Motivational Gamification Strategies Rooted in Self-Determination Theory for Social Adaptive E-Learning

Lei Shi and Alexandra I. Cristea

The University of Warwick, Coventry, CV4 7AL, UK
{Lei.Shi, A.I.Cristea}@warwick.ac.uk

Abstract. This study uses gamification as the carrier of understanding the motivational benefits of applying the Self-Determination Theory (SDT) in social adaptive e-learning, by proposing *motivational gamification strategies* rooted in SDT, as well as developing and testing these strategies. Results show high perceived motivation amongst the students, and identify a high usability of the implementation, which supports the applicability of the proposed approach.

1 Introduction

Social adaptive e-learning proposes that besides receiving personalised content, creating content and interacting with peers can also motivate learning activities. Apart from modeling students themselves, e.g., via knowledge level and preference, social adaptive e-learning also models *their relations*. The social dimension allows for new personalised recommendations, such as which groups to join, or which peers to talk to, and thus mitigates the isolation between students.

Gamification describes an efficient way of utilizing game design elements to motivate learning activities [6]. It is another area that potentially provides motivational benefits in e-learning. As gamification and social e-learning have various common mechanics, such as collaboration, discovery and achievement [12], their combination may have greater impacts. Some studies showed benefits brought by this combination [13], but very few apply these features based on *solid theoretical fundaments*, with outcomes evaluated against these theoretical concepts. This study addresses this gap by exploring how to approach gamification in social adaptive e-learning *in a systematic way*, based on the theoretical underpinning of the Self-Determination Theory (SDT) [7]. In particular, we propose *motivational gamification strategies* rooted in SDT, for a high level of perceived motivation amongst students.

2 Related Work

Social Adaptive E-Learning: Learning is known as an intrinsically social endeavour [8], and the social facets of learning are described by a variety of theoretical frameworks [18]. The social learning theory postulates that learning is a cognitive process, which can occur through observation and imitation in a social context, and can be influenced by intrinsic reinforcement, as a form of internal rewards, such as satisfaction and a sense of accomplishment [2]. Social techniques become increasingly popular in e-learning. They can attract students to interact with peers, and generate trails for peers to follow. Not only can they promote students to participate in various learning activities, but they can also motivate students to create learning content. This study establishes a clear connection to motivational triggers via *grounding in motivational theories* and evaluation of motivational effects.

Self-Determination Theory (SDT): Successful social e-learning requires mechanisms to assist students in directing their own learning and having a high level of motivation to participate in meaningful interactions [10]. In e-learning, motivation initiates and maintains goal-oriented behaviours, to effectively achieve learning goals [1]. This allows students to take a self-motivating role of participating in determining their own learning paths, yet requiring support for a self-determined approach. SDT is widely and is one of the only motivational theories that focuses on the degree to which individual behaviours are self-determined and self-motivated [7], by proffering that individuals become increasingly more self-determined and self-motivated when three basic innate needs are fulfilled: 1) **Autonomy**: a sense of internal assent of one's own behaviours; 2) **Competence**: controlling the outcome and experience mastery; and 3) **Relatedness**: a sense of connection and interaction with others within a community. A social adaptive e-learning system that fulfills all these three basic innate needs is expected to sustainably increase the students' intrinsic motivation, leading to an efficient self-determined learning experience [15]. This study *applies* SDT in the design of the *motivational gamification strategies*, to fulfill students' basic innate needs and thus to foster intrinsic motivation.

Gamification: Gamification incorporates game thinking [17] (a game-like approach to aesthetics and usability) and game elements (elements from digital games, e.g., avatars, badges, progression bars, urgent optimism, and behavioural momentum) in a non-game system, and aims to achieve certain goals, such as learning, other than just entertaining players. Preferring to learn through games results from students' motivation in playing games [14], where they enjoy the learning system and like to continue using it. Studies have proposed guidelines for facilitating SDT in gamified e-learning systems [3], showing also positive impacts on learning performances. Yet, gamification has been criticised for its "overjustification effect", which occurs when an expected external incentive demotivates students with already existent high intrinsic motivation [5]. Evidence suggests that an increased extrinsic motivation might reduce the learning performance [4]. Our study explores a "*light gamification*" approach, rooted in SDT, to promote *intrinsic motivation*, rather than a "full-fledged gamification" approach that may "over-gamify" the e-learning system.

3 Motivational Gamification Strategies

Based on the above, the *motivational gamification strategies* defined in this study are classified into three groups, towards respectively fulfilling students' three basic innate needs: *autonomy*, *competence* and *relatedness*, as detailed below.

To fulfill the Autonomy Need. Experiencing *autonomy* means feeling in charge of one's behaviour. We suggest providing meaningful, flexible choices, such as learning goals and paths for achieving them, and learning peers to interact with (via various interaction tools), to continuously balance their curiosity, skills and goals against a finite pool of resources. This way, students can feel their behaviour as based on their own intentions, so that they may adhere to desired behaviours in certain contexts. In addition, to reduce the "overjustification effect" and maintain students' intrinsic motivation, it is important to provide intrinsic choices for voluntary behaviour [5], e.g., between competition and collaboration, as students usually tend to quickly notice the loss of autonomy (being controlled), which can demotivate them. To summarise, a system could implement the following *autonomy-related gamification strategies*: **A1**. A set of learning goals with clear descriptions and multiple paths to achieve each; **A2**. Various interaction tools to complete a task; **A3**. Clear, immediate and positive feedback for learning activities; **A4**. Meaningful options with consequences; **A5**. Customizable learning context that can be adjusted by students themselves.

To fulfill the Competence Need. Experiencing *competence* means a feeling of achieving mastery of skills and confidence in the current context, where cognition and expectations are consistent with system responses, to obtain further skills and confidence with relative ease. We suggest to provide direct and positive feedback, optimal challenges and freedom of demeaning evaluations. When experiencing enjoyment, students may become so intrinsically motivated that they not even realise completing a complicated task, or achieving a difficult learning goal [5]. We thus suggest offering interesting challenges combining clear rules and goals. We further suggest to "chunk" a learning goal into small and achievable pieces, and gradually increase the difficulty during the learning process, so that students are aware of every 'instant' achievement, feel the increase of skills, and make decisions accordingly and frequently. To summarise, a system could implement the following *competence-related gamification strategies*: **C1**. Reasonable small chunks of learning goals with increasing difficulty; **C2**. Tasks with pleasantly surprising positive feedback; **C3**. Multiple choices for advancing or retracing through the learning paths; **C4**. Frequent decision-making, to keep the learning process moving forward; **C5**. Enjoyable and fun learning activities.

To fulfill the Relatedness Need. Experiencing *relatedness* means feeling connected to peers, belonging to communities, and contributing to things 'greater' than oneself. A lower feeling of *relatedness* can reduce the students' motivation to interact with the system, which in turn may affect the satisfaction related to the other two basic innate needs, i.e., *autonomy* and *competence* [16]. *Relatedness* can be supported by various social interactions, such as tagging, rating, commenting and sharing with a learning community; additionally, the visualisation of social status and reputation, via levels, badges and leaderboards, helps situating students within a meaningful community, with similar interests and preferences [10]. With *relatedness* feelings, we suggest that even if other rewards may be boring or meaningless for them, students may still retain motivation, if they enjoy the community. To summarise, a system could implement the following *relatedness gamification strategies*: **R1**. Opportunities to discover and join learning communities; **R2**. Connections of interest and goals between students and communities; **R3**. Various tools for interaction, collaboration, discussion and mutual assistance; **R4**. Visualisations of social status, reputation and contribution; **R5**. Supporting the display of appreciation to/of others (such as "like").

4 Implementation

The proposed *motivational gamification strategies* were applied to implement Topolor 2 [11], a social adaptive e-learning system, which overhauls the previous version [9] with new *motivational gamification features*. This section maps each *motivational gamification strategy* onto concrete *motivational gamification features*, as described below (more details on Topolor 2 and its other features can be found in [11]). As explained, each strategy is supported by a wealth of different features.

Structured and Chunked Goals with Increasing Challenges. In Topolor 2, a *course* is composed of structured *topics*, so students have various "layers" of goals, with a learning path that can be accessed in different ways (**A1**). They have a *long-term goal* to complete the *course*, a *medium-term goal* to finish each *topic*, and a *short-term goal* to achieve each *objective*. Topics have reasonably short descriptions, although more resources of various sizes can be added to them (**C1**). They (normally) cannot jump goal layers, but they can decide which unlocked topic to learn next, or even access locked topics (**A5)**, as many times as they wish (**C3**). Besides, a higher-level goal is usually more difficult and complicated (**C1**), so students can incrementally master new skills, and practice before they demonstrate mastery.

Immediate and Positive Feedback with Guidance for the Next Step. Topolor 2 provides clear, immediate and positive feedback for learning activities, to fulfill the need for *autonomy* and *competence*. For example, after finishing the pre-test of a course, Topolor 2 shows "congratulations" and encourages students to start the course (**A3** & **C2**) and offers thus the opportunity to join its learning community (**R1**). When a student shares a new post, such as an image or video, a reminder shows the number of the new post(s), similar to `twitter.com`, so that the student can click on it to update the post list (**A3** & **C4**). Students need to continuously decide what to study next, and they can use various mechanisms to do that - e.g., learning path, filters of resources, etc. (**C4**). After submitting a test, Topolor 2 immediately shows the result and recommends the topics that the student may need to review (**A3** & **A4**).

Visualisation of Social Status, Comparisons, and Learning Progress. Topolor 2 supports various visualisations of individuals and communities for students to feel *competent* and *related*. For example, the comparison of performance and contribution potentially encourage students to contribute more to the learning community (**C5**, **R2** and **R3**), as seeing each other's status may simulate imitation and competition. Students can also "like" an image, a video, etc. shared by others (**C3**, **R3** and **R4**).

5 Evaluation

Two studies were conducted during two real-life university courses using Topolor 2 in two countries, with students of MSc and BSC levels. In the first course, "Dynamic Web-Based Systems", 15 MSc students took part. They were learning the topic "Collaborative Filtering", at the University of Warwick, UK, in 2013. The study included two time-controlled one-hour learning session (students sat in a classroom) and a non-time-controlled learning session (students accessed Topolor 2 at their preferred time and location). Ten completed the optional online survey, after the learning sessions.

A second course on "Management" was run in 2014 with 20 BSc students, learning the topic of "Control", in the Sarajevo School of Science and Technology, Bosnia and Herzegovina. One online session took one and half hours. Then students further used Topolor 2 to revise the covered materials, for two weeks. After that, the students were asked to complete an optional online survey. Fifteen completed the survey.

The *Perceived Motivation Questionnaire* developed in [10] was adopted, targeting SDT's three basic innate needs: *autonomy*, *competence* and *relatedness*. It contained 12 statements on a five-point Likert scale (-2: strongly disagree ~ 2: strongly agree). Table 1 shows the statements and scores from the questionnaire. *Cronbach's* α of the scores is 0.81, indicating a reliable internal consistency. The *means* (μ) range between 0.52 and 1.36, and the *standard deviations* (σ) of the results are between 0.49 and 0.78. All the *means* are greater than 0 (the neutral response; overall μ= 0.88; overall σ= 0.60), suggesting that the proposed *motivational gamification strategies* can provide a positive to high level of perceived motivation amongst students.

Table 1. Statement and score of the *Perceived Motivation* questionnaire

#	Statement	μ	σ	Category
1	I felt in control of my learning process.	0.60	0.50	*Autonomy* *μ: 0.89* *σ: 0.65*
2	I felt interested in using Topolor.	0.76	0.60	
3	I felt confident to use Topolor.	**1.12**	**0.78**	
4	I felt my learning experience was personalised.	1.08	0.70	
5	I felt having fun when using Topolor.	0.80	0.65	*Competence* *μ: 0.99* *σ: 0.57*
6	I felt I only needed a few steps to complete tasks.	0.64	0.57	
7	It was easy to understand why I received recommendations.	**1.36**	**0.49**	
8	It was easy to find the content I need.	**1.16**	**0.55**	
9	It was easy to share content with peers.	0.52	0.51	*Relatedness* *μ: 0.77* *σ: 0.86*
10	It was easy to access shared resources from peers.	0.76	0.60	
11	It was easy to tell peers what I like/dislike.	0.80	0.65	
12	It was easy to discuss with peers.	1.00	0.58	

Among the statements, statement 7 obtained the highest score (μ=1.36, σ=0.49). This is not surprising, as Topolor 2 explains each recommendation. For example, in the course structure view (learning path recommendation; not shown here due to lack of space), icons explain if a topic has been learnt, and if the student is eligible to learn it. Statement 8 received the second highest score (μ=1.16, σ=0.55). This can be due to the new filtering tool implemented in Topolor 2. Statement 3 gained the third highest score (μ=1.12). This further supports the *autonomy* goal.

Overall, as seen in Table 1, all motivational goals are achieved. The *competence* goal is supported by the features the most, and the *relatedness* goal the least (with statement 9 receiving the lowest score). The latter is possibly due to the fact that most students preferring to be "consumers" and not "producers" (a situation often observed in social media: about 80% are "readers" or "consumers" and the rest "authors" or "producers"). Yet, the content sharing issue may need further investigation.

Additionally, the SUS (System Usability Scale) score for Topolor 2 is 76.1 out of 100 (σ=12.36, *Cronbach's* α=0.98), suggesting a high usability of the system. This indicates the applicability of the proposed *motivational gamification strategies*.

6 Conclusion

To tackle the challenge of designing e-learning systems able to keep students highly motivated, we propose *motivational gamification strategies*, rooted in SDT. We provide means to concretely implement SDT-rooted motivational features in e-learning systems. We recommend using these strategies to guide the development and enhancement of general e-learning systems. We also suggest a method for exploring the impact of gamification on social adaptive e-learning – a measure of the perceived motivation amongst students.

References

1. Abrami, P. et al.: Interaction in distance education and online learning: using evidence and theory to improve practice. J. Comput. High. Educ. 23, 2-3, 82–103 (2011).
2. Bandura, A., McClelland, D.C.: Social learning theory. 1–46 (1977).
3. Banfield, J., Wilkerson, B.: Increasing student intrinsic motivation and self-efficacy through gamification pedagogy. Sci. J. 7, 4, 291–298 (2014).
4. Gillet, N. et al.: Intrinsic and extrinsic school motivation as a function of age: The mediating role of autonomy support. Soc. Psychol. Educ. 15, 1, 77–95 (2012).
5. Groh, F.: Gamification: State of the art definition and utilization. In: Proceedings of the 4th seminar on Research Trends in Media Informatics. pp. 39–46 (2012).
6. Kapp, K.M.: The gamification of learning and instruction: game-based methods and strategies for training and education. John Wiley & Sons (2012).
7. Ryan, R.M., Deci, E.L.: Overview of self-determination theory: An organismic dialectical perspective. In: Ryan, R.M. and Deci, E.L. (eds.) Handbook of self-determination research. pp. 3–33 University of Rochester Press, Rochester, NY (2002).
8. Saurabh, S., Sairam, A.S.: Professors – the new YouTube stars: education through Web 2.0 and social network. Int. J. Web Based Communities. 9, 2, 212–232 (2013).
9. Shi, L. et al.: A social personalized adaptive e-learning environment: a case study in Topolor. IADIS Int. J. WWWInternet. 11, 3, 13–34 (2013).
10. Shi, L.: Scaffolding for social personalised adaptive e-learning (doctoral dissertation). Retrieved from http://wrap.warwick.ac.uk/67201 (2014).
11. Shi, L., Cristea, A.: Designing visualisation and interaction for social e-learning: A case study in Topolor 2. In: Rensing, C. et al. (eds.) Open Learning and Teaching in Educational Communities. pp. 526–529 Springer International Publishing (2014).
12. Shi, L., Cristea, A.I.: Making it game-like: Topolor 2 and gamified social e-learning. In: The 22nd Conference on User Modeling, Adaptation and Personalization (UMAP 2014). pp. 61–64 , Aalborg, Denmark (2014).
13. Simões, J. et al.: A social gamification framework for a K-6 learning platform. Adv. Hum.-Comput. Interact. 29, 2, 345–353 (2013).
14. Squire, K.: Video games in education. Int. J. Intell. Games Simul. 2, 1, 49–62 (2003).
15. Street, H.D.: Factors influencing a learner's decision to drop-out or persist in higher education distance learning. Online J. Distance Learn. Adm. 13, 4, (2010).
16. Vansteenkiste, M. et al.: Autonomy and relatedness among Chinese sojourners and applicants: Conflictual or independent predictors of well-being and adjustment? Motiv. Emot. 30, 4, 273–282 (2006).
17. Werbach, K., Hunter, D.: For the win: How game thinking can revolutionize your business. Wharton Digital Press (2012).
18. Zimmerman, B.J.: A social cognitive view of self-regulated academic learning. J. Educ. Psychol. 81, 3, 329–339 (1989).