ASSESSMENT AND MODULATION OF STUDENT BEHAVIOR THROUGH PERSUASIVE DESIGN

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ABSTRACT

The education system has existed for centuries. However, despite the rapid change in our technology, lifestyle and needs in the workforce, it has failed to adapt accordingly. The current system relies heavily on industrial-age values where students are expected to follow instructions and are stripped of their agency rather than being encouraged to actively participate in their learning process. As a result, students end up lacking motivation and engagement. Persuasive design focuses on influencing human behavior to improve long-term engagement through various mechanisms. Here, we have embedded the design in the form of gamification elements into the classroom mechanic to aid in the assessment and modulation of student behavior. "ExP", a points-based incentive system tied to all aspects of the classroom mechanics was designed to work in tandem with existing student behavior. Accurate balancing of the system effectively grants students agency and allows more clarity in their classroom interactions and stratagem. The study assesses the effectiveness of the system in improving the academic performance of Diploma-level students. A group of 21 repeating students was observed for an entire semester. A paired sample t-test using SPSS was performed to draw the results. The final exam scores indicates a significant difference in the scores before (M=42.52, SD= 3.82) and after (M=50.14, SD=11.23) the implementation the gamification system with p=0.004. It can be concluded that the incorporation

of persuasive design in the form of gamification has potential to significantly improve students' academic performance.

KEYWORDS: engagement, ExP, gamification, modulation, persuasive design

INTRODUCTION

1. Background

Education system

The education system was designed to educate and prepare young minds for their future, and ultimately the workforce. However, despite the rapid changes in the structure of said workforce in the past few decades, our education system has yet to adapt accordingly. Originating from the initial Prussian model developed in the 1800's, the education system was steadily modified throughout the years until a standardized format was agreed upon sometime in the late 1890's (Anderson, 2004) (Van Horn Melton, 2003) (Soysal & Strang, 1989). Though some variations may apply depending on which country has adopted the system, very minimal changes were made beyond the normalized education format, whereby an expert stands at the front of a class to deliver information, while students sit and listen (Seavoy, 2013). This "Factory Model of Education" was designed to cater to the needs of the industrial revolution of the 20th century, which requires a workforce that can readily stand in line and follow orders (Barlow, 1967). Undeniably, the education model was effective for the first, second and third industrial revolutions, where laborers are needed to work in an assembly line, be it metaphorical or literal (Rose, 2012) (Tyack, 1974). The fourth industrial revolution however, demands a workforce with critical thinking and communication skills, creativity, innovativeness and pro-activity. All of which are inadvertently suppressed or discouraged in the aforementioned education system, where students passively listen to lectures, ask questions only when asked to, and complete assignments only when instructed. The concerns with the current education system lie in its inherent inability to effectively cater to students' motivations, leading to reduced participation and engagement in and outside the classroom. As of late, many innovations have been made in an attempt to address this problem (Haghighi, 2013) (Bordogna, Fromm, & Ernst, 1993) (Collins & Halverson, 2018) .

Persuasive design and gamification

Persuasive design refers to a practice of influencing human behavior through the characteristics of a particular product. It essentially aims to improve user experience by capitalizing on their inherent cognitive biases. Although, typically this type of design is applied mainly in improving consumers' receptiveness to and retention of a product or service, it is very much applicable within the context of education, especially in indirectly modulating student behavior (Ainsley & Underhill, 2017). The Fogg Behavior Model (FBM) describes behavior as a result of three distinct elements; motivation, ability and triggers, which proves beneficial in the development of persuasive designs.

Motivation here refers to the willingness to take action, while ability refers to the competency necessary to perform an action, and trigger refers to stimuli that aid in starting and directing a an action (Fogg, 2009).

Gamification is the utilization of game elements in non-game settings with the intention of improving user motivation, engagement and/or participation (Deterding, Khaled, Nacke, & Dixon, 2011) (Deterding, Dixon, Khaled, & Nacke, 2011). Its emergence over the past few years has gained popularity in both the classrooms and workplace. Due to its potential in modulating behavior, it has been suggested to be an effective tool in improving the current education system (Hanus & Fox, 2015). In this study, the effects of persuasive design in the form of an extensive gamification mechanic was assessed in the context of improving student performance.

2. METHODOLOGY

Points-reward system design

The initial design of the classroom gamification revolved around typical students' behavior observed in prior semesters. Therefore, to ensure an effective persuasive design, the system should tailor the needs of the observed needs of the students. A rough review revealed common requests to include i) assignment resubmission, ii) lab report resubmission, iii) deadline extensions, iv) extra marks for tests, v) retaking tests, vi) hints for tests (prior), and vii) hints during tests. These items were then assigned point values indicating their worth. Iterative hypothetical runs were performed to evaluate the feasibility of these items, similarly to alpha testing procedures in typical game design.

Upon completion of the initial alpha tests, some of the requested items were either reduced to a single purchasable item, or further broken down. Each of these items were then assigned identifiers to dissociate them from classroom contexts and reduce pressure (**Figure 1**).

Figure 1. Screenshot of the gamified items, adapted from common requests by students.

	ITEM	COST	NOTE	TARGET	DETAILS
	ExP SHOP				ver 1.2
1	**Reset Token**	5	Resubmit	Indiv.	Redo an assignment/lab report/presentation
2	**Hint (Tier 1)**	10	Vague hint	Class	Reveal test question nature (comparison % / description %/ illustration %)
3	**Hint (Tier 2)**	15	Question hint	Class	Reveal test question topic x 1 (e.g. chapter 2; ribosomes)
4	**Hint (Tier 3)**	20	Q. Hint x 2	Class	Reveal test question topic x 2 (e.g. chapter 2; ribosomes & Chapter 5; light cycle)
5	**Nullify (Tier 1)**	30	Nullify Minor	Indiv.	Any 1-2 mark question becomes nullified (free marks)
6	**Nullify (Tier 2)**	50	Nullify Major	Indiv.	Any 3-5 mark question becomes nullified (free marks)
7	**Boost S**	25	Small boost	Indiv.	Add a small amount of % to assignment/test score
8	**Boost M**	50	Medium boost	Indiv.	Add a medium amount of % to assignment/test score
9	**Phoenix Down**	60	Retake test	Indiv.	Nullify the results of a previous test, and take a supplementary test.
10	**Prophecy**	30	Unlock	Class	Unlock "Prophet's Gamble" and "Prophet's Touch" for upoming test. Only one is needed per test.
11	**Decoder**	15	Unlock	Class	Unlock "Decryption" for upcoming test. Only one is needed per test.

The screenshot taken is of the version used during the time of writing

Agency

To empower the students with a sense of control and improve motivation, the system was emphasized to be purely voluntary. Previously mandatory assignments (contributing 10-20% of their overall assessment) were replaced completely with optional assignments dubbed "Ex Tasks" in reference to nomenclature common to Japanese games. This naming convention was intended to aid in dissociating from the mindset that assignments are "work" but instead viewed as opportunities to earn more points. The tasks were divided according to chapters, with each chapter containing several tasks of varying difficulties to choose from. Following conventional quest board design formats of games such as "Dragon's Dogma" and "Monster Hunter" as well as the "Bounty Hunts" system in "Final Fantasy XV", these tasks were made available at all times for students to freely request and undertake.

In order to ensure the balance between task and reward, lower-difficulty assignments were designed to grant fewer point rewards and higher-difficulty tasks grant greater amount of points. Furthermore, to discourage students from stockpiling easier tasks, each of these optional assignments are generally limited to three or four takers, after which the assignments would be closed off. This first-come-first-serve design effectively creates a demand in these assignments, and encourages students to be pro-active in taking assignments.

To avoid students from hoarding these optional assignments, a ruleset was defined that an individual is limited to only three assignments at a given time. The assignments were therefore designed in such a way that it is feasible to be carried out within approximately 3-5 days, whereby the deadlines were automatically generated upon approval of task requests. In addition, to dissuade students from taking up assignments with minimal intention to complete, i.e. a "just in case" mentality; a penalty will be incurred to any cancellations, withdrawals and failure to submit after the given deadline. This works in tandem with the points balancing mechanics discussed later.

Social engagement

To encourage cooperation between students, two mechanics were incorporated into the entire system. Firstly, tasks were divided into two categories; individual and group, whereby the group assignments promises greater points as a reward, but demands more work and at a severely shortened deadline (typically half the time granted to individual tasks). Furthermore, group tasks bear the ruleset of requiring a minimum of two group members and a maximum of up to five, depending on the level of difficulty. This was specifically designed to deter students from attempting to undertake the assignment alone in order to reap the larger reward, similarly with the behavior of "solo players" in Massively Multiplayer Online Role-Playing Games (MMORPGs).

Secondly, the system was also designed to benefit individual students as well as the class as a whole through items or perks purchased using the gamified points (**Figure 1.**). The "Hints" shop item was intentionally designed as three separate sub-items, with increasing cost, all of which will benefit the entire class. This encourages students to root for high achieving students and avoid resentment for not being able to keep up.

Game currency balancing

To avoid inflation of the gamification currency, several sinks were introduced in the form of penalties and resubmission fees, dubbed "Reset Tokens". Furthermore, stringency of point distribution was sustained throughout the implementation of the system, in order to avoid the points from decreasing in value. An equilibrium between point distribution and deduction was also carefully deliberated according to responses observed in the students (making points worth earning without risking reduced motivation and participation), while following the rulesets established when the system was introduced.

Introduction and execution of the design

The overall mechanics of the system was explained to the students during the introductory session of the target course. The basic rules were explained which includes i) how to earn points, ii) bonuses, iii) penalties, and iv) the shop system for using their earned points. The protocols for requesting Ex Tasks and exchanging points for perks (purchasing shop items using their earned points) were also clarified.

Measurement of participation

Throughout the semester, student participation in and out of the classroom was measured. In the former, participation was enumerated according to the points acquired through asking and answering questions. Points were distributed and updated as shown in **Figure 2**. Outside the classroom, participation is measured according to points acquired through optional assignments.
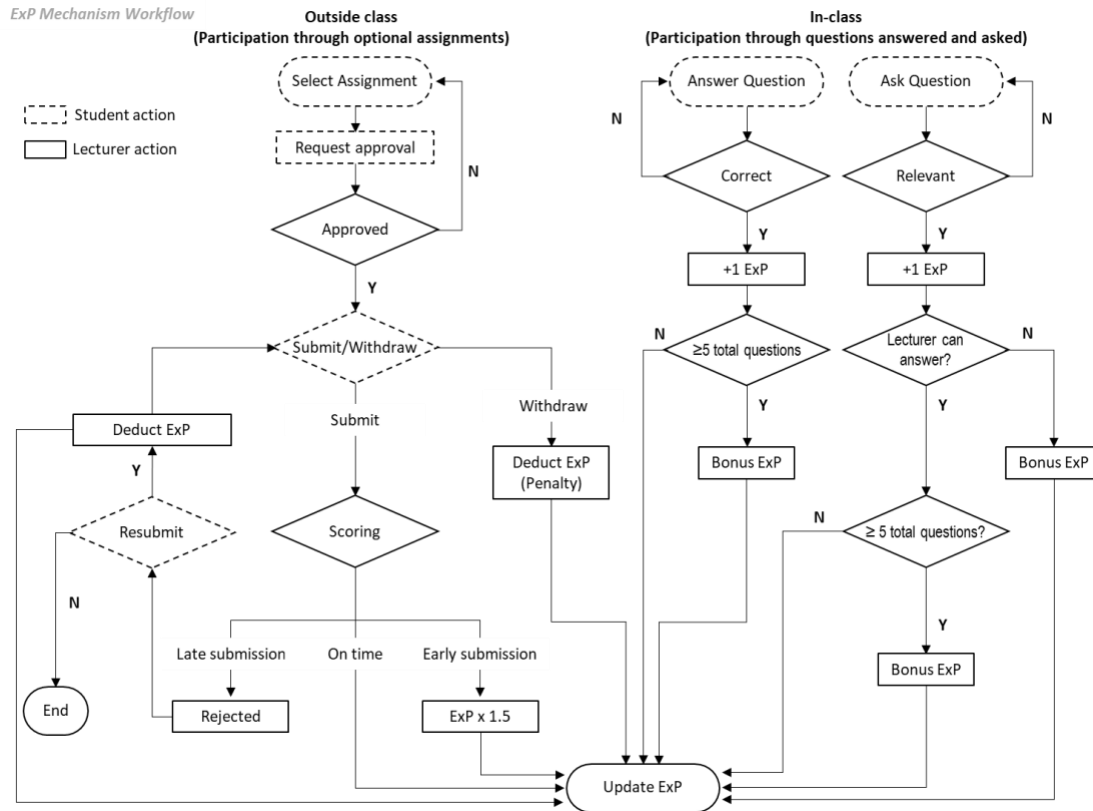
Figure 2. Overview of the gamified classroom mechanics

Sample selection

This study uses a focus group of students taking the "Plant Science (AGR122) course. Specifically, this is a group of repeaters taking the same course for the second time, whereby their first exposure to the course was without the introduction of the ExP system. These students were specifically selected to compare their performance before and after the intervention.

Pre-post test

The final exam results from the first and second semesters were compiled and compared. Outliers (students whose overall performance were significantly affected by external factors not discussed in this paper) were identified and removed to avoid skewing the data. A paired sample t-test was conducted to compare the effect of the gamified design towards student's academic performance.

3. RESULTS

Participation

Typically, traditional methods measure student participation roughly by how "active" they are in class, which leads to inaccurate assessment of student behavior. As shown in **Figure 3**, the gamified system was successful in keeping track of the targeted participation categories; asking questions, answering questions, lab participation, and optional assignments.

Figure 3. Screenshot of the admin sheet for recording and tracking student participation.

No	Questions 1p	Questions 5p	Questions Subtotal	Answers 1p	Answers 5p	Answers Subtotal	Lab 5p	Lab 5p	Lab 5p	Lab 5p	Lab Subtotal	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	URG	Ex Tasks Subtotal	Bonuses ExP	Multipliers Amount	Purchases Cost	Penalties Cost	TOTAL
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	1.0	0	0	12 ExP
2	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	0	5	0 ExP
3	0	0	0	18	5	23	3	0	5	0	8	0	0	0	0	0	0	0	0	0	0	0	20	1.0	20	0	31 ExP
4	0	0	0	13	0	13	5	0	5	0	10	0	7	0	0	0	0	0	0	0	0	7	15	1.0	5	0	40 ExP
5	0	0	0	8	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	0	5	5 ExP
6	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	1.0	0	0	16 ExP
7	0	0	0	0	0	0	0	0	0	0	0	4	0	8	0	0	0	0	0	0	0	12	20	1.0	0	0	32 ExP
8	1	0	1	13	0	13	3	5	0	0	8	0	0	0	0	0	0	0	0	0	0	0	15	1.0	10	0	27 ExP
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1.0	0	0	7 ExP
10	0	0	0	29	15	44	3	0	5	5	13	0	0	0	0	0	0	0	0	0	0	0	17	1.0	25	5	44 ExP
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	0	0	2 ExP
12	0	0	0	2	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	1.0	0	0	8 ExP
13	0	0	0	20	10	30	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	20	1.0	40	0	13 ExP
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1.0	0	0	7 ExP
15	0	0	0	14	10	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	0	5	21 ExP
16	6	0	6	46	30	76	5	7	15	0	27	0	0	0	0	0	0	0	0	0	0	0	27	1.0	45	5	86 ExP
17	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	1.0	0	5	9 ExP
18	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	1.0	0	0	13 ExP
19	0	0	0	8	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	1.0	10	5	5 ExP
20	0	0	0	17	5	22	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	20	1.0	0	5	41 ExP
21	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	35	22	1.0	0	5	52 ExP
22	0	0	0	8	0	8	3	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	2	1.0	0	5	9 ExP
23	0	0	0	1	0	1	0	0	0	0	0	0	35	6	0	0	0	0	0	0	0	41	22	1.0	0	5	59 ExP
24	0	0	0	9	0	9	11	0	2	0	13	3	0	0	0	0	0	0	0	0	0	3	10	1.0	0	0	35 ExP
25	0	0	0	10	0	10	0	0	0	0	0	3	0	0	0	0	3	0	0	0	0	6	20	1.0	0	0	36 ExP
26	0	0	0	2	0	2	0	6	0	0	6	0	0	0	0	0	0	0	0	0	0	0	15	1.0	0	0	23 ExP
27	3	0	3	36	20	56	5	9	25	0	39	0	0	0	0	0	0	0	0	0	0	0	40	1.0	30	0	108 ExP
28	0	0	0	10	0	10	5	2	0	0	7	0	0	0	0	0	0	0	0	0	0	0	15	1.0	0	0	32 ExP
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	0	0	2 ExP
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	0	0	2 ExP
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	0	0	2 ExP
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	0	0	2 ExP

The screenshot taken is of the version used during the time of writing

The table provides a clear overview of which students are active or passive by enumerating the number of points acquired through asking and answering questions, and participating in lab presentations and discussions. Furthermore, the students' weaknesses is also evident when referring to the "Questions" column in **Table 2**. Although the "Ex Tasks" columns show that there is a lack of participation in optional assignments, this is grossly due to many of the student submissions being rejected due to a high rate of plagiarism.

Performance improvement

The study was carried out on 22 students from Faculty of Plantation and Agrotechnology. A paired samples test was conducted to assess the improvement in student's performance before and after implementation of the persuasive design in the form of gamification. This study was conducted for a full semester from March 2018 until July 2018. The assessment indicators remained constant throughout the period of study. The experimental group consists of 13 male students and 9 female students, all of which are repeaters, i.e. taking the course a second time due to failing in the previous semester. In their first semester, these students were instructed through traditional means, while in the second semester, they were instructed through the first alpha version of the gamified approach. The summary of the experiment for both semesters is shown in **Table 1**.

Table 1. Comparison between instruction methods in Phase I and Phase II

Period of study	Phase I (September 2017 – January 2018) Without gamification	Phase II (March 2018 – July 2018) With gamification
Goal orientation	• Assignments are mandatory.	• Assignments are voluntary, with a minimum number recommended.
Agency	• A preset number of assignments was determined at the beginning of the semester. • Students are instructed when to do the assignments. • Deadlines are typically non-negotiable.	• Students may choose the number of assignments to undertake, with no upper limit. • Assignments are open throughout the semester. • Deadlines are pre-set according to points-reward balancing, and resubmissions/extensions are allowed, following rulesets.
Choice	• The nature of the assignments was entirely at the behest of the instructor.	• Students may choose which assignments to undertake.
Participation	• Students are called on to answer questions.	• Students are incentivized to ask and answer questions through points-reward system.

Assessment score for both semesters was recorded and the data was analyzed using SPSS for paired t-test. Normality test using Kolmogorov – Smirnov shows the normal distribution of data for both pre and post implementation of gamification as *p-value* in Test of Normality shows *p>0.05*, as shown in **Table 2**.

Table 2. Normality test

	Kolmogorov-Smirnov$_a$			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre	.174	21	.097	.906	21	.057
Post	.315	21	.065	.801	21	.031

The paired sample t-test (**Table 3**) suggests a significant difference in the score for post gamification (M=50.14, SD=11.23) and pre gamification (M=42.52, SD=3.82) in conditions; t (21) = 3.204, p= 0.004. The findings suggest a significant improvement in students score after the implementation of the persuasive design in the classroom, which is in agreement with Deif, 2016.

Table 3. Lilliefors Significance Correction

a. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post	50.1429	21	11.23515	2.45171
	Pre	42.5238	21	3.82909	.83558

b. Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	Post - Pre	3.204	20	.004

4. DISCUSSION

Participation

The design of the points-reward system as a form of participation measurement mechanic was intentional to avoid unnecessary complexity in the system. As quoted by Nintendo's highly respected video game developer, Shigeru Miyamoto, "A good idea is something that does not solve just one single problem, but rather can solve multiple problems at once" (Minkley, 2010). Through the enumeration of student participation, it becomes possible to clearly identify the strengths and weaknesses of the class as a whole, track their improvement, and plan for improvements. As the sheet tracks participation on a weekly basis (and the weeks are tied to specific chapters according to the lesson plan), it also becomes possible to identify any spikes or dips in student participation throughout the semester. In effect, instructors can determine which section of the syllabus students are most engaged with or otherwise, allowing for improvement of the study materials.

Previously, traditional teaching methods rely mostly on test scores to indicate student performance. Although effective in assessing their competency, it is ineffective in providing more information on why they are performing or otherwise. Were the questions too difficult? Did the students not study? Were they paying attention in class? Furthermore, it only allows for assessment after specific checkpoints throughout the semester (i.e. after tests or quizzes). The use of the point-rewards system on the other hand allows for on-going assessment of student participation, enabling instructors to quickly plan for corrective action.

Performance improvement

Observations indicate that the increase in student participation and engagement has resulted in an increased performance. The freedom of choice and agency provided through the gamification is also suggested to play a role in aiding students to improve their scores, as stated by Dicheva in 2014. Freedom of choice is ranked third out of eleven elements studied in the core element of

designing educational gamification as a tool of innovative learning in the classroom (Dicheva, Dichev, Agre, & Angelova, 2014).

A study by Hitchen and Tulloch also highlighted the importance of participation flexibility in educational gamification. The emphasis of which has increased student engagement as well as the overall course assessment. An interactive design and a wider selection of assessment types in combination with extrinsic rewards (e.g. tokens, multipliers, and bonuses) has been correlated with the motivation of students in completing a given task. It should also be noted that the reward and punishment mechanisms employed in gamification is also in line with the self-determination theory, whereby satisfaction when completing tasks is based on the intrinsic and extrinsic rewards received by the player (Hitchens & Tulloch, 2017).

Game literacy concerns

It was noted that students with a substantial gaming background had an easier time understanding the overall concept of the gamification system. These participants generally do not require a detailed elaboration on the mechanics, as they have been previously exposed to basic game elements such as Experience Points, Levels, Ranks, Quests, Tasks and Continues (Zwieten, 2012). However, despite some difficulties, non-gamer students showed a noticeable interest, evidenced by their consistent questions on how to earn and make use of the points introduced. But due to their limited literacy in the matter, a different approach needs to be taken in order to sustain their interest and avoid from overwhelming them with too much information and jargon.

Feedback concerns

Currently, the system developed faces the common issue of a disproportionate student-teacher ratio, which results in a significant increase in workload on the instructor's part. Therefore, the need for instant feedback as suggested by literature becomes difficult to achieve. However, it is still possible to mitigate such concerns through the use of online platforms providing automated marking. Instructors may also modify the gamified contents to either limit assignment submissions at a time, or simplifying the submission format to short-answer questions.

Conclusion

The use of persuasive design in the form of gamification has the potential to aid in improving the performance of tertiary-level students. Arguably, the development of mechanics that overlays several theories around behavior and motivation results in a relatively complicated network of paths and protocols that may overwhelm instructors. Therefore, the system itself is currently not intuitive enough for immediate application, which is a huge drawback. However, the idea of intermingling these theories is not foreign to game developers in general, especially those with extensively interconnected narratives and mechanics. Perhaps it is ideal to further blur the lines between education and game mechanics in order to open up new possibilities in teaching innovations. As games are inherently designed to enrapture its players, perhaps adopting their

approaches at the core level would allow higher-level education to evolve further, as it so desperately needs to.

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