AN EXPERT GAMIFICATION SYSTEM WITH PSYCHOLOGICAL THEORIES FOR VIRTUAL AND CROSS-CULTURAL SOFTWARE TEAMS

Isaac Chow[1,2] and LiGuo Huang[2]

[1]XO Communications, USA
[2]Department of Computer Science and Engineering, Southern Methodist University
Dallas, TX 75275-0122, USA

ABSTRACT

Gamification is the concept of applying game elements in non-game context platforms to motivate people to participate in planned activities to achieve goals.

Gamification has been applied to academic fields including software engineering (SE) in recent years. Many gamification implementations in SE have been ad hoc and lacked standardized guidelines. This paper introduces a new concept of building an expert gamification system (EGS) to provide guidelines for the implementation of gamification for virtual and cross cultural software teams (VCCST). The system will extend the core of a regular expert system to include gamification tools, a supplementary database, and an expert knowledge source. The cross-cultural data for the EGS contains the Hofstede's cultural dimensions (HCD). The expert knowledge source contains information from Maslow's hierarchy of needs (MHON), flow theory and self-determination theory (SDT).

As more and more VCCST are formed in recent years, many issues have been raised in those teams stemming from miscommunication and cultural conflicts. This paper uses the EGS to help resolve the issues in VCCST. Also, this paper is an extension of a previous paper written by the same authors in this similar topic.

KEYWORDS

Gamification, Software Engineering, Expert System, Hofstede's Cultural Dimensions, Maslow's Hierarchy of Needs, Flow Theory, & Self Determination Theory

1. INTRODUCTION

Gamification is the use of elements of game design in non-game contexts [1]. It is the application of game elements used to encourage engagement with a product or service. The concept of gamification has been around for more than a decade. There has been a great deal of commercial and academic interest on the use of gamification in recent years.

Some studies show that gamification can motivate engineers in SE if applied appropriately. However, many gamification implementations for SE are lacking a well-defined framework or guidelines. This paper develops an EGS that will provide guidelines for implementing gamification for VCCST.

DOI: 10.5121/ijsea.2017.8201

An expert system is a computer system that emulates the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning about knowledge [2]. This paper extends the core of an expert system to include gamification tools, a supplementary database with the cross-cultural data, and the expert knowledge source from MHON, flow theory, and SDT to build the EGS. The core of an expert system consists of the inference engine and the knowledge base. Figure 1 is a high-level view of the EGS.

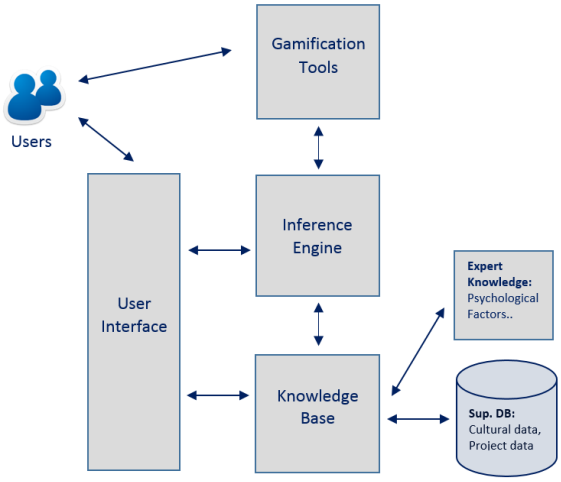


Figure 1. High Level View of the EGS

The EGS consists of the following modules:

1. Gamification Tools
2. User Interface
3. Inference Engine
4. Knowledge Base
5. Supplementary Database
6. Expert Knowledge Source

2. RELATED WORK

Gamification has been extensively researched by different types of researchers in recent years. However, there are very few studies in building an EGS as a tool for implementing gamification. Some gamification studies are intended for learning and discussed in the context of education. Other work tried to verify whether or not gamification works [3]. Some studies try to investigate the gamification mechanisms and see how gamification influences behaviours [4]. Quite a few research have indicated that gamification provides positive effects in motivation. Some studies are descriptive in nature and they have no experiment results of gamification reported [5], [6], [7], [8]. Several studies explore conceptual frameworks for classroom learning only [9].

For VCCST, some studies describe their conflicts and issues in detail but offer little help or guidance for them [10], [11]. Other research identifies the specific attributes relevant to cross-cultural concerns but does not show how to resolve the issues [12]. Some studies describe how to do cross-cultural surveys [13]. There are very few studies offering solutions for using an EGS.

3. VIRTUAL AND CROSS CULTURAL SOFTWARE TEAM

Globalization of markets has been a major theme in recent years and more software teams are working in cross cultural environments from outsourcing or insourcing work strategies [10]. It is common for a large software project to have teams in more than one location and in different countries. Many VCCST are formed across the globe with engineers from different parts of the world [14].

It has been reported that the software projects with VCCST have quite a few issues and challenges. Most of the problems are about conflicts in culture and its adverse impact to the dynamics of the team [10], [15]. In a few instances, the software engineers view their co-workers from different cultures as rivals rather than teammates. This paper designs an EGS to promote team work and collaboration for VCCST to smoothen their conflicts and problems.

4. EXPERT GAMIFICATION SYSTEM

The EGS extends the core of an expert system and consists of six components as shown in Figure

1. The core elements of an expert system are the inference engine and the knowledge base. The inference engine is an automated reasoning system that evaluates the current state of the knowledge base, applies relevant rules, and then asserts new knowledge into the knowledge base. The knowledge base represents facts and rules. Knowledge in an expert system may originate from many sources such as reports, databases, case studies, empirical data, and domain experts [2].

Other components in the EGS are the gamification tools, a user interface, a supplementary database, and an expert knowledge source. The gamification tools include the game mechanics and the platform. For example, Microsoft SharePoint can be used as a gamification tool. These tools will contain the software team profile and personal profiles. The profiles will store and show the team scores and individual scores respectively. The user interface facilitates the communications between the project admins, users, and the EGS.

The supplementary database contains the cultural data and project data while the expert knowledge source contains MHON, flow theory and SDT information.

4.1 Gamification Design Approach in the EGS

The following are the gamification design approaches in the EGS:

1. Consider the players and their profiles: Analyse the motivational drivers for the players and use the HCD data to determine their cultural profiles.

2. Determine the project goals: The users or the project managers will list their project goals. The EGS will break the larger goals into smaller achievable goals or steps and use the game mechanics to promote them.

3. Setup a monitoring process: The EGS will monitor the progress of the project and see if certain criteria or conditions for peak performance are met. If they are not met and are significantly divergent from the desired state, alerts will be sent to the project managers and the EGS administrators.

4. Refine the process iteratively: The EGS will make adjustments and improvements iteratively during the project when needed.

The following section discusses how to determine the player profiles using the HCD data.

4.2 Hofstede's Cultural Dimensions

Hofstede's cultural dimensions (HCD) theory is a framework for cross-cultural communication and it can be used to determine the player's initial cultural profiles. HCD describes the effects of a society's culture on the values of its members, and how these values relate to behaviour using a structure derived from factor analysis [16]. According to Hofstede the most important differences between cultures can be captured by finding to what extent members of these cultures differ with regard to six values [17]:

1. Power distance index (PDI) - The power distance index is defined as the extent to which less powerful people in an organization will accept and expect power to be distributed.

2. Individualism/Collectivism (IDV) – Differences between the degrees within the Individualism vs. Collectivism index.

3. Masculinity/Femininity (MAS) - Differences between the degrees within the Masculinity vs. Femininity index.

4. Uncertainty avoidance index (UAI) - Differences between the degrees within the Uncertainty Avoidance Index.

5. Long-term/Short-term Orientation (LTO) - Differences between the degrees within the Long-Term vs. Short-Term Orientation index.

6. Indulgence vs. Restraint (IND) - Differences between the degrees within the Indulgent vs. Restraint index.

Table 1 shows the Hofstede's values for these cultural dimensions for Australia, China, India, Japan, Netherlands, UK, and USA [17]. The EGS further categorizes the countries into regions such as Australia (AUS), Asia, Europe (EU), and North America (NAM) for further region processing as shown in the second columns of Table 1.

Table 1. Hofstede's Cultural Dimensions

Country	**Region**	**PDI**	**INV**	**MAS**	**UAI**	**LTO**	**IND**
Australia	AUS	36	90	61	51	31	71
China	Asia	80	20	66	30	87	24
India	Asia	77	48	56	40	51	26
Japan	Asia	50	42	90	88	75	42
Netherlands	EU	38	80	14	53	67	68
UK	EU	30	89	62	30	20	69
USA	NAM	40	91	62	46	26	68

Among HCD, three dimensions have more effect on gamification. They are Individualism, Masculinity, and Uncertainty:

1. Individualism (INV)

This is the index to indicate how people think with the mentality of "I" or "We." Some countries are very "individual" focused. They focus more on themselves and careers versus their group. The game design should take this into consideration. If the culture is more individual focused, game mechanics such as leaderboards should be used.

2. Masculinity (MAS)

Masculinity is defined as "a preference in society for achievement, heroism, assertiveness and material rewards for success." Its counterpart represents "a preference for cooperation, modesty, caring for the weak and quality of life." [17] This dimension gives important information in setting up the right game mechanics for certain cultures. For instance, many Scandinavian countries have a very low score in MAS. In those cultures, there is an important concept known as Janteloven [8]. Janteloven is essentially a set of rules for encouraging social equality, social stability, and uniformity in which one should never try to stick out from the crowd. The Netherlands is an example with a score of 14 in MAS. The EGS should take this into consideration by not focusing the games on competitiveness and leaderboards. Rather, it should promote notions of equality and creativity for them [18], [19].

3. Uncertainty Avoidance (UAI)

The uncertainty avoidance index is defined as "a society's tolerance for ambiguity" in which people embrace something unexpected, or go away from the status quo. Societies that score a high degree in this index tend to prefer strict codes of behaviour, guidelines, laws, and absolute truth. A lower degree in this index shows more acceptance of differing thoughts. Society tends to impose fewer regulations, ambiguity is more accustomed to [17]. The game design should take this into consideration.

4.2.1 Adding HCD Information to Game Mechanics and Activities

The EGS should extract the cultural information and use that information to configure the game mechanics in the system. Table 2 contains the game mechanics, the associated emotions, and their values for INV, MAS and UAI. The values represent the recommendations from the EGS for the game mechanics. For example, the value of 'all' in INV means that game mechanic is good for all values of INV. The value of 'high' in INV means the game mechanic is good if INV is high. The same rule applies to the value of 'low'. If all three HCDs have the same 'high' value for the same game mechanics, it reinforces the recommendations. If HCDs have different recommendations, INV will have the highest preference and MAS will have the second highest preference.

Table 2. Game mechanics and cultural factors

Game mechanics	**Emotions**	**INV**	**MAS**	**UAI**
Points	Reward	All	All	All
Badges	Achievement	All	High	All
Leaderboards	Competition	High	High	high
Levels	Status	High	High	high
Progress bars	Achievement	All	All	high

Storyline	Engagement	All	All	All
Feedback	Engagement	All	All	high
Challenge/between users	Competition	All	High	All
Virtual gifts	Altruism / Self-expression	All	Low	Low
System for sharing/exchanging	Collaboration/ Community	Low	Low	All

Table 3 shows a list of activities with their corresponding values for INV, MAS, or UAI. The rules for recommendation are similar to the ones in Table 2. For example, the value of 'low' in INV for 'helping others' means that activity is recommended when it has a low INV value. The same rule applies to other activities and HCDs. Also, the HCD values in the table can be changed when more knowledge or experience is gathered.

Table 3. Activity table with cultural factors

Activities	**INV**	**MAS**	**UAI**
Inviting peers to design review	All	All	All
Participating in a design review	All	All	high
Inviting peers to a code review	All	All	All
Participating in a code review	All	All	high
Inviting peers to a test plan review	All	All	All
Participating in a test plan review	All	All	High
Helping others	Low	Low	All
Giving people credits	Low	Low	All
Being a team player	Low	Low	All
Resolving issues	All	Low	High
Collaboration activities	Low	Low	All
Innovative idea	All	All	All
Voting for an idea	low	Low	All
Beating the deadline	high	All	high
Documenting code	All	All	high
Best practice	All	All	High
Writing unit tests	All	All	High

4.3 Psychological Factors

Gamification uses the psychology of engagement to motivate people. Psychology can be applied to the non-technical aspects of SE like personality, teamwork, leadership, decision-making, culture, motivation and human tendencies [15].

4.3.1 Maslow's Hierarchy of Needs

Abraham H. Maslow was a renowned psychologist in the field of motivation. He published the famous Hierarchy of Needs in 1943 [18]. It is a pyramid depicting the five levels of needs, namely

1. Biological and Physiological: air, food, shelter, water, sex, & rest
2. Safety: health, protection, stability, freedom from fear & security
3. Love and Belonging: love, intimacy, friendship, family, & affiliating
4. Esteem: self-esteem, independence, status, confidence, achievement & respect
5. Self-actualization: realizing personal potential, self-fulfilment & peak experiences

Self-actualization is the peak level in which a person's full potential is realized and the experience is intensely joyous. Maslow describes this level as the desire to accomplish everything that one can: to become the most that one can be [18]. Figure 3 shows MHON at the lower left hand corner.

4.3.2 Flow Theory

Self-actualized people are those who come to find meanings to life that are important to them and that fulfil them. Many of them experience a common phenomenon called flow, proposed by Csikszentmihalyi [20]. When people are in a state of flow, they will feel focused and concentrated. They may feel a sense of ecstasy, great inner clarity, a sense of serenity, timelessness, and intrinsic motivation. The flow is the balance between the skill level and the challenge of a task. When a task is too difficult, it causes people to worry. When a task is too simple, people will be bored. When a task is balanced between skill and difficulty, the individual will reach a state of heightened focus and immersion [20].

The flow state can be achieved if these characteristics are involved: 1. Creativity; 2. Autonomy; 3. Learning; 4. Progress; 5. Increase of skills & difficulty [21].

Csikszentmihalyi describes the conditions of flow being heavily concentrated on a balance between skill and challenge, control, intense concentration and immediate feedback to create an autotelic experience. [22]

Some research further extends the flow theory for groups. Keith Sawyer developed specific triggers needed for creating group flow [21]. Figure 2 shows the theory of flow. The detection in figure 2 indicates that the EGS will try to detect whether or not the team is in the state of flow. It will be discussed in the latter section.

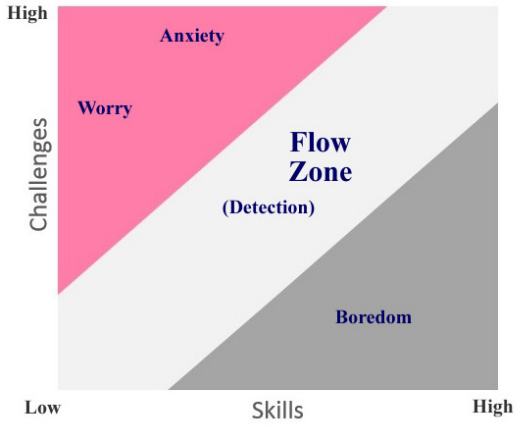


Figure 2. Flow Theory

4.3.3 Self Determination Theory (SDT)

SDT from Deci & Ryan suggests that three psychological needs have to be satisfied for individuals to flourish. The three needs are autonomy, competence, and relatedness. [23] SDT has been in place for over 30 years and has been well tested and accredited for its effectiveness. SDT shows how individuals are motivated to behave due to an intrinsic or external value. [23]
According to SDT, individuals are attracted to situations in which 'need satisfaction' may occur. Once their needs are satisfied, they are likely to feel energized and actively engage in subsequent need fulfilling activities. [23]

The following describes the three SDT needs and how the EGS should design around them.

1. Autonomy

Autonomy is to let players experience a sense of volition and freedom. The EGS should let the participants have choice, control, and personal preference in the project when possible. Multiple pathways should be designed to let the players have choices to achieve their goals.

2. Competence

Competence is about the players feeling effective. The EGS should have a path for players to increase their skills in the software process over time. These can be simple short-term achievable goals that lead to the success of long-term goals.

3. Relatedness

Relatedness is the feeling of being loved and cared for. People are intrinsically motivated to seek meaningful connections with others. The EGS should provide a meaningful community of interest. The players should get recognitions for actions that matter to them. [24]

The three SDT needs have great influence in three motivations: perceived usefulness, perceived enjoyment and perceived ease of use. In SDT, perceived usefulness is a form of extrinsic motivation while perceived enjoyment a form of intrinsic motivation. Intrinsic motivation refers to doing something because it is inherently interesting or enjoyable, and extrinsic motivation refers to doing something because it leads to a separable outcome. [23]

Autonomy has strong influence to perceived usefulness and perceived enjoyment. Competency has strong influence to perceived usefulness, perceived enjoyment, and perceived ease of use in prior studies. [25] Relatedness (community support) has a strong influence to perceived usefulness, perceived enjoyment, and perceived ease of use. [26]

Therefore, we can assume that

1. Autonomy has a positive effect on perceived usefulness
2. Autonomy has a positive effect on perceived enjoyment
3. Competence has a positive effect on perceived usefulness
4. Competence has a positive effect on perceived enjoyment
5. Competence has a positive effect on perceived ease of use
6. Relatedness has a positive effect on perceived usefulness
7. Relatedness has a positive effect on perceived enjoyment
8. Relatedness has a positive effect on perceived ease of use

Perceived usefulness has stronger effects for uninteresting tasks [27], whereas perceived enjoyment or playfulness have stronger effects in interesting tasks. [28] Perceived ease of use is a strong motivation to use a system. These perceptions have been empirically tested to have a positive relationship with the behavioural intention to use. [29] Therefore, we postulate that they have a positive effect on motivation to engage in gamification mechanics and activities. [30] These are shown in Figure 3.

4.4 Putting them all together

Figure 3 shows a high level conceptual view of MHON, flow theory, SDT and HCD with gamification in the EGS. Maslow considers human needs to be hierarchically ordered. SDT does not postulate a particular order for the needs. All three needs in SDT are considered important for individuals' flourishing and are innate similar to biological needs [23].

While flow is being encapsulated as a process, SDT is a theory of motivation that includes factors like personality and social context. Flow and SDT do have same overlaps though. [31] However, SDT covers motivation more extensively than flow does. [30]

HCD is the cultural data that the EGS can use for analysing the players' preferences for game mechanics and activities.

4.5 Monitoring the project

One of the goals in the EGS is to monitor and measure the progress of the project so that it can make adjustments and improvements iteratively when needed. It also collects the project metrics to evaluate the outcomes of the project. The following subsections describe the monitoring process.

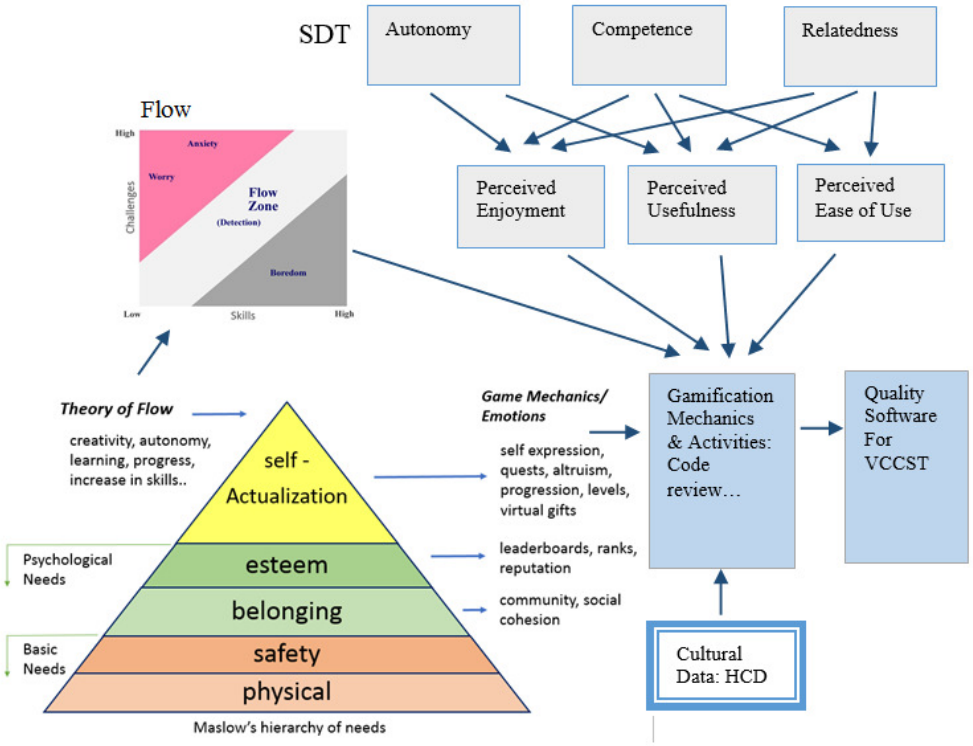


Figure 3. High Level Conceptual Model of Maslow, Flow, SDT and HCD in the EGS

4.5.1 Flow Zone Detection

The EGS should find ways to measure and detect the flow zone. There are some methods in measuring flow with questionnaires: Nakamura & Csikszentmihalyi enlist the various ways of measuring flow for Concept of Flow; Intrinsic Motivation Inventory with 10 Questionnaires; John

Marshall Reeve: Agentic Engagement Scale Questionnaires; Davin Pavlas Play Experience Questionnaire. [21] Other than using the questionnaires, the EGS will use the game statistics to detect the flow zone. Figure 4 shows a simple game flow in which the 'flow' loop is indicated with bigger arrows.

The EGS will monitor the gamification and collect the game statistics to determine if a team is in a flow state. Table 6 shows a sample of the game statistics. The average percentage of hits in that table can be a strong indicator for detecting a flow state. For example, if that percentage is at or above a pre-determined value, then the EGS will assume that the team is in a flow state or zone. It may be a trial and error process to finalize the right value for that percentage. The percentage can be cross checked with the flow questionnaire or the SDT survey form to find the optimal value.

4.5.2 SDT Survey Form

To check to see if the three SDT needs are satisfied, the EGS can use online survey forms for players to fill in. Data will be analysed after the forms are filled in by the players. An initial value will be set to define whether or not the three needs are satisfied. For example, an initial threshold value of 80%+ can be set as being satisfied.

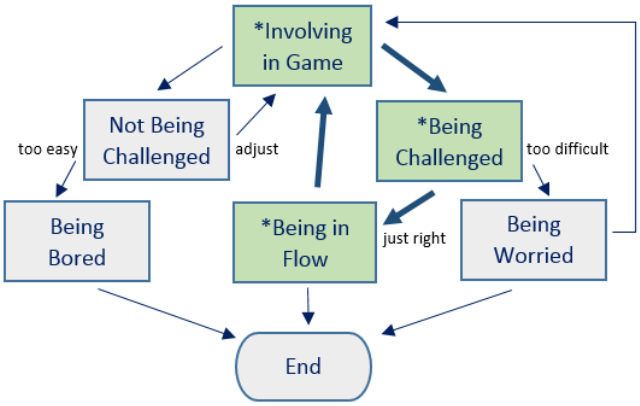


Figure 4. A Simple Game Flow

Some questions in the survey form may be negative questions. It means that a 'Yes' response is negative to the SDT motivation. Negative questions will deduct scores from those of the positive questions. The following is a sample SDT survey form.

Table 4. Online SDT survey form

	Yes	No
1. Need for Autonomy		
1.1 I felt in control of my project.		
1.2 I was having fun doing my project.		
1.3 I felt my project experience was personalised.		
1.4 I feel like I can be myself in this project.		
1.5 I feel like I have to follow other people's commands in this project.		
1.6 If I could choose, I would do things differently in this project.		

1.7 I feel free to do my tasks the way I want to get done.		
1.8 In this project, I feel forced to do things that I do not want to do.		
2. Need for Competence		
2.1 I felt confident to work on my project.		
2.2 The process was easy to understand.		
2.3 It was easy to find the information I needed.		
2.4 I don't really feel competent in my project.		
2.5 I can master my tasks in this project.		
2.6 I doubt whether I am able to perform my tasks properly.		
2.7 I am good at the things I do in this project.		
2.8 I can accomplish the most difficult tasks in this project.		
3. Need for Relatedness		
3.1 It was easy to share information with teammates in this project		
3.2 It was easy to share what I think with the team.		
3.3 I don't feel connected with other members in this team.		
3.4 I feel I am part of the team.		
3.5 I don't mix with other people in this team.		
3.6 I always feel alone when I am with my team.		
3.7 I consider some teammates I work with as close friends of mine.		

4.5.3 Project Metrics

After the project completion, the project metrics such as total lines of code and number of defects will be collected to evaluate the overall performance of the project. These data are collected as historical data and served as knowledge information. The EGS should be able to check whether or not the improvement in the project metrics matches the improvement in the SDT data or the flow data.

4.6 Sample Data

A simple prototype is developing at this time. The preliminary findings are encouraging. Table 5 contains some sample inputs to the EGS for demo purpose. The EGS will take these inputs and use the knowledge base and rules to start the process.

Table 5. Inputs to the system

Attributes	**Examples**
Project Name	VCCST Enhancement
Project Description	A demo to show how the EGS works
Domain of interest	Software engineering
Team Info	Cross-Cultural

Team Location	Virtual
Countries	USA, India, China
# of team members	20, 12, 18
# of analyst, developers, testers	4,12,4
SE Methodology	Agile

The ESG will recommend a list of game mechanics and activities for the software project. Each individual group is customized. The EGS collects data from the project for analysis. The project data will be stored and served as references for future projects. A SharePoint community site will be used as a platform for collaboration, community, and data collection.

4.6.1 Sample flow data

One of the main functions of the EGS is to monitor the project for the flow zone detection. Table 6 shows a sample of the game statistics that can be used from that purpose. The EGS uses the values from INV, MAS, UAI, and the team cultural data to determine the initial 'target %' for the flow zone. As more project data are stored and accumulated, the EGS can use the past data as reference and knowledge for further 'target %' refinement and fine tuning. If HCD recommends the activities, the 'target %' for those activities will be higher than others.

Table 6. Sample game statistics

Point for activities	# of players	# of hits	Hit %	Target hit %
inviting peers to design review	16	15	93.75	80.00
participating in a design review	16	9	56.25	80.00
inviting peers to a code review	12	8	66.67	80.00
participating in a code review	12	6	50.00	80.00
inviting peers to a test plan review	16	7	43.75	80.00
participating in a test plan review	16	4	25.00	80.00
helping others	20	6	30.00	70.00
giving people credits	20	15	75.00	75.00
being a team player	20	9	45.00	75.00
resolving issues	20	5	25.00	70.00
collaboration activities	20	12	60.00	70.00
innovative idea	20	3	15.00	60.00
voting for an idea	20	4	20.00	70.00
beating the deadline	20	4	20.00	80.00
documenting code	12	8	66.67	80.00
best practice	16	5	31.25	75.00
writing unit tests	12	11	91.67	80.00
Average %:			47.94	75.59

A: Number of analysts	4
B: Number of developers	12
C: Number of testers	4
D: Total players	20

In Table 6, the 'Hit %' is calculated by '# of hits' / '# of players'. In this sample data, there are 4 analysts, 12 developers, and 4 testers – a total of 20 players. The system assigns players to the activities according to their roles. The system collects the games statistics including the number of hits from each activity. The system compares the average 'Hit %' and the average 'Target hit

%' to determine the status of the flow zone. In Table 6, 47.94% is the average 'Hit %' and 75.59% for the average 'Target hit %'. Since the average 'Hit %' is lower than the average 'Target hit %', the EGS will infer that the project team is not in a flow zone. The EGS will send alerts to the system admins and project managers. They can choose to adjust the game mechanics/activities and or make comments about the project.

4.6.2 Sample SDT data

Table 7 shows a set of sample SDT survey results. The initial target percentage for the three needs will be 80%. That is, if the net feedback is less than 80%, then it is considered as not meeting the needs. The target percentage can be adjusted and fine-tuned to meet the needs.

Table 7. Online SDT survey results

	Yes (positive)	Yes (Negative)	Net	Target	Met
1. Need for autonomy	80%	5%	75%	80%	No
2. Need for competence	75%	10%	65%	80%	No
3. Need for relatedness	73%	12%	61%	80%	No
Average			67%	80%	No

4.6.3 Sample project data

Table 8 shows a set of sample project metrics. When more projects are in the EGS, it can compare, analyse and trend the performance of the projects. Table 9 shows the information with two projects.

Table 8. Project Metrics Comparison

Project	LOC	Defects	Duplication	Doc.	Unit Test
1	10,678	2	3.24%	40%	52%

Explanations of the metrics:

1. LOC: Total lines of code involved in the project – a lower LOC may be better in general but it may depend on the project
2. Defects: Number of defects found in the project – the lower the better
3. Duplication: Density of duplication (%) – the lower the better
4. Doc.(Documentation) - Density of comment lines (%) – the higher the better
5. Unit Test: Unit test coverage (%) – the higher the better

The duplication, unit test, and documentation metrics can be collected from SonarQube.

Table 9. Project Metrics Comparison

Project	LOC	Defects	Duplication	Doc.	Unit Test
1	10,678	2	3.24%	40%	52%
2	11,786	4	5.24%	36%	53%

5. CONCLUSIONS

This paper introduces a new concept for building an EGS for the implementation of gamification for VCCST. The goal of this paper is to open up another way of thinking in designing gamification for SE using HCD, flow theory, SDT, and the past project data for VCCST. Designing and building the EGS will help to create a user-friendly system tool for gamification implementation. The concept can be further extended to other domains for resolving different problems using gamification.

For future work in this EGS, one area to extend the scope of the EGS is to include other SE disciplines such as the CMMI maturity levels and game maturity levels. Another area is to enhance the flow zone detection algorithm and design an alternative to the SDT online survey form that works better. The third area is to incorporate more cultural data and to develop a robust knowledge extraction methodology for the system. As for VCCST, more case studies should be done using gamification with qualitative and quantitative approaches. Supporting and fostering the gamification research to improve the software development process in the cross-cultural environment could yield impactful results for VCCST.

REFERENCES

[1] Deterding, S., Sicart, M., Nacke, L., O'Hara, K. & Dixon, D. (2011). Gamification: Using game design elements in non-gaming contexts. In Proceedings of CHI 2011. New York: ACM Press, 2425-2428.

[2] Wikipedia, “Expert system”, (2016), https://en.wikipedia.org/wiki/Expert_system

[3] J Hamari, J Koivisto, H Sarsa, “Does gamification work? -a literature review of empirical studies on gamification” System Sciences (HICSS), 2014, pp. 3024-3034.

[4] Bunchball (2010), “Gamification 101: An introduction to the Use of Game Dynamics to Influence Behavior”

[5] Philipp Herzig, Michael Ameling, Alexander Schill, "A Generic Platform for Enterprise Gamification", 2012 Joint Working Conference on Software Architecture & 6th European Conference on Software Architecture, 978-0-7695-4827-2/12 © 2012 IEEE, pp. 217-223.

[6] Foong Li Law, Zarinah Mohd Kasirun, Chun Kiat Gan, "Gamification towards Sustainable Mobile Application", 2011 5th Malaysian Conference in Software Engineering (MySEC), pp. 348-353.

[7] Bogdan Vasilescu, "Human Aspects, Gamification, and Social Media in Collaborative Software Engineering", ICSE ’14, May 31 – June 7, 2014, Hyderabad, India, Copyright 14 ACM 978-1-4503-2768-8/14/05

[8] Marius Kalinauskas, "GAMIFICATION IN FOSTERING CREATIVITY", ISSN 2029-7564 SOCIAL TECHNOLOGIES 2014, 4(1), pp. 62–75.

[9] Jorge Simões a, Rebeca Díaz Redondo b, Ana Fernández Vilas, "Computers in Human Behavior", www.elsevier.com/locate/comphumbeh, 2012 Elsevier Ltd

[10] Michael Barrett, "Knowledge Sharing in Cross-Cultural Software Teams" Working Paper Series, 18/2007, Judge Business School, University of Cambridge

[11] Hannu Jaakkola, Anneli Heimbürger, "Cross-Cultural Software Engineering", Informatologia 42, 2009., pp. 256–264.

[12] A Sutharshan. S P Maj "Enhancing Agile Methods for Multi-cultural Software Project Teams" Modern Applied Science Vol. 5, No. 1; February 2011, ISSN 1913-1844 E-ISSN

[13] "Guidelines for Best Practice in Cross-Cultural Surveys" THIRD EDITION, Copyright © 2011 by the Survey Research Center, Institute for Social Research, University of Michigan, ISBN 978-0-9828418-1-5, Library of Congress Control Number: 2010937486 2011, pp.163-194.

[14] Christof Ebert, "Collaboration Tools for Global Software Engineering", IEEE SOFTWARE by the IEEE Computer Society, March/April 2010

[15] Marczak, Treude, Filho, Steffens, Singer, Redmiles, "Studying Gamification as a Collaboration Motivator for Virtual Software Teams: Social Issues, Cultural Issues, and Research Methods" CSCW '15 Companion, Mar. 14–18, 2015, Vancouver, BC, Canada. ACM

[16] Wikipedia, "Hofstede's cultural dimensions theory", (2016) https://en.wikipedia.org/wiki/Hofstede%27s_cultural_dimensions_theory

[17] Geert Hofstede, "Cultural Dimensions", (2010), https://geert-hofstede.com/countries.html

[18] Erica Sahlgren, Kendra Knorst, "Culture's impact on gamification", 2016 ,Linköping University | Department of Management and Engineering, ISRN-number: LIU-IEI-FIL-G--16/01497—SE

[19] Rilla Khaled, "It's Not Just Whether You Win or Lose: Thoughts on Gamification and Culture", CHI 2011, May 7–12, 2011, Vancouver, BC, Canada. ACM 978-1-4503-0268-5/11/05.

[20] Csikszentmihalyi, M, "Flow and the Psychology of Discovery and Invention". Harper, Perennial, New York (1997)

[21] Enterprise Gamification Wiki, "Flow theory", (2015), http://www.enterprise-gamification.com/mediawiki/index.php?title=Flow-theory

[22] Rowan Hevesi, "Flow and Self-determination theory: Toward a conceptual understanding of dynamics in relation to individuals' optimal experience", 12018677, U24171, Qualitative Methods in Psychology

[23] Ryan, R. M., & Deci, E. L., "Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being", (2000), American Psychologist, 55, 68–78.

[24] Lei Shi, and Alexandra I. Cristea, "Motivational Gamification Strategies Rooted in Self-Determination Theory for Social Adaptive E-Learning", The University of Warwick, Coventry, CV4 7AL, UK, DOI: 10.1007/978-3-319-39583-8_32, In book: Intelligent Tutoring Systems, pp.294-300

[25] Chau, P. Y. K., "Influence of computer attitude and self-efficacy on IT usage behaviour", (2001), Journal of End User Computing, 13(1), 26–33.

[26] Roca, J. C., & Gagné, M., "Understanding e-learning continuance intention in the workplace: A self-determination theory perspective", (2008), Computers in Human Behavior, 24, 1585–1604.

[27] Hsu, M., & Chiu, C., "Internet self-efficacy and electronic service acceptance", (2004a), Decision Support Systems, 38, 369–381.

[28] Moon, J. W., & Kim, Y. G., "Extending the TAM for a World-Wide-Web context", (2001), Information and Management, 38(4), 217–230.

[29] Venkatesh, V., "Creation of favourable user perceptions: Exploring the role of intrinsic motivation", (1999), MIS Quarterly, 23(2), 239–260.

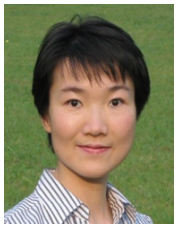
[30] Florian Brühlmann, "Gamification From the Perspective of Self-Determination Theory and Flow, Research Gate", 2013, DOI: 10.13140/RG.2.1.1181.8080

[31] CopyKowal, J., & Fortier, M. S., "Motivational determinants of flow: Contributions from self-determination theory", (1999), The Journal of Social Psychology, 139(3), 355–368.

[32] Anja Van den Broeck1, Maarten Vansteenkiste, Hans De Witte, Bart Soenens and Willy Lens, "Capturing autonomy, competence, and relatedness at work: Construction and initial validation of the Work-related Basic Need Satisfaction scale", Journal of Occupational and Organizational Psychology (2010), 83, 981–1002, 2010 The British Psychological Society

AUTHORS

Isaac Chow https://www.linkedin.com/in/isaac-chow-1aa398b Isaac got his B.S. and M.S. in CS at the University of North Texas in mid 1980's. Isaac went to teach in Southwestern Oklahoma State University as a computer science instructor from 1985 to 1989. Isaac worked for Texas Instruments as a programmer analyst for three years working on ainframe MVS system. He worked for AT&T for 10 years as a Senior Technical Staff Member and Computer Sciences Corporation for 3 years as a Computer Scientist. He worked on Internet based multi-platform systems using MVS, Unix, C/C++, Java, Sybase, and received the Circle of Excellence award. Isaac currently works for XO Communications on developing intranet applications using SharePoint, ASP .net, and c#. Isaac has worked on the Microsoft SharePoint and used it as a collaboration tool for many years. Isaac is a doctoral student in software engineering at SMU and will graduate in May 2017. He plans to contribute to the academic community through research and with his intensive software experience.



Dr. LiGuo Huang http://lyle.smu.edu/~lghuang/ Dr. LiGuo Huang Associate Professor, Department of Computer Science and Engineering at the Southern Methodist University (SMU), Dallas, TX, USA. She received both her Ph.D. and M.S. from the Computer Science Department and Center for Systems and Software Engineering (CSSE) at the University of Southern California (USC). Her current research focuses on mining and learning from systems and software engineering repositories, software quality assurance and information dependability, process modelling, simulation and improvement, stakeholder/value-based software engineering, and software metrics. Her research has been supported by NSF, US Department of Defense (DoD) and NSA. She had been intensively involved in initiating the research on stakeholder/value-based integration of systems and software engineering and published related papers in IEEE Computer and IEEE Software.