analyzing these components, we can draw parallels with the structures and strategies employed by successful online multiplayer and role-playing games.

#### B. *Yellow Brick Road (YBR)*

The YBR system, as seen in Fig. 2, is designed to keep associates on track with their tasks within specific projects, using project management and performance management tools that visualize progress and goal attainment. This concept mirrors the progression of systems found in games like World of Warcraft or Final Fantasy XIV, where players follow a questline or storyline that guides them through the game world, marking their progress and achievements. In these games, the player's journey is often depicted as a path leading to higher levels of mastery, with clear indicators of progress and upcoming challenges. Similarly, the YBR system provides a structured path for lab members, with visual cues indicating their current status and what they need to do to advance, fostering a sense of progression and achievement.

#### C. *Quest System*

The quest system in SEAL Clan Life employs a gamification strategy to categorize tasks and projects into various quest types, akin to the quest structures found in popular MMORPGs like Final Fantasy XIV and Guild Wars 2. Quests in SEAL Clan Life are created around substantial lab or student career goals, like preparing and

submitting a publication, thesis, or R&D grant proposal. These quests are designed to mirror and resemble the structure of quests in popular games, emulating, for example, story quests that drive the narrative forward, escort quests where the player must guide an NPC, and gathering quests where the player must find specific items. Each quest requires different instructions and actions to complete. This tailored approach enhances the lab experience by making what would otherwise feel like 'generic academic and research tasks' more engaging. Quests foster a sense of achievement and progress, similar to the satisfaction players feel when advancing through the rich, immersive worlds of Final Fantasy XIV and Guild Wars 2.

#### D. *Task Assignment*

In SEAL Clan Life, tasks are assigned through the Kanban and YBR systems, with quests color-coded to convey the task details quickly to members. This approach to task assignment is reminiscent of the mission or quest systems in games like Destiny 2 or World of Warcraft, where tasks can be picked up from specific NPCs (Non-Player Characters) or mission boards. These tasks vary in nature and complexity, requiring individual or team efforts to complete. The immediate addition of verbally assigned tasks to a Kanban board in SEAL Clan Life ensures that tasks are tracked and managed efficiently, echoing the in-game mechanics where players keep track of their missions through an in-game journal or quest log, prioritizing and strategizing their completion based on rewards, importance, and difficulty.

### III. GAMIFICATION TOOLS

#### A. *Ranking*

The concept of ranking in gamification plays a pivotal role in motivating participants by assigning them positions or levels within a game-based system, determined by their performance, achievements, or progress. This mechanism fosters a sense of progression and achievement as players ascend through different tiers and cultivate an environment of competition [10], thereby enhancing engagement and retention through clear objectives and incentives.

Welcome to SEAL Clan Life!				2.9 AVG Rank				Links (Check Regularly)				Clan Standing				Clan Metrics									
SEAL Clan Instructions		Sandbox Instructions		SEAL FAQs		68		32		82		82		5		Click for Status Definition		84%		99%		81%			
SEAL Info: Das Tracker, Scheduler, Timeline Program, TP Campaigns, Social Media, Command Centre, SEAL, Collaborate, Rank, Quests, Zoom, Sandboxes, RSS																									
Average SEAL HP: 84%												Total Rank Points: 220												Sandboxes: 2	
Quests Handle	Associate Name	SEAL Rank	Your Group	Team(s)	Here You Live	Task Lineup	Task Lineup (Daily)	Task Lineup (Weekly)	Task Lineup (Monthly)	Task Lineup (Yearly)	YBR	Lab Status	Bot Score	Overall Score	Leader Score	Year Score									
Aarav	Aarav Patel	04	05. Sudoku	Sudoku Group	2024/07/06	01.000	01.000	01.000	01.000	01.000	42	1. Good	1. Good	105%	100	100%									
Yuna	Yuna Kim	03	03. Plasma	Technical Writing	2024/07/05	01.000	01.000	01.000	01.000	01.000	3	1. Good	1. Good	97%	100	95%									
Diego	Diego Rivera	08	01. IAC	Shadow Team	2024/07/09	01.000	01.000	01.000	01.000	01.000	76	1. Good	1. Good	102%	100	100%									
Fatima	Fatima Al-Fihri	05	03. Plasma	Plasma Group	2024/07/05	01.000	01.000	01.000	01.000	01.000	52	4s. ToSandbox	4s. ToSandbox	99%	100	92%									
Dmitri	Dmitri Ivanov	03	02. Embedd	Embedded Team	2024/07/09	01.000	01.000	01.000	01.000	01.000	14	1. Good	1. Good	101%	100	99%									
Mei	Mei Wong	14	02. Embedd	Embedded Team	2024/07/05	01.000	01.000	01.000	01.000	01.000	6	1. Good	1. Good	100%	100	98%									
Kofi	Kofi Mensah	04	01. IAC	Home Team	2024/07/09	01.000	01.000	01.000	01.000	01.000	120	1. Good	1. Good	102%	100	100%									
Sana	Sana Shan	03	01. IAC	Travel Team	2024/07/08	01.000	01.000	01.000	01.000	01.000	49	1. Good	1. Good	96%	100	94%									
Takumi	Takumi Nakamura	05	07. Biz/Tect	YBR Team	2024/07/15	01.000	01.000	01.000	01.000	01.000	14	2. Alert	2. Alert	99%	100	100%									
Lila	Lila Dubois	04	02. Embedd	Embedded Team	2024/07/08	01.000	01.000	01.000	01.000	01.000	6	1. Good	1. Good	100%	100	98%									
Jamal	Jamal Johnson	08	03. Plasma	Mechanical Design	2024/07/09	01.000	01.000	01.000	01.000	01.000	4	1. Good	1. Good	100%	100	98%									
Elena	Elena Petrova	00	01. IAC	Home Team	2024/07/09	01.000	01.000	01.000	01.000	01.000	0	5. Onboarding	5. Onboarding	47%	100	45%									
Henry	Henry Taylor	05	07. Biz/Tect	Proposal Team	2024/07/05	01.000	01.000	01.000	01.000	01.000	1,386	1. Good	1. Good	104%	100	98%									
Anna	Anna Schmidt	09	02. Embedd	Embedded Team	2024/07/08	01.000	01.000	01.000	01.000	01.000	13	1. Good	1. Good	100%	100	100%									

Fig. 1. The SEAL Clan Life Page. This page informs students of their current lab standing, including their SEAL rank, group, team(s), login date, task lineup, and Clan Standing. Hyperlinks to various tools used throughout SEAL are additionally hosted on this page. Real names have been replaced for privacy reasons.

YBR C. Score 39%				OneOnOne				YBR				Vault				Sidra				BEP				GO				#prop-ia				Due 2024/07/13				Mei, Diego, Arrave, Yuna				Subtle Score				150 Days Left			
YBR Ver. 11.0		Task Assignments		Task Description		Yellow Brick Road		Task Dates		Recurring?		Good / Bad?		Other																																	
0. Setup Stage																																															
1991	4. Done	4. Done	Mei, Diego, Mei	0.1. Prepare the Quest	This is a SBIR NSF proposal for the Quest Proposal   Team SEAL	1.0-High	Feb-14	-	Good																																						
1992	4. Done	4. Done	Mei, Diego, Mei	0.2. Select the Quest Topic		1.0-High	Feb-14	-	Good																																						
1993	4. Done	4. Done	Mei, Diego, Mei, Diego	0.3. Select the YBR Leaders and Admin	Mei, Diego, Arrave, Yuna	2-High	Feb-14	-	Good																																						
1994	2. Doing	2. Doing	Admin, Mei, Diego	0.4. Update the Quest (STATUS UPDATE)	Every couple 2/1: no updates	2-High	Feb-14	-	Good																																						
1995	4. Done	4. Done	Mei, Diego, Mei	0.5. Name the Quest	A1. Prop-IAF NSF Air Leaks New 202	1.0-High	Feb-9	-	Good																																						
1. Definition Stage																																															
1996	4. Done	4. Done	Mei, Yuni, Kofi	1.1. Determine the Quest Flavor	New- NSF SBIR proposal	1.0-High	Feb-14	-	Good																																						
1997	4. Done	4. Done	Mei, Yuni, Kofi	1.2. Develop the Quest Overview	new QO created, will be updated as to 2/5 Mei: starting this effort now, prop	4-Low	Feb-14	-	Good																																						
1998	2. Doing	2. Doing	Mei, Yuni, Kofi	1.3. Perform Pre-Project Setup		4-Low	Feb-14	-	Good																																						
1999	2. Doing	2. Doing	Mei, Yuni, Yuna	1.4. Identify and Study the Target	2/1 Mei: This has been updated to be 1/2 This is due March 4th, 02/13	1.0-High	Feb-10	-	Good																																						
2000	3. Review	3. Review	Mei, Yuni, Yuna	1.5. Refine Project Specifications		1.0-High	Feb-11	-	Good																																						
2001	3. Review	3. Review	Mei, Yuni, Takumi	1.6. Prepare the Shared Digital ID	1/6 Mei: Slack has been set up	1.0-High	Feb-12	-	Good																																						
2002	1. To Do	1. To Do	Mei, Yuni, Takumi	1.7. Prepare the File Repository ID	1/6 Mei: Setup, link to previous drive	1.0-High	Feb-13	-	Good																																						
2003	0. Backlog	0. Backlog	Mei, Yuni, Henry	1.8. Select the Communication ID	1/6 Mei: #prop-iaf-nsf-air-leaks	1.0-High	Feb-9	-	Good																																						
2004	0. Backlog	0. Backlog	Mei, Yuni, Henry	1.9. Identify All Shared Patents	1/6 Mei: details in QO, Alex, we were	1.0-High	Feb-9	-	Good																																						

Fig. 2. The Yellow Brick Road (YBR): A project, task, and performance management tool designed to guide associates through their tasks within a Quest, ensuring progress and accountability through visually tracking their journey toward achieving a goal. Real names have been replaced for privacy reasons.

The SEAL system exemplifies an advanced application of this concept, evaluating individuals across various dimensions, such as SEAL status, lab leadership roles, SEAL certifications, academic writing, and seniority. Points are awarded for specific accomplishments within these categories, such as completing onboarding processes, holding leadership positions, obtaining certifications, publishing academic work, submitting patents, securing grants, and attaining academic degrees. These points cumulatively determine an individual’s rank within the system, which is organized into nuanced levels ranging from 00 to 20 and symbolized by icons like a snail (‘ for Rank 04 and a shark for Rank 16, offering a tangible representation of one’s accomplishments and expertise. Students find it motivating that the emoticons chosen are fun, thematic, and have feelings of upward progression.

This dual-level ranking system, featuring both numerical ranks and rank symbols, allows for a refined assessment of achievements, facilitating finer distinctions among individuals’ qualifications. It caters to diverse backgrounds and skill sets within the organization, accommodating varying paces of advancement and reflecting the diversity within the professional and academic spheres. Furthermore, the system is segmented into four rank groups—simple life forms (ranks 0- 5), fish (ranks 6-8), crustaceans (ranks 9-13), and mammals (ranks

14+)—each symbolizing a different level of achievement and contributing to a structured framework for comparison and motivation.

The visibility of these rankings within SEAL Clan Life, the lab’s central information hub, leverages social comparison theory by encouraging members to evaluate their professional

and academic achievements against those of their peers [11]. This comparison acts as both a push and pull factor, motivating individuals to aspire to advance in their careers by pursuing higher SEAL Ranks via additional certifications, leadership roles, or improved academic credentials; these aspirations are driven by the visibility of their peer’s ranks and achievements [12]. It is important that higher rankings are tied to tangible student career or lab benefits, such as student access to advanced facility spaces, recommendation letters, research independence, awards, and lab funding.

Despite these competitive aspects, the SEAL system aims to maintain a low-pressure environment through techniques like whimsical emoticons, fun tracking metrics, and comprehensive training so that students can experience a flavor of public evaluation without the overwhelming stress that traditional high-stakes corporate ranking systems have. This approach underscores the system’s role in fostering a motivating and supportive com-



munity focused on lab-wide personal and professional development.

The data on Average Rank and Average SEAL Health points (HP), presented graphically in Fig. 3, provides compelling evidence of the impact of the ranking system

on student performance within the scholarly community. The upward trajectory of Average SEAL HP, juxtaposed against fluctuations in Average Rank, serves as a testament to the transformative potential of the ranking system in enhancing academic engagement and productivity.

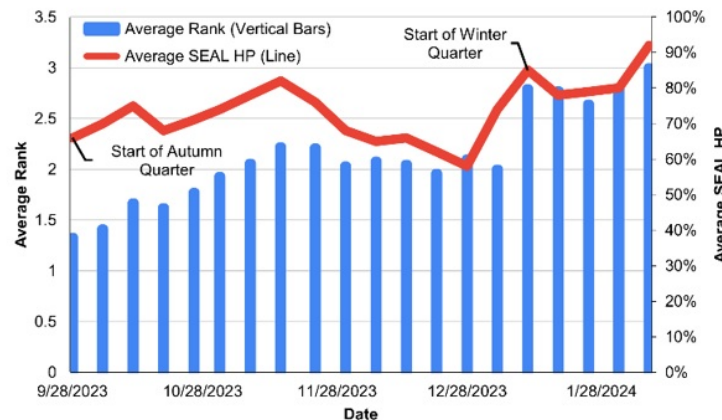


Fig. 3. Chart of the lab-wide SEAL Clan Life Average HP (line) and average rank (bars) over two quarters. Lab-wide HP has steadily improved after the introduction and further expansion of the SEAL Rank system. Reduction of Average HP during the holiday season in November-December is a predictable dynamics, as the associates are less committed to following up on their tasks during that period.

### B. Sandbox

Drawing inspiration from successful video games and software design, the "Sandbox" feature within SEAL Clan Life is similar to a tutorial or isolated learning space, where strategic intervention is given to support diverse learner engagement and progression. In SEAL Clan Life, the Sandbox is a separate limited access virtual space, similar to how software developers use secure, isolated 'sandbox environments' to test new code without risking the integrity of their production environment. At its core, the Sandbox aims to address the pedagogical challenge of balancing team dynamics and individual performance variability.

By embracing inclusive learning principles, the Sandbox facilitates a pathway for all learners to engage in research meaningfully at all speeds [13] while inside a tailored, low-stakes environment conducive to skill development and knowledge attainment. From an academic perspective, this approach aligns with contemporary educational theories emphasizing differentiated learning pathways and resilience in STEM education [14]. Essentially, the Sandbox can enable any participant who feels overwhelmed to still be able to contribute to academic achievement and meaningful research.

For high-achievers, the Sandbox can help mitigate the potential conflicts and frustrations commonly associated with collaborative research, like uneven team performance or 'dropped tasks.' As such, the Sandbox aims to

maintain high morale and motivation while giving those students who need additional help a safe space to receive it. This method promotes an equitable and supportive learning atmosphere, exemplifying a commitment to diversity, equity, inclusion, and accessibility (DEIA) in engineering [13].

## IV. STATISTICAL OBSERVATIONS

As a university-affiliated laboratory, SEAL is largely comprised of students. Teams are typically led by university students, with high school students shadowing and participating in team projects (as seen in Fig. 4).

During any given quarter, SEAL has over 80 student lab members from a variety of science and humanities majors. The lab is almost one-third women, which exceeds the representation in the University of Washington's ECE department of 19% women for B.S. students and 27% women for MS students [15]. The lab's variety and openness to all majors foster interdisciplinary research and diversity in the lab. As seen in Fig. 4, while SEAL predominantly consists of ECE majors, the lab fosters diversity, engaging students from over 13 disciplines. SEAL's interdisciplinary approach, facilitated by research's emphasis on writing, bridges the gap between humanities and sciences, fostering a collaborative environment conducive to innovation and excellence. At the same time, excessive imbalance towards ECE students shows room for improvement.

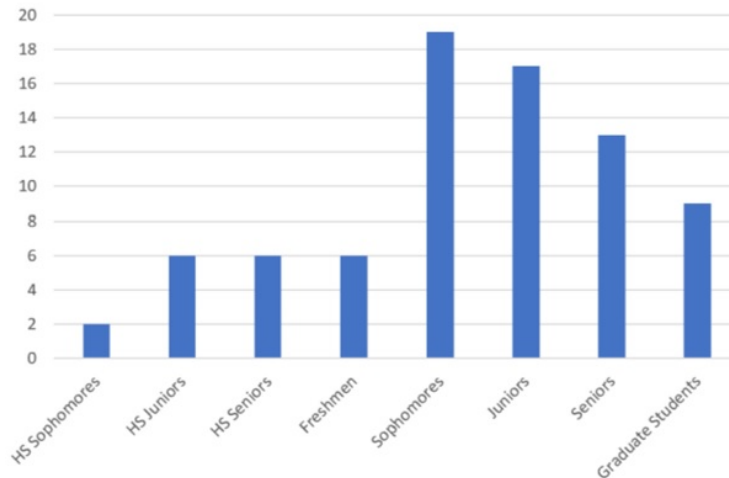


Fig. 4. SEAL lab members span a wide range of preparation levels, from high school sophomores to graduate students.

TABLE 1  
SPECIALITIES OF STUDENTS IN SEAL

Majors:	Students:
Electrical and Computer Engineering	41
Computer Science	17
Mechanical Engineering	8
Industrial Engineering	3
Business	2
Materials Science and Engineering	1
Mathematics	1
Data Science	1
Applied and Computational Mathematics	1
Philosophy	1
Public Health	1
Environmental Studies	1
Environmental Science & Resource Management	1
Total:	79

## V. CONCLUSIONS AND FUTURE WORK

The incorporation of a ranking system within the gamified environment of a research lab leverages the use of gamification principles to foster academic excellence and productivity. The paper offers actionable insights for practitioners and policymakers seeking to optimize educational experiences and cultivate a culture of excellence within academic communities. By incentivizing student engagement and performance, the ranking system stands as a cornerstone in the pursuit of academic success.

Future research should build on the foundations established by our gamification framework that has improved student engagement in research projects without undermining academic integrity. An area for further exploration is the impact of 'gamified adaptive learning' on educational outcomes and student engagement. By

using quantification to customize gamification elements according to individual preferences, performance levels, and needs, a more personalized and interactive educational journey could be constructed. Investigating the dynamics of 'gamified teams' presents another research avenue, prompting important questions about the effects of gamification in fast-paced, competitive, and collaborative environments and its influence on team cohesion and individual autonomy. Furthermore, the integration of 'Serious Games' into undergraduate research, especially if paired with gamified Virtual Reality (VR) and Augmented Reality (AR), has the potential to revolutionize the learning experience by simulating complex systems and enhancing data collection. These technologies could transform abstract concepts into engaging, accessible experiences while breaking down geographical barriers to

learning.

Finally, ethical and privacy concerns associated with gamification principles should not be ignored. Future studies should address the risks of hypercompetition and

its effects on DEIA. Gamified systems should be fair and effective, recognize and reward student contributions, and preserve the integrity of academic and educational environments.

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