

# Estimating Engagement in Gamified Activities

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**Abstract**—The premise behind gamified learning systems is that they improve students' motivation. However, there is still a scarcity of studies on examining motivational sources that may drive targeted motivation and engagement in gamified learning activities. Improving our understanding of this aspect requires a multi-faceted approach that allows both identifying relevant motivators and assessing their significance. We address this gap by employing three well-recognized theoretical frameworks: Self-determination theory, Expectancy Value theory and Big 5 Personality theory in experimental research aimed to shed new light on the driving forces behind students' engagement in gamified activities. Accordingly, in this paper we present the results of an empirical study aimed at obtaining evidence on the potential of utilizing these frameworks for predicting learners' engagement in certain categories of gamified learning activities. A specific objective is to determine which of the three scales yields the highest predictive outcomes with regard to students' engagement in gamified practicing. The initial results of the study demonstrate empirically that the EVC scale yields the best predictive ability compared to other scales. It also shows the value of using multiple scales for identifying significant sources influencing the engagement in gamified activities.

**Keywords**—gamification, gamified learning, motivation, motivational scales

## I. INTRODUCTION

Motivation is a key driver of engagement in learning, especially in optional (not required) learning activities [1] where students control their learning process without instructors' interference. The lack of motivation is among the most frequently cited barriers for learners' engagement in such activities [2]. Among the various proposed approaches for improving students' motivation and engagement, gamification [3, 4] has garnered significant attention from both education and industry [4]. Educational gamification employs game design elements to make learning activities more motivating and engaging and to enhance learning outcomes [5]. While the interest in using gamification in educational contexts is growing, due to the belief in its ability to improve and sustain students' motivation [6], the research on improving our understanding of the sources of this motivation does not follow this trend.

While gamification is commonly defined as using game design elements in non-game contexts [7], the focus of the research in this area is typically upon the motivational effect

of incorporating game design elements. Little attention is paid to the impact of the “non-game context”, which in educational gamification is usually a learning activity. Notably, many studies on educational gamification emphasize the role of the employed gamification elements, disregarding the significance of learning-related motivational factors. In particular, factors, such as learner personality, learner expectancy of success, perceived usefulness, perceived fun, perceived required efforts and drawbacks of engaging in an activity are rarely taken into consideration systematically. Yet, the learning activity in which the game elements are incorporated has an impact on the resulting motivational effect, as this effect is a result of the synergy of the motivational affordances of the gamified activity constituents.

Much of the past gamification research has been centered on understanding the relation between gamification and intrinsic needs and, in particular, on answering the research question: what types of gamification predict what kind of intrinsic needs [8, 9]. These studies were guided primarily by Self-Determination Theory (SDT) and specifically by the basic psychological needs which are central to SDT [10]. In this context, several researchers [9, 11] posit that the kind of motivation that is triggered depends on the gamified system as a whole, including the game elements and the learning activity. In line with such observations and taking into consideration recent studies (e.g., [6]), in this paper we propose to expand the focus from the motivational effect of game elements to the motivational effect of gamified activities as a whole and to adopt a learner-centered perspective.

Because the gamified activities on focus are primarily learning activities we can evaluate their motivational qualities using motivational frameworks and instruments designed to measure the motivational effects of learning interventions by enhancing them to account for the motivational affordances facilitated by gamification. As a variety of frameworks and instruments have been developed, it is of practical interest to find out which motivational framework predicts best students engagement in a particular class of gamified activities. Understanding the potentials of gamified learning may benefit from identifying the relevant motivators as they can act simultaneously as drivers for the targeted behavior.

Since motivation has been recognized as a key factor affecting student learning, many motivational frameworks and related scales have been developed [12, 13, 14] for

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assessing students' motivation when participating in learning activities. Motivation assessment scales use a variety of approaches for quantifying motivation through relevant variables. For evaluating the effect of employing gamification on targeted specific motivational outcomes it is beneficial to use instruments that are able to recognize both the gamification engendered motivators and the motivators engendered by the learning activity. Moreover, it is useful to develop instruments that can identify and quantify the significant motivating sources in the gamified activities as a whole including the involved learners [15]. Such instruments can provide formative assessment, indicating factors that contribute to high or low motivation of particular student populations thus prompting the need of extra attention. If we use such scales to quantify the tendencies of individual learners to behave in accordance with certain motivational factors, we would be able to measure these tendencies and choose motivational strategies guided by the obtained estimates.

In an earlier study we found that the EVC scale demonstrates a potential to predict learners' engagement based on both the perceived learning and gamification values of a gamified activity [6]. Guided by somewhat different objectives, SDT (rooted in needs satisfaction) has been used for examining the role of needs satisfaction on learners' engagement in learning activities and recently on relating categories of game elements to specific psychological needs [8]. Similarly, several studies have examined the role of students' personality traits on learning and performance, as well as the impact of their personality traits when involved in gamified activities [16]. As these frameworks/models have demonstrated potentials in measuring learning-related and gamification-related motivational effects, in this paper we choose to compare them in terms of their predictive abilities for estimating engagement in gamified learning activities. The two additional reasons that led to the selection of these frameworks were that they are acknowledged as major theories of motivation and are particularly appropriate for a comparative study of measuring motivation of learners involved in gamified learning. Accordingly, the objective in the present paper is to examine the potentials of the chosen motivation assessment scales for predicting learners' engagement in gamified learning activities. This leads to the following research question:

RQ Which of the three scales applied to students involved in gamified practicing will yield the highest predictive results about students' engagement?

## II. BACKGROUND AND RELATED WORK

Several motivational theories provide a helpful lens through which the impact of gamification on learners' behavior can be interpreted [17, 18, 19]. Among them, Self-determination theory (SDT) [20] is perhaps the theoretical perspective most frequently employed in gamification research. According to SDT [21], the most self-determined form of behavioral regulation is intrinsic motivation, which denotes the act of doing something because it is inherently interesting or enjoyable. Extrinsic motivation, on the other hand, refers to behavior driven by external factors, such as a reward or avoidance of negative outcomes. SDT asserts that individuals have three innate psychological needs: autonomy, competence and relatedness. Satisfaction of these three needs is directly linked to a person's well-being which is vital for an individual's intrinsic motivation. Self-

determined types of motivation occur when people feel that the activities in which they participate satisfy their psychological needs, that is, they have "autonomy (the power to make their own choices), competence (ability to effectively perform the behavior), and relatedness (social connections with others)" [21]. One popular belief is that gamification can contribute to the satisfaction of the intrinsic needs of the users [8]. However, several studies (e.g., [3, 22]) show conflicting motivational effects of using gamification elements in learning contexts, which in some cases provide feelings of autonomy, competence and relatedness but in others hinder them, and point to the importance of situational influences in gamified activities [9]. Still enjoyment can come from various sources in the learning process, such as creative accomplishments, challenges overcome, offered choices, surprises and personal recognition. Hence, SDT has been effectively applied in various educational settings [23].

The expectancy-value theory [24] offers an alternative view on learners' motivation. The expectancy-value model of achievement motivation [25] posits that students' choices, persistence, and achievement outcomes are influenced by expectancies of success and subjective task values. It subdivides the two factors into specific facets. Expectancy beliefs include a learner's task-specific success expectations (evaluation of one's capacity to succeed in the task, i.e., self-concept of ability) [26]. The task values include an intrinsic value (the enjoyment and interest that a learner gains from a task), a utility value (the usefulness of a task for personal goals), and an attainment value (the relevance of a task to a learner's sense of self) [26]. Thus, the model captures the perceived utilitarian (extrinsic) and hedonic (intrinsic) aspects of the activity [8,10] - concepts shared with Self Determination Theory [21]. It also provides a link to gamification as the potential of gamification lies in enhancing the perceived value of an activity [20] by enriching it with a gameful experience. Recently, a third factor was added to reflect the negative aspects of engaging in an activity, cost, which includes required efforts, time and emotional costs.

The Big Five personality traits theory distinguishes five factors as dominant to personality [27]. Personality traits refer to individual differences that explain the unique and consistent patterns of cognitions, behavior, and emotions shown by individuals in a variety of situations [27]. The Big Five personality factors are also commonly addressed in educational psychology [28, 29]. Recently, a number of studies have been investigating the effect of personality traits on gamified learning [30] and their role in personalized gamified applications [31], as well as predictors of the acceptance and continued use of gamified learning environments [16]. The five personality traits identified by the theory are: extraversion, agreeableness, openness, conscientiousness and neuroticism. Extroversion includes the traits of sociability, spontaneity and adventurousness. Agreeableness is characterized as tending to be honest, courteous, acquiescent and kind. While conscientiousness is linked to responsibility, dependability, and orderliness, neuroticism is characterized by insecurity, emotional instability and immaturity. Openness to experience is associated with curiosity, flexibility, intellect, and originality [32]. Johnson and Gardner [33] have studied the relationship between the Big Five personality traits and the satisfaction of psychological needs. They reported positive correlations

between agreeableness, competence, and openness to experience and autonomy.

These theories provide alternative explanations of why people engage in behavior of diverse kinds. The results from their practical use highlights the importance of using different motivational constructs such as the ones based on SDT, Expectancy Value model and the Big Five theory, since they have been shown to predict important variables such as learning effort, persistence and experienced fun. While they have been used in variety of contexts for assessing learning related and gamification related outcomes their predictive qualities have not been compared based on a specific gamified activity. In this study we attempt to address this gap by performing empirical analysis of their predictive abilities for gamified practicing. The outcomes of such comparison can also help us make informed choices. Using the most appropriate instruments for a given class of gamified activities may enable us to obtain valuable information on what aspects need more attention for achieving the targeted motivational outcomes and whether this is attainable. Such comparisons may provide also insight for identifying the main drivers for engaging in gamified activities and their motivational sources.

### III. THE EMPIRICAL STUDY

We conducted an experimental case study in which the relation between different motivational and personality measurements were evaluated against students' engagement with a gamified learning activity. The study involved students who have participated in a semester long gamified course using the OneUp gamification platform [34] at a large Kyrgyz university.

#### A. Procedure and Participants

This study revolved around a 16-week undergraduate Discrete Computational Structures course. The gamified activity in the course was out-of-class practicing. The instructor created warm-up challenges (practice quizzes) for self-learning and self-assessment in the OneUp gamification platform. The students were encouraged but not required to take them. The employed gamification element was virtual currency (VC). The game element virtual currency commonly symbolizes rewards that can be exchanged with virtual or real goods [4]. Virtual currency can also have some exchange value within the system. For this study, the earned VC could be exchanged for course-related benefits. Although, VC is not frequently used in educational gamification, we chose it for its potential appeal to both intrinsically and extrinsically motivated learners as it can serve several functions. Students earn VC by completing practice quizzes and the earned amount depends on their number, level of difficulty and correctness. They could spend it in the course shop for purchasing course-related 'benefits', such as deadline extensions, homework re-submission, excuse for skipping a class, etc., as decided by the instructor. Following Ryan and Deci [10] we can assume that virtual currency can also promote intrinsic motivation when it is awarded for the accomplishment of certain challenges. Depending on learners' motivational drivers, VC can be perceived as feedback, as a reward, as a progress indicator, as an accomplishment or as an incentive for practicing.

The students in the gamified course were invited by email to participate in the study. 26 students (of which 9 female) volunteered to participate. The majority of the

students were between 21 and 25 years old. A survey questionnaire was designed to collect demographic information and information about the personality and motivation of the students. Three scales were utilized: a modified version of the Basic Psychological Needs Satisfaction Scale – Work Domain [12], Expectancy-Value-Cost Scale (EVC) [13] and a short version of the Big Five Inventory (BFI-S) [14] to assess the self-determination needs, students' perceptions about the expectancy, value and cost of the gamified activity and their personality traits, respectively. Thus, the questionnaire for the survey consisted of four sections. The first one gathered demographic information about the participants. The second consisted of 20 questions assessing to what extent students experience satisfaction of their three intrinsic psychological needs — autonomy, competence, and relatedness from the gamified learning activity [12]. There were 6 questions for autonomy, 6 for competence and 8 for relatedness (see Table 1).

TABLE I. BASIC PSYCHOLOGICAL NEED SATISFACTION SCALE [12]

Category	Items
Autonomy	<ol style="list-style-type: none"> <li>I feel that I can make a lot of input in deciding how my classwork gets done.</li> <li>I feel pressured in this class. (Reversed)</li> <li>I am free to express my ideas and opinions in this class. When I am in this class, I have to do what I am told.</li> <li>My feelings are taken into consideration in this class.</li> <li>I feel like I can pretty much be myself in this class.</li> <li>There is not much opportunity for me to decide for myself how to go about my work in this class.</li> </ol>
Competence	<ol style="list-style-type: none"> <li>I do not feel very competent when I am in this class.</li> <li>People in this class tell me I am good at what I do.</li> <li>I have been able to learn interesting new skills in this class.</li> <li>Most days I feel a sense of accomplishment in this class.</li> <li>In this class, I do not get much of a chance to show how capable I am.</li> <li>When I am in this class, I often do not feel very capable.</li> </ol>
Relatedness	<ol style="list-style-type: none"> <li>I really like the people I am in this class with.</li> <li>I get along with people in this class.</li> <li>I pretty much keep to myself when I am in this class.</li> <li>I consider the people in this class to be my friends.</li> <li>People in this class care about me.</li> <li>There are not many people in this class that I am close to.</li> <li>People in this class do not seem to like me much.</li> <li>People in this class are pretty friendly toward me.</li> </ol>

For measuring students' expectancy, value and cost motivators to practice in the gamified Discrete Computational Structures course, we employed the EVC scale [13]. The corresponding section consisted of four subscales containing 12 questions and using a 6-point Likert scale ranging from 1 (Strongly Disagree) to 6 (Strongly Agree). We added three additional (intrinsic-value related) questions to the original questionnaire for estimating learners' intrinsic interest in practicing in the gamification platform. The scale formed by the four subscales is given in Table 2.

TABLE II. EXPECTANCY-VALUE-COST SCALE [13]

Category	Items
Expectancy	1. I know I can learn how to solve the practice problems in OneUp.
	2. I believe that I can be successful in practicing with OneUp.
	3. I am confident that I can understand the material practiced in OneUp.
Learning Value	4. I think practicing is useful for boosting my grades. 5. I value practicing as a way of learning. 6. I think practicing is important for success in this class.
Intrinsic Value	7. Practicing in OneUp appeals to my curiosity. 8. I think practicing with OneUp is interesting 9. Practicing in OneUp gets me emotionally involved.
Cost	10. Practicing with OneUp requires too much time and effort. 11. I'm unable to put in the time and effort needed to do well in my practicing with OneUp. 12. I have to give up too much to do well when practicing with OneUp.

The last section was intended to measure the Big Five personality factors [14]. It consisted of 15 items measuring five personality traits - extraversion, agreeableness, conscientiousness, neuroticism and openness to experience - using a 5-point Likert scale (see Table 3).

TABLE III. BIG FIVE PERSONALITY SCALE [14]

Category	Items
Extraversion	1. Tends to be quiet. 2. Is dominant, acts as a leader 3. Is full of energy
Agreeableness	4. Is compassionate, has a soft heart 5. Is sometimes rude to others 6. Assumes the best about people
Conscientiousness	7. Tends to be disorganized 8. Has difficulty getting started on tasks 9. Is reliable, can always be counted on.
Negative Emotionality	10. Worries a lot 11. Tends to feel depressed, blue 12. Is emotionally stable, not easily upset
Open-Mindedness	13. Is fascinated by art, music, or literature 14. Has little interest in abstract ideas 15. Is original, comes up with new ideas

By completing out-of-class practice quizzes, the students earned set amounts of virtual currency (the game element used). The amount of accumulated VC was also an indicator for learners' engagement with the gamification aspect of the activity, as some learners may enjoy accumulating VC independently of the associated external benefits.

### B. Results

To answer the research question, a linear regression analysis was performed on students' responses to each

motivation and personality questionnaire, included in the survey, namely, the Basic Needs satisfaction, EVC and the Big 5 scales, where engagement was operationalized as the total number of taken warm-up challenges and the level of emotional engagement was indicated by the amount of earned VC. Accordingly, two dependent variables were used in the regression analysis - the total number of completed warm-ups (practice quizzes) and the amount of earned VC.

The aim of the first analysis was to assess the effect of each of the Basic Needs factors as measured by the Basic Need Satisfaction inventory [12] on students' engagement in gamified out-of-class practicing during the semester. The results of the regression analysis indicated no significant impact of students' basic needs satisfaction on the number of completed warm-ups (see Table 4 which shows iteration 1 and iteration 4 results).

TABLE IV. EFFECT OF BASIC NEED SATISFACTION ON THE NUMBER OF WARM-UPS

Iteration	Basic Needs Model	Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	Autonomy	28.333	56.395	.502	.626
	Competence	18.567	38.406	.483	.639
	Relatedness	-2.616	32.340	-.081	.937
...	...	...	...	...	...
4	(Constant)	58.143	20.827	2.792	.015

<sup>a</sup>. Dependent Variable: Total number of warm-ups taken by a student.

The second analysis evaluated the effect of each of the Basic Needs factors as measured by the Basic Need Satisfaction inventory [12] on the level of students' striving to earn VC. According to the results, only competence predicted the amount of virtual currency earned from gamified practicing (see Table 5). The effect is positive, meaning that students who had a higher score in the competence need satisfaction, ended up with a higher amount of VC.

TABLE V. EFFECT OF BASIC NEED SATISFACTION ON THE AMOUNT OF VC

Iteration	Basic Needs Model	Unstandardized Coefficients		t	Sig.
		B	Std. Error		
3	(Constant)	-72.497	55.054	-1.317	.201
	Competence	21.369	10.846	1.970	.061

<sup>b</sup>. Dependent Variable: Amount of earned virtual currency.

With the next analyses we aimed to assess the effect of each EVC factor on students' engagement. As before, two regression analyses were carried out – one with the number of warm-ups and the other with the amount of earned VC as dependent variables. According to the results, the effect of expectancy, learning value and cost on the number of warm-ups were all statistically significant. While the learning value had a positive effect, the expectancy of success and cost were negatively related to the number of completed warm-ups (see Table 6).

TABLE VI. EFFECT OF EVC ON THE NUMBER OF WARM-UPS

Iteration	EVC Model	Unstandardized Coefficients		t	Sig.
		B	Std. Error		
2	(Constant)	86.446	73.415	1.177	.266
	Expectancy	-141.680	44.735	-3.167	.010
	Learning Value	157.595	44.144	3.570	.005
	Cost	-33.873	17.083	-1.983	.076

<sup>c</sup> Dependent Variable: Total number of warm-ups taken by a student.

As to the amount of earned VC (which can be viewed as a measure of emotional engagement), the results of the regression analysis indicated that it can be predicted by students' expectancy of success in the practicing tasks and its perceived cost (time, efforts, etc.) (see Table 7).

TABLE VII. EFFECT OF EVC ON THE AMOUNT OF THE VC EARNED

Iteration	EVC Model	Unstandardized Coefficients		t	Sig.
		B	Std. Error		
3	(Constant)	233.145	60.922	3.827	.001
	Expectancy	-20.651	9.679	-2.134	.044
	Cost	-23.325	9.602	-2.429	.024

<sup>d</sup> Dependent Variable: Total amount of virtual currency earned.

We note here, that the EVC measurements conducted in the middle of the semester demonstrated strong relations between the perceived learning and perceived intrinsic values of the practicing activity and the collected amount of VC. This indicates that both the perceived learning value and the perceived fun of the gamified practicing activity played a role in students' engagement.

TABLE VIII. EFFECT OF BIG 5 ON THE NUMBER OF WARM-UPS

Iteration	Personality Model	Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	246.691	367.426	.671	.521
	Extraversion	-27.080	40.252	-.673	.520
	Agreeableness	11.372	52.876	.215	.835
	Conscientiousness	24.934	76.425	.326	.753
	Negative Emotionality	-54.340	43.486	-1.250	.247
	Open Mindedness	-26.537	32.616	-.814	.439
...	...	...	...	...	...
6	(Constant)	58.143	20.827	2.792	.015

<sup>e</sup> Dependent Variable: Total number of warm-ups taken by a student.

With the last two analyses, we intended to examine if any of the Big 5 personality factors as reported by the participating students could be used as predictors for students' engagement in gamified activities, where as before, the engagement was measured by the numbers of completed warm-ups and the amount of earned VC. The results of the

regression analysis showed no significant relations between the self-reported Big 5 personality scores and both the number of completed warm-ups (Table 8) and the amount of earned VC (Table 9).

TABLE IX. EFFECT OF BIG 5 ON THE AMOUNT OF THE VC EARNED

Iteration	Model	Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	82.800	158.134	.524	.607
	Extraversion	-16.573	17.784	-.932	.363
	Agreeableness	14.264	24.446	.584	.566
	Conscientiousness	25.619	36.864	.695	.495
	Negative Emotionality	-16.522	17.704	-.933	.362
	Open Mindedness	-27.126	17.867	-1.518	.145
...	...	...	...	...	...
6	(Constant)	33.920	11.290	3.005	.006

<sup>f</sup> Dependent Variable: Total amount of virtual currency earned.

This initial analysis shows that the EVC scale demonstrates the best performance in terms of predicting students' engagement in gamified practicing from their expectancy for success, perceived value of practicing and the perceived cost scores. Surprisingly, the expectancy for success displayed a negative relation to student engagement. Based on the initial evidence, we can speculate that students underestimated the skills and knowledge required to succeed in practicing tasks. While the Basic needs and the Big 5 scales displayed a weak predictive ability, we assume that the small size of available data, which in this initial study were limited to the participating 26 students, may have contributed to such results. Furthermore, the Basic needs and the Big 5 scales were designed to measure more general psychological patterns, while EVC was designed to measure motivational factors specific for the learning domain. Thus, it captures features with stronger relations to students' engagement in gamified practicing.

#### IV. CONCLUSION

Various motivational theories have been used for estimating students' engagement in both learning activities and gamified platforms. In the majority of conducted empirical studies a single motivational framework has been used to measure a limited number of motivational drivers. However, the motivation in gamified learning activities is shaped through the interplay between motivational affordances of gamification and the motivators originating from the learning activity. Understanding the effects of such interactions requires a multi-faceted approach that allows capturing a diversity of relevant motivational drivers and measuring their significance for the involved learners. We addressed this need by employing three well-recognized theoretical frameworks: Self-determination theory, Expectancy Value theory and Big 5 Personality theory in a study aimed to shed a new light on the driving forces behind students' engagement in gamified activities. Specifically, the objective of this work was to examine empirically the potentials of three motivation assessment scales which were based on these motivational frameworks for predicting

learners' engagement in gamified learning activities. A derived objective was to determine which of the three scales would yield the highest predictive results regarding students' engagement in gamified practicing.

The initial results of this study demonstrated empirically that the EVC scale yielded the best predictive ability compared to the other two scales. The Expectancy-value theory was developed in the field of educational psychology and intended for use in the learning domain; therefore, it is domain specific in contrast to the SDT and the Big 5 scales. As a result, the EVC scale can capture relevant intrinsic and extrinsic learning-specific motivators rather than general psychological measures. This study also shows the value of using multiple scales for identifying significant driving forces for engaging in gamified learning activities.

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