Gamified Approach to Database Normalization

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ABSTRACT

This paper explores how gamification can be applied in learning the normalization concepts in database. Modeling the concept with game challenges improves the learning. The model consists of different levels; each level corresponding to a normal form. The levels are further divided into stages. On crossing each stage, the student (player) would get points depending on the difficulty level. The gamification provides positive effect; however, the effects are greatly dependent on the context in which the gamification is being implemented, as well as on the users using it. A good database design depends on tools required to minimize redundancy and anomalies, preserve known functional dependencies, prevent spurious information from emerging, and identifying keys. This proposed model will make learning normalization more interactive and easier.

General Terms

Database Normalization, Gamification in education, Virtual Learning Environments, game mechanic

Keywords

Gamification, Normalization, E-learning, database normal forms, computer education

1. INTRODUCTION

Games and game-like elements have begun to invade the real world. Gamification is the use of game thinking, game mechanics, game dynamics and frameworks in a non-game context in order to engage users, solve problems, improve user experience, and promote desired behaviours. In simpler words, gamification is simulated learning[3]. Gamification is a recently coined concept referring to design that affords gracefulness into a non-game activity. Gamification is an emerging technique that refers to the use of digital game design techniques and video game elements to solve non-game problems, such as business and social impact challenges [2]. It is applicable to a number of areas including business applications, education, training etc. The primary goals of gamification are to tap into the psychology of motivation to both improve user interaction and interest. The 'gamification' concept is increasingly taken over in business, in education, health-care and other public-good oriented professions, and, consequently, in academic research as well. This upsurge is accompanied by animated debates and blazing criticism, currently situated mainly in opinion articles and in conference venues[3]. A frequently used model for gamification is to equate an activity in the non-game context with points and have external rewards for reaching specified point thresholds. One significant problem with this model of gamification is that it can reduce the internal motivation that the user has for the activity, as it replaces internal motivation with external motivation. If, however, the game design elements can be made meaningful to the user through information, then internal motivation can be improved as there is less need to emphasize external rewards.

2. GAMIFICATION IN EDUCATION

Gamifying education can be beneficial for both learners and teachers. Intuition suggests that gamification may be able to motivate students to learn better and to care more about studies. Making the case for gamification, however, requires more than intuition. We must clearly define what is meant by gamification, evaluate it for its benefits and drawbacks, explore current implementations and future possibilities, and better understand the theoretical rationale behind gamification [5]. This will allow us to create effective interventions rather than guessing in the dark by adding game elements, such as rewards, leader boards etc., in a syllabus the learning process can become a more joyful experience. Gamification gives a more dynamic character to education and promotes lifelong learning. As reported on the web site of Wired UK, this approach is being applied for example in Code academy, a social learning platform dedicated to programming [8].

In this paper we define key design goals and propose a model of a normalization aimed at computer database education, which includes (1) structure of the platform, (2) concept of gamification-driven normal forms progress, (3) basic platform functionalities, and (4) methodology of implementation [6]. A new gamifying is being developed, which will eventually serve as a proof of concept for the design proposed here. Nevertheless, conceptualizing gamification [2] in the manner presented here allows us to connect the concept to the literature on motivational affordances in IS research, and further, break down the studies reviewed herein

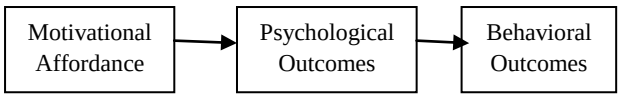

Figure 1: Gamification

3. NOMENCLATURE EQUIVALENCY OF TRADITIONAL AND GAMIFIED APPROACH FOR NORMALIZATION[2]

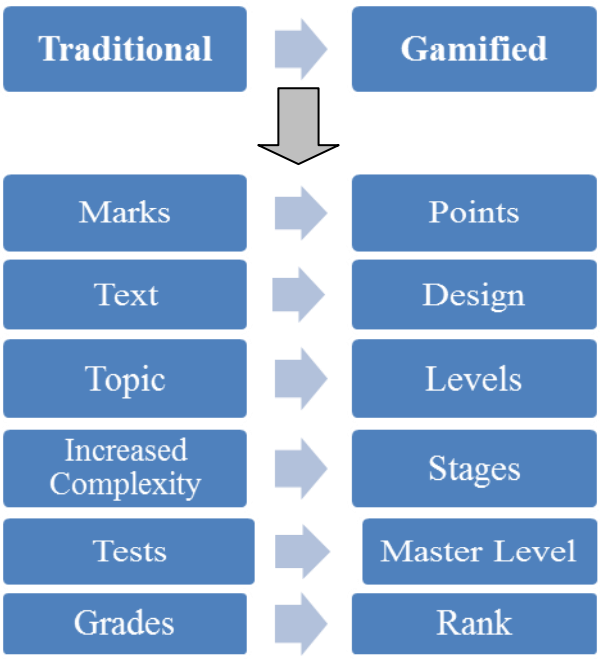

Figure 2: Traditional Vs. Gamified Model

4. PROPOSED NORMALIZATION DESIGN METHODOLOGY

According to the methodology for reaching to next level students need to complete on each preceding level by completing all the stages. Each level of game is equivalent to a normal form.

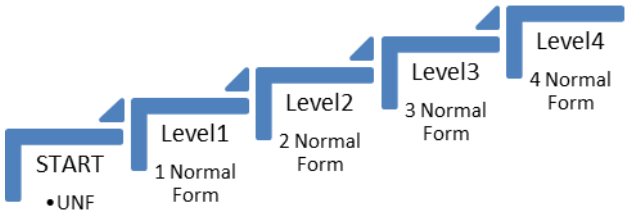

Figure 3.1: Normalization Levels

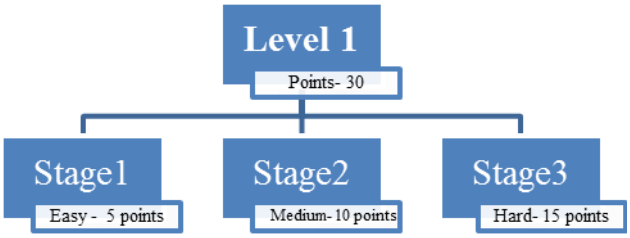

Figure 3.2: Levels into stages and associated points

Each level will have stages and each stage will have associated points. In stage-1 the relation having less redundancy will be given to play. As the stages will increase the redundancy within the levels will be increased. Once a student will complete all the stages, Level-1 will be completed [8]. If the student fails to complete any of the stages then the game will be over and the points/score will be shown to them.

5. GAMIFICATION APPROACH FOR NORMAL FORMS

5.1 Gamifying 1NF (Level 1):-

This form requires any duplication of columns in the same table to be removed. Then separate tables will be developed for each entity of related information and each identified with a primary key. A primary key is a unique identifier for each record, creating a column for your primary key helps eliminate redundancy of entities within a table. This problem can be gamified by dividing it into different stages according to the level of redundancy.

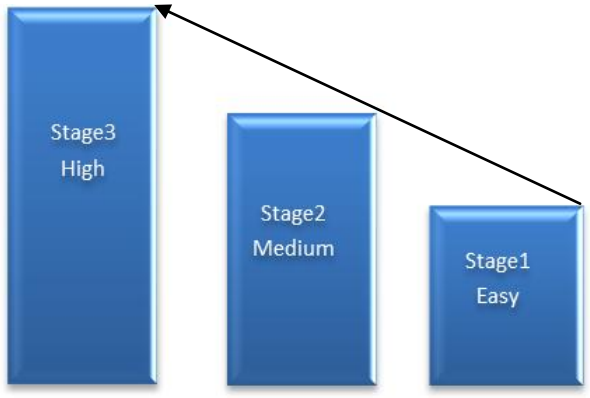

Figure 4: Different stages for Level 1

5.1.1. Stage 1: (Easy Level)

In this level students will be given generalized tables like (student, customer, order etc.) that contain less redundancy means that table can be normalized by decomposition into two tables. Consider an example of CUSTOMER relation that is in un-normalized form (contains redundancy due to multivalued attributes).

Table 1.1: Un-normalized Table Customer

Customer ID	First Name	Surname	Telephone
123	Robert	Ingram	555-861-2025
456	Jane	Wright	555-403-1659 555-776-4100
789	Maria	Fernandez	555-808-9633

Above table can be decomposed into following two tables to remove the redundancy.

Table 1.2: Customer Name

Customer ID	First Name	Surname
123	Robert	Ingram
456	Jane	Wright
789	Maria	Fernandez

Table 1.3 : Customer Telephone Number

Customer ID	**Telephone Number**
123	555-861-2025
456	555-403-1659
456	555-776-4100
789	555-808-9633

5.1.2 Stage 2: High level

In this level students will be given tables that contain more redundancy means that table need to be normalized by decomposition into at least three tables.

Example Table "Company" that is not normalized:

Table 2.1: Company table

Name	Pers. ID	Dept. No.	Dept. Name	Project No.	Project Name	Job in Project	Salary / h
A S	1	1	Europe	5,7,8	Soap, Pasta, Olive Oil	Analysis, Leader, Marketing	13,18,15
S K	1	2	USA	5,8	Soap, Olive Oil	Leader, Leader	18,18

Table 2.2: Employees table

Name	Pers. ID	Dept. No.	Dept. Name
A S	1	1	Europe
S K	1	2	USA

Table 2.3: Projects table

Project No.	Project Name
5	Soap
7	Pasta
8	Olive Oil

Table 2.4: Project Assignment

Project No.	Pers. ID	Dept. No.	Job in Project	Salary/h
5	1	1	Analysis	13
5	1	2	Leader	18
7	1	1	Leader	18
8	1	1	Marketing	15
8	1	2	Leader	18

Thus in company table the level of redundancy is high and require more effort of student. So the points /score for successful decomposition will be high (like 10 points).Once all the stages of Level 1 will be completed student will be moved to next level 2.

5.2 Gamifying 2NF (Level 2):-

Please In 2NF no non-prime attribute should be functionally dependent on a part of a candidate key that means we have to remove any of the partial dependency. So to gamify the 2NF we need to perform following steps.

i. First student need to identify the candidate (or primary) keys.

ii. Once the candidate keys are known then table will be decomposed.

iii. In decomposition student need to conform that one decomposed tables must include primary key and attributes that are fully functional dependent on that primary key and other decomposed table will include remaining attributes that are not dependent.

EXAMPLE: **Table 3: Sample example of Level 2 'Client Rental' Table**

Client No	PropertyNo	cName	pAddress	rentStart	rentFinish	Rent	ownerNo	oName
CR76	PG4	Akash	Jalandhar	1-Jan-14	31-Jan-15	350	CO40	Ram
CR76	PG16	Akash	Delhi	1-Feb-14	1-Mar-14	450	CO50	Mohan
CR56	PG4	Nikhil	Jalandhar	1-Feb-13	31-Mar-13	350	CO40	Ram
CR56	PG36	Nikhil	Ludhiana	1-Mar-13	1-May-13	375	CO50	Mohan
CR56	PG16	Nikhil	Delhi	1-Apr-14	1-May-13	450	CO50	Mohan

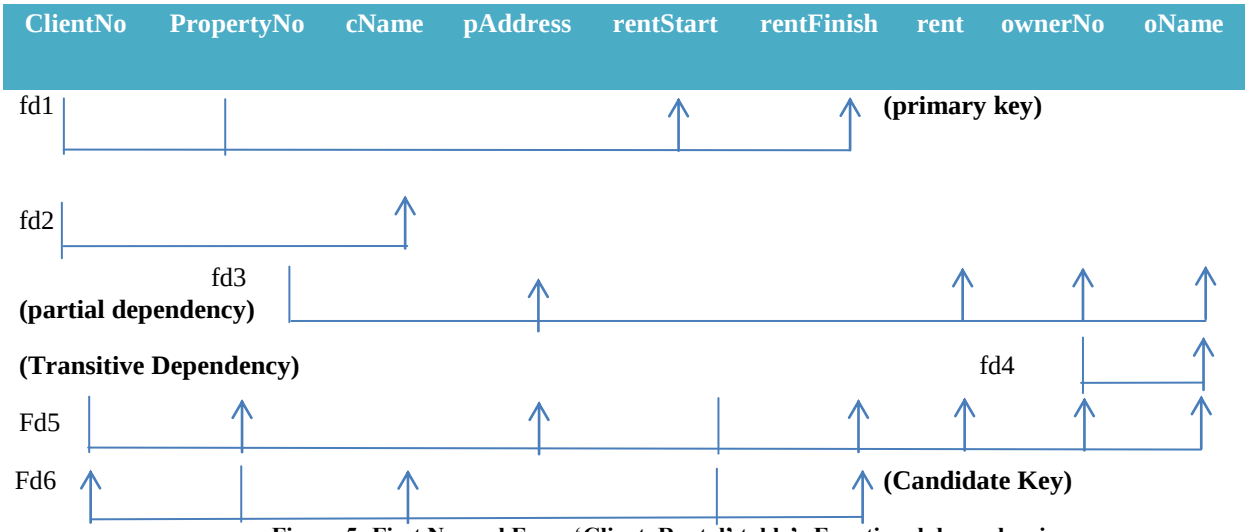

Figure 5: First Normal Form 'Client_Rental' table's Functional dependencies

After the decomposition through 2NF the **ClientRental' table** have the following tables: - Client (clientNo, cName), Rental (clientNo, propertyNo, rentStart, rentFinish) ,PropertyOwner (propertyNo, pAddress, rent, ownerNo, oName)

Table 3.1: Client

Client No	cName
CR76	Akash
CR56	Nikhil

Table 3.2: Property Owner

PropertyNo	pAddress	Rent	OwnerNo	oName
PG4	Jalandhar	350	CO40	Ram
PG16	Delhi	450	CO50	Mohan
PG36	Ludhiana	375	CO50	Mohan

Table 3.3: Rental

lientNo	PropertyNo	RentStart	RentFinish
CR76	PG4	1-Jan-14	31-Jan-15
CR76	PG16	1-Feb-14	1-Mar-14
CR56	PG4	1-Feb-13	31-Mar-13
CR56	PG36	1-Mar-13	1-May-13
CR56	PG16	1-Apr-14	1-May-13

5.3 Gamifying 3NF (Level 3):-

In 3NF, no non-prime attribute should be functionally dependent on a set of non-prime attributes[6]. So we have to remove the transitive dependency among the attributes. To gamify the 3NF we need to perform following steps.

i. Provide set of functional dependency between the attribute so that transitivity dependency an easily be identified.

ii. Now with the help of FD (Functional dependency the student can decompose the table easily).

Example:

In above ClientRental' table after 2NF to transform the PropertyOwner relation into 3NF we must first remove this transitive dependency by creating two new relations called PropertyForRent and Owner. The new relations have the form**.**

Table 4.1 Property for Rent

PropertyNo	pAddress	rent	ownerNo
PG4	Jalandhar	350	CO40
PG16	Delhi	450	CO50
PG36	Ludhiana	375	CO50

Table 4.2: Owner 1

OwnerNo	oName
CO40	Ram
CO50	Mohan

3NF: Decomposition of Property_Owner table

5.4 Gamifying 4NF (Level 4)

In 4NF we have to remove multi-valued dependencies in tables, so user first need to identify multivalued dependency in given table and then decompose it.

Table 4.3: Example of 4NF

Table that is 3NF but not in 4NF		
Car	**Color**	**Engine**
Mustang	Red	F3.2L
Mustang	Red	F4.5L
Mustang	White	F4.5L
Mustang	Blue	F4.5L
Cirrus	Red	C2.1L
Cirrus	Red	C3.0L
Cirrus	Green	C2.1L
Cirrus	Green	C3.0L

The primary identifier is [Car, Color, and Engine]. None of the attributes are dependent on any of the other attributes — thus, there is no partial key dependency or transitive dependency. The MVDs (multi-valued dependencies) in this case can be fixed by breaking up the original table into two tables

Table 4.4: Car color table

Tables that are in 4NF	
Car color table	
Car	**Color**
Mustang	Red
Mustang	White
Mustang	Blue
Cirrus	Red
Cirrus	Green

Table 4.5: Car Engine table

Car engine table	
Car	**Engine**
Mustang	F3.2L
Mustang	F4.5L
Cirrus	C2.1L
Cirrus	C3.0L

6. GAMIFIED EVALUATION – IMMEDIATE RESULTS

Evaluation will be done stage by stage and on the completion of the level. The evaluation of the each stage will be based on work done by each student at different stages. For correct evaluation of each set of relation given to the students a predefined normalized form will be used to compare the both form will be used to compare the both values [6]. At beginning the user will be given choice to selection the type of database they want to play for example Student, Customer, Employees, and Sales etc.

Table 5.1: UN Normalized Table

Column1	Column2	Column3	Column4
…..	……	……..…	…
……	……	……	……
….	……	……	……

If the decomposition of this relation consists of following relations then evaluation will be based on the attributes selected by the student that will be compared with the available original decomposition of table.

Table 5.2: Normalized Form 1

Column1	Column2	Column3
……	…….	…….
…….	…….	…….
…….	…….	…….

Table 5.3: Normalized Form 2

Column1	Column4
…….	…….
…….	…….

If the attributes are matched then the points to the students will be given based on difficulty level of each stage.

7. FUTURE SCOPE

The next step of our research will be to test how the platform works in a real educational environment. The proposed model for the normalization can be implemented by using a high level language. So as a future work we have to design new methods to automate the normalization with different levels, and also develop the tools to enable them to create and modify the gamified learning experiences easily, making the underlying technological infrastructure transparent. Unsupervised scoring/Points systems (Goldberg & Song, 2004) may also be an interesting solution to this problem, and response-driven feedback approaches (Fernandez Aleman, Palmer-Brown & Jayne, 2011) can help us to produce meaningful and rapid feedback

Furthermore this model can be enhanced for advanced normal forms like BCNF, 5NF etc. to nomalize them using gamification.

8. CONCLUSION

The model proposed here for the normalization using gamification is one of the modern concepts. It aims not only to improve student motivation but also encourage them to participate in various activities of learning, they could otherwise neglect, like learning from instructional materials, practicing coding, taking part in database competitions and help them to learn normalization with fun.

This study also suggests that evening out challenge distribution over the term and making them fairly rewarded might significantly improve student participation and performance rather than learning normalization concepts from books. Students seem to score better with the gamified version of the concept and grade differences between them seem to decrease. For future work we would like to further study the impact of our approach over student outcomes and perform a formal engagement evaluation.

9. ACKNOWLEDGMENTS

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