Comparison of Task Performance with Different Entertainment Elements

Tomohiro Ichinose
Nara National College of Technology
Nara, Japan
Email: ichinose@info.nara-k.ac.jp

Hidetake Uwano
Nara National College of Technology
Nara, Japan
Email: uwano@info.nara-k.ac.jp

Abstract—This paper quantitatively compares the effectiveness of entertainment elements which enhance the workers' motivation and work performance. The authors select three entertainment elements which were used in previous studies; 1)Contest, 2)Improvement, and 3)Collection. Three systems which implements the entertainment elements were used in student experiment to measure the task performance. The result of the experiment showed that the all entertainment elements increase the task efficiency and motivation compared with non-entertainment support. Among the three elements, Contest increased the work efficiency the most, and Collection increased the work motivation the most.

I. Introduction

Ticket Tracking System (TTS) is a software system which manages tasks in a software development project as tickets. The system supports the project manager by visualizes task existence, progress, and workload estimation. Also the TTS collects task modifications caused by specification changes and/or bug detection; the manager easily grasps current status of the project. On the other hand, the system needs frequent ticket update by developers between the development tasks. From the viewpoint of developers, ticket updating is a dull management work, hence the ticket update will become inadequate and sparse. It is difficult to solve the problem by improve the work environment or by developers' re-allocation because the most of projects have only a limited budget or human resources. In recent years, the worker's motivation attracts researchers' attention in Software Engineering [1][2][3]. These articles suggest the methods that improve the quality of software and lower the costs of the production. The problem of the TTS may solve by motivating the developers.

To enhance the workers' motivation, some articles add entertainment elements into simple activities such as diet exercise, text transcription, and spreadsheet input [4][5][6]. These articles suggest that addition of the entertainment element increases the workers' motivation similar to training or environment improvement. These previous studies evaluated the effects of the entertainment with questionnaires or interviews subjectively. Also the studies evaluated the effects using a system which implemented multiple entertainment elements at once.

In this paper, we evaluate the impact of each entertainment element for workers' efficiency and motivation. We select three entertainment elements which are used in previous studies; *Contest* with others, *Improvement* from previous, and *Collection* of achievement. Each element were implemented into a different systems to compare the difference quantitatively. Result of the experiment contributes the development of the effective support system with simple (i.e. easy to develop) structure.

II. Related Research

Singer and Schneider suggest the system which encourages computer science students to make more frequent commits to version control systems by using a social software application [1]. The system generates messages that congratulate the users who achieve an enough number of commits. In the experiment, the authors found that the system inspire students to commit more frequently. In this paper, we focus on the TTS and compare the effect of entertainment elements which may motivate developers to update the ticket more frequently.

Magy et al. proposed a system "Igniteplay" which encourages users for diet by competition with others or their own best record [4]. They evaluated subjects' motivation by questionnaires based on Markland and Tobin's Exercise Motivations Inventory, and semi-structured interviews of motivations inventory [7]. They found that two types of participants: participants who liked to see how they were progressing compared to others in the community, and participants who preferred to see their progress in a noncompetitive way. However, the article did not evaluate an effect to diet itself, i.e. support target activity. Hence how the entertainment elements affects to the support target is unclear. In this paper, we evaluate how the entertainment elements increase the task performance and subjects' motivation.

"Weekend Battle" motivates workers by battle between virtual creatures which grows up based on workers' subjective workload [6]. The system has three elements of amusement from Caillois; *competition* (*Agôn*), *chance* (*Alea*) and *simulation* (*Mimicry*) [8]. Also the system implements *Collection* which is well used element in entertainment such as trading card. Evaluation showed that the system increases keystrokes speed and work efficiency by four entertainment elements. In this paper, we evaluate three entertainment elements individually to compare the difference of each elements. Support system with less entertainment elements is easy to build for developers, and easy to understand for users than system with complex entertainment element. The result of this paper is useful to build the efficient support system with simple entertainment element.

III. PREPARATION

A. Ticket Tracking System

TTS is a software system which manages tasks during a software development project as tickets. Fig. 1 shows an example of ticket. One ticket describes one task, including task status, assigned worker, deadline, priority, etc.

Fig. 2 shows a flow of task management using TTS. First, a project manager registers a task as a ticket with detailed information such as deadline, priority, and task descriptions. Then, the manager assigns the ticket to a developer. The developer implements a software based on the assigned ticket. Each task progress is reported to the manager through the ticket update, so the manager can predict a project progress and modify the schedule if needed. When the developer finishes the task, s/he updates the ticket status as "Finished" and upload products which created during the task to the system. Finally, the project manager reviews the ticket and the products, then close the ticket. In Ticket-driven development (TiDD) which manages a development process using a TTS, fine granular ticket is essential to precise estimation of the project progress and remain-workload. Also the TiDD ease the management of tasks because any modification to a software, schedules, task assignment, and detected fault is reported to the manager frequently.

On the other hand, TTS requires the developer who updates the ticket frequently. Ticket update itself does not contribute to a software development directly, therefore, some developers feel the ticket update is an unnecessary work. Also the lack of motivation for the ticket updating cause an inadequate and infrequent reporting. Some rewards for the ticket updating or re-allocation of the developers are one of the solution to enhance the workers' motivation. However, it is difficult for most of software development projects because of a limited budgets and human resources.

B. Motivation

In 16 basic desires defined by Steven, we focus three desires; 1) Saving, the need to collect, 2) Social status, the need for social standing/importance, and 3) Vengeance, the need to strike back and to compete [9]. Competition and collection, the common entertainment elements used in previous research and system to enhance the users' motivation, satisfy the three basic desire through the implemented system. Therefore, we select competition and collection as entertainment elements which evaluate in this paper. Details of two entertainment elements are explained in next section.

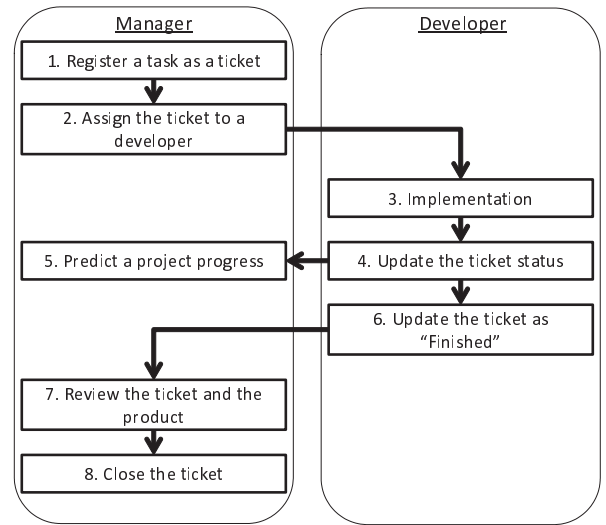

Fig. 1. Example of ticket

Fig. 2. Flow of task management

C. Entertainment Elements

1) Competition: Competition motivate workers because explicitly describe that which is better than other from particular aspects; the entertainment which includes competition satisfies workers' $Vengence$ In this paper, we separate competition in two different elements, $Contest$ and $Improvement$, based on the research by Magy et al [4].

$Contest$
>> $Contest$ is the state that the result of the support target work is opened, ranked, and compared with those of other users. The element increases the work efficiency by motivating the workers who want to win in competition with other workers.

$Improvement$
>> $Improvement$ is the state that the best result of the past own work is shown to her/himself to compare with the present result. The element increases the work efficiency by motivating the workers who want to refine their own abilities.

2) Collection: $Collection$ is the state that the workers can get achievement (fictitious medals and trophies as a prize) in proportion to their work result; acquired achievement is opened to others. The $collection$ satisfies "Saving" and "Social status" because the achievement proofs workers' ability or status. This element increases the work efficiency by motivating the workers who want to get the achievements, and boast the achievement to others. The element partly contains a elements $contest$ because the acquired achievements are showed to others. However, we treat the $Collection$ as a different element from the $Contest$ because the difference of ranking and comparison.

IV. EXPERIMENT

In the experiment, the effect of three entertainment elements for the work efficiency is compared. We give participants the simple task using the three different systems which the entertainment element is embedded (Entertainment System; ES.)
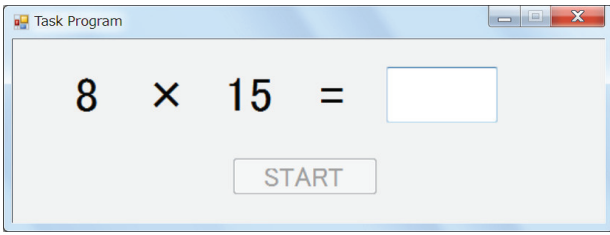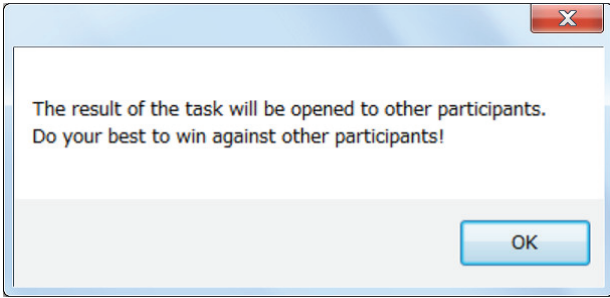
Fig. 3. Multiplication task

Fig. 4. Message of *Contest*

Fig. 5. Message before the task

Fig. 6. Message after the task

A. Task

Ticket update during the software development is our support target work. However, the task which includes the software development requires long time and the result of the experiment become the too complex to evaluation. Here, software development activity (implementation, design, debugging) is a complex and difficult work, meanwhile the ticket update is a simple, routine work. Therefore, we select the multiplication in which multiplier and multiplicand are randomly selected between one to fifteen as support target work as a task.

The task is displayed on system in which the entertainment element is embedded (Entertainment System; ES.) In each session of the experiment, the task is continuously displayed to the participant within five minutes (see Fig. 3.) If the participant's answer is correct, the next task is displayed. Each task is automatically judged as incorrect when five seconds elapsed. The participants can input an answer repeatedly within the five seconds.

B. Entertainment System

We implemented three ESs which the entertainment element is embedded individually. Each ES is a GUI program developed by C#. The length of the program is from 200 to 600 lines.

1) Contest: Our implementation for *Contest* inspires the participants to contest with others by showing a message "the result of the task will be opened to other participants" before the task. Fig. 4 shows the message on display. In the experiment, the result of task is hidden from the participants to exclude the element *Improvement*.

2) Improvement: Our implementation for *Improvement* inspires the participants to improve themselves by show the best score of previous tasks before start the task. To distinguish
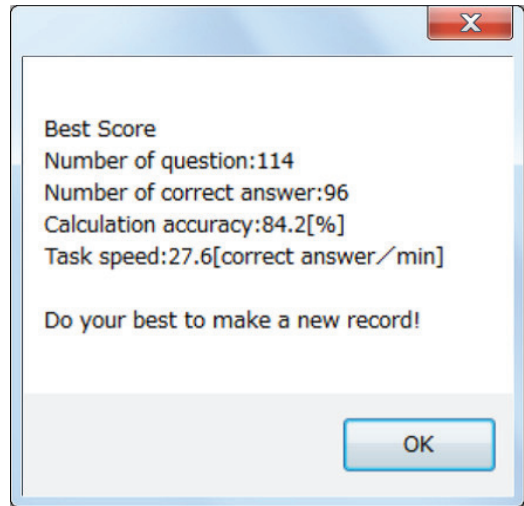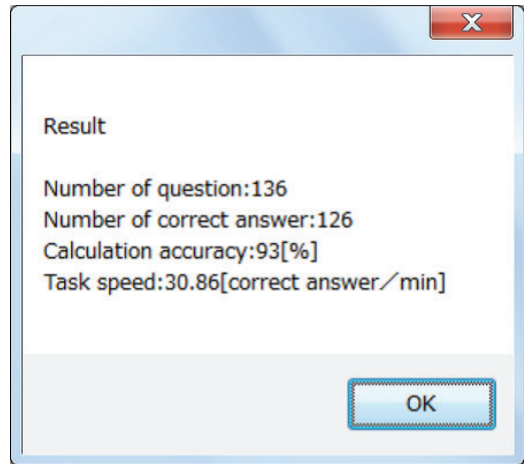
from the element *Contest*, the task results are not shown to other participants. Fig. 5 is a message displayed before the task, which shows the best score of the participant in their previous tasks. Also the message includes a text which motivates the participant to surpass their best score at a next task. Fig. 6 is a message displayed after the task, which shows the result of the task.

3) Collection: Our implementation for *Collection* inspires the participants to collect achievements. The participants can turn the panels on according to the result of the task, then acquire the achievements when the panels fulfill specific conditions. Fig. 7 shows the screenshot of the panels. The participants can turn a panel on each predetermined number of correct answers. The number of the correct answer to turn the panel on is an important variables. In this implementation, we select the number that the best performance participant can turn on the all panels. The optimum number of correct answers to open a panel is a future work. Also the implementation shows a message "the acquired achievements are to be opened to other participants" before the task.

The achievements are acquired when the number or ar-

Fig. 7.   Panels and achievements

TABLE I.   ACHIEVEMENTS

Conditions	Achievement
Turn on one panel	Bronze medal
Turn on four corners' panels	Bronze medal
Turn on five panels	Silver medal
Turn on one file of panels	Silver medal
Turn on one rank of panels	Silver medal
Turn on one oblique line of panels	Silver medal
Turn on ten panels	Gold medal
Turn on periphery of panels	Gold medal
Turn on twenty panels	Silver trophy
Turn on all panels	Gold trophy

rangement of opened panels fulfills specific conditions. The acquired achievement are displayed as medals and trophies in Fig. 7. Table I shows the list of achievement and its conditions.

C. Experimental procedure

We divide the participants into four groups at random. Each group executes five sessions of task using ESs in different order. Table II shows the order of the task for each of group. At first, all groups execute one session without ES ($Nothing$.) Second, each group performs four sessions with ESs support; $Contest$, $Improvement$, and $Collection$. The order of each ES is counter balanced. Finally, the participants answer the questionnaire about ES.

D. Metrics

Each ES measures the following metrics as a result of task during the session in the experiment.

- Number of question
- Number of correct answer

TABLE II.   ORDER OF THE TASK FOR EACH OF GROUP

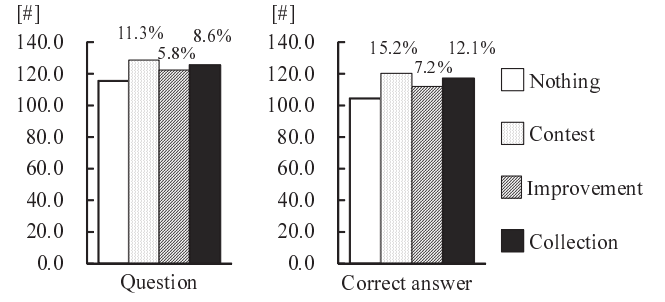| Group	ES		
	1st	2nd, 3rd	4th, 5th
C1	$Nothing$	$Contest$	$Collection$
I1	$Nothing$	$Improvement$	$Collection$
C2	$Nothing$	$Collection$	$Contest$
I2	$Nothing$	$Collection$	$Improvement$

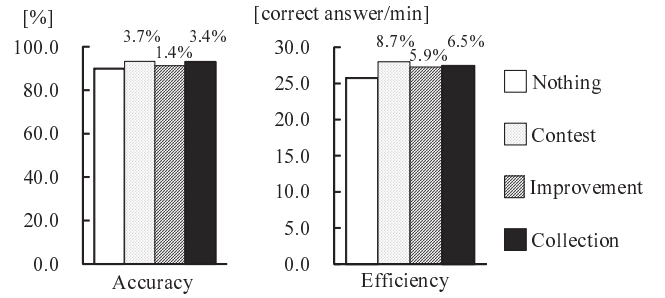Fig. 8.   The Numbers of the question and those of correct answer

Fig. 9.   Calculation accuracy and efficiency

- Accuracy[%]
- Efficiency (Number of correct answer per minute)

The accuracy and efficiency are calculated as follow:

$$Accuracy = \frac{Number\ of\ correct\ answer}{Number\ of\ question} \qquad (1)$$

$$Efficiency = \frac{Number\ of\ correct\ answer}{Total\ task\ time} \qquad (2)$$

In the questionnaire, the participants answer the following subjective evaluations with four-point Likert-scale.

- Did you feel motivated?
- Did you feel fun?
- Do you want to use the system in future?

V.   RESULT AND DISCUSSION

Fig. 8 and Fig. 9 show the results of the experiment with twelve participants from Department of Information Engineering, Nara National College of Technology. Each figure represents the average of the task result which was performed with ES respectively. The percentage above of each bar represents the relative differences with $Nothing$. These figures describe that every metrics increased at all entertainment elements as compared with $Nothing$. Especially, the $Contest$ increased the most on the all ESs at every metrics; 11.3% in the number of answer, 15.2% in the number of correct, 3.7% in accuracy, and 8.7% in task speed. On the other hand, the increase of
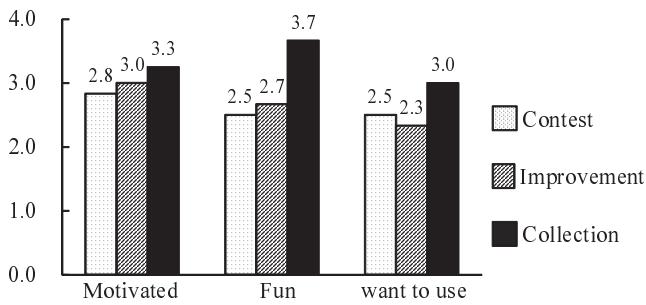
Fig. 10. Subjective evaluations

all metrics from the *Improvement* was the smallest in the ESs. Compared with other elements, *Improvement* hid the task result from other participants. The result suggests that the openness of the task result affects to the task performance.

Fig. 10 shows the result of the questionnaire for each ES. Each item that indicate more than 2.5 (median of evaluation scale) means the participants evaluated positively to the questionnaire item. Except "want to use" for *Improvement*, all subjective evaluation indicate more than 2.5 at all ESs. In particular, *Collection* had the best evaluation in all metrics; 3.3, 3.7, 3.0 respectively.

In the interview after the experiment, we received several comments to the *Collection* such as "I could challenge the task with concrete objective." Similar positive comments were observed were acquired to *Improvement* such as "I tried to get the best score during the task." The ESs with *Improvement* or *Collection* showed the task result to the subject after the task. Therefore, the participants could set their concrete objective to each task; break the current record or specific number of the metrics for example. On the other hand, the ES with *Contest* hid the result from subjects; hence the participant difficult to determine the concrete objective for the next task. The results suggest that an immediate proposition of the task result motivates the workers.

The subjective evaluation shows *Improvement* of "Motivation" and "Fun" are higher than *Contest*, however the task efficiency is became the lower than *Contest*. Subjects' comments after the task indicates that the *Improvement* reduces the motivation when the result of a current task is expected the lower score than the present best score. The result showed that although the task efficiency is enhanced by the *Improvement*, the effect is limited when the efficiency reaches the limit. The comment from the interview expresses that *Collection* entertained the subjects, such as "I enjoyed to turn the panels on because the visualization is interesting," or "I tried the tasks hard because I wanted to collect the Achievements." The ES with *Collection* visualizes the number of the task completion as medals and trophies, so it is assumed that the participants were motivated than *Contest* and *Improvement* which show the score or message by texts. It is also considered that the motivation is enhanced at *Contest* and *Improvement* to show the result of task visually with pictures and tables.

In the experiment, the *Collection* increased the motivation the most in the three ESs. In contrary, the *Contest* increased the task efficiency the most. The result means the enhancement

of the workers' motivation is not inevitable factor to increase the task efficiency. More detailed analysis is required to understand the relationship about work motivation and performance.

VI. CONCLUSION

In this paper, the authors developed the system which motivated the participants to perform the simple task, and measured the task performance difference with support of three entertainment elements, *Contest, Improvement*, and *Collection*. The result of the student experiment showed that all three entertainment elements increased the work motivation and efficiency compared with non-entertainment support. Among the three entertainment elements, *Contest* increased the work efficiency the most, and *Collection* increased the work motivation the most.

The authors supposed a TiDD-based software development process, which divides the task into fine-graded (i.e. a many of) tickets as a support target. In the TiDD-based software development process, update of the ticket is a frequent, dreary task to software developers. The results of the paper shows that the apply of the entertainment elements into the TTS assists the developer to frequent ticket update. Also the other management system is a good target to support by entertainment elements.

In the experiment of this paper, we used a simple multiplication task instead of a ticket update task as a support target task. As a future work, we plan the experiment with ticket update task on the TTS that implements the entertainment element. Also comparison of the effect of the entertainment elements with other incentives such as financial rewards is an interesting research.

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