Motivators Matter When Gamifying Learning Activities

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Abstract. Gamification, the use of game design elements in non-game contexts, has become a promising strategy for enhancing learners' motivation, engagement, and performance. However, our understanding of how the motivational affordances of gamification interact with the motivational drivers engendered by a learning activity is still limited. In most of the studies the focus is on the role of the incorporated gamification elements, disregarding motivational factors associated with the learning activity, such as perceived utility, expectancy of success, and needed effort to complete it. Expectancy-Value model offers a practical method for estimating the level and quality of learners' motivation towards a particular task as it accounts for both intrinsic and extrinsic motivators. Employing this model can shed a new light on the motivational potential of educational gamification. Accordingly, in this paper we present experiments with Expectancy-Value-Cost scale (EVC) as an instrument for estimating the level of students' motivation towards a gamified learning activity. We studied empirically how the motivational factors measured by EVC relate to the level of learners' engagement in gamified practicing and assessed their predictive qualities.

Keywords: Educational Gamification, Expectancy-Value Model, Motivational Design

1 Introduction

Motivation has been increasingly recognized over the years as one of the factors affecting learning. Lack of motivation and inability to engage learners to achieve desired learning objectives are among the top barriers to learning [1]. Improving and maintaining learner motivation has consequently emerged as a key challenge in education. Gamification, the use of game design elements in non-game contexts [2], is a promising strategy for enhancing learners' motivation, engagement, and academic performance. The basic idea behind it is that it is possible to motivate learners by creating enjoyable gameful learning experiences. Typically, the reason for gamifying an activity is that learners' motivation to engage in it is low and gamification is seen as a way to strengthen it. Many empirical studies have demonstrated that gamification can inspire motivation for engagement [3]. It is, however, difficult to draw definite conclusions about gamification's motivating potential in education [4] as the existing research is yielding contradictory findings [3,4,5]. Since the existing literature presents an ambivalent picture about the effect of gamifying learning environments, several researchers

(e.g. [4,6]) argue that the gamification practice would benefit from better understanding of the psychological mechanisms involved in the interaction with gamified platforms. For example, our understanding of how motivational affordances of game elements interact with the motivational drivers [7] engendered by a learning activity is still limited.

Motivation is a major driver of engagement, particularly in optional activities, such as practicing problem solving, where students carry out learning on their own [8]. Our experience with gamifying out-of-class problem-solving practicing shows that regardless of what gamification features are enabled in a gamified platform, there is always a group of students who either give up after a few attempts or never practice on it [9]. This leads to the question of what motivating factors could facilitate bringing such students to the gamified activity on a more regular basis so that they could experience the effect of gamification. We do not clearly understand how gamification can induce an interest for attempting a particular gamified activity and what other factors may influence that interest. In particular, the understanding of which motivational variables play a significant role in demotivating learners to take part in a gamified activity and whether gamification can moderate such effects is still fragmented.

Learners are commonly motivated by a combination of intrinsic and extrinsic reasons [10]. In gamification research their effects have been studied mostly from the perspective of Self Determination Theory [11]. However, motivational factors associated with the learning activity being gamified, such as student expectancy of success, perceived usefulness, perceived fun, perceived efforts, and drawbacks of engaging in an activity (*expectancy*, *value,* and *cost*) are rarely taken into consideration systematically. The observed gap prompted us to explore the impact of those motivational factors.

For estimating student motivation to participate in gamified learning activities, we chose to employ the Expectancy Value theory [12], which aims at determining students' motivation in learning processes. The expectancy-value model posits that learners' expectancy beliefs and subjective task values can be strong motivators for choice, persistence, and performance in learning activities [13]. It offers a practical method for estimating the level and quality of learners' motivation to participate in a particular task. One possible way to measure this level is through instruments developed within this model, such as the Expectancy-Value-Cost scale (EVC) [14, 15]. The EVC scale was developed to address the practical need for a rapid and brief measure of student motivation to participate in a task. It is intended to provide formative assessment on what motivational factors are high or low in a particular group of students and are in need of intervention. Employing this scale for studying gamified activities can shed a new light on the motivational potential of educational gamification. If we use such a scale 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 this paper we present experiments with the EVC scale as an instrument for estimating the level of students' motivation towards a gamified learning activity. The goal is to improve our understanding of how the estimated motivational drivers interact with the motivational affordances of gamification to promote engagement and thus make the targeted effects of gamifying learning activities more predictable. The focus is on optional (non-graded) learning activities, as these are the activities that are typically in

need of extra motivational boosters. To achieve the stated goal, we use the EVC scale to measure students' motivational drivers towards out-of-class problem-solving practicing and relate them to the level of actual student engagement in the gamified activity. Accordingly, we address the following research question:

RQ: Do the EVC measures have a predictive value for student engagement in gamified practicing?

2 Background

Gamification is alternatively defined as "a process of enhancing a service with motivational affordances for gameful experiences in order to support user's overall value creation" [16]. This definition reflects the widely held belief that the goal of gamification is to influence users' behavior through their motivation, and this motivation can be positively influenced by the motivational affordances commonly found in games. From this perspective, the desired learners' behaviors are assumed to emerge from their gameful experiences [5, 17]. Thus, gamification is frequently interpreted as an intervention with the purpose of enhancing the perceived fun of a targeted activity. Many studies on educational gamification emphasize the role of the incorporated gamification elements, disregarding the significance of learning-related motivational factors. Accordingly, the targeted behaviors are commonly explored as effected by the motivational affordances of the incorporated game elements in isolation from motivational drivers that might be engendered from the learning activity itself.

However, there are several motivational forces that influence learners' engagement in a gamified activity. For example, the authors of [18] suggest that the initial attitude of the learners towards a gamified activity would likely affect their motivation and engagement in it. While gamification research demonstrates that gamification can inspire motivation for performing a learning task [19], there is no clear understanding of how motivating or demotivating factors emanating from the learning activity co-create or fail to co-create the targeted motivation. Gamification research strives to address learning-related objectives through the interplay between motivational affordances of gamification and activity-induced motivation, but this interplay is not well understood due to the synergy that arises in applying multiple motivational drivers [20]. For example, it is unclear how the effects of the motivational affordances of gamification change when the learning-induced motivational drivers vary.

Although gamification is commonly defined as using game design elements in non-game contexts [2], the main focus of gamification research is centered on the motivational effect of incorporating game design elements. Less attention is paid to the impact of the "non-game context", which in the case of gamified learning is typically a learning activity. However, some findings suggest that the influence of gamification is driven by both utilitarian and hedonic benefits (e.g. [8,10]).

The achievement of the motivational objectives of gamifying a learning activity depends on two conditions: 1) The level of learners' willingness and ability to take part in the activity; 2) The level of learners' motivation to pursue the goals suggested by the rules shaping the gamification experience. As mentioned above, the attention in the

educational gamification research so far has been focused on (2), i.e., on studying how to boost motivation for performing a gamified activity by incorporating appropriate game elements [21]. However, for estimating the potential success of gamifying an activity it is beneficial to consider also (1), i.e., to explore the effect of learners' motivational dispositions towards the learning activity. We consider that the activity-related motivational drivers, such as expectancy for success in the activity, its perceived value, and the cost of engagement, play a substantial role in student motivation to participate in a gamified activity. If these drivers are too weak, they can act as demotivators for engaging in the activity which may hinder the potential effect of gamification. For example, if a learner considers an activity of low importance and with little expectations for a successful outcome, the likelihood of deciding to engage in a gamified version of that activity might be slim [22].

We chose the expectancy-value model [12] as we were looking for motivation constructs that address students' beliefs about their abilities, as well as the reasons for engaging (or not engaging) in behaviors suggested by the gamified activity. This model proposes that achievement behavior is largely influenced by expectancies of success and subjective task values [23]. Expectancy beliefs include a learner's task-specific expectations for success. The task values include an intrinsic value (the enjoyment and interest gained from a task), a utility value (the usefulness of a task), and an attainment value (the importance of a task) [24]. Thus, the model captures the perceived utilitarian (extrinsic) and hedonic (intrinsic) aspects of the activity [8,10]. It also provides a link to gamification, as the potential of gamification lies in enhancing the perceived fun value of an activity. The negative aspects related to the engagement in a task are referred to as *cost* [24]. Costs include effort and time required by a task, opportunities that are lost because of the engagement in the task, and emotional costs [25].

Research on task value [26] has demonstrated that students who value a task spend more time and effort on it. In particular, value was shown to be essential in motivating learners to engage in low-stake activities, such as practicing [12]. A task (e.g., taking a practice quiz) might be of value to a learner because it is interesting and fun. Another task (e.g., completing a graded assignment) can have utility value to a learner because it facilitates the attainment of important goals (i.e., successful course completion) even when the learner is not interested in it for its own sake and does not experience intrinsic satisfaction in doing it. Notably, if a learner sees little purpose or value in an activity (e.g., practicing), they may find more value in not doing it [27]. More interestingly, in their study Reid et al [28] reported that badges motivated learners who placed value on the learning activity, but not so much learners who placed little value on the activity. Another empirical study that examined the role of perceived cost [29] has shown that students are less likely to engage in a task when the perceived cost is too high. Yi and Rosenzweig have further revealed in their study [30] causal relationships between cost and avoidance-related academic behavior.

With this study we aim to contribute to the understanding of the sources that can motivate and demotivate learners to engage in gamified learning activities and their interplay, which is still limited. Lack of such understanding makes it difficult to determine why a particular gamified activity fails to engage learners: because of a bad gam-

ification design or because of demotivating factors originating from the learning activity. Accordingly, the objective of this paper is to examine empirically how the motivational factors measured by the EVC scale [14, 15] relate to the level of learners' engagement in a gamified activity and thus assess their predictive qualities. We were also interested to explore whether there exist certain motivational thresholds [6] that need to be exceeded for getting the learners to participate in a gamified activity.

The above considerations led us to reformulate the initial research question into three more concrete research questions that guided our study:

RQ1: Does a higher level of *expectancy* for success increase student engagement in gamified practicing?

RQ2: Does a higher level of perceived activity *value* increase student engagement in gamified practicing?

RQ3: Does a higher level of perceived *cost* decrease the engagement in gamified practicing?

3 The Study

The study involved students who have participated in a semester long gamified courses using the OneUp gamification platform [31] at one Historically Black University (HBCU) and one private research university in the US. The gamified activity in the courses was *out-of-class practicing*. The instructors created in OneUp challenges (practice quizzes) for self-learning and self-assessment. The students were encouraged but not required to take them. The employed gamification element was virtual currency (VC). As a gamification element, virtual currency typically stands for all kind of rewards which can be exchanged with virtual or real goods [4]. It can be viewed also as a reward that has 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 based on the amount, level of difficulty, and correctness of completed practice quizzes and could spend it in the OneUp course shop on purchasing deadline extensions, homework re-submission, and other course-related 'benefits', as decided by the instructors. As in this form earning virtual currency evokes perception of gaining benefits with a positive impact on course outcomes, it is more extrinsic in nature. Still, extrinsic motivation can be beneficial in situations where it can be seen as a basis for gradual developing of intrinsic motivation [22]. On the other hand, based on Ryan and Deci [11] we can assume that VC can enhance intrinsic motivation when it is awarded for the accomplishment of specific 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.

For measuring students' motivation to practice in OneUp, we employed the EVC scale [14], replacing 'task' with 'practicing in OneUp'. The EVC survey consists of 11 questions grouped in three separate sub-scales (expectancy, value, and cost) using a 6-point Likert scale ranging from 1 (Strongly Disagree) to 6 (Strongly Agree). We added

to the survey an additional question "I find practicing with OneUp interesting" for estimating learners' intrinsic interest in practicing in the gamification platform. The scale formed by the three subscales is given in Table 1. The learners' engagement was operationalized as the number of taken practice quizzes. As the amount of earned VC is proportional to the number of taken quizzes, the latter is also an indicator for learners' engagement with the gamification aspect of the activity (accumulated VC).

An invitation to participate in the study was sent by email to the students in the gamified courses at the two universities. Seventy-three students (forty-nine males and twenty-four females) – thirty-five from the HBCU and thirty-eight from the private research university responded to our invitation and completed the survey two weeks after the start of the semester long courses forming two groups of respondents.

Table 1. Expectancy-Value-Cost Scale.

Category	Items
Expectancy	- I know I can learn how to solve the practice problems in OneUp. - I believe that I can be successful in practicing with OneUp. - I am confident that I can understand the material practiced in OneUp.
Value	- I think practicing with OneUp is important. - I value my practicing with OneUp. - I think practicing with OneUp is useful. - I think practicing with OneUp is interesting.
Cost	- Practicing with OneUp requires too much time and effort. - Because of other things that I do, I don't have time to put into practicing with OneUp. - I'm unable to put in the time and effort needed to do well in my practicing with OneUp. - I have to give up too much to do well when practicing with OneUp.

The EVC survey is designed to measure expectancy, value, and cost as three separate, unidimensional scales. A confirmatory factor analysis of the expectancy, value, and cost was performed with varimax rotation to check the structural validity of the survey. As shown in Table 2, the results of the factor analysis provide support for the model validity of the used scales.

As expected, the proposed model resulted in three distinct factors (labeled as F1, F2, F3 in Table 2), with all items loading in their respective categories (see Table 2). The minimal factor loading among the items was 0.596, while for most of the items it was greater than 0.750. Cumulative percentage of variances explained by these three factors is 80.410. Accordingly, we calculated the mean scores *e, v*, and *c* for expectancy, value, and cost, as proposed in [14]:

$$e = (e1+e2+e3)/3, \quad v = (v1+v2+v3+v4)/4, \quad c = (c1+c2+c3+c4)/4$$

referring to them as *expectancy score*, *value score,* and *cost score,* correspondingly.

Table 2. Expectancy-Value-Cost Scale Factor Loadings.

	F1	F2	F3
v1	.311	-.417	**.744**
v2	.131	-.290	**.846**
v3	.316	-.116	**.794**
v4	.496	-.470	**.596**
e1	**.919**	-.149	.136
e2	**.845**	-.236	.375
e3	**.849**	-.168	.280
c1	.038	**.728**	-.255
c2	-.179	**.779**	-.372
c3	-.302	**.853**	-.126
c4	-.478	**.741**	-.175

We were interested to find out if there is a significant relation between the students' perception of expectancy, value, and cost of the activity as derived from the EVC survey and students' actual engagement in the gamified activity as captured in the OneUp system log. We used the numbers of challenges (practice quizzes) taken in OneUp as an indicator for students' engagement. The number of challenges offered in OneUp differed for the groups at the two universities. To make the numbers of taken challenges comparable, we normalized them by dividing the number of challenges taken by each student by the average number of challenges for the corresponding group.

4 The Results

To answer the research questions, we carried out a series of ANOVA tests and regression analysis. Results of the ANOVA test are presented in Table 3. They show that in accordance with the expectancy-value-cost scale, all three factors have an impact on students' engagement in the gamified practicing activity (p-values are 0.001, 0.000, and 0.002 respectively). To assess the slope of this impact, a Pearson correlation analysis was performed. The results show that *expectancy* and *value* both have a positive impact (Pearson correlation coefficients are 0.551 and 0.541, respectively, both statistically significant at 95% confidence interval), whereas *cost* has a negative impact (Pearson correlation coefficient = -0.481, $p < 0.05$). This is a confirmation of the relation between cost and practicing intensity hypothesized in the third research question - a high cost resulted in low practicing attempts and thus reaffirming its demotivating role.

These analytical results suggest that as the perceived (extrinsic and intrinsic) value of practicing decreases, the level of meaningful engagement in the activity also decreases. In addition, the level of engagement exhibits certain positive correlation with the expectancy score (similarly to the value score). Reversely, as the perceived cost

(reflecting negative aspects of engaging) of practicing increases, the level of engagement in the activity decreases.

Furthermore, the results of the regression analysis reveal an impact of the individual expectancy scores *e*, value score *v*, and cost score *c* values on the number of challenges completed in the gamified practicing platform (see Table 4).

Table 3. ANOVA results on impact of variables of engagement.

		df	Mean Square	F	Sig.	Hypothesis status
Expectancy	Between Groups	10	1804.164	3.379	.001	H1 accepted
	Within Groups	62	533.938			
	Total	72				
Value	Between Groups	16	1808.782	4.562	.000	H2 accepted
	Within Groups	56	396.523			
	Total	72				
Cost	Between Groups	17	1346.693	2.622	.004	H3 accepted
	Within Groups	55	513.673			
	Total	72				

Table 4. Regression analysis for prediction of engagement.

Coefficients *						
Model		Unstandardized Coefficients		Standardized Coeff.	t	Sig.
		B	Std. Error	Beta		
3	(Constant)	-6.807	22.019		-.309	.758
	Expectations	7.916	3.363	.271	2.354	.021
	Value	6.272	3.021	.277	2.076	.042
	Cost	-5.069	2.783	-.221	-1.822	.073

* *Dependent Variable: Engagement*

These results suggest that each student from a given group of students can be characterized by a score $s_{e,v,c}$ based on their individual expectancy *e*, value *v*, and cost *c* scores, which can be used to predict the level of their engagement in a particular activity. In in our case, $s_{e,v,c} = -6.807+7.916e+6.272v-5.069c$ (see Table 4).

If such relationship holds for a more general student population, it could make possible the identification of a threshold $t_{e,v,c}$ as a function of the perceived expectancy, value, and cost below which gamification of the activity would be ineffective. Thus, if for most students in a class their score $s_{e,v,c}$ is below the threshold $t_{e,v,c}$, the overall effect of gamifying the learning activity for this class is somewhat unlikely to be achieved.

This implies that gamification can have a motivating effect on a non-required gamified activity when there is sufficient initial motivation towards the activity, as indicated by students' perceived value, expectancy, and performance cost.

To visualize the relationship between the numbers of challenges taken by individual students and the corresponding value and cost scores, we partitioned the students into two groups: *low value OR high cost: {v ≤ 3 OR c ≥ 3.75} and high value AND low cost: {v > 3 AND c < 3.75}* (Note that *3.5* is the middle point of the Likert scale interval 1-6). Fig. 1 displays the number of challenges taken by each student, where the bars representing students from the *low-value OR high-cost* group are orange, while the bars representing the remaining students (from the *high-value AND low-cost group*) are blue. As it can be seen, for almost all students from the first group the number of completed challenges is below the average number of taken challenges, which indicates low engagement.

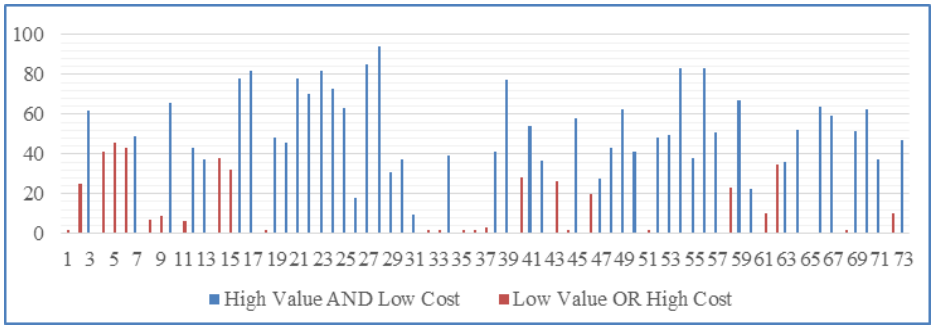

Fig. 1. Distribution of taken challenges by student.

In contrast, the numbers of challenges completed by the second group are mostly above the average number, which indicates higher engagement. In particular, the largest proportion of students who have taken a high number of practice challenges (above 60) are from the *high-value/low-cost group*. Another interesting observation is that there are quite a few students with zero or a very low number of taken challenges. These are mostly students that have responded with low-value or high-cost scores. This observation suggests also that both the perceived low value and perceived high cost of an activity play roles of demotivators of engagement in it. Accordingly, three groups of students can be distinguished from this descriptive analysis: students showing sustained engagement in the gamified activity, students showing sporadic engagement, and students disregarding the activity. The interesting insight is that this grouping can be derived from the relation of the expectancy, value, and cost scores to students' engagement in the gamified activity.

This analytical illustration exhibits a positive correlation between the perceived value of practicing and the level of engagement in the activity and a negative one between the participation cost and the level of engagement. Although not depicted in Fig. 1, the expectancy score also exhibits a positive correlation with the engagement.

5 Discussion and Conclusion

Educational gamification builds on the assumption that learner behavior and attitudes may be influenced by transferring the motivational potential of games to non-game learning environments. In reality, such transfer brings hedonic motivators to a system with utilitarian features resulting in an environment where the behaviors and attitudes of the learners are driven by both utilitarian and hedonic reasons. Thus, educational gamification influences learners by evoking a combination of utilitarian and hedonic motivators that may vary according to the learners' goals and interests. Knowing the factors that can influence learners' engagement can guide the gamification design for a particular activity. In order to gain a better understanding of the interacting motivational processes driving educational gamification, we designed a study aimed at providing empirical evidence on how expectancy, value, and cost as measured by the EVC scale relate to the level of learners' engagement in a gamified activity. The initial results show that the EVC motivational constructs are promising predictors for student engagement in gamified activities. Specifically, they shed light on the research questions by confirming that *expectancy* and task *value* have a positive effect on student engagement in gamified practicing, while *cost* affects it negatively. The results also suggest that there might be some expectancy-value-cost thresholds that need to be surpassed for learners to overcome the demotivation for taking part in the targeted gamified activity.

In the study, we observed three groups of practicing behaviors: persistence practicing, sporadic practicing, and no practicing. This grouping reflects the distribution of the levels of learners' engagement in the gamified activity as a function of their level of motivation (as measured by the EVC scores). It also relates the practicing behaviors to the three challenges experienced when gamifying learning: bringing learners to the gamified activity, engaging them with it, and sustaining their engagement. The study reveals that learners who value the learning activity (for its intrinsic or extrinsic qualities) and have positive expectations about the outcomes of their effort show tendency for sustained engagement in the gamified activity. On the other hand, learners with lower scores for value and expectancy are showing somewhat sporadic engagement. Based on the initial evidence we can speculate that this group has a potential to benefit from a gamification intervention if gamification features that can boost the perceived usefulness and fun value of the activity are incorporated.

Finally, the group of learners who disregard the gamified activity cannot experience any influence from the motivational affordances of gamification. These are mostly students with very low value or expectancy scores or high-cost scores indicating unwillingness or inability to engage in the gamified activity. As the effect of gamification is experienced through engagement in the learning activity, any intervention targeting this group should start with strategies enticing students to try the gamified activity. A possible approach is to apply a persuasive-type strategy that can get some of the learners reluctant to practice on board, so that they can experience the effect of gamification.

This paper is a step in a series of experimental works aimed at increasing our understanding of the effects of gamification in educational contexts. It provides empirical insights on how the subjectively experienced motivational factors originating from the learning activity contribute to shaping the engagement in gamified learning.

In terms of limitations, the study was limited by the selection of game elements used to gamify the learning activity. Future work should test whether other gamification features (e.g., competition-fostering game elements) would bring out different engagement dynamic. While the sample size in this study was sufficient to confirm our hypotheses, further research with larger samples will provide a more solid basis for generalization. Furthermore, longitudinal research with a larger sample size is needed to explore the potential evolution of motivational drivers over time. For example, the perceived learning value or perceived fun may change over time. Lastly, the appropriateness of using EVC to identify demotivational factors for certain groups of learners in order to use them for selecting gamification strategies that can facilitate overcoming demotivation is an interesting open research question.

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References

1. Priego, R.G., Peralta, A.G.: Engagement Factors and Motivation in E-Learning and Blended-Learning Projects. ACM International Conference Proceeding Series. pp. 453–460. ACM Press, New York, New York, USA (2013).
2. Deterding, S., Dixon, D., Khaled, R., Nacke, L.: From game design elements to gamefulness: Defining "gamification". In: 15th MindTrek'11 Conf: Envisioning future media environments, pp. 9-15. Tampere, Finland, ACM (2011).
3. van Roy, R., Zaman, B.: Unravelling the ambivalent motivational power of gamification: A basic psychological needs perspective. Int. J. Hum. Comput. Study (2018).
4. Dichev, C. & Dicheva, D. Gamifying education: what is known, what is believed and what remains uncertain: a critical review. In International Journal of Educational Technology in Higher Education 14:9 (2017). DOI: 10.1186/s41239-017-0042-5.
5. Hamari, J., Koivisto, J., & Sarsa, H. Does gamification work?--a literature review of empirical studies on gamification. In 2014 47th Hawaii international conference on system sciences (pp. 3025-3034). IEEE (2014).
6. van Roy, R., Deterding, S., Zaman, B.: Uses and Gratifications of Initiating Use of Gamified Learning Platforms. In: Proceedings of CHI'18 Extended Abstracts, ACM CHI Conf. on Human Factors in Computing Systems, pp. 1-6. Canada, ACM, New York (2018).
7. Klyczek, J.P., Gordon C.Y.: Choosing a motivation construct. British Journal of Occupational Therapy, 51 (9), 315-319 (1988).
8. Dichev, C., Dicheva, D. & Irwin, K. Gamifying learning for learners. Int J Educ Technol High Educ 17, 54 (2020). DOI: 10.1186/s41239-020-00231-0.
9. Dicheva, Darina, et al. "Exploring the Impact of Non-conventional Gamification Elements on Student Motivation and Engagement." IEEE Frontiers in Education Conference (FIE). IEEE (2021).
10. Clinkenbeard, P. R.: Motivation and gifted students: Implications of theory and research. Psychology in the Schools, 49(7), 622-630 (2012).
11. Ryan, R.M., Deci, E.L.: Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25, 54-67 (2000).
12. Eccles, J. S., Wigfield, A.: Motivational beliefs, values, and goals. Annu. Rev. Psychol. 53, 109–132 (2002). DOI: 10.1146/annurev.psych.53.100901.135153.

13. Wigfield, A., Eccles, J.S.: Expectancy-value theory of achievement motivation. Contemporary Educational Psychology. 25, 68-81 (2000).
14. Kosovich, J.J., Hulleman, C.S., Barron, K.E., Getty, S.: A practical measure of student motivation: Establishing validity evidence for the expectancy-value-cost scale in middle school. The Journal of Early Adolescence, 35 (5–6), 790-816 (2015).
15. Barron, K. E., Hulleman, C. S., Getty, S. G., Taylor, J.: Expectancy-value-cost survey of student motivation: User guide. Charlottesville, VA: The Motivate Lab (2017).
16. Huotari, K., Hamari, J.: Defining gamification: a service marketing perspective. In: Proc. of the 16th Int. Academic MindTrek Conference, pp. 17-22. Tampere, Finland (2012).
17. Landers, R., Tondello, G., Kappen, D., Collmus, A., Mekler, E.D., Nacke, L.E.: Defining gameful experience as a psychological state caused by gameplay: Replacing the term 'Gamefulness' with three distinct constructs. Int. J. Hum. Computer, Study (2018).
18. Hallifax, S., Serna, A., Marty, J.-C., Lavoué, G., Lavoué, E.: Factors to consider for tailored gamification. In: Proc. of the Annual Symposium on Computer-Human Interaction in Play, pp. 559-572. ACM, New York, NY, USA (2019).
19. Sailer, M., Homner, L.: The gamification of learning: A meta-analysis. Educational Psychology Review, 32(1), 77– 112 (2020). DOI: 10.1007/s10648-019-09498-w.
20. Morschheuser, B., Hassan, L., Werder, K., Hamari, J.: How to design gamification? A method for engineering gamified software, Information and Software Technology. 95, 219-237 (2018).
21. Klock, A.C.T., Wallius, E., Hamari, J.: Gamification in freight transportation: extant corpus and future agenda. Int. Journal of Physical Distribution & Logistics Management. 51(7), 685-710 (2021).
22. Meyer, J., Fleckenstein, J., Köller, O.: Expectancy value interactions and academic achievement: Differential relationships with achievement measures, Contemporary Educational Psychology, 58, 58-74 (2019). DOI: 10.1016/j.cedpsych.2019.01.006.
23. Eccles, J. S., Wigfield, A.: Motivational beliefs, values, and goals. Annual Review of Psychology. 53, 109 –132 (2002).
24. Dietrich, J., Moeller, J., Guo, J., Viljaranta, J., Kracke, B.: In-the-Moment Profiles of Expectancies, Task Values, and Costs. Frontiers in Psychology, 10 (1662) (2019).
25. Perez, T., Cromley, J., and Kaplan, A.: The role of identity development, values, and costs in college STEM retention. J. Educ. Psychol. 106, 315–329 (2014).
26. Hulleman, C.S, Durik, A.M., Schweigert, S.A., & Harackiewicz, J.M. Task value, achievement goals, and interest: An integrative analysis. Journal of Educational Psychology, 100(2), 398-416. DOI: 10.1039/0022-0663.100.2.398.
27. Wigfield, A., Cambria, J.: Students' achievement values, goal orientations, and interest: Definitions, development, and relations to achievement outcomes. Developmental Review, 30(1), 1-35 (2010).
28. Reid, A., Paster, D., and Abramovich, S. Digital badges in undergraduate composition courses: Effects on intrinsic motivation. Journal of Computers in Education, 2 (4), (2015).
29. Anderson, P. N. Cost perception and the expectancy-value model of achievement motivation. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA (2000).
30. Yi, J., Rosenzweig E.Q. "Using cost to improve predictions of adolescent students' future choice intentions, avoidance intentions, and course grades in mathematics and English." Learning and Individual Differences 86 (2021): 101978.
31. D. Dicheva, K. Irwin, and C. Dichev, "OneUp: Supporting Practical and Experimental Gamification of Learning", Int. J. of Serious Games, 5(3),5 – 21 (2018).