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Poster Proceedings

Preface

This volume contains the paper abstracts of the posters presented at the 25th International Conference on Collaboration Technologies and Social Computing, CollabTech 2019. The conference was held during September 4-6, 2019, in Kyoto, Japan.

The aim of the poster session was to provide an opportunity for poster presenters to present late-breaking research results, ongoing research projects, and speculative or innovative work in progress in more casual and interactive way. Overall, nine posters were accepted and appear in the poster proceedings. We hope that the poster session of CollabTech 2019 provides a great opportunity for researchers to present and to receive direct feedback from the audience as well as to gain visibility for ongoing significant work.

As conference and program chairs, we would like to thank the authors of all CollabTech 2019 poster submissions and everyone who contributed to making CollabTech 2019 possible.

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Group Formation and Grading in Learning Analytics Platform

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Abstract. The paper introduces a system for collaborative learning that helps teachers to form and grade groups. The data sources for group formation come from the Moodle learning management system and from learning logs. The main components of the system are the group formation parameter console where teachers choose group formation input variables and a grouping algorithm, and the page where formed groups are visualized and can be graded in multiple dimensions. The group formation and grading system is an extension of a learning analytics platform and provides an infrastructure for conducting collaborative learning activities.

Keywords: Collaborative Learning, Group Formation, Learning Analytics.

1 Introduction

In collaborative learning students work together to complete a task or to reach a group goal. Students leverage on each other's expertise and engage in joint discussion and argumentation processes dealing with misconceptions and advancing to the final solution[2]. By employing collaboration in the educational process social skills and sense of belonging can be fostered [6].

In this paper, we introduce a collaborative learning system that enables teachers to form groups based on learning log data and grade the groups' performance. The system also contributes to the learning analytics platform by accumulating group performance data thus supporting further learning analytics-based services. Visualization support provides teachers with the means of making informed decisions on structuring group work activities.

2 Group Formation and Grading System Design

The Group Formation and Grading System modules are extensions of the Dashboard application, a central component in the learning analytics platform described in this paper [4]. As illustrated in Fig. 1, learning data is collected from the BookRoll system [3, 5], organized into a student model [1] and stored into an analysis database. The

group formation system uses the data to generate groups. Accumulated group performance data can be used to update the learner model for further learning analytics use.

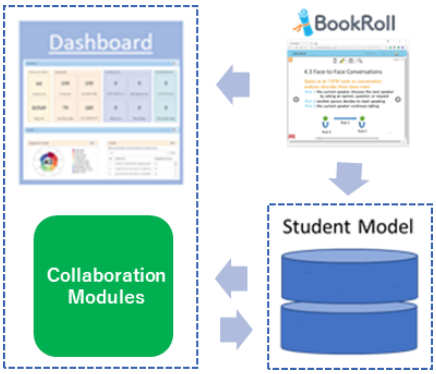

Fig. 1. The main learning analytics components including the group formation module

Fig. 2 presents the process of group formation. The system automatically gets the user model of students including the course and performance data coming from the Moodle LMS platform. The teacher then uses the group formation parameter console to set the group formation parameters. Tables 1 2 list the grouping algorithms and grouping variables available.

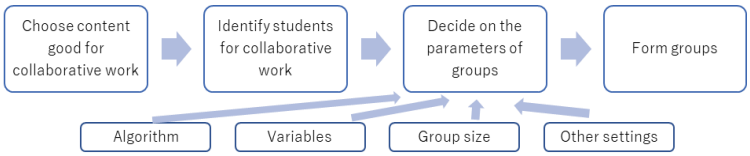

Fig. 2. Process of group formation

Table 1. Algorithms used in the group formation process

Algorithm	Algorithm Operation Description
Homogenous	The algorithm groups students with similar values of a variable.
Heterogenous	The algorithm groups students with differing values of variables.
Friendship	The algorithm groups students who are friends as identified by the teacher.
Random	The algorithm groups students randomly.

Following the group formation process, teachers can view the created groups and evaluate group performance. Three rating dimensions are provided:

1. *Collaboration Quality* - focuses on interaction and communication in group work.
2. *Speed / Efficiency* - evaluates if group work was executed in a timely manner.
3. *Performance* - focuses on the result and outputs of group work.

With the data increasing across the group rating dimensions, the group score user model variable will reflect the group work ability more accurately.

Table 2. Variables used in the group formation process

Variable	Variable Explanation
Engagement	The variable records the time student spent on using the learning platform.
Reading style	The variable models two reading styles: receptive reading and responsive reading. The former refers to the style of reading page after page sequentially and the latter deals with students engaging in more interaction with the digital material (taking notes and posting comments).
Concept	The variable describes the mastery of each key concept found in academic materials of a course.
Score	The variable records store previous assessment scores.
Group score	The variable models students' previous performance of in group, gathered as part of group grading.

3 Group Formation and Grading System Implementation

The collaboration module is constructed and integrated into the system dashboard so that the teachers can choose parameters for group formation. (Fig. 3).

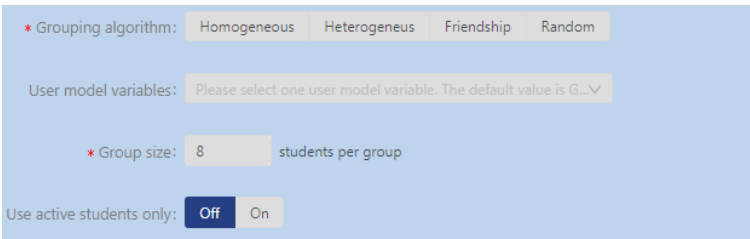

Fig. 3. Parameter setting page for the group formation

Fig. 4. Result of group formation (three groups of 4 students) and the indication of individual and group-level collaboration performance

Fig. 4 shows the results of a homogeneous grouping with group size of 4. The teacher is provided with an indication of the individual and group performance using red, yellow and green colors indicators. The color of the group card header indicates average group score and the previous groupwork performance.

4 Conclusions and Future Work

The presented system is an extension of the learning analytics platform and is used to assist teachers in group formation in their collaborative class activities. Future work will examine the ways of evaluating group performance since social loafing and free-riding remain challenging problems in collaborative learning. Secondly, the role and importance of individual and group scores needs to be reflected upon. Finally, grouping goals variable will be introduced to suggest the algorithm for group formation depending on group formation purpose.

Acknowledgements

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Exploring High School Students' Collaborative Learning Experiences in Workplace English with Virtual Reality

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Abstract. Virtual Reality has been used extensively in digital learning. However, concerns over its high cost and technology threshold have driven the present research to opt for VR photography as a low-cost alternative for students to simulate their future workplaces based on situational learning. The present research features panoramic images from VR photography in a simulation of the workplace where high school students at the department of automobiles might be employed post-graduation. The VR photography simulation also featured workplace English as a learning goal for student participants. The present research involved a total of 53 students at the department of automobiles in a private vocational high school in Taiwan and aimed to explore their collaborative learning experience in the proposed model of digital learning. The results have shown positive attitudes and perceptions as well as a high level of satisfaction among student participants for the proposed digital learning model, where they get to experience virtual workplace through VR. The proposed model increased learning motivation among students and raised its own prospects among them to be further applied to other aspects of their learning. It also enhanced the use of the following three learning strategies, which include concrete imaging, note taking, and drills, among student participants. Results of the present research may inform teachers in various fields and the authority about relevant implications on their teaching and prospective research projects.

Keywords: situational learning, virtual reality, panoramic image, collaborative learning

1. Introduction

Though Virtual Reality (VR) has been widely used and well received among various fields of education [1], however, it raises many other issues, including costs, technology threshold, concerns over user-friendliness, and failure of keeping the actual represented setting up to the authenticity of a real one. The introduction of a 360 degree circle in this case provides an ideal alternative that is cost efficient, saves space, portable, can be easily assembled [2], and affords real-time presence. Also, its post-production process can be handled without prior knowledge of its operation and, thus, giving out authentic representation of a real setting for learners without burdening the instructor in class [3].

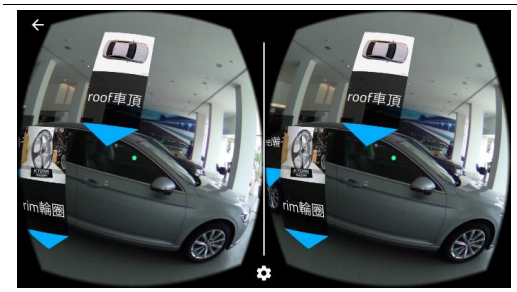
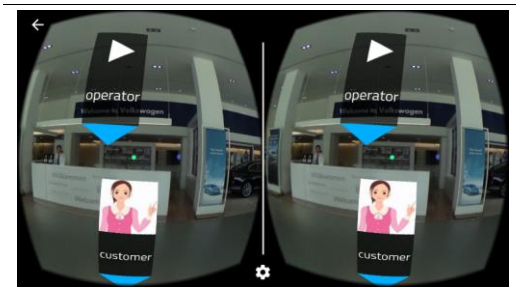
Situational learning calls for interaction between learners and the real setting in which learning takes place. Such interaction is based on authentic activity through which students form a complete system of knowledge [4] and interact with the real setting as a way to understand knowledge. However, a persistent lack of opportunity to gain first-hand experience among students at departments of automobiles in Taiwan had led the present research to take advantages of panoramic images of VR in a course where the students learned domain knowledge of vehicle dynamics as well as workplace English through situational learning.

The present research aimed to help student participants build up links between their prior

knowledge and what was taught in class without taking a trip to a car manufacturer. Exposure among students to a panoramic image also provided them with genuine images and hands-on learning experience, both of which enhanced their understanding of the knowledge and optimized their knowledge system as a result. This application of a 360 degree panoramic simulation of a real work setting was a rare yet innovative approach to language learning. Results of the present study help fill in the gaps within studies on the integration of panoramic images into a course on workplace English for students majoring in automobiles at a vocational high school.

2. Methods

The present research designed and edited its classroom materials on EduVenture (see Figure 1 for an overview of the vocabularies, conversations, voice recordings, and pop quizzes across different chapters). Real workplace conversations were provided with videos containing voice recordings. Students who had went through the materials were then instructed to take a pop quiz given by VR for a formative assessment. A total of 53 participants, all of whom were seniors at a department of automobiles at a vocational high school in Taiwan, were divided into groups of 4 to 5. Each group used a Google Cardboard as a viewer for the VR panoramic image and engaged in collaborative learning on a worksheet in class. The course stretched over a period of four weeks, the first three weeks of which featured collaborative learning among students on APP EduVenture while the last of which was dedicated to the implementation of interviews and a survey questionnaire among student participants on their satisfaction from the proposed learning model.

Panoramic image (VR)	Note
	**Vocabularies for automobiles (split screens intended for 3 dimensional effect when viewed using Google Cardboard.)**
	**A listening practice for students to identify the information involved in a conversation between an operator and a costumer in a simulated scene.**

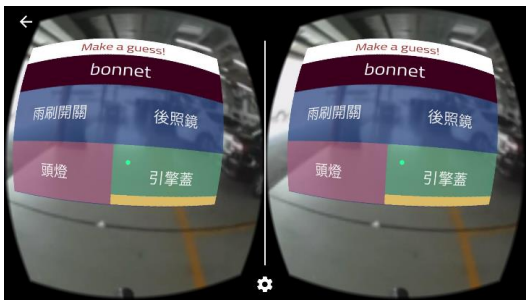
	**A vocabulary pop quiz, where the correct response turns green and an incorrect one is marked red as the participant makes a final choice on the question. The menu will not close until the participant identifies the correct response.**
	**A formative assessment given to student participants on a conversation included in their worksheet.**

Fig. 1. Snapshots of panoramic images (VR) as appeared in the course material

3. Results

3.1 Analysis of learning satisfaction

The present research implemented a survey questionnaire among student participants to find out their satisfaction from the proposed learning model. The survey questionnaire was comprised of a total of six questions, each was scored by a rating scale from 1 to 5. Some of the questions included, “The proposed learning model is more fun than the others I have ever tried” and “I prefer the proposed learning model to other ones.” Results of the descriptive statistics among student participants have shown that student responses to each question reached 4.7 and above. This indicated that a majority of the students held a positive attitude toward the proposed learning model for workplace English.

3.2 Qualitative analysis

(1) An increase in learning motivation among student participants

Results of interview responses among student participants have suggested that the proposed learning model with its use of panoramic images from VR for workplace English enjoyed more acceptability than conventional models ever did among the students and were considered more fun to have in class than its textbook-based counterparts. Student participants also attributed their overall increase in learning motivation as well as confidence in learning workplace English to the proposed learning model. Some students wished that the same model was carried into other subjects, such as automobile repair, for their learning.

(2) Learning strategy

The use of panoramic images from VR in the course material incorporated three learning strategies: concrete imaging, note taking, and drills. The strategy of concrete imaging was applied to the material to help familiarize student participants with the terms commonly used in an actual workplace to refer to

various objects and settings in English. The strategy of note taking can be seen among student participants in their use of outlines drawn from the worksheet. The strategy of drills, however, was marked among student participants by their use of replay when they needed to address a particular issue by revisiting and repeating one or a number of scenes in the video. The use of the above strategies has received positive feedbacks among student participants in their interviews, where they shared various ways of how these strategies may be applied to a decrease in the cognitive load they experienced with the material.

4. Conclusion

The present research aimed to explore among 53 seniors in the department of automobiles at a vocational high school in Taiwan their collaborative learning experience in workplace English with the use of panoramic images from VR. The results of a survey questionnaire among student participants on their satisfaction from the proposed learning model revealed that the students were highly satisfied with its use in class. Both the attitude and perceptions toward it among student participants were positive in the qualitative results of their interview responses. The proposed learning model was also found to have increased learning motivation among student participants, raised their expectation for its expanded use onto other aspects of learning, and enhanced their application of certain learning strategies such as concrete imaging, note taking, and drills. Research findings in the present research are in line with those of its predecessors [5] [6] [7] [8] and proves that situational learning based on the use of virtual reality indeed increases learning motivation among students and thus contributes to their learning. These findings may inform teachers in various fields and the authority about relevant implications on their teaching and prospective research projects.

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Combining Learning Analytics and the Zone of Proximal Development to Provide Recommendations for Finding Peers

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Abstract. This work aims to propose a method to support students in finding appropriate peers in collaborative and blended-learning settings. The main goal of this research is to bridge the gap between pedagogical theory and data-driven practice to provide personalized and adaptive guidance to students who engage in computer-supported learning activities. The research hypothesis is that we can use Learning Analytics to model students' cognitive state and to assess whether the student is in the Zone of Proximal Development. Based on this assessment, we can plan how to provide scaffolding based on the principles of Contingent Tutoring and how to form study groups based on the principles of the Zone of Proximal Development.

Keywords: learning analytics, personalization, adaptation, student modeling, zone of proximal development, social learning.

1 Introduction

The term "*Learning Analytics*" [12] is commonly used to describe the application of computational methods to analyze the learning process and to improve learning outcomes. Even though learning analytics is widely used to support students and instructors in monitoring, mirroring and guiding [6] by providing adaptive and personalized instruction [13], there is little work on using learning analytics to adapt and personalize group formation based on student characteristics. Mainly three approaches are proposed for forming study groups: a) teachers are responsible for setting up groups based on their experience [10], b) students are free to decide on how to form groups, usually based on their personal relationships or preferences, and c) by applying an algorithmic approach for grouping students based on sets of criteria such as skills, demographics and work styles [2]. However, in most cases these approaches do not take into account the cognitive state of the students. Most importantly, these approaches are disconnected from the teaching or feedback strategies that are followed, from the learning resources students are given and from the learning goals or context in general.

In this work, we propose a holistic, multilevel approach to support collaborative learning activities. This approach combines the use of student models along with estab-

lished pedagogical theories in order to address students' specific needs on the individual level and to use this information to create meaningful collaborative, learning experiences. In particular, we aim to provide personalized guidance by adapting scaffolding to the students' background knowledge and cognitive state. To monitor and model knowledge and cognitive state, we use computational learning analytics (LA) and machine-learning methods. To maintain the most up-to-date representation of students' knowledge and cognitive state, student models will be dynamically updated during students' practice. Furthermore, we aim to support social aspects of learning by engaging students into collaborative tasks and group discussions with peers. In order to form appropriate study groups – that is, groups that can contribute to collaborative knowledge building – we follow the principles of social development theory and the Zone of Proximal Development (ZPD) [14].

2 Background

The Zone of Proximal Development (ZPD) is one of the most popular pedagogical theories. It was introduced by Lev Vygotsky as one of the main themes of the Social Development theory, along with the Social Interaction and the More Knowledgeable Other constructs [5]. The ZPD can be defined as: "*the difference between what a learner can do without help and what he or she can do with help*" [11]. The definition of the ZPD indicates the significance of appropriate assistance in relation to the learning and development process and the importance of choosing suitable peers when forming study groups. Criticism regarding the ZPD usually focuses on the ZPD being an abstract theoretical concept and not an actual, observable and measurable construct [15]. Therefore, it is critical to establish ways for formalizing and operationalizing the ZPD that can contribute towards revealing, understanding and documenting the mechanisms that drive learning and development [8].

There are several approaches to modeling the ZPD. For example, Luckin and du Boulay proposed a design framework (*Ecolab*) that is based on the application of the ZPD for educational software design [7]. The ZPD of a student is assessed using domain knowledge representations, Bayesian Belief Networks (BBN) and two tags, the ability belief and the collaborative support tag. Chounta et. al. [3, 4] operationalized the ZPD using the concept of the Grey Area, that is the area in which a student model's predictive accuracy is questionable. The rationale is that if the student model cannot predict with acceptable accuracy whether a student is able to carry out a learning task successfully, this may indicate that the student is in her/his ZPD.

3 Student modeling for group formation

So far, operationalizations of the ZPD have been used to detect affect such as boredom or frustration [9], to provide learning resources to students [7], or to dynamically adapt tutorial dialogues for students who practice conceptual physics [1]. In this work, we propose the use of the Grey Area operationalization for choosing peers when forming study groups. Based on the Grey Area definition, we can use it as a proxy for assessing

when a student is above, below or in her/his ZPD. The Grey Area is individual for each student (just like the ZPD) and it depends on the learning task a student is asked to carry out. On the other hand, the ZPD pinpoints the concept of learning with the assistance of a more knowledgeable other. This means that a low threshold of the ZPD signifies tasks a student can carry out when working alone and the high threshold of the ZPD signifies tasks a student can carry out when working with – or assisted by – a more capable peer. This suggests that in order for learning to potentially take place, a student below her/his ZPD should form a group with a student in or above the ZPD and a student who is in the ZPD should be paired with a student above the ZPD. A student who is already above her/his ZPD can participate in groups of all combinations because this student is already capable of achieving a task on her/his own. This hypothesis has been previously suggested by related research on group formation based on group members heterogeneity with respect to knowledge background [8]. However, it is not yet clear to what extent heterogeneity – or else, distance in terms of background knowledge – supports and facilitates learning. For example, as depicted in Figure 1, if a student below the ZPD (student a) is paired with a student above the ZPD (student c) will she learn more or faster than if she were paired with the student in the ZPD (student b)? One could argue that the larger knowledge "distance" for the first pair (ac) compared to the second pair (ab) will lead to higher learning gains.

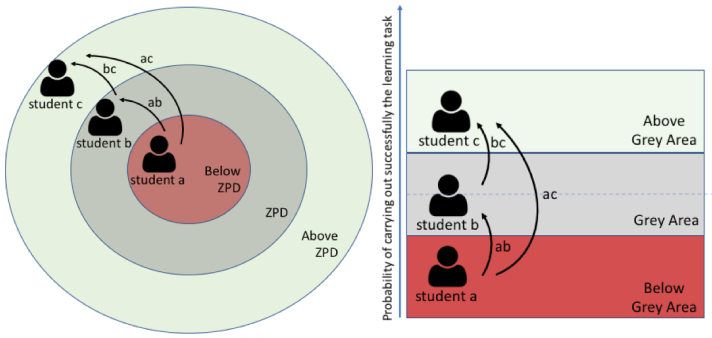

Fig. 1. The proposed methodology for forming study groups based on the concept of the ZPD (left) and according to the Grey Area as a proxy of the ZPD (right)

4 Discussion

We aim to explore the proposed approach by providing students with collaborative tasks and dynamically assigning group members based on the Grey Area assessment. The research question is to explore how the knowledge "distance" of group members – that is, the difference in terms of their background knowledge – might affect the outcome of their common work and the learning gains both on the individual and group level. The contribution of this work will be twofold: a) using learning analytics to dynamically keep track and assess student's cognitive state and b) dynamically assigning and adapting study groups based on the participants' knowledge state and with respect to the principles of established pedagogy, namely the ZPD. A key broader impact of

this work is that it can support complex pedagogical decision-making necessary for providing effective scaffolding on multiple levels: instruction, learning materials and recommendations for appropriate peer-matching. Once the proposed approach has been developed and evaluated, it can be widely used in various contexts, such as online courses, MOOCs and collaborative learning environments.

Acknowledgements
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Students' Preferences for Teachers' Online Self-Disclosure in Out-of-Class Communication

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Abstract. Social media is a well-known tool for out-of-class communication between students and teachers. However, few studies have been investigating students' preferences of social media platforms in terms of online self-disclosure and their influence on learners' course satisfaction and expectations toward instructors. In the present work, using both qualitative and quantitative data of 231 Taiwanese university students we examined the most popular social networking site and instant messaging application in Asia from a students' perspective. We found that learners' online self-disclosure level significantly correlated with their choice for online communication platform and experience. Moreover, participants preferences for the amount of personal information that teachers disclose online and in a real classroom are not the same. Interestingly, similar information mentioned on social network sites and in face-to-face interaction may be perceived by the participants differently and lead to different conclusions and course satisfaction. These results suggest that cultural differences and personal characteristics of students should be taken into account by instructors when they choose online platforms for out-of-class communication.
Keywords: First Keyword, Second Keyword, Third Keyword.

1 Introduction

For past decade technology has dramatically shaped modern education as many teachers in both schools and universities expand education outside physical space. Such an approach requires new tools for communication able to conveniently share related multimedia, links, applications or other digital materials. With current instant messaging applications and social networking sites students are able to ask their questions directly to teachers when they have some troubles material comprehension, and receive help not only limited by text enlarging learners' subject understanding and expertise. Indeed, out-of-class communication plays a vital role in student-teacher relationships [3], encourages students' social bonding and social learning [7, 8], motivation and pressure decrease [6, 9] and positively correlates learning outcomes [4]. However, teachers who are engaged in online communication outside the classroom often face the hard choices of suitable tools and communication strategy with their class. Social network sites are familiar to most of the students and convenient in use, but they are mostly created for personal purposes and raise the problem of individual privacy. Instant messaging applications, on the other hand, provide less functionality but have an advantage of establishing private boundaries. In order to investigate which online communication tool can

assist teachers the best in creating a trustworthy and comfortable atmosphere among learners and how much personal information should instructors allow themselves to reveal online, the present study investigated the phenomenon of teacher-student out-of-class communication on social network sites and messengers from the vantage point of students.

2 Methodology

In order to examine the connection between students' OSD and their preferences in teachers' OSD level, both quantitative and qualitative data were gathered. A sample of 231 Taiwanese university students (60% female with an average age of 23.3) with experience of using Facebook (65%) and popular in Taiwan messenger LINE (78%) to communicate with their teachers participated in the self-administrated online survey posted in April 2018. Follow-up semi-structured interviews were conducted with 37 participants (54% female with an average age of 22.7).

2.1 Measurements

The self-administered questionnaire contained 50 close-ended questions and consisted of 6 parts written in Chinese: (1) demographics, (2) online communication experience, (3) short modified version of The Revised Self-Disclosure Scale (RSDS) [10] about participants, (4) modified version of RSDS about preferred level of teachers' OSD, (5) preferred way of online communication with instructors, and (6) course satisfaction.

A short modified version of RSDS explored how much information students reveal about themselves online and how much online information they are comfortable to see from their teachers by asking participants to report their agreement to 38 statements using a 5-point Likert scale. Factor analysis using direct oblimin and unweighted least squares as extraction method found four factors with eigenvalues greater than 1.0, explaining 73.56% of the variance for students and 67.6% for teachers: (1) honesty-accuracy, (2) positive-negative, (3) control of depth, (4) intended disclosure. Honesty-accuracy subscale (5 items) measures how honestly and accurately information is disclosed, positive-negative subscale (3 items) evaluates positivity and negativity of the information, control of depth subscale (3 items) assesses intimacy of sharing, and, finally, intended disclosure subscale (3 items) judges the awareness of disclosure behaviors. The fifth factor measuring preferred length of shared information, originally in Wheeless and Grotz [10], was excluded in this study due to low validity and reliability for both teachers' and students' scales and factor analyses as short posts may be had little connection with OSD since they are easier and faster to read and therefore get more response from followers.

The fifth part of the survey asked participants to choose between "LINE" and "Facebook" as a preferred way of online communication tool with teachers. The last part required students to self-report (using a 5-point Likert scale that ranges from strongly agree (5) to strongly disagree (1)) their satisfaction with various components of courses where they encountered out-of-class online communication.

3 Results and discussion

An independent-samples t-test between the two groups of participants preferred Line and preferred Facebook for online communication with teacher (Facebook: n = 56; LINE: n = 175) and their own level of OSD, yielded a significant difference, $t(231) = 8.308$, $p < 0.001$. These results propose that participants from high OSD group preferred social networking sites for interaction with their teachers while participants with medium and low OSD level were more comfortable using messengers. In order to determine whether there is a connection between students' past experience, level of OSD and preferred level of teacher's OSD a Pearson's correlation was run between these three variables. The findings show that there is a significant positive correlation at the 0.01 level, $r = 0.64$ between last two variables advocating that students who are open online prefer their teacher to be also open in online space. A positive correlation at the 0.01 level, $r = 0.52$ between the first and the last variables suggest that participants who wanted their instructors to share less personal information online have less experience of online communication outside of their classroom, no matter whether the experience was positive or negative.

Semi-structured interviews were conducted with 17 students from high and 20 students from low OSD groups. Using thematic content analysis, we found that participants from the last group displayed higher expectations for teachers' participation in the classroom than students who wanted their teachers to be more open online. Moreover, students' preferences for the amount of personal information that teachers disclose online and in a real classroom are not the same. Interestingly, even the same information mentioned on social network sites and in face-to-face interaction may be perceived by the participants differently, lead to different conclusions and even influence their course satisfaction. The findings assume that there are several categories of information that tend to be ambiguous: children, accomplishments, and travels.

4 Conclusion

The present work is an important first step in investigating the relationship between OSD and the preferred method of online communication with instructors in Taiwan. Most research in this field is limited by concentrating only on social networking sites, such as Facebook, or focusing on the positive outcomes of teacher self-disclosure (e.g., [2]), setting aside their possible disadvantages. This research, however, clearly shows that high level of teachers' OSD is not appropriate for all participants and that there are some types of information which may be perceived differently in online space compare to the usual classroom.

The findings of this study display the tendency of Taiwanese students to prefer out-of-class communication tool with lower OSD level: 76% of participants chose to use LINE with their instructors perceiving it as a more private communicational tool and only 22% of sample chose Facebook for the same needs, looking for more personal and open communication. This case follows founded earlier predisposition of users from collectivistic countries to disclose online less and in a more indirect way than people

from individualistic cultures [5]. Consequently, even though Facebook is currently promoted as a useful and engaging tool for classroom interaction or management [1] and also highly popular among people around the world, educators should carefully consider their choice of online communication platforms depending on learners' personality, online behavior and cultural factors. The results of this study revealed some promising potential consequences of adjusted communication teacher-student interaction from the students' perspective.

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Preliminary Systematic Literature Review on Design Rationale Studies in Software Engineering

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Abstract. Design rationale is important information in software development because it contributes to knowledge sharing among stakeholders. In spite of it, systematic literature review on design rationale studies in software engineering has not been conducted. This study reports on preliminary systematic literature review on design rationale studies in software engineering. As the result, we clarify the followings: (1) more than half studies deal with the upstream processes such as design, architectural design, or requirement analysis, (2) top five of research issues are "traceability," "insufficient support," "cost for capturing design rationales," "little knowledge for its effectiveness," and "shortage or difficulty of rationale capturing," and (3) IBIS, gIBIS, QOC, DRL, and PHI, which are representative rationale representation models, are not used frequently.

Keywords: Design rationale, Systematic Literature Review, Software engineering

1 Introduction

Various types of decision making are done in the software development process. Results of the decision making are represented in the form of document and/or source code. On the other hand, there exist intents and/or rationale that lead to the decisions behind the decision making. They are called "design rationale (hereafter we call it DR)" whose origin is Issue-Based Information System (IBIS) developed by W. R. Kunz and H. Rittel in 1970 [7].

Design rationale is very important information for software development because it contributes to knowledge sharing among stakeholders. Various definitions are given for design rationale [5]. In those, Dutoit et al. defined design rationale as "reasoning of discussions that lead to decisions of design of artifacts" [2]. As for significance that records design rationale, Alkadhi et al. described documentation of knowledge regarding development and its reuse enables measures to changes and/or efficient maintenance [1].

Although research on design rationale has actively been conducted in the field of Computer-Supported Cooperative Work (CSCW) and so on, systematic literature review on design rationale in software engineering is not published to our knowledge.

This paper conducts preliminary systematic literature review (hereafter we describes it SLR) targeted at design rationale in the software engineering field.

adfa, p. 1, 2011.

2 Related work

Some survey papers target at design rationale have been published.

Sagoo et al. conducted SLR on its definitions, its representation schemes and capabilities of design rationale [5]. It did not focus on software engineering, therefore the target differs between them and me.

Regli et al. published a survey paper on design rationale systems [4]. It describes representation schemes of design rationale, recording functions of design rationale and retrieval functions. Their paper was published in 2000, therefore survey paper on the initial stage of design rationale studies.

3 Procedure of SLR

A systematic literature review (SLR) is a means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest [3]. The procedure is as follows: to formulate the research questions, database search, to study the selection criteria and selection process, to extract the data and to synthesize the data. I describe each item in this study as follows.

(1) Research Question (RQ)

I set the following research questions (RQs):

RQ1. Where is the target phase of the software development by each study?

RQ2. What types of problems in software development are focused on by each study?

RQ3. Which representation model is adopted to capture DR?

I describe motivations behind the RQs. From RQ1, I clarify in which phase of the software development process the DR research focuses on. From RQ2, I clarify what problems the researchers try to solve. A number of DR representation models have been proposed. Sagoo et al. listed up Issue-Based Information System (IBIS), questions, options and criteria (QOC), decision representation language (DRL), procedural hierarchy of issues (PHI) as the DR representation model [5]. However, how much they are used is not clarified. This paper clarifies this aspect by RQ3.

(2) Database search

SCOPUS of Elsevier [6] is used as a database for literature search. I set ("software engineering" AND "design rationale") as the search formula and conducted the search in 2 October 2018. As the result, a list of 178 papers was got.

(3) Inclusion/exclusion criteria and filtering papers by them

To determine literature to be investigated, the following inclusion/exclusion criteria were set.

- ✓ paper or article published in international journals, international conferences, international workshops or books whose theme is design rationale in software engineering written in English.
- ✓ paper whose main topic is design rationale in software engineering in the abstract section
- ✓ paper whose number of citations is more than five

✓ paper whose number of pages is more than four

I excluded papers that do not match to the above criteria and survey papers. As the result, I decide to include 43 papers for the SLR.

4 Answers to the RQs

This section describes the results to the RQs.

4.1 RQ1: Target phase in software development

The most papers targeted design phase, next in particular, targeted architectural design. Then requirements analysis phase follows. More than half of the papers targeted the upstream phases, such as requirements analysis and design.

On the other hand, although the number is few, some papers targeted implementation phase such as coding or refactoring.

4.2 RQ2: Awareness of issue

I identified categories for awareness of the issue as follows: “traceability,” “insufficient support,” “cost problem for recording DR,” “unclearness of effectiveness of DR,” “difficulty of extracting DR,” “low understanding for DR,” “no support to evolution of DR,” “no support to impact analysis,” “lack of sharing of historical data,” and “others.”

“Traceability” is the most awareness of issue, then “insufficient support” follows. Then, “cost problem for recording DR,” “unclearness of effectiveness of DR,” and “difficulty of extracting DR” follow. These five items make up around 75% of all papers.

4.3 RQ3: DR representation model

IBIS, gIBIS, QOC, DRL, PHI are well-known DR representation models. Therefore, I suppose they are often used. Around 20% of all the studies used IBIS, gIBIS, QOC, DRL, or PHI as the representation model of DR. On the other hand, more than half did not refer to the models. In case of reference, other models are adopted, concretely speaking, AREL was more used because its developer published a number of papers.

5 Threats to validity

This preliminary SLR identifies the following threats to validity:

- Issue on exhaustiveness in paper search: this study conducts only one search formula. Recall should be improved by related words.
- Issue on bias regarding interpretation of papers: The answers to each RQ are given only by the author. Therefore bias may exist to the results. Results should be checked by some people.

6 Conclusion

This paper has conducted preliminary systematic literature review on design rationale studies in software engineering under the recognition that systematic literature review on design rationale studies in software engineering has not been conducted. I formulate three research questions (RQs) and show the results for them.

The most papers targeted design phase, next in particular, targeted architectural design and then requirements analysis phase follows. Major research issues are “traceability,” “insufficient support,” “cost problem for recording DR,” “unclearness of effectiveness of DR,” and “difficulty of extracting DR.” Only around 20% of all the studies used IBIS, gIBIS, QOC, DRL, or PHI as the representation model of DR

In recent years, new directions are emerging, such as rationale extraction by mining technologies. This field is conducting a study that extracts rationale from information publicly available on the Internet.

This SLR does not fully deal with such emergent topics. Enhancement of the result of the SLR will be required as future work.

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Development of the Mobile Learning System for Local Tour Guide Training in Chinese

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Abstract. In Hokkaido, over 60% of the inbound visitors come from Chinese speaking regions. Therefore, the tourism industry needs Chinese rather than English as a means of communication. That is why the development of multilingual human resources is indispensable. However, a systematic foreign language teaching program has not been developed yet. The objective of this study is to develop a mobile learning system for the Chinese guide interpreter training. This paper reports the details of the process of development, platform construction with LMS, contents design, development environment, and primary evaluation by National Government Licensed Guide Interpreters.

Keywords: Mobile Learning, e-learning, Educational Material Development, Tourism Education, Chinese Language Teaching.

1 Introduction

As an initiative of the government, tourism promotion and the environment for welcoming inbound tourists are being upgraded. The development of multilingual human resources with intercultural competency through tourism and foreign language education is highly required. The National Government Licensed Guide Interpreter system has changed in 2018 in a way that allows anyone who can speak a foreign language to work as a paid guide interpreter without a license. That is why there is a great need to ensure the quality of volunteer guides and service industry workers. In the field of this study, Hokkaido, the number of inbound tourists has continued to grow for six years straight, and in 2017 it exceeded 2.79 million of which visitors from Chinese speaking regions account for over 60% (Ministry of Hokkaido Economy and Tourism Bureau, 2017). For this reason, we developed a mobile learning system aimed at the training of Chinese guide interpreters in Hokkaido.

2 Literature review

Topics such as the curriculum design of tourism faculties and collaboration between the industry and the academia have been discussed in the field of tourism education (Yajima, 2013; Negi & Orito, 2015). These studies suggest the inconsistency between

the needs of the industry and finding employment opportunities as well as the unbalanced quality of basic education and vocational training. On the other hand, various mobile language environments for Chinese language learning have been developed (Yuyama, Shinozuka and Yamamoto, 2019; Kan and Ito,2018; Wu, Kato and Yang, 2012). However, in most of the previous studies, the learning goals were set based on the traditional pedagogy of Chinese for General Purposes (CGP) to enhance the four basic skills of language learning. It can be argued that the social needs of multilingual human resource development require a combination of vocational training and language learning, i.e. Chinese for Specific Purposes (CSP). In order to respond to the specific needs of the tourism industry, we have developed a mobile learning platform. Based on the practical experiences of the Chinese licensed guides, we have classified the workflows of guide and concierge services, as well as enhanced the training of oral communication skills. This study will contribute to the integration of vocational training and Chinese language teaching, as well as the promotion of an online independent learning environment. It is also expected to enrich the learning environment for lifelong learning of senior volunteer guides.

3 Development Environment

The whole process of the system development can be summarized as follows.

1. **Construction of the mobile learning platform**. Taking cost effectiveness, convenience of learning, development and maintenance into consideration, we used the open source WordPress LMS plugin (LifterLMS). The page design, quizzes, assignment sending/receiving and evaluation functions were required.
2. **Classification of the communication scenes between tourists and the guide interpreters**. The course topics were made to match the flows of guide and concierge services. The learning course consisted of; (1) tutorial, (2) meeting at the airport, (3) public transportation, (4) hotel check-in, (5) sightseeing spots (Okurayama and Sapporo Olympic museum), (6) cuisine, (7) shopping and souvenirs, (8) hotel check-out and (9) sending off at the airport.
3. **Creation of scenarios consisting of dialogues between tourists and the guide interpreters**. Each course topic had multiple dialogues and Q&As both in Chinese and Japanese.
4. **Creation of quizzes and Q&As focusing on listening and speaking skills training**. The exercises and Q&As were specially designed for each video material section. The Japanese and Chinese interpretation exercises and Q&As used excerpts from the videos. In addition, an evaluation questionnaire created with Google Forms was added to the end of each course. Learners were asked to answer the five-grade evaluation questionnaire as well as some open-ended questions. The evaluation criteria included; (1) page design, (2) leading goals, (3) contents, (4) evaluation of learning achievements, (5) communication between learners and instructors, (6) privacy protection, and (7) comprehensive evaluation.

5. **Filming of the movies on each topic**. In general, original content such as films of the on-site guide interpretation were used. Some facilities such as airports, public transportation and sightseeing spots required the permission of filming. **Recording of the audio files used for dialogues and exercises**. Clear audio had to be recorded separately as the sounds recorded during the filming process included various noises inappropriate for educational materials.
6. **Editing of videos and sounds**. Each clip should be less than 5 minutes in order to prevent learners from feeling distracted.
7. **Implementing of materials and exercises in the system**. The platform was constructed with WordPress, LifterLMS and Loco Translate.
8. **Debugging of the teachers'/learners' functions.** Checking all the functions such as sign-in, watching videos, listening to audio files, doing exercises, sending and receiving assignments, as well as scoring and grading.
9. **Testing of the trial version.** Conducting the primary evaluation.

4 Primary Evaluation

With the cooperation of the National Government Licensed Guide Interpreters, we conducted the primary evaluation of the system. There were seven Japanese participants who were advanced-level learners. They tested the system *e-Learning de Hokkaido×Chinese Guide* (http://chugokugokobo.sakura.ne.jp/e-daoyou/) (see Fig. 1) and answered the open-ended evaluation questionnaire.

Fig. 1. Top Page and Video Material Page of the Mobile Learning System

After studying the tutorial at first, the participants chose two different courses. They used their own mobile devices such as Windows PC, Android tablet PC, Android smartphone and iPhone. The network used was the University Wi-Fi or 4G band. Each participant wrote free comments, requests and opinions for improvement. The participants gave their opinions about functional errors and proposed adjustments of the

materials. The differences between the PC and smartphone environments were discovered and errors were fixed to meet the evaluators' requests.

5 Conclusion and Future Challenges

In this study, we developed the mobile learning system for Chinese local guide interpretation training. As the study is ongoing, we described the process of development, the platform construction with WordPress and LMS, the design of the courses and materials, the environment and summarized the primary evaluation. As a result, the following improvements were deemed necessary: (1) The Q&As and exercises needed more educational hints. (2) The quality of sound in the materials must be ensured as they may affect the learners' concentration. (3) The words and phrases used in the materials should be included in the vocabulary list as much as possible. (4) The instructors should explain the learners that the pronunciation in the materials is not always the same as in the lexical definition. (5) The default notification function should be adapted to suit the learners' tastes. (6) The videos explaining sightseeing spots and facilities are sometimes unnecessary and they affect the efficiency of the training. (7) As Japanese students prefer reading and writing, the instructors need to teach them to also practice repeating and shadowing.

The future challenge is the actual usage and evaluation of the system in the flipped class. We are planning to conduct cooperative learning with Japanese and Chinese students in the guide-interpretation training class. The improvement of the efficiency of the flipped class should be considered based on the experiences gained in actual educational practice.

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Children's Mobile Peer-Tutoring Learning Behaviour in Chinese Language Arts

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Abstract. The purposes of this study were to analyse children's online peer-tutoring behaviour and investigate the effects of 'help' tools provided in the online tutoring environment on children's learning in Chinese language arts. Twenty-six sixth-graders participated in the study for twelve weeks. They used the mobile synchronous peer-tutoring system in learning Chinese language arts. The online learning logs were examined by cluster analysis. The two clusters identified contained distinct tutor and tutee behaviours. Chinese language arts achievement test scores were significantly higher among 'guided tutors' than among 'active tutees'. The tutors' viewing of answers was the most important behaviour predicting achievement.

Keywords: Mobile peer tutoring, learning analytics, Chinese language arts.

1 Introduction

Language is a critical subject for children's academic success. Deficits in language development have been linked to social problems, conduct problems and delinquency [1]. Peer learning is one of the most effective instructional strategies for language arts from a social interaction perspective.

The increased use of computer-mediated collaborative activities in the classroom has changed the way in which collaboration can be structured [2]. Scaffolding tools that facilitate participation during online peer tutoring have made a major contribution to the success of computer-supported collaborative learning (CSCL) [3]. Online peer tutoring is a well-structured form of CSCL. The achievement of such success, through the combined application of computer support and collaborative learning to effectively enhance learning, is challenging [4]. In a previous study, the incorporation of 'help' tools, especially a tool with which tutees could request that tutors indicate errors, into a synchronous peer-tutoring system significantly improved learning achievement in mathematics for low-achieving children [5].

Previous study analysed two patterns of peer-tutoring behaviour – active (tutors) and reactive (tutees) – in a written composition task. They found a large quantity of messages in the draft writing segment and the tutors in the splicing and guided cooperation messages [6]. A study examining online peer-tutoring conversations between 79 tutors showed that the tutors were more likely to ask questions in this online setting than they were in a lecture setting [7]. An analysis of online face-to-face behaviours of low-

achieving students revealed that tutees performed 55.07% of the behaviours. The online 'help' tools facilitated these behaviours and prompted more instruction from tutors in face-to-face online peer-tutoring activities [5].

As technology becomes ubiquitous, mobile computer-supported collaborative learning has emerged in recent years to support the process and products of collaboration. Few analyses of students' computer-mediated help-seeking and -giving behaviours have been conducted in mobile CSCL research [5]. In this study, a mobile synchronous peer-tutoring system for Chinese language learning (iPTC) was developed. The aim of the study was to explore children's learning behaviour in the iPTC.

2 Methods

This study was conducted an elementary school in Taipei using a case study approach. Participating students used tablets for face-to-face peer tutoring activities with the iPTC for one session (forty minutes) a week for 12 weeks.

2.1 Participants

Participants were 26 sixth-grade students (14 boys and 12 girls). Students were grouped in peer-tutoring dyads of heterogeneous achievement; high-achieving students were paired with average-achieving students, and above-average–achieving students were paired with below-average–achieving students.

2.2 Online synchronous peer tutoring procedure

Each student was provided with an ASUS Eee Pad mobile tablet for the face-to-face online peer-tutoring activities with the iPTC. A turn-taking strategy was used. The teacher assigned activities in Chinese language arts on three themes – Chinese characters, word and vocabulary building, and sentence exercises. The iPTC system randomly selected problems from the item bank assigned by the teacher. First, the tutees answered the questions using the tablets' touch screens. Most questions required handwritten answers on the tablets. Then, the tutors used various tools for guided tutoring. When tutees encountered problems, they could use the system's tools to ask for help. Tutors could use scaffolding tools to give hints or feedback.

2.3 Instrument

2.3.1 Coding scheme for face-to-face online peer-tutoring behaviour

Based on previous research [5, 8, 9], the coding scheme used in this study included 19 sub-categories of participant behaviour, which were divided into three patterns of peer interaction: tutor, tutee and procedural behaviours. Two coders were trained to analyse the students' online discourse before the experiment. The inter-coder reliability coefficient for this sample of 125 units was 0.94. A set of 11,025 peer-tutoring behaviours in the six sessions was selected for content analysis in the study.

2.3.2 Chinese language arts achievement test

The four sixth-grade teachers participating in the study to develop a Chinese language arts achievement test. The average difficulty was 0.67 and the discrimination index was 0.47.

3 Results

3.1 Cluster analysis of students' online behaviour during iPTC use

The results of analysis students' online behaviour showed that procedural behaviours were the most frequent (n = 8819), and tutor behaviours (n = 1531) were more frequent than tutee behaviours (n = 675). The most frequent tutor behaviour was the viewing of answers (n = 594), followed by the use of the correction pen (n = 314). The most frequent tutee behaviour was asking for the demonstration of solutions (n = 157).

Students' online peer-tutoring behaviours were examined using hierarchical cluster analysis based on squared Euclidean distances. The agglomeration schedule coefficients indicated the presence of two clusters representing distinct behavioural patterns. The two clusters identified contained distinct tutor and tutee behaviours. Students in cluster 1 (n = 11) were designated as 'guided tutors'. Students in cluster 2 (n = 14) showed more tutee behaviours overall than did students in cluster 1. We thus designated cluster 2 students as 'active tutees'.

3.2 Students' achievement in Chinese language arts

Students' achievement test scores were compared between groups using the Mann–Whitney U-test. The results indicated that achievement scores were significantly higher in guided tutor group (M=16.41) than in active tutee group (M=10.32) (Mann–Whitney U=39.5, p<.05).

3.3 Results of linear regression

Automatic linear modelling was adopted to examine whether students' tutoring behaviour was beneficial to their Chinese language arts learning. The forward stepwise regression model included all tutor and tutee behaviours listed in Table 1. The regression equation was significant (F = 20.54), with an R^2 value of 0.83; the model explained 68% of the variance in achievement test scores. Viewing answers (β = 5.50, importance index=0.46), followed by using stamps for reward (β = –7.98) and asking for help to demonstrate solutions (β = –2.00), were the most important predictors of students' Chinese achievement.

4 Discussion and conclusions

The results of this study show, in agreement with other studies [5, 8], that the nature of the online behavior is associated mainly with the task's content. The results of this study

showed that tutor behaviours were more frequent than tutee behaviours. The most frequent tutor behaviour was the viewing of answers. The most frequent tutee behaviour was asking for tutor to demonstration of solutions in writing characters or sentences. This study also proposed categorization allows for distinguishing between two groups of online peer tutoring behaviors. The guided tutors were more beneficial in learning Chinese than the active tutee. Moreover, the most critical tutoring behaviors were tutor viewing answers. This helping tool facilitated students' learning achievement. Our results indicated that using more stamps tool for rewarding by tutors and requesting more demonstrate solutions by tutee may result reduce their scores in achievement test. The rewarding tool may not be necessary for upper-level of elementary students in online setting.

The results of this study allow us to support the idea of the relationship between the form of online peer tutoring behaviour and students' learning in Chinese. Future research is needed to replicate the findings of this study and examine the qualitative results of scaffolding tools in online peer-tutoring environments.

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Analysis of Descriptions on Medical Collaboration in Nursing Records

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Abstract. Communication and collaboration between hospitals and nursing homes is required in these years. It is important to record the state of the patient at another facility in hospitals. Thus, we analyzed the nursing records in University of Miyazaki Hospital to find descriptions of another facility and the state of the patient there. The analysis was done on nursing records of four nurses by hand because we focused on the high-level notions. We also analyzed the relationship between the existence of the descriptions of another facility and the work experience of nurses. The results showed that there are little records according to the state of the patient at another facility. However, nurses with enough work experience tend to write the information of another facility or the information of the patient's family.

Keywords: Electronic medical record, Nursing record, Third Keyword.

1 Introduction

In recent years, the collaboration between hospitals, that between the hospital and nursing-care facility and that between the hospital and the patient's home is getting important due to the diversification of medical needs and the specialization of the medical area. In such medical collaboration system, it is important that information be shared by core hospitals with advanced medical functions such as university hospitals, general hospitals of community-based type such as city hospitals, regional clinics such as family doctors, nursing facilities such as nursing homes and day care services, and patients' homes.

The information collected by the electronic medical record is expected not only to be shared in its department but also to be shared among other departments and hospitals [Lucini, et al. 17]. In addition, it should also be shared in the community medical clinic and nursing facilities after the patient transfer or leave the hospital. However, in the electronic medical record in each medical institution, it is not known how much information about the collaboration between such medical facilities and families. Therefore, we analyze the nursing record of the university hospital to reveal how much information exits on the collaboration between various medical organizations.

2 Survey data

Japanese Nursing Association describe about nursing record as follows in “Guidelines on handling of nursing records and medical care information”.

1. Describe everything you need without omission
2. Don’t write what you don’t need
3. Change the reality of unprotected nursing records
   - Description of personal emotions
   - Impressions, speculations, personal views
4. [Major principle] Change the recording method to chronological recording when a serious medical accident occurs

The format of nursing record has database, nursing plan, progress record and summary. However, nursing record is used as notes for life history, examination history, reservations, etc. There is no clear rule in the progress record, because it is text data, and the detailed description method differs depending on the writer [Mowery, et al. 12]. The nurse remembers the words said by the patient, takes notes, and finally enters them into an electronic medical record [Kushima, et al. 12].

In this paper, we research about the nursing record which is utilized in University of Miyazaki hospital. At the time of acquisition, the patient’s name and the writer’s name in the data are anonymized. The outline of the data is as follows: The number of records is 805,751, the total number of records is 1,808, the total number of patients is 16,171, and the description period is from 2013/10/5 to 2018/3/30.

3 Method

3.1 Survey lists

Regarding the target data, we manually investigate whether the following information was written.

Information about medical care collaboration. We determine whether there is a description about collaboration with other facilities in the record, and add it a tag. Specifically, a description of the patient’s condition at the hospital treated before the hospital change and a nursing facility who entered the hospital, a description of the patient’s living condition at home after discharge, and the description issued by the patient’s family. In addition, as information related to the information (features of nurses’ records), we investigate the following items manually or by computer.

The number of adjectives. Adjectives are often used for subjective descriptions. Check how many adjectives are used. Specifically, the text in the nursing record is morphologically analyzed and the number of adjectives is recorded by computer.

Text Data. Investigate the volume of nursing records.

3.2 Nurse Attributes

Whether to write information on hospital/clinic collaboration may depend on the nurse's career and experience. Therefore, the recorded age and years of work experience of the nurse are also calculated. This information was obtained from staff list data (personal information is anonymized).

4 Results

Since this analysis includes manual tagging, it takes time to cover all data. To begin with, the analysis was carried out for a patient who had medical examination in internal medicine (5th floor, west ward, department of internal medicine) for the record which 4 nurses (A, B, C, and D) in Table 1 described.

The survey results are shown in Table 1. Description on the patient's behaviors in other medical institutions could not be seen in the nursing records. There were 15 descriptions on the schedule of outpatient of other hospitals and the existence of the introduction letter after leaving the hospital. We also found that there was description on the patient's family.

Table 1. Number of descriptions in the department of internal medicine

Nurse	A	B	C	D
Year of work	5	3	2	2
Total number of records	728	539	508	324
Patient's behavior at other institutions	0	0	0	0
Information about related institutions	13	2	0	0
Patient's behavior at home	5	1	0	2
Statement by family	27	6	3	5

5 Discussion

There was no description of the patient's behavior in other medical institutions. This record concerns inpatients in a certain ward (5th floor west ward). Since the history to the hospitalization should have been described in the medical record by doctor, it might not be necessary for nurses to confirm it with the patient.

Some nurses wrote about the collaboration among the hospital and nursing-care homes. When a patient is discharged from a university hospital and is to be treated or cared for at another facility or home, a nurse gives instructions on leaving the hospital to the patient. Thus, this type of information is written in the nursing records.

Compared to other type of information, the number of the statements of the patient family was especially large. Nurse A wrote 27 statements about the patient family, and, and 19 of them were records of informed consent. Nurses often attend the meeting on

informed consent with the doctor and wrote the state and reactions of the family members in the nursing records. In some cases, details of the wishes of the patients themselves and their families were recorded.

Finally, we discuss the characteristic and attributes of nurses. The nurse who wrote information about other facilities and patient's family was nurse A whose work experience is the longest among the four nurses. It is thought that work experience contributed to the recording of collaboration and communications with other stake holders [Yamazaki, et al. 15].

6 Summary and Future Plans

In present investigation, the information on the medical-nursing collaboration was described only in the office content such as date and existence of the letter of introduction. And, the description on the patient's behaviors in other medical institution was not observed. However, the description on the word by family existed which seemed to be useful after the discharge from hospital. From the survey results, it was found that there is a possibility that there are few useful descriptions about the collaboration between medical treatment, nursing care and welfare in nursing records in university hospitals. However, not only the medical treatment in the hospital, but also the fact that the words of the patient's family were recorded may be helpful in promoting the medical/nursing collaboration. In the future, we will check the number of technical terms, and the number of data will be increased for analysis.

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Gamification Approach for Gathering Barrier Information

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Abstract. Several barriers (e.g., steps and slopes) hinder the free movement of impaired people, both indoors and outdoors. Existing approaches for detecting barriers have an accuracy/coverage trade-off problem. For example, approaches that use a wheelchair with an accelerometer cannot detect barriers in areas which wheelchair users have not gone through. However, approaches that try to detect barriers from street images on the Internet fail to increase the accuracy of barrier detection because of occlusions that obscure the surface of the road. To address this problem, a method is used to estimate the existence and type of barriers with high precision using the acceleration data acquired from smartphones of able-bodied pedestrians. However, it is difficult to keep users motivated because the task of "just walking" offers a weak incentive for users to collect a large amount of data. To address this issue, we propose a barrier information gathering system based on gamification, wherein users can collect acceleration data by playing an encampment battle game.

Keywords: Gamification, Barrier-free, Human Computation.

1 Introduction

Several barriers (e.g., steps and slopes) hinder the free movement of impaired people, both indoors and outdoors. Identifying the positions of such barriers is beneficial to enabling the smooth movement of impaired people and urging the government to address this issue. It is, therefore, effective to use a method that estimates the existence and type of barriers with high precision using the acceleration data acquired from smartphones of able-bodied pedestrians [1]. However, it is difficult to keep users motivated because the task of "just walking" offers a weak incentive for users to collect a large amount of data. To address this issue, we propose a barrier information gathering system based on gamification; users can collect acceleration data by playing an encampment battle game. The contributions of this work include the following:

- A novel method for collecting a large amount of acceleration data used to estimate the existence and type pf barriers with high precision by introduction of gamification.
- A development of encampment battle game for users to collect acceleration data.

2 Related Works

Gamification is an action of the addition of game-specific ideas and mechanisms to provide users with incentives in areas other than games [2] [3]. This allows the user to continue monotonous work such as power saving, cleaning, and information gathering. A gamification framework for collecting sensor data has been proposed [4], however, this method does not support people to collect sensor data of walking behavior.

3 Goal

Since there are many barriers in living space, it is important to collect barrier information and provide impaired people with this information. Barrier assessment activities by professional investigators cost too much, hence, it is effective to use a method that estimates the existence and type of barriers with high precision using the acceleration data acquired from smartphones of able-bodied pedestrians [1]. As described in [1], a method based on a deep learning approach requires much larger amounts of data than basic machine learning approaches. However, the task of collecting walking data is monotonous and it is difficult for people to stay motivated because there is no direct incentive. To the best of our knowledge, existing works have not dealt with this problem. These lead us to set our goal to keep users motivated during the walking data collection.

4 Approach

In order to solve the problem described in the foregoing section, it is necessary to give some motivation for monotonous work. As described in Section 2, gamification is often used as a means for providing people with some motivation to conduct a monotonous work. Therefore, we introduce a gamification approach. At this time, it is necessary to select the type of game to be used appropriately according to the given task. The task we want users to perform is to walk inside and outside and collect walking data.

A game with high affinity to this task is a location-based mobile game. Ingress Prime [5], a typical example of this type of game, has been distributed to more than 200 countries and regions around the world, and has recorded more than 20 million downloads. It is inferred that this type of game is highly acceptable to the user. When observing a set-up game of multiple commercial products, the most engrossing factors are the score by position acquisition, the ranking of each user based on the score, and the team division to allow the users to divide into multiple groups and compete. This is recognized as playing an important role.

Based on the above observation and consideration, we propose a system that collects walking data while maintaining a user's motivation through the use of an encampment battle game. In this system, the user can expand her/his territory by actually walking

inside and outside. In order to keep users engaged and motivated, elements of score, ranking, and team division are also incorporated. The following sections describe specific implementation content and its effects.

5 An Encampment Battle Game Based on Users Walking

5.1 Walking Data Collection

The walking data collection is classified into two broad categories: "unsupervised walking data collection" and "supervised walking data collection". Unsupervised walking data collection is the act of collecting walking data for use with unsupervised machine learning. This act could be done at low cost because the user does not have to add metadata (e.g., barrier type) to walking data. On the other hand, supervised walking data collection is the act of collecting walking data for use with supervised machine learning with the barrier type as a label. This act costs too much because it is necessary for the user to record the barrier type and the barrier start and end points as metadata.

5.2 Game Summary

A prototype system is shown in Fig. 1. In this game, users are divided into teams and walk while collecting walking data to expand their territories by walking. In this game, the user collects walking data while using three actions properly. The three actions are *Gain*, *Shield*, and *Break*. The greatest feature of this game is that it maps the high cost of walking data collection to the high value of the action in the game. More specifically, we map low-cost unsupervised walking data collection to the low-value Gain action in the game. In addition, we map high-cost supervised walking data collection to the high-value Shield/Break actions in the game. The outline of these actions is follows:

- Gain action: The user can acquire territories.
- Shield action: The user can acquire territories and can shield it.
- Break action: The user can break the shield of the other team and can acquire territories and shield it.

In addition, this game incorporates score, ranking, and team division elements. The outline of these elements is follows:

- Score: The score can be increased each time the user expands her/his territory.
- Ranking: The higher the user's score, the higher the ranking.
- Team division: The users can select one team they want to belong to from multiple teams.

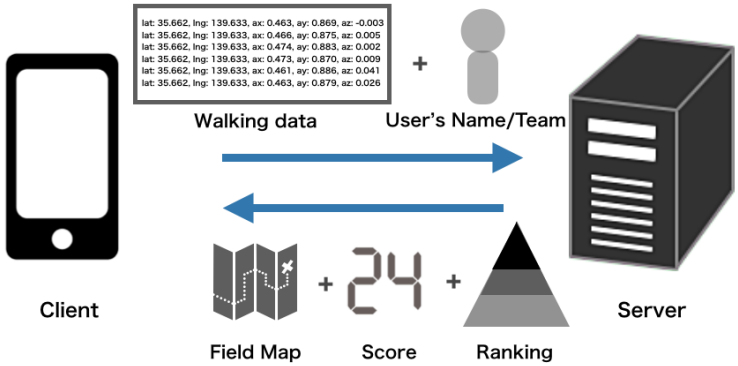

Fig. 1. Overview of the proposed system.

6 Evaluation and Conclusion

We proposed a barrier information gathering system based on gamification where users could collect acceleration data by playing an encampment battle game. We have conducted comparative experiments to verify whether the existing or the proposed method results in users staying more motivated. The results of the evaluation task show that our approach could provide users with motivation for collecting walking data. In future work, we need to increase the number of subjects and determine if this difference is significant. In future work, we plan to verify the difference between the quality of acceleration data with and without gamification. Also, we plan to publish barrier information detected from the acceleration data collected in this game as a barrier-free map.

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