

Gamifying with OneUp: For Learning, Grades or Fun?

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Abstract. Gamifying learning is a challenging task assuming holistic thinking about the learning experience rather than focusing on specific game elements. Part of the challenges in this task stem from the fact that gamification represents a class of systems combining utilitarian and hedonic benefits. In addition, there is a lack of appropriate tools supporting gamification of learning. To bridge this gap, we developed OneUp, a course gamification platform. This paper examines the challenges associated with gamifying learning along with OneUp’s support for overcoming them. It also presents a preliminary study of the impact of utilitarian and hedonic values in the context of a gamified Data Structures course.

1 Introduction

Gamification in education refers to the enrichment of learning environments with game design elements in order to reinforce desired behaviors through experiences typical of games. Although gamification has been actively explored in education, as evident from the fast growing number of gamification systems and related publications [1], it still faces a lack of sufficient empirical evidence confirming its benefits in educational contexts as well as of practical methods for its design and implementation [2]. There are no commonly accepted theoretical frameworks or general principles on how to apply gamification strategies to specific learning situations. This is not surprising, since gamifying learning is a complex task - it involves combining utilitarian benefits, such as learning efficacy, and hedonic benefits, such as enjoyment, in a single system.

Creating a gamified course fitting a particular course structure aligned with the vision of the course designer can be time-consuming and design limited without supporting tools. In addition, gamifying learning “from scratch” often requires some software development skills that many instructors lack. This entails a need for appropriate tools to support learning gamification. One possible solution is to bring educational gamification development closer to the educators, allowing them to realize their own approaches to gamified learning and experiment with them autonomously. However, our study [3] confirmed that there is a dearth of appropriate tools to support comprehensive gamification of learning, particularly in higher education. In addition, reports on how to gamify learning and, in particular, skill-based learning are scarce. To bridge this gap we developed OneUp Learning, a course gamification platform [3]. In this paper we examine challenges associated with gamifying learning. We also describe OneUp’s support for overcoming them. Further, we present a preliminary evaluation of the impact of utilitarian and hedonic values in the context of a gamified Data Structures course.

2 One Up: A Platform for Gamifying Learning Activities

The analysis of the current state of educational gamification and the barriers for its growth motivated us to develop OneUp Learning, an educational gamification platform aimed at facilitating the gamification of academic courses/learning activities and fostering experimental research on gamifying learning [3]. The main functionality of the platform includes: (1) support for instructors to integrate game design principles and mechanics in the instructional methods they use in their courses, (2) authoring of static and dynamic problems, and (3) learning analytics and visualization to inform students and instructors of the student performance and progress throughout the course. The platform enables instructors to define course activities and create exercises for practicing and self-assessment and quizzes or exams for testing knowledge and skills. Learning activities are supported by OneUp with immediate feedback including detailed progress information and possibly some kind of reward (e.g. badges or virtual currency).

The platform is highly configurable and enables tailoring gamification features to meet the vision of the instructor. Its configuration includes two parts: one related to the course structure and another to the gamification features to be used in the particular course. The course configuration includes specifying the course topical structure, the learning objectives (skills) targeted in the course, and the milestones and activities planned for the course (with their corresponding points), but none of these is required. The gamification related configuration includes the choice of the game elements to be used in the course along with specification of gaming rules for them. The system currently supports the following game elements: points (challenge points, skill points, and activity points), progress bar, virtual currency, badges, leaderboard, skill board, learning dashboard, avatars, and immediate feedback. The gaming rules define the conditions upon which certain game elements are applied (e.g. a specific badge is awarded). The rules are standard production rules in the form *IF* <condition> *THEN* <action>, where the condition is a Boolean expression of arbitrary complexity. The rules are served by a game rule engine, which is built in the platform.

The platform supports two types of challenges: warm-up challenges (for student practice and self-assessment) and serious challenges (graded course quizzes and tests). For each problem included in a challenge, the instructor specifies the challenge points earnable from that problem, i.e., the problem's points in the context of the specific challenge. The instructor could also specify skill points which indicate how the problem contributes to increasing the level of student mastery of related skills (from the pre-defined set of skills). The challenges are built of problems and OneUp supports two type of problems: static and dynamic. Static problems (for which the correct solution is given at creation) include multiple-choice questions, multiple answer questions, true/false questions, and matching questions. Dynamic problems are problems for which the system does not contain solutions entered by the instructor. These problems are short computer programs which use a random seed to generate a unique instance of a particular programming or calculating problem and then grade the correctness of the submitted answer. Somewhat in between are the Parson's problems. These are a type of code completion problems in which the learner must place given mixed up code lines/ blocks in a correct order. By dynamically generating problem instances, the platform makes available a sufficient pool of exercises of a particular type for students to practice.

All elements of the OneUp platform - course topics, targeted skills, warm-up and serious challenges, activities, game elements and relations between them are configurable, which makes OneUp a course independent, customizable platform. Depending on the configuration, it can function as a full-fledged LMS or as a simple online practicing platform. Any game element can be turned on or off to allow studies on the effectiveness of various combinations of game elements.

3 Challenges to Gamifying Learning

Despite the growing number of gamified courses and learning activities, there are no established practices on how to gamify learning. While some publications (e.g. [4]) provide recommendations and guidelines, most implementations follow a simple reward-feedback pattern.

Learning is multifaceted and gamifying it is a difficult task for several reasons:

- Promoting behavioral change through gamification is based on psychological principles which implies understanding a range of underlying motivational factors and how they can be used in the gamification design [5] for achieving the desired behavior.
- Successful gamification of learning assumes holistic thinking about the whole learning experience rather than focusing on specific game elements and should result in well-planned activities incorporating intrinsic and extrinsic rewards.
- Unlike games, the primary aim of gamification in learning is not to entertain but rather to shape learners behavior through the use of game design elements which assumes a separate design approach.
- The enjoyment associated with playing games cannot be easily incorporated into learning activities to produce effective and enjoyable learning experiences. How a learner perceives the gamification is highly dependent on the nature of the activity and the contextual factors related to it, in addition to the individual's own personal and demographic characteristics [5].
- Evaluating the outcomes of gamifying learning is also a challenging endeavor. Typically the impact of gamifying a particular learning activity is measured by performance and less by behavioral and motivational metrics. While learning outcomes are easier to measure, they are not always the best indicators of what is valued in the gamified activity nor the best predictors for sustainable behavior.

All these challenges contribute to the complexity of the design and implementation of a gamified learning system. OneUp was built with the goal of addressing these challenges and facilitating the process of designing and implementing gamified learning activities. The following section describes how OneUp alleviates these challenges.

3.1 Addressing Difficulties of Gamifying Learning

Psychological principles backing OneUp gamification. We have chosen the Self-Determination Theory (SDT) [6] as a theoretical framework guiding the design of the OneUp platform. According to SDT, the most self-determined form of behavioral regulation is intrinsic motivation, which denotes the pursuit of an activity for the sake of

the activity itself. Extrinsic motivation refers to behaviors carried out to attain outcomes unrelated to the activity itself, such as rewards or praise. In line with SDT, humans have three fundamental psychological needs: autonomy, competence and relatedness. Satisfaction of these three needs is essential for an individual's intrinsic motivation. People experience more self-determined types of motivation when the activities in which they participate make them feel that they have *autonomy* (the power to make their own choices), *competence* (ability to effectively perform the behavior), and *relatedness* (social connections with others). The OneUp support for intrinsic motivation includes: non-required warm-up challenges and skill development (autonomy); immediate, multifaceted feedback and leveling challenges (competence); and sharing achievements and healthy competition (relatedness).

According to Goal Theory [7], the goal serves as a stimulator to motivate and direct the learners towards desired learning behavior. Learners are motivated by SMART goals: Specific, Measurable, Attainable, Realistic and Time-bound. This type of goal motivation is supported by OneUp learning analytics and the related learning dashboard.

Support for holistic gamification design in OneUp. Since the most common form of educational gamification is course gamification, the discussion in this section will center on course gamification, which typically incorporates different types of learning activities. Gamifying learning with OneUp assumes more than decorating existing content with achievements and rewards mechanics.

The creation of a new course with OneUp includes specifying the course topics, targeted skills, and milestones, as well as the game elements to be used in the course. The instructor also has to enter warm-up challenges for student practice and self-assessment and serious challenges for course assessment (if desired). When defining a challenge, instructors can choose from problems available in OneUp's problem bank or create new ones. For each problem included in the challenge, they specify challenge points earnable from that problem and possibly skill points. The instructor can also enter activities, which will be manually graded. In this aspect, OneUp has pretty much the standard functionality of a Learning Management System (LMS).

The distinguishing feature of OneUp is that it empowers instructors with control over how to link learning activities to the intended game mechanics provided by the platform. The mere presence of game elements in the environment is not sufficient to produce an engaging experience for the learners. Making learning more compelling entails creative use of game design elements. Accordingly, through the course gamification interface, OneUp encourages the instructor to look at the entire course organization systematically and holistically, considering various aspects such as: which activities should give rewards and at what scale, how to organize feedback loops, which activities should award virtual bucks and how learners can spend them, which activities support autonomy, which activities strengthen competency, how to stimulate feeling of relatedness, how to reinforce goal orientation, etc. From a technical perspective, gamification rules are what links the learning activities to the game design elements, for example, the conditions upon which a badge is awarded or course bucks are earned. In fact, rules combine the learning activities (the utilitarian activities) with the game design elements (hedonic utilities) in a coherent gamified course. Another important difference from LMSs is that the instructor can specify how the problems contribute to increasing the level of student mastery of each related course skill.

Using the rule engine for driving motivation and learners' behavior. Gamification is commonly used for behavior change, as a meaningful use of game design elements can encourage certain behaviors to be exhibited. It has gained significant traction as a method of steering user behavior in a desired direction in a variety of domains, including education. Looking at the traditional educational practices, when instructors want to exert influence on students to encourage certain behaviors, they reward the positive behaviors and discourage the undesirable. OneUp supports an analogous strategy through the gamification rules. From a behavioral perspective, rules can be viewed as:

if_satisfy (action, condition) then offer (incentive),

where *action* denotes any measurable process performed by a learner and *incentive* denotes any award supported by OneUp. For example,

If a student completes more than 10 challenges in a given session award her a badge.

Using OneUp rules an instructor can define tactics similar to the traditional approach of steering learners' behavior. For creating meaningful rules an instructor has to decide first what behavior is to be encouraged and then what incentives are more compelling for the targeted learners. For example, if the goal is to encourage practicing, any measurable practicing action can be incentivized (extrinsically or intrinsically) with rules such as:

After your first five attempts you will receive a "Beginner" badge.

One of the first five problems is lucky: if you solve it, you will earn 5 course bucks.

While OneUp provides extrinsic mechanisms for steering learners' behavior, instructors can use also the intrinsic motivational factors. For example, making practicing a voluntary activity where students can choose which problems to solve will meet their need for autonomy. Similarly, showing students a comparison between points earned so far and the total amount of points that will be earned if the student keeps their current level of performance will aid their goal orientation and feedback needs.

Support for gameful experience and enjoyment. Enjoyment can come in many different forms, including feelings of competence, overcoming challenges, creative accomplishments, experience of choice, personal triumph, amazement and surprise. OneUp provides two levels of support for promoting gameful experience and enjoyment - through utilizing gameful activities and through incorporating appropriate rules.

Challenges in games are motivating experiences. Overcoming non-trivial challenges creates an experience of satisfying the competence need [8]. Deciding to approach a game challenge and then choosing which challenges to approach and which strategies and actions to apply satisfies the need for autonomy. Furthermore, the outcome of a non-trivial challenge is usually uncertain, stimulating curiosity and interest. An analogue of game challenges in learning contexts are exercise problems provided for students in various disciplines. First, choosing to exercise is typically a voluntary decision. Which problem to approach and how many is also a learners' choice. Second, solving a problem successfully engenders a sense of competence. Following this correspondence, OneUp offers a platform for deliberate practice that provides multiple opportunities for demonstrating competence and receiving immediate feedback in a risk-free environment. Creating and structuring learning exercises that make the practice interesting and engaging is at the heart of designing a motivating experience. In order to approximate the repetitive pattern of game play featuring instant feedback and freedom to fail, we included support for immediate assessment where the counterpart of game challenges are

exercise problems with automatic checking. This is also in line with the value of deliberate practice for mastering particular skills, especially in sciences and mathematics, which assumes a rich pool of problems of different levels of difficulty. The latter is essential, since students are more likely to be motivated by the feeling of flow [9], experienced when challenges match their individual skills and knowledge level. This is achieved by offering a sufficient number of challenges with varying levels of difficulty, realized by the dynamic generation of problems from templates.

Exercise problems are probably as old as education itself. But, in general, they have not been considered as a gameful activity. The missing part is the game rules. The rules along with the challenges define the game-like experience. In fact, they combine the utilitarian (usefulness) values with hedonic (enjoyment) values. While practicing can be meaningful without rules, it would not be perceived as a game-like activity without appropriate rules. Rules are what can make an experience game-like, interesting, and intriguing. By defining rules with different conditions and game elements that are granted upon these conditions, instructors can induce different forms of enjoyment, such as, an experience of curiosity, surprise and novelty or experience of choice/autonomy as illustrated by the following examples:

One of the next five consecutive days is lucky: if you solve three problems in the lucky day you earn 3 course bucks.

You can choose to retake any quiz for 50 course bucks each.

4 What are the Motivations for Using the OneUp Platform?

Systems or services, such as LMSs or videogames, can be classified as either utilitarian or hedonic in nature. Traditionally, utilitarian and hedonic systems were considered as separate entities. While utilitarian systems provide instrumental value (e.g., increased participation or learning performance), hedonic systems provide self-fulfilling value (e.g., fun or pleasurable experiences) [10]. In contrast, gamification combines both hedonic and utilitarian values in a new kind of motivational aggregate. The underlying assumption is that adding hedonic elements, such as those found in games to utilitarian activities, will create the level of engagement observable in games. However, this assumption has not received sufficient empirical support yet - a fact that reflects why this combination known as gamification is difficult to design in learning contexts. While the use of gamification is driven by both utilitarian (usefulness) and hedonic (enjoyment) benefits, we still lack sufficient understanding of which factors predict why learners use gamified systems. More specifically, how motivation to learn can be influenced by utilitarian and hedonic factors. Several studies have explored the reasons for using gamified systems [10] including in a learning context [11]. However, these studies do not explore learners' motives for using a gamified system in the context of a specific course, where factors such as course grades, exams, homework, and skills may impact the reasons for using the system. We aimed to bridge this gap with a focused study, stimulated also by the fact that this context is the most common way of utilizing OneUp.

In this section we report preliminary results, the initial part of a large scale study involving several STEM courses over a three year period. The first phase of the study was conducted in a Data Structures course during Fall 2017 and Spring 2018 semesters. Students in both groups were able to use OneUp during the entire semester where the

goal was to motivate regular practicing with the provided warm-up challenges. Practicing was a voluntary activity. The students in the control group (17 students, Fall 2017) were using a non-gamified version of OneUp, while the students in the experimental group (12 students, Spring 2018) were using a gamified version. Based on predefined rules, students in the experimental group could earn experience points (XP), badges and course (virtual) bucks through practicing. Course bucks could be spent for course related “goods”, such as buying an extension for an assignment, buying a resubmission, etc. Students from the experimental group could track their performance in their personal learning dashboard and compare it to the other students’ performance on a customizable class leaderboard.

Tracking students’ behavior. Using the data in OneUp’s logs we compared the number of attempts for solving warm-up challenges of the control group with the number of attempts of the experimental group. The average number of warm-up challenge attempts for the control group was 4.5625, while the average number of challenges for the experimental group was 46.1667. The t test ($t = -3.1574$, $p\text{-value} = 0.008895$) showed that the difference was statistically significant. For the experimental group, we also looked at the distribution of warm-ups. The distribution shows peaks around the dates of the three course exams. These results signal that after the gamification intervention, students’ practicing has intensified significantly. In this context and from the viewpoint of utilitarian and hedonic factors, the central question guiding the next part of our study was: *What are the reasons driving students to use OneUp?*

To answer this question we adopted a combined qualitative and quantitative approach: a focus group and a survey.

Focus group. We used a focus group interview to seek input from students enrolled in the experimental group. Eleven students (seven males and four females, ranging in age between 19 and 31 years old) participated in the focus group discussion. The following questions (inspired by [11]) provided the basis for the discussion: *What was your reason to use OneUp? What prompted you to start a practicing session in OneUp? What made you continue a practicing session? Do you think using the system affected your behavior in any way?*

From the analysis of the discussion data, four themes emerged that encapsulated the experiences of the students:

1. *Utilitarian factors – the main driver for using the platform.* The majority of the participants expressed the opinion that they were using warm-up challenges to either improve their learning or boost their grades or to successfully pass exams or get extrinsic/intrinsic awards that help reaching their learning goals.

I go there for learning. OneUp gives you, like, kind of confidence. I will do the questions, and I will try to do the implementations, and I will continuously do them until I know I can do the assignments and tests.

My reason for doing it was that it did give me a lot of help for a lot of different concepts I did have troubles on. But also course bucks - there was a lot of things that was in the course store that really helped me as far as being able to resubmit stuff or being able to get extra time on something.

2. *Utilitarian values amplified by hedonic values take students on board.* For many participants, the typical factors triggering students to start a practicing session were

improving learning and grades. However, for some students the triggering factors to start practicing session were game elements such as competition, rewards or goal-related.

Knowing that it will help me with the tests and assignments I go and try the challenges until I learn how to solve them.

I liked the incentives too, although I did always used to practice and stuff but I like the incentives too - to know that, hey, if I'm practicing I can get something for it.

3. *The effect arising from the interaction of utilitarian and hedonic values keeps students on board.* The majority of students noted that grades were a strong motivator for keeping them going when practicing in OneUp. At the same time, many participants shared that the game elements had also a positive effect on their motivation to continue. This suggests that when students practice in a gamified environment, utilitarian and hedonic values interact and form a specific motivational value impacting their experience.

When you're getting questions correct it makes you more to continue, continue, more like you feel good. And when I am accumulating points towards getting rewards that would make me want to continue practice further if I'm accumulating something.

I put both of those together. If I'm getting it wrong, I want to keep doing it. Also I know I'm getting compensation at the end. Not compensation, but rewards.

4. *Utilitarian and hedonic values have different motivational effects on different groups of students.* In several parts of the focus group discussion, a number of participants noted that improving learning or their grades were the major reason for practicing in OneUp. In a similar fashion, a number of participants commented that various gameful features were the driving force for their practicing in OneUp.

If you have questions and want to find the answer by yourself. I guess practicing really gives you some clarity, and this just gives you additional ways for learning.

I don't know if this is a bad thing but sometimes, if you look on the dashboard and you can see like the different, like, you don't know who the people are, but you can see the icons and see what they're doing. I'm like, okay, I'm gonna keep going till I get to the top.

Student survey. To gain a better insight into how the utilitarian and hedonic factors influence the use of OneUp practicing support, the focus group qualitative study was conducted in parallel with a quantitative study – a survey based on a standard Student Course Engagement Questionnaire administered to the experimental group at the end of the course. The survey was augmented with questions addressing the reasons for OneUp use inspired by [11]. The questionnaire uses a 5-point Likert scale. All students enrolled in the course responded to the questionnaire. The following is an excerpt from the questions and Fig. 1 presents a graph capturing students' responses.

1. A desire to boost my grades prompts me to start a new practice session in OneUp.
2. A desire to get new OneUp badges prompts me to start a new practice session.
3. A desire to earn more virtual currency prompts me to start a new practice session.
4. The learning experience with OneUp prompts me to start a new practice session.
5. The enjoyment I experience with OneUp prompts me to start a new practice session.
6. A desire to boost my grades encourages me to continue practice sessions in OneUp.
7. A desire to earn more OneUp badges drives me to continue practice sessions.

8. A desire to earn more virtual currency drives me to continue practice sessions.
9. The learning experience with OneUp drives me to continue practice sessions.
10. The enjoyment I experience encourages me to continue practice sessions.

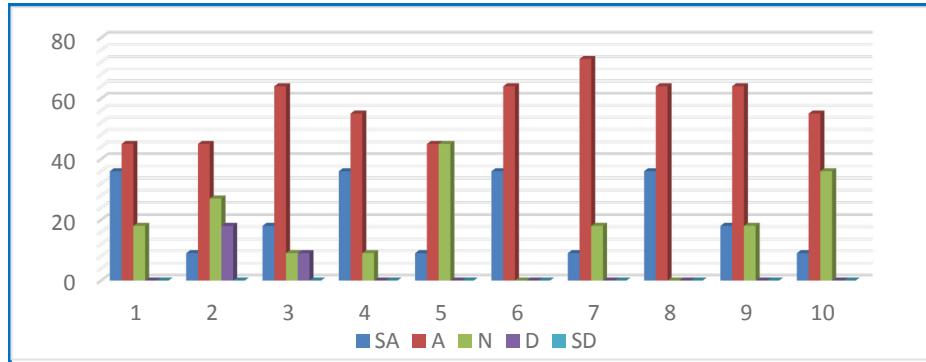


Fig. 1. Aggregated responses to the above questions (Strongly Agree (SA), Agree (A), Neither agree nor disagree (N), Disagree(D), Strongly Disagree (SD)).

As illustrated by Fig. 1, the results of the questionnaire are in line with the preliminary findings from the focus group. The most frequent reported reason for starting (82% agree or strongly agree) and continuing (100% agree or strongly agree) a practice session are the grades. While the questions related to the desire to earn virtual currency yielded strongly positive responses, we interpret them as a further confirmation of the significant influence of the utilitarian value on using OneUp, since the earned virtual currency could be spent for buying resubmissions, time extensions or dropping the lowest homework grade – benefits with positive impacts on course grades. Interestingly, the questions related to the driving effect of game design elements on starting or continuing practicing sessions yielded also positive responses (more than half of the respondents either agree or strongly agree). We interpret these preliminary results as evidence that the motivational effects driving students to start or continue practicing sessions are generated through the interplay between the hedonic and utilitarian values, where the gamification plays a role of a mechanism reinforcing students' extrinsic (grades, rewards) and intrinsic (competency, goal orientation) motivations. It is backed by the fact that OneUp practicing support was available to all students in the control group (using the non-gamified version) but its use was very low. This result suggests that its utilitarian value (in terms of improving learning or grades) had an insufficient motivational power. Notably, our preliminary study does not confirm the motivational threshold effect reported in [11]. In summary, enhancing the practicing support with gamification results not only in hedonic enrichment but also in activating pre-existing intrinsic and extrinsic factors. This observation suggests also that learning activities, such as practicing, that are amenable to a gameful reconstruction can be transformed into motivating learning tasks.

4 Conclusion

Gamifying learning is a complex process that requires knowledge of motivational psychology and understanding how that knowledge can be used in the gamification

design for achieving the desired learner's behavior. This implies a need for appropriate tools to support gamifying learning in order for the theoretical and practical fields of educational gamification to continue to grow. The OneUp platform was developed in response to that need with the purpose to facilitate the gamification of academic courses and to foster empirical studies aimed at understanding the effects of educational gamification.

Part of the design challenges of gamifying learning stem from the fact that gamification represents a class of systems combining utilitarian and hedonic benefits. Traditionally, hedonic design focuses on making interaction fun and enjoyable, while utilitarian design emphasizes utility. In contrast, gamification aims at motivating learners toward learning-related goals through hedonic drivers, essentially acting as a hedonic instrument for enhancing learning. From this perspective, the purpose of our preliminary study was to gain insight into utilitarian and hedonic motivational factors that drive the use of gamified learning environments. The results suggest that the motivational effect is created through interactions between utilitarian and hedonic factors of the gamified system and preexisting extrinsic and intrinsic learners' motivations.

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