Evaluating Gamification features in Mastery Grid

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1   Abstract

Open learner model has become so popular in recent years, as it provides additional tools to create the self-study and self-regulation behavior in students. In this model, all the efforts have been done toward motivating students to study, so their level of knowledge will be directly relevant to how they put efforts on learning something and correct mistakes they have made. Mastery grid is one of the successful implementation of open learner model which allows students to see their progress compare to their past attempts to solve the problems included questions and examples in each topic. Task recommender is one of the newest features of Mastery Grid which suggests the best next action based on the past records of the student. The evaluation of the algorithm behind this recommender system cannot be done perfectly due to these recommended activities are ignored by some of the students. In this project, to stimulate the student to click more on suggested activities, we provide some gamification techniques such as achievement badges. These badges will be given to students according to how many points they can collect from our point system. Finally, by collecting the data from each student's profile at the end of one semester as well as data from same class in previous semesters without this tool we will assess how much this gamification tool is productive and how much it makes the Mastery Grid more interactive.

2   Introduction

Recommender Systems have become so increasingly popular in recent year. Its usage can be extended into majority number of areas including medical, education, social tags, etc. Recommender systems are typically produce the new content in one of two ways, through Collaborative Filtering or through Content-based Filtering. The later one also known as personality-based approach which tried to recommend new objects based on the history of behavior of one person. In Education area, this way of recommending is popular due to the various personality each student has shown.

Mastery grid is one of the successful example of Intelligent Torturing System which provide content with the aim of visualizing the progression of students given resources, examples, coding and challenges in each topic of Java programming. In Mastery Grid, each cell represents the list of activities the learner has done on a specific topic. By clicking on cells, students can see their progress in each sub-topic. Then, learners can click on single activities to open the new window which shows Example, Challenge or coding (based on learner's choice) content. The aim of this method is to recommend students a set of most relevant activities derived from our knowledge about that specific student. Students can read some code and description of each line of code. Afterwards, when they find themselves ready, they enter a challenging section and asked to complete the blank parts of the code. Whatever they are successful or fail they can still read the explanation of their wrong or right choice. For approaching this purpose,

they add a new feature to Mastery Grid which is little star symbol at the up-left corner of the cell to show that this content recommends to them .
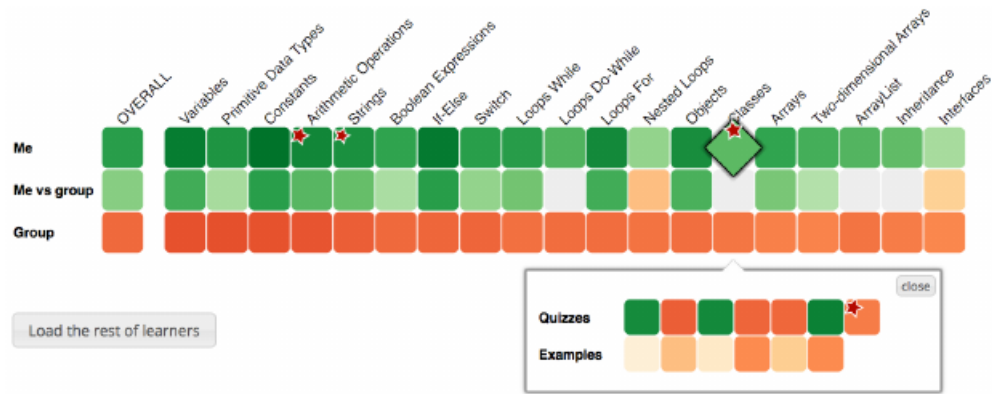

Figure 1: Stars that appear on recommended activities

3   Problem we have

For whole one semester, this feature added to mastery grid to see how many students would notice these star symbols and the results showed that this feature was ignored by some students more often. So, evaluating the example-based solving problem idea become hard due to the lack of data. consequently, to stir up learner to be more aware of marked examples, we encourage to add other features to Mastery Grid. Thus, the idea of using Gamification may be helpful.

3.1   Gamification

Digital Gaming has gained much attention in recent years and the age range of players become less and less in proportion of accessibility to smart devices. While growing the number of researches experimenting with game-play, there also has been increased attention to Gamification a new way of representing hard concepts, motivate people to engage more in non-game contexts and incite their intentions to achieve goals using game dynamics.

The primary advantages provided by Gamification to is make learner engage to system voluntary and this can only happen if this system become part of their culture and habit. Afterward, we would expect that user may use our system regularly and return to system by their own choice. so, Learner can leverage their knowledge and skills concurrent with hooking by fun.

Psychology behind Gamification is that, your body releases dopamine when you experience pleasure. This pleasure includes all kinds of things, including rewards. The more goals you achieve, the more dopamine it releases, and the easier it is to stay motivated. Gamification tries to tap into this by offering you

rewards for the completion of small goals. Gamification is just a means to set goals and track your progress for achieving them., but gamification still mostly relies on our own ambitions.

Moreover, tons of theories exist about what motivates us, but Scientific American breaks it down into three basic elements:

Autonomy: You gain motivation when you're in charge. When you feel like you're in charge, you tend to stick to your goals for a longer period.

Value: You're more motivated when you value a subject. If you think a goal is important there's a better chance, you'll complete it.

Competence: The better you get at something, the more likely it is you'll continue doing it. Likewise, when you know that something takes hard work as opposed to some innate talent, you're more likely to keep trying at it.

Beside all the things mentioned about the effectiveness of Gamification, resent researches find some restrictions of this method. Dominguez et al. (2013) claim that although using gamification seems to have potential to motivate and encourage learners, it is not trivial to get desired effects and it will need a tremendous effort on establishing such a system. So, we need to create a framework with enough quality to attract learners. In the case of gamification, context matters. No evidence shows that gamification could motivate someone to do something they don't want to, and there isn't enough research into the effect of actual game design on the outcome. Likewise, gamification seems to work best in helping with short term and smaller goals. If you aren't motivated, gamification won't get you in shape or lose weight, make you more productive, or make you a better person. However, it can add to an existing foundation that could help you get there if you want it to.

Based on Auvinen, Hakulinen, and Malmi, (2015) each learner responds to these Badges based on their intention named as Goal Orientation and they categorized them into five group: Mastery-intrinsic, Mastery-extrinsic, Performance-approach, Performance-avoidance, and Avoidance. Their results show that students' interest toward badges was totally matched with Mastery-extrinsic orientation and that because of the nature of badges which are the exterior indicators of learner's performance.

4 Implemented System

4.1 Point System

To design these badges, we need to create a system to handle the score of each learner. For example, click on each component or cell give various point to learner. Based on the value of each click the student can get one of these points $(+6, +4, +2, +1)$. We don't consider the negative point in our system since we anticipate that it may decrease the eagerness of learners. In addition, three prioritized activities are chosen in each topic by our recommender system. Its ordered can be identified by their scored and bolded star symbol on upper right

of cell $(+6, +4, +2)$. For showing the importance of reading the description of each line in Examples, $+1$-point assign to clicking of example-lines for first time.

Your Score: 217

5 Recent Points:

+1 Challenge Solved!

+1 Example Line Clicked.

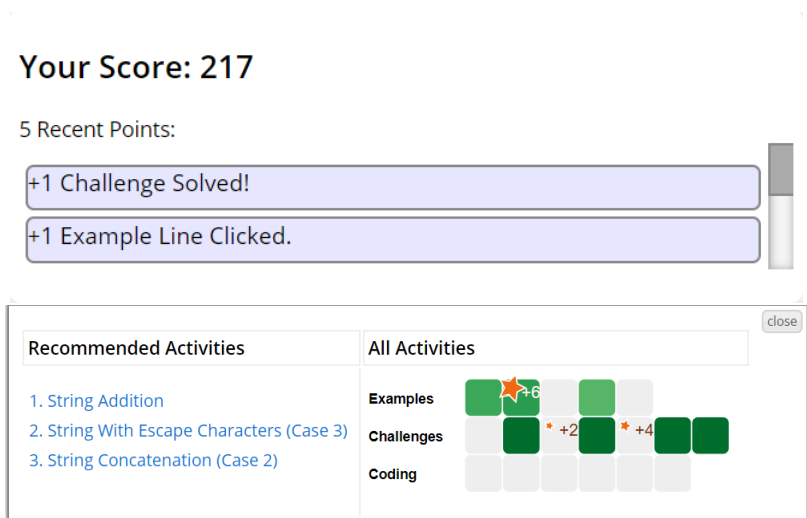| Recommended Activities	All Activities
1. String Addition	Examples
2. String With Escape Characters (Case 3)	Challenges
3. String Concatenation (Case 2)	Coding

Figure 2: above figure shows the list of recent points user has got and the below image shows the three most recommended activity on each topic

4.2 Achievement Badges

Mastery Grid is the profile-based system which required learners to sign in first and then proceed to other sections. Our approach is to add some components to Mastery grid to let the learners know about their points and their badges that they have got so far. At this step, we only give the learners points based on their clicks on where we want them to, so we evaluate their performance by the total point they will get. As mentioned before, we do not have negative points, so the learner's point always rises. There are four sets of badges:
1- Recommended Badges 2- Example badges 3- Challenge badges 4- Coding Badges And player can get each of these badges after solving respective activity.

5 Dataset

For evaluating our proposed tool for mastery grid, there are 3 datasets that we can get the summary report for the usage of the system.
System with Gamification: INFSCI17Spring2018 dataset - mostly 18 out of 50 students use this system. We also know the time of Midterm and final exam of this course which are respectively March 12 -March 19 (weeklong take home

Figure 3: List of all categorized Badges

exam) and April 23.

Baseline Systems: 1- CIS220Spring2018 dataset: This class was intermediate Java class, has recommendation, but no gamification features 2- INFSCIFall2017 dataset: This class had a similar cohort to INFSCI17Spring2018, did not have recommendation, no gamification features. The final exam was on Dec. 7, 2017.

6 Analyzed Data

One of the parameter that we could measure to evaluate the effective of gamification in our system is to calculate the total time they spend working with Mastery Grid. The other parameter can be a number session they had during one slice of time. Also, regarding the main purpose of implementing this extension, the number of recommended activities they've done will be informative. Generally, we called these parameters as System Usage.5

Analyzing data can be done for whole class during 1 semester and calculate the average behavior changing for three different classes we already had, we will call this analysis, Accumulated Analysis. The data can be interpreted for each student in various time slots to see how gamification change the behavior of that person and we call this Individual Analysis.

The ideal usage of system regard to the time would be: the highest amount of rising at the beginning then a sharp drop in the usage. After that we expected to have rise but not as much as beginning and then the usage become approximate steady.

As can be seen in Table 1 the average of system usage in whole semester with respect to the Mastery grid time duration or the number of session they had or even the number of attempts they had to solve the example significantly increased.

Also for analyzing the individual behaviour to see whether they, we choose the *Total time they spend in Mastery grid* as variable and separate it into different
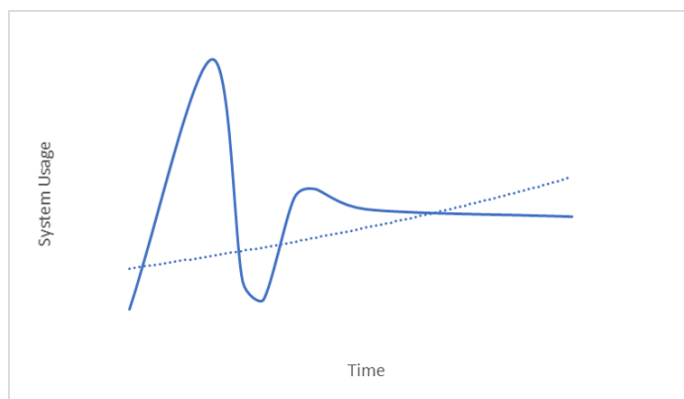
Figure 4: this plot shows the expected behaviour from user in using system during the time
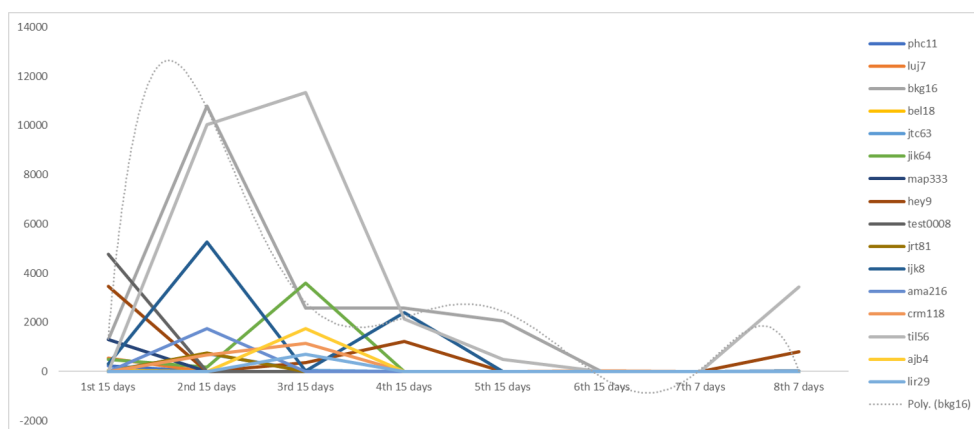

Figure 5: this plot shows each student's time spend in mastery grid in different time interval. The dotted plot also shows the polynomial equivalent of all students.

time slots(15 days) and create a plot for each student. Figure 5, shows the plot. It Also can be seen there is an extra dotted plot which represent the polynomial equivalent of all students in each time interval.

The similarity between this plot and the behavioural expectation plot shows that the gamification feature can motivate student to use the system better at least for short period of them. Moreover, to interpret the behavior. if we consider the time of Midterm and final exam which student wants system to learn the things more than any other time, our results also shows the same. The results also shows that the student are more curious to get points and badges at the initial steps and by the time pass, because these two features are not the long-term

System Usage Measures	INFSCI17Spring2018	CIS220Spring2018
Number of sessions	**6**	4.23
Median of number of activities in session	**14.5**	8.63
AMedian of time spent in a session (second)	**984**	694
Median of assessment activities done (challenges, coding exercises) in a session	**8.5**	7.8
Median of example lines clicked in a session	**62**	5.3
Topics covered	2.6	**3.6**
Total time they spend in Mastery grid	**4741**	2124
pcex topics covered	**2.5**	1.44
example lines actions	**148.5**	58
pcex success first attempt	**5.83**	1.97
pcex success second attempt	**2.83**	1.75
pcex success third attempt	**1.3**	0.92
total durationseconds	**7552**	4082
pcex example durationseconds	**240.3**	56.91

Table 1: System usage measures for two classes with Gamification Difference

feed back, they effect on student behavior are not sustain for long period of time.

7   Conclusion

In this project, we tried to change the interface of Mastery Grid by using gamification techniques to encourage students to click more on recommended activities. So, we create a point system to manage each student's score and give them proper badges based on that score. At the end, we evaluate these techniques by collecting each student's final system usage such as Total time they spend in Mastery Grid or the number of session they had and etc. Our results shows the positive effect on user motivation to use the system more than the class without gamification features. But as we expected, these two features of gamification has short-term effect on behavior.

8   Future Work

we can combine our results we pre and post assessment of knowledge. Doing pre
and post surveys which help to find out the psychology aspect of gamification
(which behavior our participants show) like Mastery-extrinsic or performance-
approach. As we said in results part if we other long-term approach gamification
features such as leader-board, we may keep participants to stay on our system
much longer.

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