英文分会

English Paper Track

Wong, L.-H., Cheng, H., Lin, C.-P., Huang, R., Guo, S., & Guo, J. (Eds.) (2020). Proceedings of the 24th Global Chinese Conference on Computers in Education (GCCCE 2020). Lanzhou, China: Northwest Normal University.

What make students improve argumentation skills in online collaboration?

The effects of students' motivation and preference for group work

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Abstract: *Online collaboration is considered as one of the effective strategies to improve students' argumentation skills. This strategy reduces the effects of production blocking and evaluation apprehension on group performance. There are currently few studies that examine the role of students' characteristics in argumentation skill improvement via online collaboration. During a fifty-minute argumentation lesson conducted by the secondary school English language teacher, students learned to construct argumentation by establishing ideas, claims, and evidence in an attempt to address contemporary issues via an online collaboration system. Prior to the lesson, students completed a motivation scale and preference for group work scale and an argumentation writing task. A similar argumentation writing task was also completed by the students after the lesson. Overall, this study demonstrated that explicit instruction in argumentation skills via online collaboration has positive effects on student' argumentation skills gains, especially on students with a high preference for group work. Results showed that students' extrinsic goal orientation negatively predicted their argumentation skills, whereas students' task value and preference for group work positively predicted their argumentation skills on the posttest. The implications of the findings on the teaching practices of argumentation skills are discussed.*

Keywords: argumentation skills, online collaboration, motivation, preference for group work

1. Introduction

An educational goal is not only about what students know, but also about how and why they know. When students conduct inquiries, interpret and evaluate evidence and make claims, they construct a deeper understanding of the topic at hand (Simon, Erduran, & Osborne, 2002). Students with good argumentation skill could evaluate the sufficiency or necessity of existing evidence, and judge the validity of claims (Lin & Mintzes, 2010). Argumentation is one of the crucial thinking skills in the toolkit of the 21st century (Trilling & Fadel, 2012).

Online collaboration is considered as one of the potential pedagogical strategies to improve students' argumentation skills (Liu, Liu, & Lin, 2018). There are many benefits of online collaborative argumentation as compared with face-to-face (F2F) collaborative argumentation. One of the benefits with online collaboration is students' ability to share their ideas, claims and evidence simultaneously via an online system without the need to group members would have to take turns to express their ideas. Specifically, online collaborative argumentation settings reduce production blocking and students could share their ideas, claims and evidence without the limitation of turn-taking and shame avoidance (Paulus & Nijstad, 2003). This would expose them to multiple perspectives and thus stimulate their improvement in argumentation (Noroozi, Hatami, Bayat, van Ginkel, Biemans, & Mulder, 2018). It should be noted that not every student can be equally stimulated for argumentation to take place. Previous studies on collaborative argumentation have shown that most students are inadequately prepared to analyze the claims and evidence shared by others and to construct their own arguments (Naylor, Keogh & Downing, 2007). Therefore, it is reasonable to assume that students' characteristics could affect their achievement in online collaborative argumentation.

Motivation is a crucial factor that affects students' academic achievement (Mega, Ronconi, & De Beni, 2014). It is dynamic and contextually bound, that is, students' motivation varies in different lessons (Duncan & McKeachie, 2005).

According to Duncan and McKeachie (2005), motivation includes six dimensions: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. Intrinsic goal orientation means that students focus on learning and mastery; whereas extrinsic goal orientation means that students focus on grades and approval from others when they are learning. Task value refers to students' judgements of how interesting, useful, and important is the course content. Control of learning beliefs refers to students' beliefs that outcomes are contingent on one's own effort, rather than external factors such as the teacher or luck. Self-efficacy for learning and performance refers to students' judgments of their ability to accomplish a task and confidence in one's skills to perform a task are collapsed within the general term self-efficacy. Finally, test anxiety refers to students' worry and concern over taking examinations.

Accumulative studies have shown that students with different academic achievements (e.g., high, average, and low) show differences in their motivation (Turner, Chandler, & Heffer, 2009). For example, students' intrinsic motivation, task value, control of learning beliefs, and self-efficacy for learning and performance positively predict their academic achievement. This is because students with high characteristics in these dimensions tend to engage in deep-processing strategies and metacognitive regulation whereas students' extrinsic goal orientation and test anxiety negatively predict their deep-processing strategies and achievement (Høigaard, Kovac, Øverby, & Haugen, 2015; Turner et al., 2009). Therefore, it is reasonable to assume that students' motivation may be related to their argumentation skills improvement via online collaboration.

Furthermore, the improvement of students' argumentation skills might be influenced by their preference for group work via online collaboration. Students' preference for group work refers to the degree to which students have strong preferences for group work rather than individual work (Shaw, Duffy, & Stark, 2000). Previous studies have shown that the students who have a strong preference for group work display better individual performance of various tasks in groups (Shaw et al., 2000). For example, students with a strong preference for group work perform better with decision-making and creative tasks in a group context (Larey & Paulus, 1999; Tekleab & Quigley, 2014). Thus, it logically follows that the students who prefer group work would be more satisfied and perform more effectively in group settings, while those with a preference for individual work would be more satisfied and perform more effectively when tasks are more individualized. Taken together, these studies support the view that students' preference for group work is strongly related to their performance in the group context.

Currently, there are few studies that test the role of students' characteristics in argumentation skills improvement via online collaboration. Hence, this study will focus mainly on the relationship between students' characteristics of motivation and preference for group work and their acquisition of argumentation skills through online collaboration by comparing their argumentation skills from the pretest and the posttest.

On the basis of previous studies, we hypothesized that: (1) Students' argumentation skills would be improved after the online collaborative argumentation intervention. (2) Students' intrinsic goal orientation, task value, control of learning beliefs, and self-efficacy for learning and performance would positively predict their argumentation skills on the posttest, while students' extrinsic goal orientation and test anxiety would negatively predict their argumentation skills on the posttest. (3) Students' preference for group work would positively predict their argumentation skills after online collaborative argumentation intervention. (4) Students with a high level of intrinsic goal orientation, task value, control of learning beliefs, and self-efficacy for learning and performance would show better argumentation skills on the posttest than on the pretest, while students with a low level of these characteristics would gain similar scores on the pretest and posttest of argumentation. (5) Students with a low level of extrinsic goal orientation and test anxiety would show better argumentation skills on the posttest than the pretest, while students with a high level of these characteristics would gain similar scores on the pretest and posttest of argumentation. (6) Students with a strong preference for group work would show better argumentation skills on the posttest than on the pretest.

2. Methods

2.1. Participants, Context and intervention

A class of 37 secondary one students (13 years old on average) in Singapore participated in the study. All students were proficient in using the computer as a learning tool. All the students were heterogeneously grouped by the teacher. There were ten groups, with three to four students in each group. Each group comprises students of varying academic abilities. The teacher had two years of experience in English language teaching and she is tech-savvy. The teacher and students had given written informed consent for this study.

Prior to the study, researchers provided professional development sessions on how to design and deliver collaborative argumentation lessons via an online collaborative system developed by our research team. The collaborative argumentation activities were co-designed by the teacher and the researchers. Students were tasked to answer the argumentation question "Do you agree that social media negatively influences youth's ideas of harmony in Singapore?" during the fifty-minute English language lesson that took place in the computer laboratory. Before the intervention, all students completed a survey on motivation and preference for group work. Students addressed the argumentative question by constructing and refining their explanations via the online collaborative system. All students were also tasked to write argumentative essays to the same question before and after the lesson as pretest and posttest.

2.2. Online collaboration system

The AppleTree system developed by the authors (Figure 1) was employed for the online argumentation task. This system was designed for supporting generalized coordination of collaborative argumentation among students. The system possesses a graph-based argumentation workspace to represent argument elements, where a cloud represents an idea, an ellipse represents a claim, and a rectangle represents an evidence.

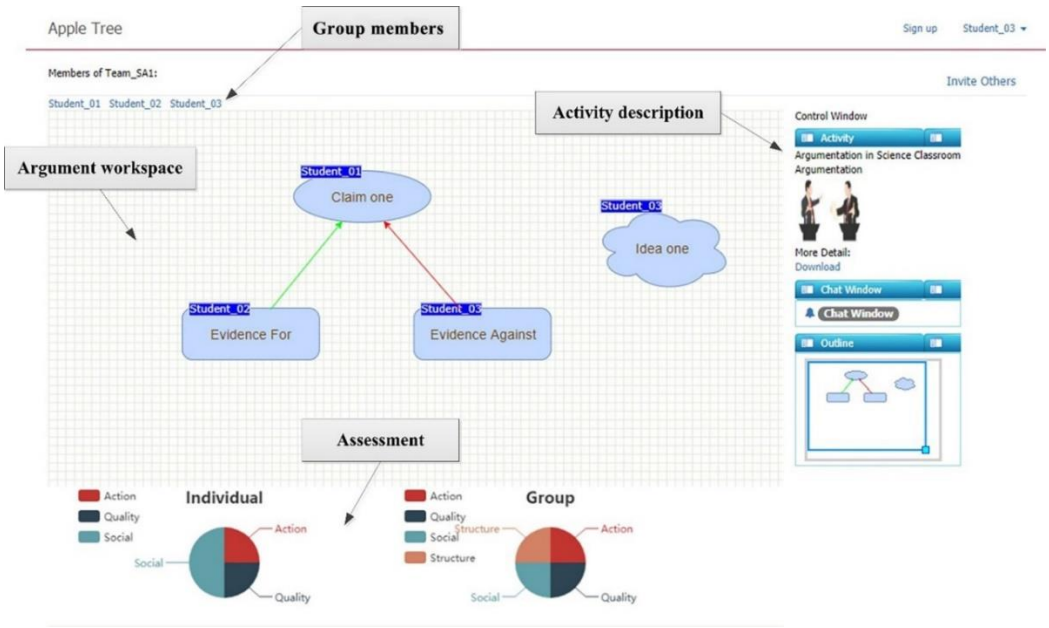

Figure 1. Screenshot and explanation of AppleTree system.

2.3. Measures

2.3.1. Motivation scale

Motivated Strategies for Learning Questionnaire (MSLQ) motivation scale was used to measure students' motivation (Duncan & McKeachie, 2005). The scale included 31 items and the items were divided into six dimensions: intrinsic goal

orientation (four items), extrinsic goal orientation (four items), task value (six items), control of learning beliefs (four items), self-efficacy for learning and performance (eight items), and test anxiety (fine items). Students answered the items on a 5-point Likert-type scale, from 1 (not at all true of me) to 5 (very true of me). Each dimension had satisfactory reliability in the study (Respectively, Cronbach's $\alpha = 0.82, 0.79, 0.88, 0.76, 0.91, 0.74$).

2.3.2. Preference for group work scale

Eight items were used to measure students' preference for group work from the preference for group work scale (Shaw et al., 2000) and group preference scale (Larey & Paulus, 1999). Students responded to the items on a 5-point Likert-type scale, from 1 (not at all true of me) to 5 (very true of me). The scale had satisfactory reliability in the study (Cronbach's $\alpha = 0.91$).

2.4. Rubrics for students' argumentation essays

Students' argumentative essays were assessed by their performance in the argumentation question: Do you agree that social media negatively influences youth's ideas of harmony in Singapore? Each student's answer was rated on a 4-point scale by the teacher. The rubrics are shown in Table 1.

Table 1. The rubrics of argumentation.

Criteria	Level 1: Below Expectations	Level 2: Approaching Expectations	Level 3: Meeting Expectations	Level 4: Exceeding Expectations
Explanation	No evidence.	Attempt that providing evidence.	Provides adequate evidence.	Provides substantial evidence.
Rating details	Uses details and pieces of evidence that are inadequate and irrelevant.	Uses details that attempt to develop the argument but there may be contradictions and omissions.	Uses details and evidence that develop and support the argument.	Use details and evidence that strengthens the argument.

3. Results

3.1. Effects of intervention

The descriptive statistics of students' argumentation indicate that their performance on the pretest was generally not good before the instruction (mean (M) = 1.86, standard deviation (SD) = 0.67). After the instructional intervention, the students demonstrated improved skills in making claims, evidence, and ideas on the posttest (M = 2.30, SD = 0.91). The simple univariate effect of the instructional treatment was explored by comparing total pretest and posttest argumentation scores for all students, using a paired t-test. As our hypothesis predicted, students' scores on posttest were higher than scores on pretest ($t(36) = 2.74$, $p = .009$). Initially, it seemed that the students' argumentation skills were significantly enhanced by the treatment.

3.2. Motivation and preference for group work as predictors of argumentation skills

In order to explore the combined and relative effects of intrinsic goal orientation (X_{11}), extrinsic goal orientation (X_{12}), task value (X_{13}), control of learning beliefs (X_{14}), self-efficacy for learning and performance (X_{15}), test anxiety (X_{16}), and preference for group work (X_2) on argumentation skills (Y), six dimensions on motivation and preference for group work were entered into a multiple linear regression analysis to predict posttest scores: $Y = \text{Constant} + \alpha X_{11} + \beta X_{12} + \gamma X_{13} + \delta X_{14} + \varepsilon X_{15} + \zeta X_{16} + \eta X_2$ (α, β, γ, δ, ε, ζ, and η in the equation are regression coefficients of different dependents).

As partially hypothesized, students' extrinsic goal orientation negatively predicted their argumentation skills on posttest, but students' task value and preference for group work positively predicted their argumentation skills (Table 2). The results suggested that students with a high level of extrinsic goal orientation showed lower argumentation skills, but students with a high level of task value and preference for group work showed high argumentation skills.

Table 2. Results of multiple linear regression analysis.

Model	Unstandardized B	Coefficients SE	Standardized Coefficients Beta	*t*	*p*
Constant	2.97	1.18		2.51	.018
Intrinsic goal orientation	-0.03	0.61	-0.02	-0.05	.957
Extrinsic goal orientation	-0.57	0.29	-0.38	-1.98	.058
Task value	1.14	0.57	0.61	1.99	.056
Control of learning beliefs	-0.29	0.55	-0.16	-0.53	.602
Self-efficacy for learning and performance	-0.82	0.47	-0.45	-1.74	.093
Test anxiety	-0.26	0.28	-0.17	-0.92	.365
Preference for group work	0.63	0.30	0.38	2.07	.047

3.3. Effect of extrinsic goal orientation on argumentation skills

To test the effect of students' extrinsic goal orientation on argumentation skills, students were classified as low extrinsic goal orientation and high extrinsic goal orientation. The descriptive statistics are shown in Table 3.

Table 3. Descriptive statistics of argumentation skills among students with low and high extrinsic goal orientation.

Argumentation	Extrinsic goal orientation	*n*	*M*	*SD*
Pretest	Low	19	2.05	0.71
	High	18	1.67	0.59
Posttest	Low	19	2.58	0.77
	High	18	2.00	0.97

A Repeated Measurement Analysis of Variance (ANOVA) was conducted, with argumentation test as within-subjects factor and students' classification as between-subjects factor. The main effects of argumentation test and students' classification were observed, but the predicted interaction was not found (Table 4). The main effect of argumentation test showed that students gained higher scores on the posttest than on the pretest; and the effect of students' classification showed that students with low extrinsic goal orientation gained higher argumentation skills than those with high extrinsic goal orientation (Figure 2a).

Table 4. The results of ANOVA.

Classification criterion	Source of variation	Type III sum of squares	*df*	*F*	*p*	η_p^2
Extrinsic goal orientation	Test	3.42	1	7.30	.011	0.17
	Classification	4.30	1	5.97	.020	0.15
	Test × classification	0.17	1	0.37	.548	0.01
Task value	Test	3.39	1	7.37	.010	0.17
	Classification	0.20	1	0.24	.629	0.01
	Test × classification	0.42	1	0.91	.347	0.03
	Test	3.64	1	8.73	.006	0.20

Preference for group	Classification	2.71	1	3.54	.068	0.09
work	Test × classification	2.09	1	5.06	.031	0.13

Note: We used a significance level of .05 for all analyses. Partial eta square (η_p^2) was reported as a measure of effect size for the ANOVAs, with η_p^2 = 0.01, η_p^2 = 0.06, and η_p^2 = 0.14 corresponding to small, medium, and large effects, respectively (Cohen, 1988).

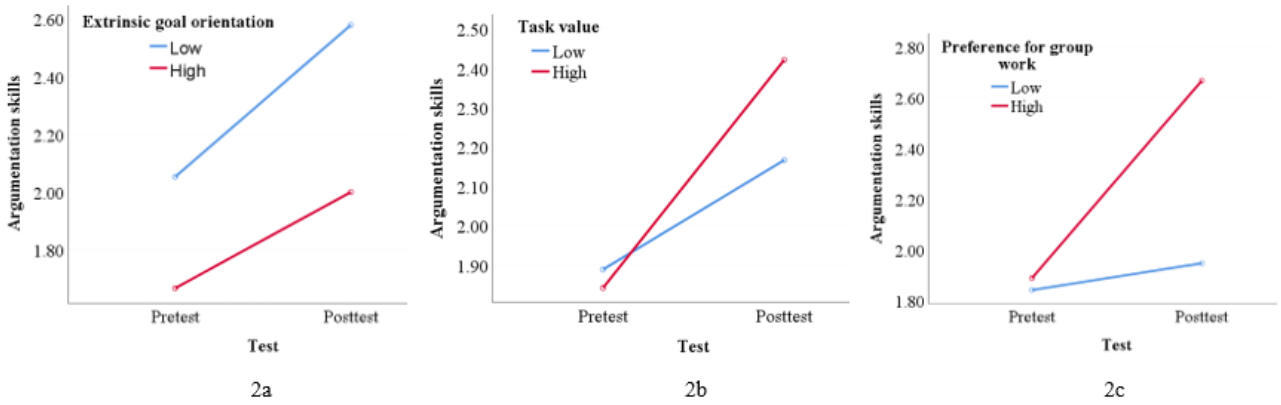

Figure 2. The differences on pretest and posttest between the students with low and high extrinsic goal orientation.

3.4. Effect of task value on argumentation skills

To test the effect of students' task value on argumentation skills, students were classified as low task value and high task value. The descriptive statistics were shown in Table 5.

Table 5. Descriptive statistics of argumentation skills among students with low and high task value.

Argumentation	Task value	*n*	*M*	*SD*
Pretest	Low	18	1.89	0.83
	High	19	1.84	0.50
Posttest	Low	18	2.17	0.86
	High	19	2.42	0.96

The ANOVA results only found the main effect of argumentation test, not the main effect of students' classification and the predicted interaction (Table 4). The main effect of argumentation test showed that students gained higher scores on the posttest than on the pretest (Figure 2b).

3.5. Effect of preference for group work on argumentation skills

To test the effect of students' preference for group work on argumentation skills, students were classified as having a low preference for group work and high preference for group work. The descriptive statistics is shown in Table 6.

Table 6. Descriptive statistics of argumentation skills among students with low and high preference for group work.

Argumentation	Preference for group work	*n*	*M*	*SD*
Pretest	Low	19	1.84	0.83
	High	18	1.89	0.47
Posttest	Low	19	1.95	0.71
	High	18	2.67	0.97

The ANOVA results showed the main effect of argumentation test, the interaction, and the main effect of students' classification reached marginally significance (Table 4). As expected, students with high preference for group work gained higher scores on the posttest than on the pretest ($t(17) = 3.76$, $p = .002$), while those with low preference for group work gained similar scores on the posttest with the pretest ($t(18) = 0.49$, $p = .630$) (Figure 2c).

4. Discussion

This study examined the effects of students' motivation and preference for group work on their argumentation skills improvement after an online collaborative argumentation intervention. The results confirmed the beneficial effects of the online collaborative argumentation intervention on improving students' argumentation skills. More importantly, students' extrinsic goal orientation negatively predicted their argumentation skills, but students' task value and preference for group work positively predicted their argumentation skills on the posttest. Interestingly, students having a strong preference for group work showed more argumentation skills gains than those having a weak preference for group work. This study represents unique contributions to the argumentation literature in that the findings highlight the interaction role of students' characteristics and the online collaboration instruction for students' argumentation skills.

Previous research has shown that middle school, high school, and undergraduate students can be taught to construct better arguments when the teacher explicitly focuses on argumentation skills and provides opportunities for practising these skills (Osborne et al., 2004). Results from this study are consistent with past studies as they had demonstrated that the online collaborative argumentation intervention was able to help students improve their argumentation skills (Osborne, Erduran, & Simon, 2004). However, this simple picture became substantially more complex after further consideration of the effects of students' characteristics on their argumentation skills.

Considering students' motivation, we found that students having a low level of extrinsic goal orientation, but having a high level of task value tended to gain more argumentation skills after the collaborative intervention. As mentioned earlier, introducing incentives, such as food and water, disrupted rather than facilitated puzzle-solving among their subjects, rhesus monkeys, extrinsic motivation can have a negative connotation (Lin, McKeachie, & Kim, 2003). Furthermore, extrinsic rewards undermined the students' feeling of self-determination and freedom of choice (Deci & Ryan, 1991). Therefore, the students having higher extrinsic goal orientation gained fewer argumentation skills after the intervention. In addition, students with high task value were more likely to use deep-processing strategies and metacognitive regulation (Høigaard et al., 2015; Turner et al., 2009). Therefore, those students used their cognitive sources to master argumentation skills.

Moreover, the results of the study further suggest that explicit instruction in argumentation skills could have more positive effects on students with a high preference for group work, which is also consistent with previous studies (Lin & Mintzes, 2010; Tekleab & Quigley, 2014). For example, Lin and Mintzes (2010) found that nearly half of the students, including some high achievers, did not demonstrate well-developed skills in making arguments. Argumentation is one of the high order thinking skills, and it is a more difficult cognitive task for most students (Garcia-Mila & Andersen, 2007). During the collaboration, the students with a strong preference for group work tended to interact more with their peers, and consequently, they were more likely to share their ideas, claims, and evidence with peers; whereas, the students with a low preference for group work prefered to solve problems by themselves. Therefore, they were more prone to answering argumentation questions on their own (Larey & Paulus, 1999; Tekleab & Quigley, 2014). Therefore, the students with a strong preference for group work mastered more argumentation skills after online collaboration intervention. This illustrates that individual differences in learning argumentation skills and knowledge about the issue cannot be ignored.

To conclude, what stands out in the present study is that explicit instruction in argumentation skills via online collaboration has positive effects on student' argumentation skills gains, especially on students with high preference for group work; students' extrinsic goal orientation negatively predicted, but students' task value and preference for group work positively predicted their argumentation skills on the posttest. The findings lead to a strong recommendation for

explicit argumentation teaching: Teachers should reduce students' extrinsic goal orientation, but increase the task value and students'preference for group work.

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Using gamification in an English-as-Second-Language (ESL) kindergarten context: Effects on Chinese preschoolers' classroom behavior and English learning performance

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Abstract: *This paper describes the findings of a quasi-experiment that examined the effect of gamification on Chinese preschool children's ESL learning and classroom behaviors. One class (n = 25) kindergarteners used the digital points and leaderboard available in ClassDojo, a free online classroom management system, another class (n =25) used a non-digital system where points and the leaderboard were displayed in writing on a class poster, while another class (n = 25) preschoolers used the traditional classroom format where the teacher gave verbal praise. All three classes were taught by the same teacher using identical learning materials. Data sources included the preschoolers' pre-test and post-test English scores, as well as the teacher's observations of the preschoolers' classroom behavior. The results showed that the use of digital points and leaderboard significantly improved the preschoolers' ESL learning compared to the other two groups. Teacher observational data showed that the gamified preschool class exhibited more positive and on-task classroom behaviors than the traditional point-leaderboard poster class and the traditional verbal praise class.*

Keywords: gamification, game elements, English as Second Language (ESL), early childhood, engagement

1. Introduction

English language education is currently a mandatory requirement for education at all levels in Mainland China (Jin, Wu, Alderson, Song, 2017). Yet despite its importance, Chinese students say that "the only significant learning occurs in the first three years of junior secondary, because the final three years of high school having been hijacked by endless drills for the high-stakes college entrance exams" (Yeung, 2017, para. 2). We believed that the learning of English should start as early as possible in a child's education, such as at the preschool or kindergarten stage. However, previous research has shown that low student motivation towards learning English has had a significant negative impact on students' English language attainment (Poon, 2009). Limited contact with an English community can adversely affect their motivation to learn the language.

Classroom behaviors can also affect children's learning (Turney & McLanahan, 2015). Previous research has often reported that behavioral problems increase during class (Hutchings et al., 2013). Learners with behavioral problems often run the risks of academic failure. Findings from the Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K) show that learners who exhibit behavior problems tend to score lower in reading and math tests than those without behavior problems (DiPrete & Jennings, 2012). Frequent classroom behavioral problems include learners' failure to pay attention in class, or failure to respond actively (Pianta, Cox, & Snow, 2007). Among these classroom behavioral problems, attention-related behaviors exert more significant influence on learners' school success (Razza, Martin, & Brooks-Gunn, 2012). Therefore, addressing classroom behavioral problem is often an important target for school intervention.

Traditionally, teachers have used a myriad of ways to promote students' appropriate classroom behaviors and motivate students to learn English. These include the use of rewards (e.g., giving marks, and praising students), or punishments (e.g., deducting marks, issuing warning notes). In this paper, we were interested to examine the use of gamification as an alternative means to promote appropriate classroom behaviors, and motivate students to learn

English. Gamification may be more specifically defined as the application of digital game elements in non-gaming contexts to motivate user behavior (Educause, 2011). Some of the common game elements used in gamified applications are badges, challenges, leaderboard/rank, levels/unlock, storyline, points, progress bar, and teams (Huang & Hew, 2018).

Gamification is a rapidly evolving phenomenon which is attracting much hype in the education field for its perceived potential to promote user engagement and learning. Gamification has emerged as one of the most significant phenomenon in recent years. A recent online article reported that the global gamification market was valued at US$6.8 billion in 2018 and it is expected to reach US$40 billion by 2024 (ReportLinker, 2019). Yet, despite the interest in gamification as a promising new method to engage individuals, it has also attracted controversies and critiques. Although some research has reported positive effects of gamification (e.g., Marín, Frez, Cruz-Lemus, & Genero, 2018), there are critics who argue that current forms of gamification are shallow and superficial (e.g., Bogost, 2011). There are also others who caution about the possible negative effects of gamification (e.g., Toda, Valle, & Isotani, 2018).

Hitherto, a majority of education-related gamification studies to date had been conducted in the higher education sector (de Sousa Borges et al., 2014; Dicheva et al., 2015). To the best of our knowledge, no published research has taken place at the kindergarten or preschool level. There is a distinct lack of experimental studies that examine the potential of gamification in the preschool context. In response to this, this paper investigates the potential of gamification on improving classroom behavior and learning of ESL among preschool children in a Southern city in Mainland China.

3. Method

The main purpose of this study was to compare the use of digital points and leaderboard afforded by ClassDojo (ClassDojo, n.d.) versus a traditional points-leaderboard classroom where the points and the leaderboard were displayed in writing on a class poster, and a traditional classroom where the teacher gave verbal praise on Chinese preschool children's English learning and classroom behavior engagement. Points refer to tokens that can be collected by users, which can be used as status or progression indicators. The following main questions were addressed in this study:

Research question 1: To what extent does the use of digital points and leaderboard have an impact on preschool children ESL learning when compared to a traditional points-leaderboard poster classroom, and a traditional verbal praise classroom?

Research question 2: To what extent does the use of digital points and leaderboard influence preschool children classroom behavior when compared to a traditional points-leaderboard poster classroom, and a traditional verbal praise classroom?

3.1. Participants

This study consisted of a total of 75 kindergarten children. The first class (n = 25, treatment group) used a free online learning management platform called ClassDojo, and the second class (n = 25, traditional points-leaderboard group) did not use ClassDojo. The third class (n = 25, control group) did not use any game elements. In the three classes, the content of the classes for the children were the kindergarten's English textbooks. The same English teacher taught all three classes. Each week the preschool children had two sessions of English lessons for three weeks. All the preschool children were six years old. Ethical approval for data collection and student/parents/principle consent were obtained before the project began.

In order to help the preschool children better understand the use of gamification, the rules of the game elements were explained to the treatment group in advance. During these lessons, ClassDojo was used to award points to students for achieving certain targeted behavior (e.g., answer questions). For example, in class, the children needed to raise their hands to answer questions after hearing the questions raised by the teacher. Each correct answer would earn 2 points which were recorded manually by the teacher on the class' homepage on ClassDojo, while wrong answers would not be

added or subtracted. For the treatment group, teacher introduced the avatars in ClassDojo to students, each student had his or her own cartoon avatar (Figure 1). At the bottom of each avatar laid the name of each student and the number displayed in the bottom right corner of the avatar was the score obtained by the student after correctly answering the question. The teacher used the overhead projector to display the class home page (Figure 1) on the whiteboard for all students to see. The scores of the students can also be sent to the parents through the ClassDojo account, so that the parents could keep track of the English learning performance of their children.

Children in the traditional points-leaderboard poster group did not use ClassDojo. The leaderboard in this group was pasted on the wall during the student's weekday class which can be seen at all times (Figure 2). The preschoolers did not have an avatar on the leaderboard; only the score for each child was shown on the class poster. Children in the control traditional class did not use any gamification. The same teacher who taught the treatment and traditional points-leaderboard groups taught the control group using the same textbook, and learning materials. The teacher in the control group also encouraged the children to answer the questions raised in class. Children who answered the questions correctly were verbally praised by the teacher.

Figure 1. Cartoon avatars in the treatment group (treatment group)

姓名	分数	姓名	分数	姓名	分数
Student 1		Student 10		Student 18	
Student 2		Student 11		Student 19	
Student 3		Student 12		Student 20	
Student 4		Student 13		Student 21	
Student 5		Student 14		Student 22	
Student 6		Student 15		Student 23	
Student 7		Student 16		Student 24	
Student 8		Student 17		Student 25	
Student 9					

Figure 2. Traditional points-leaderboard posted on the class wall

3.2 Measures: pre-test and post-test

The treatment group and control group were both tested before and after the research study. Before the research started, the children took a pre-test on paper to verify whether the two classes had significant differences in English performance. At the end of the project, the children also took a post-test on paper to determine whether the use of

gamification had any effect on the preschool children's English learning performance. The English words appearing in the pre-test and post-test were the words that the children would learn or had learned during class. The pre-test and post-test were at the same difficulty level as determined by the class teacher. The children were asked to match the eight words with the right pictures. The full score for both the pre-test and post-test was eight each. An example of the post-test is shown in Figure 3.

Figure 3. Questions in the post-test

3.3 Measures: classroom behavior

A behavior chart was used to record the teacher's observations of the children's classroom behavior during the lessons of the treatment, traditional point-leaderboard poster, and the control groups (Table 2). The specific behavioral indicators shown in Table 2 were informed by relevant literature (e.g., Razza et al., 2012; Tulley & Chiu, 1995) as well as the teacher's own expectations of the students during the lessons. In this study, we developed specific indicators to observe these behaviors (e.g., whether students listen to teacher, concentrate on learning). Each class had a teaching assistant who observed the children's classroom behaviors. Six rating categories - *Nearly all of the Students (except 1 or 2)*, *Most of the Students (except 3 or 4)*, *Some of the Students (6-10 students)*, *Only a few Students (4 or 5 students)*, *One or Two Students*, and *Not Applicable* – were used to quantify the behavior by the whole class during lessons.

4. Results

RQ 1: To what extent does the use of digital points and leaderboard have an impact on preschool children ESL learning when compared to a traditional points-leaderboard poster classroom, and a traditional verbal praise classroom?

Table 1 summarizes the results of the pre-test and post-test for the three groups. The result of the pre-test indicates that there was no significant difference among the three groups, as determined by one-way ANOVA ($F(2,72) = 1.221$, $p = 0.301$. Therefore, all three groups could be considered equivalent in terms of their prior English knowledge. With regard to the post-test results, there was a significant difference between groups as determined by one-way ANOVA ($F(2,72) = 14.231$, $p < 0.001$). A Tukey post hoc test revealed that the treatment group's post-test score was statistically significantly higher (4.56 ± 1.00, $p = 0.036$) compared to the traditional point-leaderboard poster group (3.8 ± 1.12). The treatment group's post-test score was also statistically significantly higher ($p = 0.001$) compared to the traditional verbal praise group (2.96 ± 1.06). The traditional point-leaderboard poster group had significantly higher post-test score ($p = 0.017$) than the traditional verbal praise group.

Table 1. Results of the pre-test and post-test scores.

	Pre-test		Post-test		
Group	Mean	SD	Mean	SD	Pairwise comparison
Treatment (n = 25) (G1)	3.36	1.50	4.56	1.00	G1 > G2*; G1 > G3**

Traditional point-leaderboard poster (n = 25) (G2)	3.48	1.50	3.80	1.12	G2 > G3*
Control (n = 25) (G3)	2.88	1.30	2.96	1.06	

*$p < 0.05$, **$p < 0.01$ (Tukey post hoc test)

RQ 2: To what extent does the use of digital points and leaderboard influence preschool children classroom behavior when compared to a traditional points-leaderboard poster classroom, and a traditional verbal praise classroom?

A total of 18 lessons were observed, each group was observed in six lessons. Table 2 shows the performance of the treatment group, while Table 3 and Table 4 show the performance of the traditional point-leaderboard group and control group respectively. In each table, every particular behavior has two figures under each of the six measurements. For example, the behavior *Concentrating on learning* in Table 2 (treatment group) displays 4 and 67% under the measurement *Nearly all of the students*. The first figure shows the *number of lessons* that the treatment group achieved that measurement, while the second number is this number of lessons expressed as a percentage of the total number of lessons observed (n = 6). So, in about 67% of the classes, *nearly all of the students* in the treatment group concentrated on learning during the English lessons. Table 2 shows that the majority of students in the treatment group behaved considerably well in all behavior categories. The treatment group achieved a score of over 80% in all five categories (A, B, C, D, E) for *nearly all of the students*, and *most of the students*. For example, in 100% of the lessons nearly all or most of the students concentrated on learning, and in 84% of the lessons nearly all or most of the students actively raised their hands to answer the questions. Compared to the treatment group, the traditional point-leaderboard poster group achieved a score of over 80% in only three categories (A, B, C) for *nearly all of the students*, and *most of the students* (Table 3).

Table 2. Behavioral chart data for the treatment group (n = 6 lesson observations)

	Assigned Points	5	4	3	2	1	0
Code	Behavior	Nearly all of the students	Most of the students	Some of the students	Only a few students	One or two students	N/A
A	Concentrating on learning	4 67%	2 33%	0 0%	0 0%	0 0%	0 0%
B	Obeying the Class order	5 83%	1 17%	0 0%	0 0%	0 0%	0 0%
C	Completing the instructions	6 100%	0 0%	0 0%	0 0%	0 0%	0 0%
D	Raising hands actively	4 67%	1 17%	1 17%	0 0%	0 0%	0 0%
E	Answering correctly	2 33%	3 50%	1 17%	0 0%	0 0%	0 0%

Table 3. Behavioral chart data for the traditional point-leaderboard poster group (n = 6 lesson observations)

	Assigned Points	5	4	3	2	1	0
Code	Behavior	Nearly all of the students	Most of the students	Some of the students	Only a few students	One or two students	N/A
A	Concentrating on learning	2 33%	3 50%	1 17%	0 0%	0 0%	0 0%
B	Obeying the Class order	2 33%	3 50%	1 17%	0 0%	0 0%	0 0%
C	Completing the instructions	2 33%	3 50%	1 17%	0 0%	0 0%	0 0%
D	Raising hands actively	2 33%	1 17%	3 50%	0 0%	0 0%	0 0%
E	Answering correctly	1 17%	2 33%	3 50%	0 0%	0 0%	0 0%

Students in the control classes exhibited less positive classroom behaviors in almost all behavior categories (Table 4). The percentage of lessons in which *nearly all the students* achieved the behavioral targets A to E was less than the treatment group, with the highest percentage being only 33%. When combining the measurements *Nearly all of the students* and *Most of the students* together, it can be seen that only two of the targeted behavioral goals were achieved in more than 50% of the lessons by most of the students or more. Instead, the majority of the targeted behavioral goals in the control group were achieved by *Some of the students*.

Table 4. Behavioral chart data for the control group (n = 6 lesson observations)

	Assigned Points	5	4	3	2	1	0
Code	Behavior	Nearly all of the students	Most of the students	Some of the students	Only a few students	One or two students	N/A
A	Concentrating on learning	1 17%	1 17%	4 67%	0 0%	0 0%	0 0%
B	Obeying the Class order	2 33%	2 33%	2 33%	0 0%	0 0%	0 0%
C	Completing the instructions	1 17%	2 33%	2 33%	1 17%	0 0%	0 0%
D	Raising hands actively	1 17%	1 17%	4 67%	0 0%	0 0%	0 0%
E	Answering correctly	0 0%	2 33%	4 67%	0 0%	0 0%	0 0%

To help illustrate the differences in behavior between the two groups better, a weighted mean score was obtained for each of the behavior types. Each of the six measurements were assigned points – 5 points - *Nearly all of the Students*, 4 points - *Most of the Students*, 3 points - *Some of the Students*, 2 points - *Only a few Students*, 1 point - *One or Two Students*, and 0 points for *Not Applicable*. The higher the weighted mean score, the more positive the classroom behavior. The weighted mean score was calculated by multiplying the number of lessons each behavior measurement was recorded in a particular behavior by the assigned points, and dividing this figure by the total number of lessons (count). For example, the mean score of 4.7 for treatment group concerning the classroom behavior *Concentrating on learning* was computed by (4 x 5 + 2 x 4 + 0 x 3 + 0 x 2 + 0 x 1 + 0 x 0) / 6 = 4.7. Figure 4 illustrates the differences in behavior among the three groups. Overall, the treatment group demonstrated more positive classroom behaviors than the other two groups. The treatment group scored a weighted mean score of 4.2 or more (equivalent to most of students showing a particular behavior in class) in all five behaviors, compared to the traditional leaderboard poster group that managed to score a mean of 4.2 in three behavior categories, and the control group that only managed to score a mean of 4 in just one behavior.

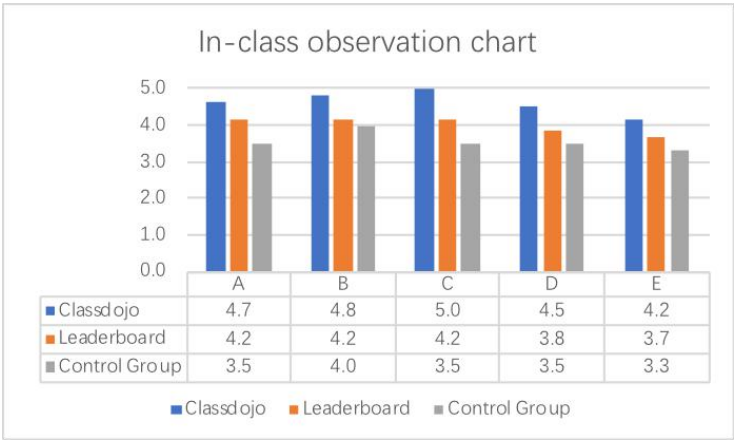

Figure 4. Weighted mean scores

5. Discussion and Conclusion

The aim of this paper was to explore if the classroom behavior and learning of ESL young children at a kindergarten in Southern China was influenced by the incorporation of gamification into the lessons. The results indicated that the use of gamification significantly improved the preschoolers' English learning and exerted a positive impact in influencing the behavior of the children during lessons.

One possible explanation for the favorable results for the treatment group concerning the preschoolers' learning and behavior is the motivating power of the game elements (e.g., digital points) which has previously been highlighted in previous empirical studies. Points can serve as a form of feedback by providing direct input on a user's performance (Richter et al., 2015). The display of points for each child can motivate learners to compare their performance with other learners. Such social comparison can push learners to be more engaged in their lessons (Chen & Chen, 2015). Since, motivation is a key factor in effective second language acquisition, this motivational aspect is extremely important in explaining the positive impact on learning for the treatment group. The motivational aspect inspires learners to try harder, thus subsequently increasing learner engagement and as a result improving the behavior of students during lessons, as observed in the treatment group (Wroten, 2014). The motivational power of the use of game elements encourages learners to pay more attention in class, complete the teacher's instructions, and be more willing to answer questions in class as illustrated in Figure 4, and as a result helps explain the positive impact on learning that gamification had for the experimental group.

Another possible explanation for the treatment group favorable results concerning learning and classroom behavior is the game-like attributes that Class Dojo brought to the lessons. Unlike the control and traditional point-leaderboard poster groups, the use of Class Dojo helped create a game-like learning environment in the treatment group in which the game elements were part of all aspects of a complete learning experience (Jacobs, 2013). Students were immersed in the experience throughout the whole lessons, as Class Dojo became part of the learning. This game-like environment helped create a positive attitude towards learning, with elements of challenge, such as earning points, enhanced with competition among the children, provided the preschoolers with the opportunity for recognition, increasing engagement, participation, and encouraging risk taking, and thus potentially explaining the favorable results for the treatment group both in learning and behavior (Educause, 2011; Jacobs, 2013). In addition, the use of the online ClassDojo created a heightened sense of pervasiveness in the learning environment. The children can view the class home page which shows each child's achievements inside as well as outside class. The teacher verbal praise system in the control group, and the traditional point-leaderboard poster can only be implemented in-class.

Limitations of the present study included the relatively short implementation duration of three weeks, and small sample sizes. Since this was the first time the pre-schoolers used gamification, there is a possibility that the positive learning and behavioral outcomes might be due to the novelty of gamification. For future research, a larger study in which young children are exposed to digital points for longer periods would therefore be beneficial in assessing its potential long-term impact on classroom behaviour and learning. Further studies should also focus on the impacts of digital points in a number of subject areas and not just English as Second Language.

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Development of Mathematical Concepts on Linear Functions Using a Technology-Supported Platform: With Potential for Flipped Classroom Strategy Implementation

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Abstract: *This paper reports on an intervention in the form of a two-day summer camp which used a technology-supported platform Cornerstone Maths to engage junior secondary students in a dynamic exploration of the mathematical concepts on linear functions. A total of 139 Grade 7 students from five secondary schools in Hong Kong participated in the intervention comprising two components – (i) 15 sessions for the self-directed exploration of four topic-specific mathematical concepts on "Speed", "Rate", "Slope", and "Slopes in Linear Equation", using the Cornerstone Maths platform and its corresponding workbook; and (ii) six sessions for the individual completion of four topic-specific consolidation worksheets, with mentor-guided group discussions. From the pre-post-tests, the intervention successfully supported the students to make statistically significant growth in understanding all of the four topic-specific mathematical concepts. From the questionnaire survey, the students positively perceived the support from the technology-supported platform and the mentor-guided discussions in their exploration of topic-specific mathematical concepts, particularly for learning the concepts on "Slope" and "Speed". These positive results imply the potential to implement the intervention as a flipped classroom strategy for mathematical inquiry among junior secondary students – in which students conduct self-paced learning with Cornerstone Maths platform and workbook before class, and then have face-to-face discussions about consolidation worksheet tasks in class.*

Keywords: exploration, junior secondary, linear functions, mathematical concepts, technology-supported platform

1. Introduction and Background of Study

"Linear functions" is an important topic in secondary mathematics education. Its topic-specific concepts are fundamental to the knowledge transition for learning other mathematical topics such as algebra and calculus (Byerley & Thompson, 2017; Johnson, 2015). The secondary mathematics curriculum in Hong Kong, as like the ones in other regions, focuses on instructing four concepts on linear functions – "Speed", "Rate", "Slope", and "Slopes in Linear Equation" (Byerley & Thompson, 2017; Curriculum Development Council, HKSAR, 1999). The instruction of these concepts aims at students' growth of two abilities: (i) to identify, connect and translate the linear relationship between covarying quantities in three ways – algebraic expression/equation, graphic representation, and tabular representation; and (ii) to understand and interpret the properties such as gradient and *y*-intercept from a structural view of linear functions and the corresponding graphic meanings (Johnson, 2015; Wang, Barmby, & Bolden, 2017). In conventional lessons on linear functions, students face a common challenge to reason about the relationship which involves multiplicative comparisons between changes in covarying quantities. Students are hard to use ratio-based reasoning for making sense of slope to make multiplicative relationships between quantities involved in slope, even though they are taught to know the definition of slope as a constant rate of change (Jiang, Hwang, & Cai, 2014; Wang et al., 2017).

Digital technology is well-recognized to be potential to transform mathematics education; many technology-supported platforms are so developed for mathematics education. These technology-supported platforms afford students to make physical operation of mathematical ideas through the dynamic visualization and interactive manipulation of mathematical objects, and so promote their cognitive development of mathematical ideas (Healy & De Carvalho, 2014; Hoyles, Noss, Vahey, & Roschelle, 2013). The technological affordances on dynamic visualization and interactive manipulation of mathematical objects are considered particularly helpful for learning the topics like "linear functions" which emphasize students' connection and interpretation of multiple representations of mathematical objects. The *Cornerstone Maths* platform is one of the well-established technology-supported platforms for learning the topic of linear functions (Clark-Wilson, Hoyles, Noss, Vahey, & Roschelle, 2015; Hoyles et al., 2013).

The *Cornerstone Maths* platform is a web-based software environment for engaging students in a dynamic and interactive process of exploring and understanding important but hard-to-teach mathematical concepts. Its content scope covers four units on four major topics in secondary mathematics curriculum, including linear functions (Clark-Wilson & Noss, 2015; Hoyles et al., 2013). The *Cornerstone Maths* unit on linear functions contains 14 investigation activities, in which students follow the activity instructions in the unit-specific workbook to use the unit-specific dynamic simulations for exploring the procedures of calculating speed, rate and slope; and interpreting the concepts of slopes in linear equation. The *Cornerstone Maths* software enables students to control the simulations by manipulating the parameters in the graph or the algebraic equation on the interface; and select to show or hide certain representations on the interface for their mathematical interpretation (Clark-Wilson & Noss, 2015; Clark-Wilson et al., 2015).

2. The Study: Research Design and Evaluation Methods

This study implemented and evaluated a technology-supported intervention, which used *Cornerstone Maths* platform and its workbook and supplementary with consolidated worksheet tasks, for students to explore concepts on linear functions. This study set to give evidence and confidence that the designed intervention is promising for flipped classrooms for mathematical inquiry. The intervention was administered as a two-day summer camp (see Figure 1). It contained 15 sessions of using the *Cornerstone Maths* platform and workbook for students' self-directed exploration of the four target concepts (see Figure 2); supplementary with six sessions for students to complete four topic-specific consolidation worksheets (see Figure 3). Mentor-guided group discussions concluded the consolidation worksheet tasks.

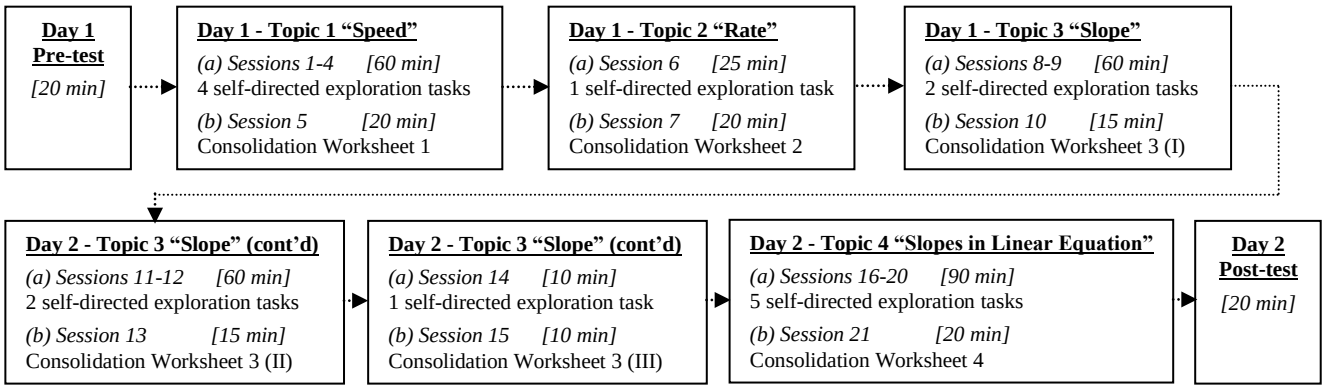

Figure 1. The flow of the two-day summer camp in the intervention.

A total of 139 Grade 7 students were successfully invited from five Hong Kong secondary schools, through an open invitation to all 465 local secondary schools (see Table 1). Each student strictly followed the scheduled flow as shown in Figure 1 to self-explore and consolidate the target concepts. This study focused on two research questions: (1) What did the learning achievement of the students in the intervention for exploring the mathematical concepts of linear functions? (2) How did the students perceive their learning experience in the intervention for exploring the mathematical concepts of linear functions? Two methods were adopted for evaluating the intervention.

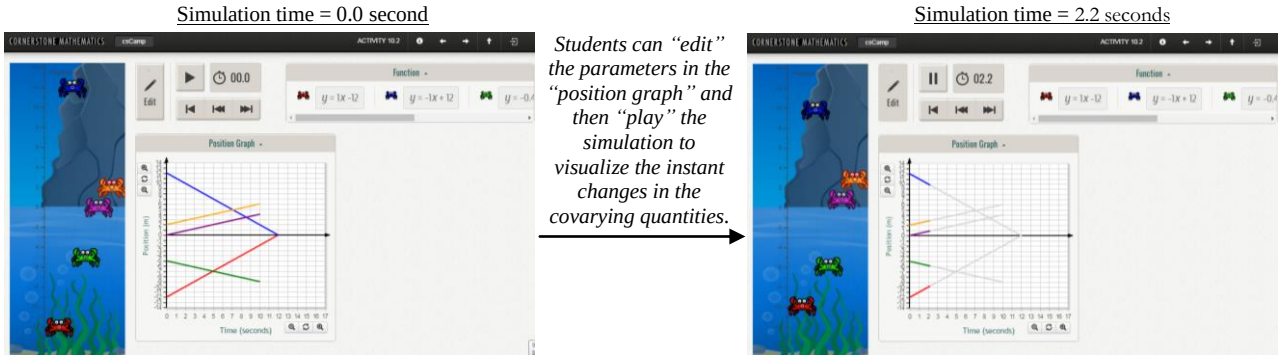

Figure 2. The interface of the *Cornerstone Maths* platform for exploring the concepts on linear functions.

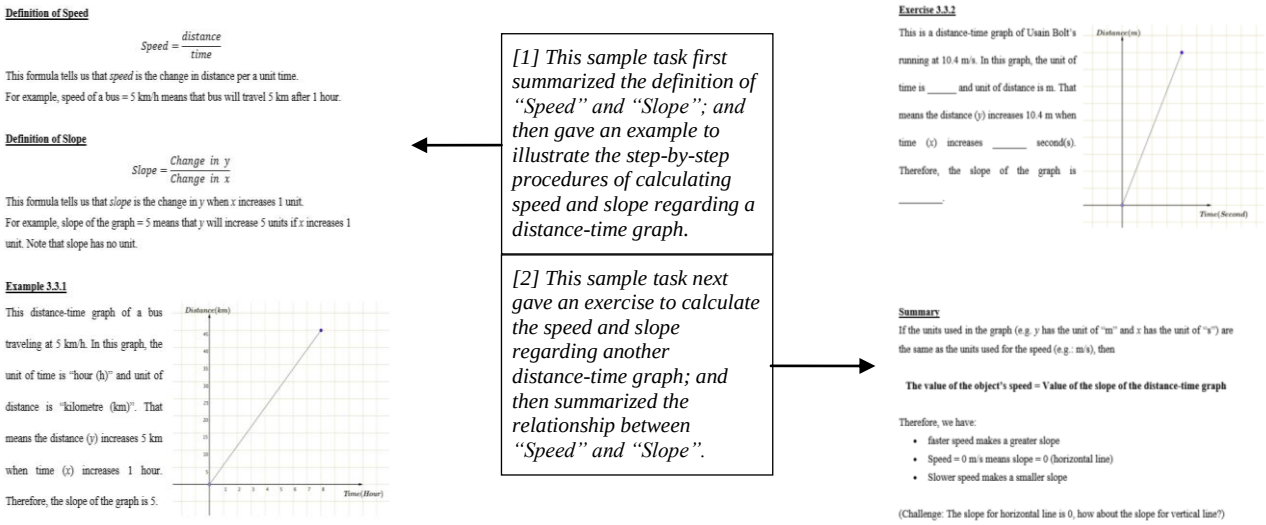

Figure 3. The sample of a consolidation worksheet task for exploring the concepts on linear functions.

Table 1. Profile of student participants in this study.

School	***School type***	***No. of participants***
School 1	An aided, co-educational, non-special secondary school	40
School 2	A government, co-educational, non-special secondary school	21
School 3	A government, co-educational, non-special secondary school	23
School 4	An aided, co-educational, non-special secondary school	40
School 5	An aided, co-educational, non-special secondary school	15
	Total	***139***

Firstly, the pre-post-tests were conducted at the beginning and the end of the intervention to investigate students' achievement of mathematical exploration in the intervention. The test papers contained 19 questions; of which seven questions on testing the concepts on "Speed", two on "Rate", three on "Slope", and seven on the overall perspective including "Linear Equation", "Reading Graph" and "Describing a Scenario based on a Graph". The Cronbach's alpha reliability coefficients for the pre-test and post-test are 0.752 and 0.739 respectively.

Secondly, a questionnaire survey was conducted at the end of the intervention to investigate students' perception of mathematical exploration in the intervention. The questionnaire contained eleven 4-point Likert scale questions which asked students to indicate how effective the intervention helped to learn and understand the four target concepts; how well they understood the four target concepts after the intervention; and how worthy for them to join the intervention for mathematical exploration. The Cronbach's alpha reliability coefficient for the questionnaire survey is 0.927.

3. Results and Discussion

3.1. Students' Achievement of Mathematical Exploration in the Intervention

The pre-post-tests found that the intervention effectively supported students to develop mathematical concepts on linear functions (see Table 2). The students had a statistically significant increase in the post-test scores for the question items on all of the four target topics, namely "Speed", "Rate", "Slope", and "Slopes in Linear Equation".

Table 2. Students' achievement in developing concepts on linear functions before and after the intervention (N = 129).

Question items			***Pre-test scores***		***Post-test scores***		**t-*test***
Topic concepts	***No. of items***	***Max. scores***	***Mean***	***SD***	***Mean***	***SD***	
A. Speed							
(1) Speed	3	6	4.659	1.747	5.233	1.290	3.254*
(2) Average Speed	1	2	1.225	0.956	1.457	0.884	2.269*
(3) Concept of Speed	3	5	3.062	1.424	3.725	1.442	4.558***
B. Rate							
(4) Rate	1	2	1.252	0.958	1.721	0.673	4.866***
(5) Average Rate	1	2	1.043	0.996	1.721	0.696	6.535***
C. Slope							
(6) Slope	2	4	0.419	0.958	2.837	1.585	15.914***
(7) Concept of Slope	1	2	0.558	0.901	0.899	0.999	3.294*
D. Overall							
(8) Slopes in Linear Equation	3	9	1.221	2.281	6.376	2.804	18.651***
(9) Reading Graph	3	6	3.977	1.523	4.213	1.556	1.330
(10) Describing a Scenario based on a Graph	1	2	0.686	0.805	1.027	0.766	3.801***
Total	***19***	***40***	***18.101***	***6.677***	***29.209***	***8.180***	***16.906******

$*p < 0.05$ $***p < 0.001$

The pre-post-test results indicate that after the intervention, the students comprehensively mastered the fundamental concepts on linear functions. The students particularly succeeded in understanding "Concept of Speed", "Rate", "Average Rate", "Slope" and "Slopes in Linear Equation". Junior secondary students typically find these concepts challenging, as the conventional mathematics classrooms seldom put emphasis on fostering them to reason about the nature fundamentally across "Speed", "Rate" and "Slope" – a relationship which involves multiplicative comparisons between changes in covarying quantities. The positive pre-post-test results confirm that the students can develop a true understanding of these hard-to-teach concepts when using the *Cornerstone Maths* platform for visualizing the mathematical objects in different representations, and manipulating the dynamic simulation of the mathematical objects for comparing and linking different representations of the mathematical objects. This reveals the potential of the intervention to transform students' mathematical inquiry for a better outcome in learning the topic-specific concepts.

3.2. Students' Perception of Mathematical Exploration in the Intervention

The questionnaire survey found that the students were generally satisfied with the intervention for their mathematical exploration (see Table 3). The students confirmed the effectiveness of the online platform support for learning the concepts on linear functions; and the consolidation worksheet tasks with mentor-guided group discussions. The students appreciated much the help from the mentors on guiding them to complete and discuss consolidation worksheet tasks which were designed to summarize the target mathematical concepts for deepening students' understanding of linear functions. Echoing with the pre-post-test results, the students particularly agreed with the effectiveness of the intervention on supporting them to enhance their understanding of the topic-specific concepts on "Slope" and "Speed". These findings reveal the potential of the intervention to transform students' mathematical

inquiry for a better experience in learning the target topic. It is feasible to integrate the *Cornerstone Maths* intervention with the consolidation worksheet tasks and group discussion activities in mathematics learning process.

Table 3. Students' perception of the intervention for exploring the mathematical concepts on linear functions (N = 129).

Items	***Mean (1-4)****	***SD***
The mentors help me learn and understand Linear Functions and related concepts.	3.320	0.706
I understand more about "Slope" after the intervention.	3.316	0.720
I understand more about "Linear Functions" after the intervention.	3.307	0.716
I understand more about "Speed" after the intervention.	3.305	0.756
The *Cornerstone Maths* platform helps me learn and understand Linear Functions and related concepts.	3.205	0.656
Overall, the intervention is well organized and worth participation.	3.199	0.683
The consolidation worksheets help me learn and understand Linear Functions and related concepts.	3.194	0.715
I understand more about "Rate" after the intervention.	3.168	0.701
The *Cornerstone Maths* workbook helps me learn and understand Linear Functions and related concepts.	3.093	0.664
The *Cornerstone Maths* arouses my interest in mathematics learning.	3.085	0.662
I will recommend *Cornerstone Maths* to my classmates and/or friends.	3.034	0.788

**Note: 1 = "strongly disagree", 2 = "disagree", 3 = "agree"; 4 = "strongly agree".*

3.3. Implication: Potential of the Intervention for Mathematical Exploration of Concepts on Linear Functions

In summary, the pre-post-tests and the questionnaire survey affirmed that the intervention can support students to effectively explore and successfully enhance the target mathematical concepts; and brought about students with an encouraging experience of which students consider the *Cornerstone Maths* intervention helpful for them to learn and understand the target mathematical concepts. It is noteworthy that the intervention is found, from both students' objective test-achievement and their subjective self-perception, to be particularly helpful for exploring the topic-specific concepts on "Slope" and "Speed". This indicates that the potential to use the learning materials in this intervention to stimulate students to effectively learn these traditionally hard-to-teach concepts. These positive results imply the pedagogical value of the intervention in mathematics classrooms to foster students' exploration on linear functions. A pedagogical example from this study is drawn for further discussing the potential of the intervention in mathematics classrooms.

3.3.1. Pedagogical potential of the Cornerstone Maths platform and its corresponding workbook

The first part of the pedagogical example reveals the pedagogical potential of the *Cornerstone Maths* platform and its corresponding workbook. It was the *Cornerstone Maths* activity about investigating the motions of swimming crabs, which engaged students in the self-directed exploration of concepts on positive slope and negative slope (see Figure 4).

The *Cornerstone Maths* platform activity-interface afforded students to manipulate the parameters in the graph (i.e. the position of a certain point along the *y*-axis) or the algebraic equation (i.e. the value of *y*-intercept); and then activate the dynamic simulation for visualizing the instant changes along with the parameters-manipulation (i.e. the position and movement of the moving crabs in the simulation interface as well as the position and direction of the straight lines on the graph); and finally connect outcomes and translate relationships of the changes in covarying quantities (i.e. the faster the speed of the moving crabs in the simulation interface, the greater the slope in its graphical representations).

The *Cornerstone Maths* workbook questions guided students to calculate the speed and velocity of each moving crab; and then identify the equation giving the position of each moving crab in terms of time; and finally self-check the correctness of their identified equations by referring to the window of linear functions on the *Cornerstone Maths* platform activity-interface. The students in this case can infer step-by-step the calculation of slopes in linear equation on their own. This pedagogical example indicates that the *Cornerstone Maths* platform and its corresponding workbook are resources appropriate for students' individual inquiry into the mathematical concepts of linear functions.

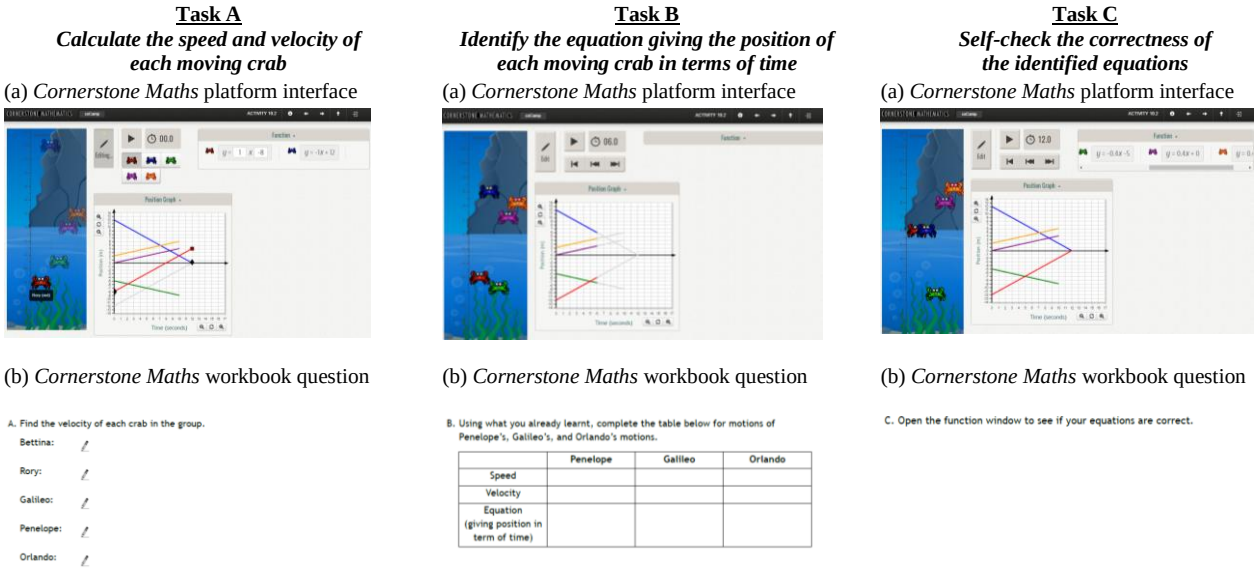

Figure 4. The *Cornerstone Maths* activity for the self-directed exploration of positive slope and negative slope.

The students rated high for the questionnaire survey items about the helpfulness of the *Cornerstone Maths* platform and its corresponding workbook to support them to learn and understand linear functions and related concepts. Such platform and workbook are thus resources favorable to students' topic-specific exploration in mathematics classrooms.

3.3.2. Pedagogical potential of the consolidation worksheet tasks with mentor-guided group discussions

The second part of the pedagogical example reveals the pedagogical potential of the consolidation worksheet tasks with mentor-guided group discussions. It was the consolidation worksheet task on "Slopes in Linear Equation", of which students consolidated the learned concepts of positive slope and negative slope (see Figure 5).

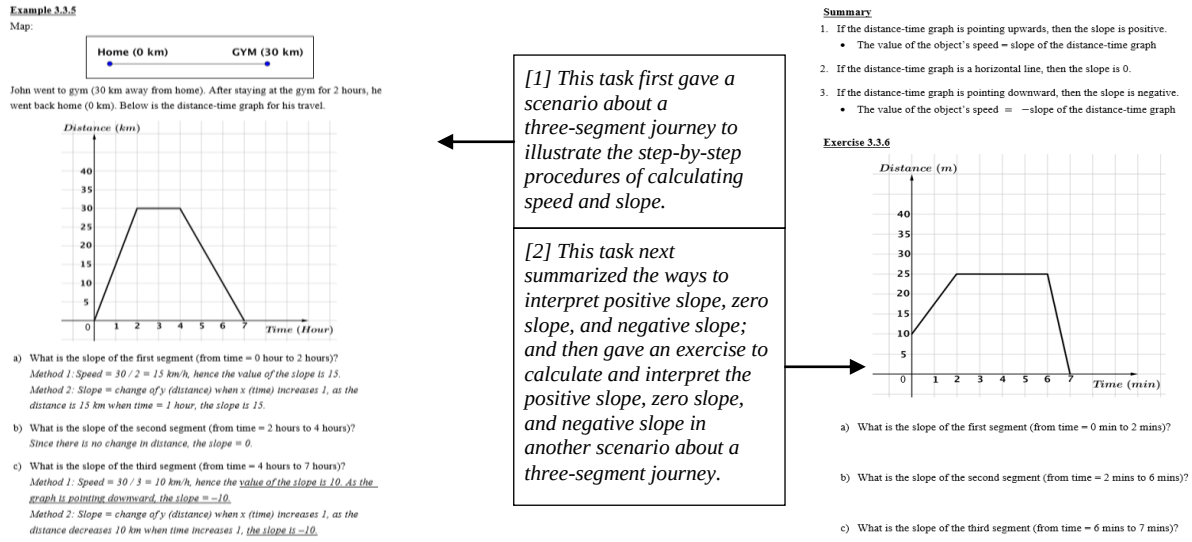

Figure 5. The consolidation worksheet task for students to consolidate the concepts of positive slope and negative slope.

The consolidation worksheet task guided students to gradually consolidate the learned concepts through step-by-step illustrations of calculation procedures (i.e. to master the steps of calculating a speed and a slope); and then short summaries of key concepts (i.e. to connect and translate the relationship between the value of a speed and the value and direction of its corresponding slope in the distance-time graph); and finally problem-solving exercises requiring the application of target concepts (i.e. to calculate and interpret two slopes in a distance-time graph for comparing and explaining the speed of two segments). Following the individual completion of the consolidation

worksheet task, a group discussion guided by a mentor was arranged for each student group, to guide students to check their answers-correctness and then discuss the misunderstandings causing their errors. Mentors played a secondary role in group discussions; their main responsibility was to solve technical problems in the *Cornerstone Maths* activities, and they kept minimal discussion-mediation unless students made inquiries or showed biases toward misunderstandings. The *Cornerstone Maths* materials and the consolidation worksheets served as the primary and active resources to guide students' learning exploration and consolidation. Students in the questionnaire survey rated highest for the helpfulness of the mentors in their learning of the topic-specific concepts. This indicates the perceived importance of mentor-guided group discussions and the practical need to arrange this activity in mathematics classrooms for topic-specific learning.

4. Conclusion and Future Direction

An intervention in the form of a two-day summer camp was organized for 139 Grade 7 Hong Kong students from five secondary schools to dynamically explore the mathematical concepts on "Speed", "Rate", "Slope", and "Slopes in Linear Equation" in the topic of linear functions. The students joined 15 sessions of using the *Cornerstone Maths* platform and workbook for the self-directed exploration of four target concepts; supplementary with six sessions of consolidation worksheet tasks with mentor-guided group discussions. The results of pre-post-tests and questionnaire survey confirm that the intervention was effective to foster students' statistically significant growth in the understanding of the target concepts; and was also well-received by the students for supporting their mathematical exploration of the target concepts.

The positive results imply that the intervention has the potential to transform students' mathematical inquiry for a better experience and outcome in learning fundamental concepts on linear functions. These research results serve as a foundation to recommend the future direction on implementing the intervention as a flipped classroom strategy for mathematical inquiry. Flipped classroom strategy refers to the pedagogy which arranges students' work typically done as homework to be undertaken in class with teachers' guidance; and correspondingly moves teachers' knowledge delivery outside of formal class time and arranges formal class time for students to actively engage in knowledge construction through extensive interactions with peers and teachers (Hwang, Yin, & Chu, 2019; Kong, 2014; 2015). Flipped classroom strategy can foster students' responsibility, initiative and reflection in self-paced learning (Chen, Hwang, & Chang, 2019; Chen & Hwang, 2019; Kong, 2014). Students in flipped classrooms can develop and demonstrate higher-order thinking to critically collate and synthesize knowledge when they learn (Chen et al., 2019; Hwang et al., 2019; Kong, 2015).

The recommended flipped classroom strategy engages students in the self-paced learning with *Cornerstone Maths* platform and workbook before class; and then the face-to-face discussions of consolidation worksheet tasks in class (see Figure 6). In the exploration task before class, students take initiative to collate and synthesize the target knowledge on their own through the self-directed exploration tasks on the *Cornerstone Maths* platform and workbook. Afterward, teachers can assign a student in each group to be the group leader for distributing *Cornerstone Maths* workbook question answers to group members for self-checking; instead of the practice in this study that mentors distribute the workbook question answers during the mentor-guided discussion tasks. In the consolidation task in class, students can then focus on completing the consolidation worksheets for reflecting on and deepening their understanding of the target concepts, and then discussing with peers and mentors about their misunderstandings which cause their errors in tasks.

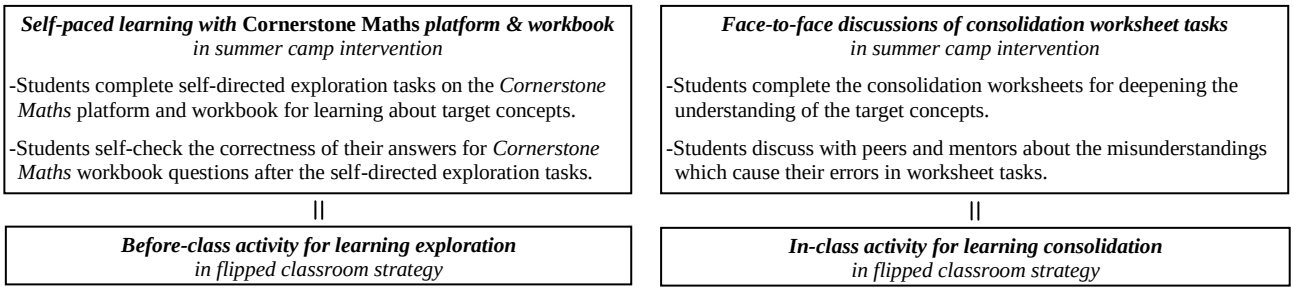

Figure 6. Implications of the summer camp intervention: The recommended flipped classroom strategy.

The recommended flipped classroom strategy is believed helpful to transform the conventional mathematics classrooms to better foster students to master the challenging concepts on linear functions, so to lay a solid foundation to learn other important mathematical topics like algebra and calculus. Future research will study additional variables such as the relationship of students' level of self-motivation with their level of concept-improvement, to see if students who are highly self-motivated in the *Cornerstone Maths*-integrated flipped classroom will perform better in mathematical inquiry.

Acknowledgements

The authors would like to acknowledge the support of the project "Mathematical Concept Development for Secondary School Students through e-Learning" funded by the Li Ka Shing Foundation donation.

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Investigating the Differences of Students Self-Regulated Learning from the Perspective of Online Video Viewing

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Abstract: *Online learning environment delivers an objective way to investigate students' self-regulated learning through learning behavior. This study unpacks the differences of self-regulated learning from the perspective of online video viewing. Based on person-centred modelling approaches, the students are grouped into two clusters by different levels of academic performance to investigate the role of self-regulated learning in MOOC-flipped context. Research results revealed that viewing time reflects significant differences only on units with challenging tasks, and high-performing students tend to apply better self-regulated learning strategies on video-viewing learning, they bear better skills on viewing time management, and carry better persistence on challenging tasks. The findings lead to suggestions for students and instructors for effective learning and teaching.*

Keywords: self-regulated learning, MOOC-flipped learning, video viewing, learning strategy, learning behaviour

1. Introduction

More and more online learning environments are developed for learning. In most cases of online learning context, students learn in a self-paced style, which needs the skill of Self-Regulated Learning (SRL). According to the related literatures, most of researches employed surveys to acquire students' response on motivation, emotion, and learning strategies(Cho & Heron, 2015; Cho & Shen, 2013; Musso, Boekaerts, Segers, & Cascallar, 2019). Whereas, survey responses are inevitably biased by subjective inclination or personal preference, along with inaccuracy from memory or estimation, which may hurt the scientific and rigorous nature of a research. Therefore, it is necessary to analyze learners' learning behavior through objective data to understand their self-regulated learning.

On the one hand, in the context of online learning, students' learning behaviour can be recorded by technology platforms, which provide objective data for learning analytics. The gathered data from online learning platforms, because of their accuracy and objectivity on use behaviour, provide a good opportunity for instructors and educational researchers to detect and analyze students' learning behaviors(Breslow et al., 2013). Therefore, it is feasible to explore data gathered from online environment to reveal patterns and principles of learning through the perspective of SRL.

On the other hand, related research revealed that learners in the context of online environment spend the majority of their time on viewing lecture videos(Breslow et al., 2013; Seaton, Bergner, Chuang, Mitros, & Pritchard, 2014), whereas other interactive course components are barely engaged or even ignored(Vitiello, Walk, Helic, Chang, & Guetl, 2018). Hence, focusing on students' viewing behaviour on lecture videos is essential to clarify the anecdotal evidences between learning input and learning outcome.

The rest of this paper is organized as follows. Section 2 provides related work and introduces research questions. Section 3 describes the context and dataset of this study. Research design is delivered in Section 4. Section 5 presents the analyzing results with tables and figures. Discussions are provided in Section 6. Finally, conclusions and future works are described in Section 7.

2. Literature Review and Research Questions

SRL has been one of the important areas in educational research. The process of systematically organizing one's thoughts, feelings, and actions to attain specific learning goals is referred to as Self -Regulated Learning(Zimmerman & Schunk, 2011). Usually, SRL is explained with motivation, emotion, and learning strategies(Abar & Loken, 2010; Artino, 2009; Azevedo, 2005).

In a long period of SRL research, many literatures focused on motivation, inclination and their impacts on behaviour from the perspective of educational Psychology. Minna Puustinen & Lea Pulkkinen have surveyed and summarized five models (Minna Puustinen & Lea Pulkkinen, 2010). Roger Azevedo studied the role of SRL in enhancing student learning taking hypermedia as a metacognitive tool (Azevedo, 2005). Many of literatures in this period focused on psychological measurement of SRL and their impacts on learning outcome.

With the development of online learning, more and more researchers transferred their attention from intention to behaviour relating to SRL. Technology-enhanced learning environments provide ample opportunities for learners to self-regulate their learning processes and activities for achieving the intended learning outcomes in various disciplines (Noroozi, Järvelä, & Kirschner, 2019). However, SRL is challenging to many students in a technology-mediated learning environment, particularly in an online learning environment, where they may lack immediate support and feel lost or socially isolated (Cho, Demei, & Laffey, 2010; Jerry Chih-Yuan & Robert, 2012). Hence, multidisciplinary innovations and technologies for facilitation of SRL has become a topic attracting more researchers (Noroozi, Järvelä, et al., 2019).

However, compared with the booming of online SRL researches based on surveys, the ones based on accurate behaviour data are still limited. Traditional subjective measurement such as self-reported data of learners own intentions, beliefs, and perceptions of their learning experiences are inadequate since such data often do not match with what actually happens during learning process(Noroozi, Alikhani, et al., 2019). Therefore, acquiring data reflecting learning behaviour from technology platforms provides new opportunity for the exploration of SRL in the environment of online learning.

A review on 12 SRL-related literatures found that the strategies of time management, along with other elements of SRL were positively correlated with academic outcomes (Broadbent & Poon, 2015). Therefore, we focus on students with different academic performance and their strategy on management of video viewing time on different learning tasks in this research. What we want to unpack is how the strategy of SRL works in online environment, especially the MOOC-flipped context. Therefore, measurements need to be acquired for further empirical study. For academic performance, we take scores of tests as the gauge, for viewing behaviour, we take viewing time as the measurement. So, we propose the following research questions:

•*RQ Do students with different levels of academic performance spend different time on viewing videos?*

Through the comparisons between different groups, we expect to explore further in details of video-viewing behaviour and students' management on viewing time to unpack the role of SRL in online learning, therefore, the sub research questions are proposed as follows:

• *SQ1 Do students with different levels of academic performance spend different time on viewing videos for challenging tasks?*

• *SQ2 Do students with different levels of academic performance spend different time on viewing videos for plain tasks?*

Based on the proposed research questions, we investigate the role of SRL through learning behaviour and academic performance, that is to investigate the role of students' SRL in learning through online video viewing behaviour.

3. Context and Dataset of the Study

In this research, we take students and their flipped class based on a College Computing MOOC are as the research object. There are 169 online videos in this course. Students view course videos on the MOOC website, then take software operating and programming on the exercise & test systems. All course materials are deployed on the internet or campus LAN. The research analyzed a dataset collected from the MOOC platform and the three exercise & test systems, which consist of students' video-viewing data and test data. There are 50118 video-viewing records collected from the MOOC platform. In order to eliminate the heterogeneity raised by the difference between mandatory and optional units, we extract video-viewing records on 87 of 169 videos, which are mandatory units.

4. Research Design

4.1. Participants and data pre-processing

In this study, 199 freshmen from a MOOC-based flipped class are selected as the participating cohort, they enrolled in a same School and were taught offline by a same instructor. Such selection minimizes the disturbance to the learning behaviour, which is favor of acquiring unbiased results. After the first step of data screening, one student was deleted from the dataset because most of his behaviour data are missed, with 198 left in the dataset for further analyses. The data were pre-processed with normalization before analytics. The normalization is employed to eliminate the bias caused by the difference of video length.

4.2. Measurements

The target of grouping is to investigate the differences of viewing behaviour on 87 lecture videos between two groups with different levels of learning performance. Therefore, the grouping variable in this study is averaged score of all tests, which is calculated by the average value of all tests. Samples were sorted in descending order and grouped into three clusters with 66 in each group. Randomly selecting 30 from the top and bottom groups respectively, which is an acceptable sample size for ANOVA. Students with higher test scores are grouped as high-performing learners, whereas those with lower test scores are low-performing learners. Investigating variables are viewing data of all 87 lecture videos, including 10 videos in Part 1, that is basic principles of computer science, 57 videos in Part 2, that is office application, 20 videos in Part 3, that is Python programming. All viewing data are normalized by max-min method for eliminating heterogeneity caused by different length of videos.

As for the definition of challenging tasks and plain tasks, we follow two criteria: the difficulty level of understanding and practicing, not just follow the content of videos. Therefore, 12 videos are selected as the ones for challenging tasks in learning, and the rest are plain tasks.

4.3 Data Analysis

We tested the significance of grouping variables between two groups because of the measurement type. The ANOVA results ($F\ (1, 58) = 624.924,\ p = 0.000$) showed that the difference of average scores between two groups is significant, therefore, the grouping division in this study is effective. To investigate the differences of video-viewing behaviour between the two groups, data were analyzed using one-way ANOVA models on each video. Statistical significance was determined using $p \leq .05$.

5. Results

In this study, there are 87 videos analyzed. The line chart of 10 videos viewing time (normalized) in Part 1 is shown in Figure.1.

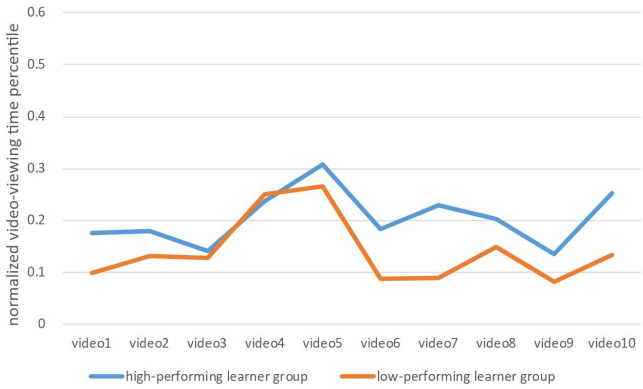

Figure 1. The line chart of 10 videos in Part1

The line chart of 57 videos viewing time (normalized) in Part 2 is shown in Figure.2.

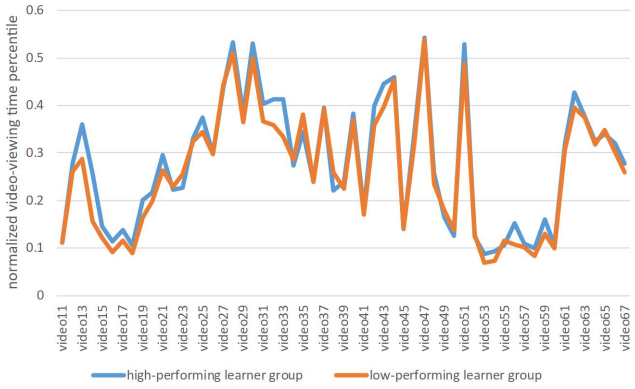

Figure 2. The line chart of 57 videos in Part2

The line chart of 20 videos viewing time (normalized) in Part 3 is shown in Figure.3.

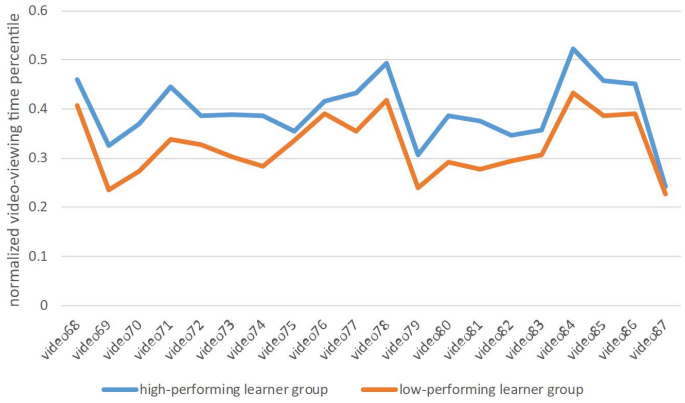

Figure 3. The line chart of 20 videos in Part3

The charts illustrate differences of video-viewing time between two groups. In the chart of Part 1 and Part 2, the lines of two groups twist each other. But in Part 3, the line of high-performing learner group is totally above that of low-performing learner group. Further identification of the challenging level of all videos shows that the high-performing group spend more time on video viewing usually. ANOVA is employed to further identify the significance. The ANOVA results are listed in Table.1, which reveal that 12 of 87 videos are significant on viewing time, which are shown below.

Table 1. The ANOVA results of videos

Video ID	ANOVA result(F/sig.)	Mean (H)	Mean (L)	Standard Deviation (H)	Standard Deviation (L)	Significance level
7	7.213/0.009	0.229	0.089	0.248	0.139	**
10	4.408/0.040	0.252	0.133	0.269	0.158	*
25	4.878/0.031	0.374	0.343	0.165	0.031	*
33	6.850/0.011	0.414	0.334	0.257	0.236	*
51	4.989/0.029	0.529	0.488	0.092	0.041	*
69	7.792/0.007	0.326	0.235	0.145	0.102	**
70	6.700/0.012	0.370	0.273	0.150	0.140	*
71	5.921/0.018	0.444	0.339	0.178	0.161	*
74	6.758/0.012	0.386	0.285	0.158	0.145	*
79	4.483/0.039	0.307	0.239	0.137	0.109	*
80	4.754/0.033	0.386	0.292	0.192	0.138	*
81	10.602/0.002	0.376	0.278	0.121	0.111	**

Note: H/L stands for High-performing learner group/Low-performing learner group. * p < 0.05, ** p < 0.01, ***p < 0.001

To present the significant difference clearer, we deliver the line chart with error bars on all twelve significant videos in Figure.4.

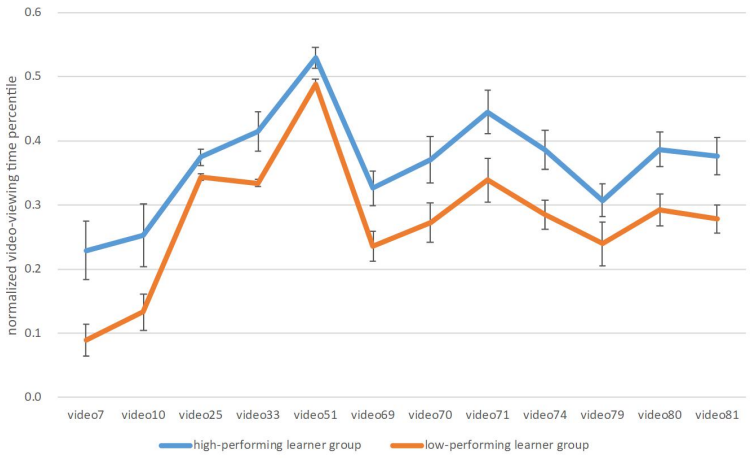

Figure 4. The line chart of significant videos with error bars

The chart in Figure 4 shows that high-performing learner group bears a higher level of averaged viewing time in all difference-significant videos.

6. Discussions

The subtle analysis on the behaviour differences between groups uncovers some patterns of SRL strategy under the condition of different challenging-level learning task in the environment of MOOC-flipped learning.

RQ Do students with different levels of academic performance spend different time on viewing videos? For RQ, the ANOVA results unveil some interesting facts. There are 75 videos tested as insignificant with ANOVA, only 12 of 87 videos, that students with different levels of academic performance spend different time on video viewing.

SQ1 Do students with different levels of academic performance spend different time on viewing videos for challenging tasks? For SQ1, there are 12 videos with significant difference between groups, accounting for 13.79% of all. More interestingly, the significant videos are on challenging tasks.

SQ2 Do students with different levels of academic performance spend different time on viewing videos for plain tasks? For SQ2, the results show that no significant differences are found in video viewing time between high performance and low performance in plain tasks.

Comprehensively, the answers of SQ1 and SQ2 imply that in the context of self-regulated online learning, students with different academic performance show different strategy of video-viewing time management.

For the first, in general, spending more time on viewing lecture videos can lead to a better performance only in the condition of challenging task. Therefore, it is essential for acquiring good performance by investing time differently on different lecture videos strategically according to the challenge level of learning tasks, which is a reflection of time management in SRL.

For the second, students well performed tend to spend more time on video viewing. Interestingly, all the significant videos are challenging task related. There are 5 learning tasks are split into two successive videos, 3 of them were tested as significant in ANOVA. Therefore, another finding is that students with high performance executing better persistence on learning than low-performing group.

As a consequence, we infer that well-performed students have a better strategy on SRL, such as better allocation of video-viewing time and persistence.

In this research, based on the person-centred modelling approach, we use ANOVA to identify the role of learning strategy in the context of online learning. First, SRL play a subtle role in the condition of challenging task learning. Better outcome in challenging task learning is achieved by viewing longer. Second, it is revealed that well performed students have a better SRL strategy in online environment. What we have found is similar to the findings of the role of SRL when facing challenging tasks (Azevedo, 2005; Broadbent & Poon, 2015; Cho & Heron, 2015; Cui, Wise, & Allen, 2019), but our findings are in the context of MOOC-based flipped class. Furthermore, our findings unpack that high-performing students display a better persistence when facing challenging tasks, whereas low-performing students do not show the strategy when facing different tasks, which is seldom found in the previous literatures.

7. Conclusions and Future Works

In this study, we found the fact that the impacts of SRL on learning outcome are traced by video-viewing behaviour, which is outlined by objective data but not self-report data and seldom has been explored in former researches. The

findings of this research show that high-performing students apply better SRL strategy when facing challenging tasks, they spend more time on video viewing and persist better. The findings lead to the following suggestions: For students, investing enough time on viewing lecture videos, especially on challenging tasks, is necessary. Taking an effective SRL strategy is essential for online learning. For instructors, keeping track on students' learning behaviour is beneficial for teaching. Instructors can push students when they encounter challenging tasks and encourage students improve their SRL skills.

Since a potential limitation of this research is lacking of further exploration on different aspects of video-viewing behaviour, such as repeat frequency, video-viewing accomplishment, future research will investigate the multiple aspects of video-viewing to explore subtle role of SRL in technology-enhanced online environments.

Acknowledgements

This work was funded by the National Natural Science Foundation of China under grants #61977001, Foundation of Association of Fundamental Computing Education in Chinese Universities under grants #2018-AFCEC-049, 2019-AFCEC-108 and 2017 Key Project in the Foundation of Teaching and Reform by North China University of Technology.

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Developing Awareness of Talent through Character-based Gamification: Perceptions of Design and Media Students

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Abstract: *The study investigates the potential of character-based gamification in addressing the question of design and media students' identity in terms of their talent. The intervention is to get them to know their talent so that they can propose projects that they are talented in. Students were guided to use their roles and personality attributes to complete their creative project. We analyzed data from 30 students of diploma programmes in design and media at a tertiary arts institution in Singapore. The results indicate that the students have an increased awareness of their talent through pre- and post-study surveys. Students found that character-based gamification is useful in helping them to identify and become aware of their talents. Some students also experienced positive affect after knowing their talent, while others highlighted that it guides them to their future career paths. We discuss the relevance of character-based gamification and how it can be applied for the teaching of art and media disciplines in higher education.*

Keywords: Character-based gamification, Avatar identification, Talent, Art and media, Higher education

1. Introduction

Character-based gamification in learning is the use of characters or avatars as the core game element in designing gamification whereby the character represents a student in a gamified learning intervention. It has been shown to have benefits of students' identity attachment, projection and experimentation, as well as social and behavioral influencing effects, resulting in student engagement (Analytica, 2016). However, to date, there is a lack of strong evidence on its effectiveness to education. This is because avatars or characters is the least common gaming mechanism used in education as compared to badges, points and leaderboards (Majuri, Koivisto & Hamari, 2018). Therefore, this study examines the missing gap and possible contribution of character-based gamification in education in developing students' self-awareness of talent. The need to help students develop awareness of their talent, especially during higher education, should be urgently emphasized to help them avoid a directionless plunge into the workforce.

2. Literature Review

Talent is a natural and habitual potentiality that can be productively applied and actualized through learning and development. It is through learning to reason about one's self that we start to sense our "self" or "personality" and our awareness of own unique character (Brook, 2013) and abilities. Ricoeur (1992) believes that character, personality and identity coincide. Contrary to other gamification, character-based gamification begins with character as its core design basis. It gives a practical approach on designing a gamification since gamification is a "player centered design" (Marache-Francisco & Brangier, 2013). The character is an agency that allows mental rapprochement between the player and character (Klimmt, Hefner, & Vorderer, 2009), allowing the player to get "into the game" quickly. Designing the character of similar and ideal characteristics desired by the player has positive effects (Hoffner &

Buchanan, 2005). Students can potentially transfer self to the character (Klimmt et al., 2009) and vice-versa. Gamified characters provide agency (Fullerton, 2014) for the students to interact and identify strongly with, giving them confidence and direction as they seek to become the character. Character-based gamification also allows educators to quickly understand the profile of the students through the character they play. As students emulate the character, they also acquire its desirable characteristics (Hoffner & Buchanan, 2005). Students of high self-discrepancy or difference between the actual/own self-state and ideal self-state (Higgins, 1987) will feel better about themselves (Klimmt et al., 2009). Characters can potentially help students articulate the talents they currently possess as well as those they wish to develop. Nevertheless, there is a dearth of studies regarding how character-based gamification develops students' self-awareness of talent as well as students' perceptions of the usefulness of the process.

3. Research Questions

Two research questions are examined: RQ1. Does character-based gamification enhance students' perceived self-awareness of talent? RQ2. How do students perceive the usefulness and importance of character-based gamification?

4. Methodology

The participants for this study were 30 design and media students, nine males and 21 females, undertaking the module "Alternative Applications". This module is adequately and well suited to the study as it is an academy-wide project-based module whereby students were open to propose their own design and media project with a wide range of alternative screen-based mediums to express their talent and creativity. The module was gamified with characters and assigned a mission to complete. Multiple quests unfolded along with a storyline throughout the lessons to guide students to achieve their learning outcomes via gamified learning app. As online players are more satisfied when their virtual world character resembles their personality (Ducheneaut, Wen, Yee, & Wadley, 2009), personality inventories for the talented (Cohen & Ambrose, 1993) were referenced when designing characters to enhance the perceptions of similarity and idealization (John & Srivastava, 1999). A total of 20 characters were created – "Explorer", "Mingler", "Protector", "Intellectual", "Independent", "Nurturer", "Fighter", "Communicator", "Strategist", "Idealist", "Associate", "Official", "Celebrity", "Champion", "Creator", "Controller", "Investigator", "Leader", "Scholar" and "Founder". Each character has personality attributes that are associated to design and media roles such as illustrator, animator, media producer as well as general roles such as manager, writer and entrepreneur. For example, "Creator" has roles of artist, writer and educator etc. Character-based gamification is designed into the first lesson whereby students used personality assessment as a reference of their most fitting characters. Students personalized their characters by picking the roles and personality attributes through playing the first quest, like most of the role-playing games begin with choosing and customizing character. It is important for the students to identify their desired roles and talents in the first lesson so that they can begin to work on their project ideas and develop them on the following lessons.

The study was conducted on the first lesson of the module where character-based gamification was introduced. Data was collected through a pre- and post-survey of students' awareness of talent. The first research question was examined with 12 questions to assess students' talent awareness in terms of similarity, wishful, embodied, usefulness and relatedness that were adapted from Van Looy, Courtois, De Vocht & De Marez (2012) and the Intrinsic Motivation Inventory (IMI) (Ryan & Deci, 2000). Each question was assessed on a seven-point Likert scale where "1" – Strongly disagree, "2" – Disagree, "3" – Slightly disagree, "4" – Neutral, "5" – Slightly agree, "6" – Agree, "7" – Strongly agree. All students responded to both surveys. Adequate Cronbach alpha reliabilities were obtained for the construct of the pre- and post-study survey, each having a value 0.82. Research question 1 was answered with a paired-sample t-test. Research question 2 was answered with content analysis of students' open-ended response to the survey question about their perception of the usefulness and importance of character-based gamification. Each sentence constituted a unit of

analysis. A second rater coded a random selection of the transcript to an inter-agreement of 80% to ensure consistency of the coding. The rest of the transcripts were then coded by the first author.

5. Findings

5.1. Research question 1 – Perceived awareness of talent

Students generally agreed that there is an increased awareness of their talent through character-based gamification: Pre-study survey ($M = 4.91$, $SD = 0.84$), Post-study survey ($M = 5.29$, $SD = 0.79$). Paired-sample t-tests found significant differences in students awareness of talent before and after the lesson ($t(29) = 2.05$, $p < 0.05$).

5.2. Research question 2 – Students' perceptions of character-based gamification

The highest percentage (42.22%) of the students' open-ended responses described character-based gamification as helpful for supporting their self-awareness of talent. One of the responses is "it allows me to realize my talent, hidden potential". 17.78% of them comes from identification which means a handful of students are not sure about themselves and their talent at all. One such response is "[it] identifies my talent and strengths". Students also said that it drives to develop their talent (15.56%) and has guided them on their career paths (15.56%). There are students who experienced emotional effects (8.88%) such as being inspired, feeling great confidence and commitment to make their talent a reality.

6. Discussion

In line with previous studies on relationship between player and character, it has demonstrated that character does serve as an agency for psychological match. The findings of the study also supported the thesis that characters used in gamification must enable students to feel they are similar (Hoffner & Buchanan, 2005) and create connection with their characters (Klimmt et al., 2009). The findings suggest that the traits of gamified characters can be used as stimulus for learning as well as for the development of students' awareness of talent.

The study and its results have clearly shown high relevancy of character-based gamification for higher education learning in art and media disciplines. Firstly, the customization of personality for their character through the selection of its roles and personality attributes need critical thinking. One must learn in order to reason to form their self-identity (Brook, 2012), thus, more appropriate for higher education. Secondly, character-based gamification helps students to find their talent and thereby guides them on appropriate career path based their talent. It is useful as they are heading to the workforce in just a couple of years' times. Thirdly, constructing identity is part of the creative process and that this function as a resource in visual art education (Gee, 2007). It is a valuable resource for art, design and media students to know their talent. Knowing their talent gives them direction in exhibiting their creativity and their creative outcomes are built upon their talent. Furthermore, they express their talent through artworks to form their identity in the audiences' mind. Thus, this talent and identity expression are more obvious in arts, design and media than in other fields.

7. Limitations and Future Research

There are two emerging areas for future improvement and research. Firstly, beside the perception of students, their work progress and submitted project can be reviewed to validate students' identified talents. Secondly, the study examined students' use of character assessment at a point in time whereas such patterns may be subjected to change over time (Bialystok, 2009), leading us to explore on whether students change character as they understand their talents better.

8. Conclusion

In this study, evidences have shown that character-based gamification has contributed to higher education learning in design and media. It can be integrated into a module to shape students' talent. Students not only experienced an increase of awareness of talent, it guides them to suitable career paths. This approach can be further explored in future studies.

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Feedback is not always better: Interpolating question before learning but no feedback in video lectures facilitating students' performance

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Abstract: *Recent research on video lectures has indicated that interpolated questions are the end of passive viewing. So, this study examined which version of interpolated question is the best way to enhance active learning, and whether the positive effect would disappear when plus feedback. In study 1, Nighty-one students were randomly assigned to view one of three video lectures: with no-question interpolated (no-question), with interpolated question before video segments (pre-question), or after video segments (post-question). The results showed pre-questions improved learning performance than others. In study 2, One hundred and twenty-eight students were assigned to view one of four video lectures: pre-question but no-feedback, pre-question plus feedback, post-question but no-feedback, and post-question plus feedback. The results showed that pre-question but no-feedback improved learning performance more than post-question but no-feedback, while when providing feedback, pre-question and post-question have the same effect on learning performance. This suggested that interpolating pre-question without feedback can be a valuable means in video lectures.*

Keywords: interpolated question position; learning performance; video lecture; feedback; online learning

1. Introduction

Videos as one of the important instructional material in online course, are considered as having great promise for education, as they can present information through vivid visual and audio forms simultaneously (Homer, Plass, & Blake, 2008; Pi & Hong, 2016). However, fluent vivid visual and audio can be easy to make students absent-minded. Previous studies found that interpolating questions into video lecture might avoid mind wandering and increase the students' engagement, leading to the increase of learning performance (Vural, 2013; Callender & Mcdaniel, 2007).

1.1 Interpolated question

Although commonly considered as a measurement tool, testing or questioning has been repeatedly shown to be an efficient technique for improving retention of both learned and to-be learned information . Thus, interpolated questions are believed to be one of the considered instructional strategies. And accumulative research has proved that interpolated question could enhance learning performance (Mcdaniel, Agarwal, Huelser, Mcdermott, & Roediger, 2011; Carpenter & Delosh, 2006).

One specific way is through post-question--posing question to students about have-learned material after they learned it. It is reasonable for most of what we know about the benefits of testing comes from studies in which students were tested over information after it was presented to them. For example, Jing, Szpunar and Schacter (2016) had 39 undergraduate students learn a 40-min video lecture about the topic of medicine and other social factors on public health. The results demonstrated that students in post-question group performed better than the control group.

Comparing to interpolated post-question, another is interpolated pre-question—posing questions to students about to-be-learned material before they have learned it (Carpenter & Toftness, 2017). In text reading, robust of studies

demonstrated many significant benefits of pre-question for it may serve as an orienting material that provides students with a preview of what they will learn (Mayer, 1984). For example, Carpenter & Toftness (2017) had students viewed a video lecture about the history of Easter Island. The results showed that students in pre-questions group recalled significantly more than students in other groups.

1.2 Feedback

Yet, there is another boundary condition of interpolated question in video lecture -- feedback. Instructional designers considered feedback as one of the important elements of effective instruction (Lin et al., 2013).), as it has the potential to assist learners monitor their own learning (Butler & Winne,1995). However, previous researches on interpolated question on video lecture have not discussed the role of feedback. Carpenter & Toftness (2017) interpolated pre-questions and Jing et al. (2016) interpolated post-questions without feedback, others interpolated questions with feedback (Rose et al., 2016), but they all find that interpolated question is better for learning. Previous studies did not distinguish between interpolated questions and feedback.

Most studies demonstrated that when students answer the interpolated-questions, they are eager to get feedback to know whether right or wrong, and teachers are used to give feedback (Guo & Wei, 2019). Researchers found that adding feedback following questions would be better for middle school students' learning motivation and academic emotions (Yu, Wu, & Huang, 2018). Theories believe that feedback allows students to correct errors and dispel cognitive conflict, resulting in superior performance in comparison with no feedback (Butler & Rd, 2008).

Providing feedback is better in video lecture learning. Researches founded students viewed interpolated post-question and feedback video lectures gained better learning performance than those without feedback (Lin, 2011). Feedback would be effective in improving recall video information (Roberts, et al., 2016). And the combination of interpolated questions and feedback could be of value for those who have some hesitation with respect to the resources needed for constructing and validating the knowledge (Bälter, Enström, & Klingenberg, 2013).

However, feedback has not always been better. Kluger & Denisi (1996) found that 38% of the feedback may lead to academic decline, because the feedback may bring psychologically relaxation. With comparison to interpolated post-question, providing feedback is unclear in interpolated pre-question. Pre-question on text reading benefit for learning through causing the cognitive conflict and help students identify the current state of knowledge then focus on the learning content (Rahim, Noor, & Zaid, 2015). Although, providing feedback will inform students of the correctness, it also eliminates cognitive conflicts.

In summary, there are two kinds of boundary conditions in interpolated questions, including the position and feedback. This study examined the interacting effects of the version of question interpolated and the feedback condition on their learning performance in video lectures. Based on above literature, the presented studies reported two experiments which explored the following issues:(1) What is the impact of the version of question interpolated (no question, pre-question and post-question) on students' learning performance?(2) Whether the impact of the version of question interpolated on learning performance is mediated by the feedback conditions.

2. Experiment 1

2.1. Method

Participants： A total of 91 undergraduate students (ages from 18 to 25, M = 20.7 years, 78 females) were recruited from a China university. Participants all signed a written informed consent and were paid for their participation.

Materials： The topic of the video is nutrition and it lasted 7 min. The video was divided into six segments according to the distribution of knowledge points using Adobe Captive software. Then, we interpolated multiple choice questions before or after video segments, which respectively as pre-question group and post-question group (See Figure 1).

Measurements： Demographic questionnaire. Participants were asked to report their gender, age and major. ***Prior knowledge test.*** Seven items were used to test participants' prior knowledge of nutrition. And the results showed no significant difference between three groups. ***Learning performance test.*** Learning test was created by the instructor (α=

0.787). Part of the question was the same as that questions interpolated into video lecture, while the remaining part of the questions had not been seen before.

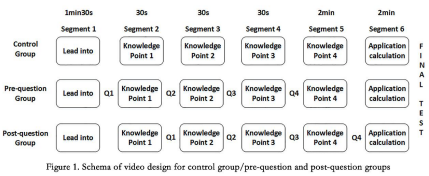

Figure 1. Schema of video design for control group/pre-question and post-question groups

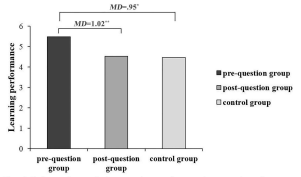

Figure 2. Final test performance for the pre-question group / post-question group and control group Note. * p < .05.

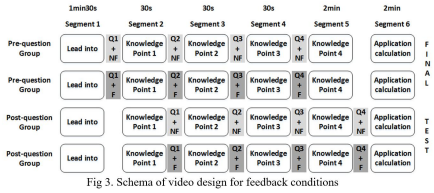

Fig 3. Schema of video design for feedback conditions

2.2. Results

Figure 2 shows learning performance test for the pre-question group, post-question group and control group. The results of a post hoc (*LSD*) test showed that overall performance was significantly higher for the pre-question group compared to the post-question group and control group.

3. Experiment 2

In Experiment 2, we aimed to extend the results of Experiment 1, adding feedback after they answered pre-question or post-question.And the methods used in Experiment 2 were very similar to those of Experiment 1.

3.1. Method

Participants: A total of 128 healthy undergraduate students (ages 18 to 25, M = 20.3 years, 110 females) were recruited from a China university. And The results of piror test showed no significant difference between three groups.

Materials: Different with Experiment 1, some participants will immediately receive simple short answer feedback after answering a question.

3.2. Results

Learning performance: There was an interaction effect on **learning performance**. It found that when students received NF, students in pre-question group would have higher learning performance score than those in post-question group; however, when they received feedback, students in pre-question or post-question group have no difference on learning performance score (see in Figure 4).

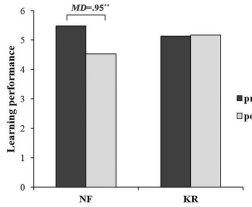

Fig 4. final test performance for four groups

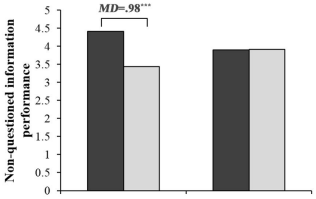

Fig 5. final test performance on non-questioned information for four groups

Questioned information: The main effect of question position, feedback and the interaction effect were non-significant.

Non-questioned information: An interaction effect and main effect of question position were found. In the condition of without feedback (NF), students in pre-question group significantly performs better than those in the post-question group; when providing feedback, there was no different between two groups (see in Fig. 5). Thus, pre-question produced enhanced learning of the information from the video lecture.

5. Discussion

This study examined which version of the interpolated question (non-question vs pre-question vs post-question) was the best one in enhancing video lectures learning performance, and whether providing feedback (no-feedback vs feedback) changed the question position positive effect. The experiment 1 showed that compared to students in the no-question group and post-question group, students in the pre-question group gained higher learning performance score. And when providing feedback, in experiment 2, in the no-feedback condition, students in the pre-question group gained higher learning performance score than those in the post-question group while when providing feedback, students performed similarly in both groups.

In Experiment 1, results showed that interpolated pre-question did improve learning performance score but interpolated question not, which was partly consistent with previous studies (Vural, 2013; Callender & Mcdaniel, 2007; Carpenter & Toftness, 2017). Pre-question could act as an orienting material (Mayer, 1984) and cause the cognitive conflict by challenging their existing concept and help them identify current state of knowledge then focus on the learning content (Rahim, Noor, & Zaid, 2016; Brod, Hasselhorn, & Bunge, 2018). Interestingly, this study did not find the positive effect of post-question, which was inconsistent with previous studies (Szpunar, Jing, & Schacter, 2014). The reason may be that in experiment 1 we did not provide feedback after they answered the question.

Furthermore, Experiment 2 confirmed this result again. Without feedback, pre-question are more beneficial to students than post-questions, which was consistent with the results of experiment 1. However, when providing the feedback, pre-question and post-question have the same effect on learning. An explanation is that feedback plays a different role in the post-question condition. Feedback in the post-question can help students clearly position their current learning level, and students can adjust their state in a timely manner (Shu, 2016), which confirms our hypothesis. We suspect that feedback can help students learn not only by focusing on the information mentioned in the question, but also by influencing other information. However, how does feedback affect the influence of the pre-question and post-question on the information not questioned needs to be proved by further research.

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The Use of Designed Music in Learning: Influence on Students' Affect for Learning

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Abstract: This research investigated the links between the use of designed music and the affective reception of arts students from an Arts Institution in Singapore. A total of 29 diploma level students were assigned to their personality audio in the activity. The soundtracks were established, composed and exclusively selected by the first author, using the musical elements like the rhythm, tempo, melody, timbre and harmony to create instrumentals music in correspondence to the emotional attributes, accordingly to the appointed roles and students' personalities types. The findings suggest that designed music has generated creative stimulation and supported students' concentration in learning. The use of digital music in the contexts of arts learning are discussed.

Keywords: Music, Emotions, Feelings, Mood, Learning

1. Introduction

The use of digital tools in classrooms can be a form of pedagogical innovation. Still, there are concerns of it becoming a distraction as students occupy themselves by listening to music, watching a video, doodling or playing an online game while attending lessons or lecture. Multitasking across multiple digital devices is predominant among students nowadays. A recent survey was conducted and revealed that two-thirds of Generation Z students were frequently on numerous devices at one time (Seemiller & Grace, 2018). Yet, when used purposively, can such kinds of diversions serve as a complimentary that aids teaching and learning? This study describes an experiment conducted with 29 Design and Media students from an arts college in Singapore, where they engaged in drawing activities with and without the accompaniment of music that was designed for their personality type. The students were then surveyed about how such kinds of music influenced their emotions and feelings while drawing. The implications of using designed digital music to maximize the learning potential of students in classrooms are discussed.

2. Literature Review

Music is sound patterns that can be composed and designed with musical elements, such as rhythm, tempo, melody, timbre and harmony as musical interpretations. Music integration with the use of computers can be manipulated to create recordings that express emotions and feelings. Music can influence mentality and attitude (Thomson, 2009) as well as one's affect even when played sublimely (Schneck & Berger, 2016). Affect refers to emotions that are physical responses to external stimuli which are the factor that can influence feelings, that one is consciously aware of but can sometimes choose to let it remain hidden (Watson, Clark, & Tellegen, 1988). In therapy, behaviour restructuring is facilitated by using music to access patients' emotions, feelings, and memories (Juslin & Slobada, 2002). He, Wong, & Hui studied (2017) 584 primary school children with different styles of classical music and found that music must first influence children's emotions in order to have effects on their creative performance (He, Wong & Hui, 2017). Yet, the choice of musical involvement is influenced by personality (Corrigall, Schellenberg, & Misura, 2013). This study

examines if digital music that is purposively designed to correspond to students' personality type that can be used to improve students' affect in the learning of creative arts.

3. Research Questions

Two research questions are examined:

1. How does music designed based on personality types influence students' affect while drawing?
2. How does music designed based on personality types influence the students' creative decision making?

4. Methodology

4.1. Study participants

As per the ethical procedures of the institution, 29 out of the 30 second-year students majoring in Design and Media at an arts institution in Singapore provided voluntary consent for study participation. The participants were between 18 to 25 years old and only 29 students gave consent that comprised of 20 (69%) female and 9 (31%) males for this study participation.

4.2. Course context

The students were attending a course on Alternative Applications, where they learnt to create screen-based media campaigns using digital tools and software applications. They were required to work on a group-based semester-long project for fifteen weeks with an allocated role such as an illustrator, graphic designer, video content producer and advertising designer, that were typical of media design project teams. The study was conducted during the first session that focused on project administration. The students were encouraged in developing self-understanding before they chose their team-mates, which they had to complete a self-assessment of their personality attributes that were based on ten personality types (e.g. Idealist, Intellectual and Explorer) adapted from Ricoeur (1992). Following this, students were given ten minutes to draw representations of themselves, based on their emotions and feelings at the moment. They were allowed to surf the internet for ideas. In part two of the activity, a Soundcloud webpage with their ten personality audio was given. The instrumental music were designed and selected by the first author of various genres of music including pop, electronic music and soundtracks. Students were then asked to draw a second self-representation while listening to their personality audio. All the students proceeded with their earpieces on and had the Soundcloud webpage on their digital devices. During the rest of the session, they were given time to form groups from different disciplines.

4.3. Instrumentation, data collection and analysis

The research questions were examined through a survey that was administered after students completed each drawing. Research question 1 reviewed on the influence of sounds and music on students' affect with 16 items taken from the PANAS scale, (Watson et al., 1988) with eight items related to positive affect (active, excited, determined, strong, alert, inspired, enthusiastic, proud) and eight items related to negative affect (upset, afraid, jittery, irritable, distressed, ashamed, scared, hostile). All items rated on a five-point Likert-scale question where "1 - Very slightly or not at all", "2 – A little", "3 – Moderately", "4 – Quite a bit", "5 – Extremely". To derive a measure for students' overall affect rating, all items related to negative emotion and feelings were reverse coded prior to running the statistical tests. Reliability was established with Cronbach alpha as follows: Affect after first drawing (α= 0.91); Affect after second drawing (α= 0.96). After establishing normality of the distribution with the Shapiro-Wilks test, paired-sample t-tests were used to answer the research question 1. Research question 2 was based on content analysis of students' responses to the open-ended question in the survey after the second drawing where students were asked to describe how the audio clip influenced their creative decision-making as they drew. Each survey response was coded for distinct ideas

(Daniel & Harland, 2017) and reliability was established by a second-rater who coded a part of the transcript to an inter-agreement of 80%. The first author coded the remaining data.

5. Findings

5.1. Research question 1- Affect

Paired sample t-tests showed significant differences between student ratings of affect before and after the introduction of personality-associated music: Affect after first drawing (M=3.03, SD=0.78), Affect after second drawing (M=4.03, SD=0.59). Students' affect ratings improved when they completed their drawings accompanied with digital music designed according to their personality ($t(28) = 4.96$, $p < 0.0001$).

5.2. Research question 2- Creative decision making

The results of this analysis have confirmed that students perceived personality-designed music have considerable effects with their creative decision making (See Table 1).

Table 1: Students' drawing approaches

Category	Example	No.of coded units	%
Creative stimulation	I can visualize my drawing based on the rhythm of the music.	28	33.33
Concentration	It did make me feel like creating something meaningful without thinking [about] anything around me.	16	19.05
Emotional stimulation	Music brings out different emotions, which affects my decision making when I was drawing my character.	14	16.67
Mood setting	Yes, it helped me set the mood for my drawing.	13	15.48
Feelings of connection	It gave me inspiration for my character personality.	11	13.10
Not important	Does not really matter if we do the audio clip in our inner self we realize [our] strengths.	2	2.38
		84	100.00%

N =29

Personality-designed music served as creative stimulation and helped concentration. The students felt connected to the music, as it elevates their emotions, mood and feelings. Thus, this added a new layer of understanding about their personality and their character. Such kinds of affect motivated their artistic decision-making during the activity.

6. Discussion

In selective private listening, people plug into earpieces to mask environmental sounds while multitasking. Just as classical music can evoke experiences of emotions and feelings. This study shows that designed music based on personality types can also have a positive affect on students as they approach creative tasks. Content analysis of students' open-ended survey results suggests that the effects of music on learning can be accentuated when it is composed towards students' personality types. This establishes symbolic and relatedness with students' emotions, mood and feelings. It brought both excitement and composure to their creative decision-making during the activity. While the PANAS scale considered emotions and feelings synonymously (Watson et al., 1988), it appears that mood is also

important to students. Mood seemed to frame how the students would engage and take in what interests them right from the start. For example, people prefer music that matches their mood (Hunter, Schellenberg & Griffith, 2011). Music serves as sensory input that generates thoughts, allowing feelings and the information to flow with new creative connections (Merritt, 1996). The music-emotion match could influence creative thinking (Callaghan & Growney, 2013) and affect the results of performance (Cskszentmihalyi, 2013).

7. Limitations and Future Research

This study was conducted with 29 students in the learning of creative arts. The results can be verified with larger sample sizes and random assignment and can be replicated with drawing tasks of different difficultly levels. Pre-assessment of students' mood and emotional state was not conducted prior to the first drawing activity. Future research could examine the effects of students' pre-study emotional state as well as how different room acoustics may influence learning. Lastly, it would be ideal to have in-depth interviews to gather more student feedback.

8. Conclusion

Gen Z students have multiple exposures to digital media that could make them more sensory receptive. If purposively leveraged, this could positively enhance their mood, emotions and feelings for learning. The use of designed music based on personality types has added significance and relevance to this endeavour. Its beneficial results can be further explored.

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Scripting peer-rating for collaborative knowledge improvement – A study on pre-service teachers' collaborative lesson design

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Abstract: *This paper examines the effect of a scripted peer-rating procedure for collaborative knowledge improvement in a computer-supported collaborative learning (CSCL) environment. The context of the study was in pre-service teacher education. Participants underwent two rounds of computer-supported collaborative lesson design (CSCLD) guided by the five-phase Spiral Model of Collaborative Knowledge Improvement (SMCKI) script. The intergroup peer-rating phase (phase 3 of SMCKI) provided opportunities for participants to view and critique lesson ideas of other design groups. To ensure the quality of peer-rating, the rating procedure was micro-scripted so that the issues of social loafing, the bias in opinion, and avoiding criticism in the attempts to maintain harmony in the Asian culture norm can be averted. The findings show that the micro-scripted intergroup peer-rating bring forth quality feedback. Results also reveal that the feedback helped develop the pre-service teachers' TPACK competencies in Technology-Enhanced Learning (TEL) design, indicating that micro-scripted peer-rating was effective in supporting collaborative knowledge improvement.*

Keywords: Peer-rating, Collaborative knowledge improvement, Micro script, Pre-service teacher education

1. Introduction

Peer-rating is a pedagogical method and a form of collaborative learning where students learn through assessing and rating each other's' work (Miao & Koper, 2007; Wadhwa, 2003). Past research has shown that this method helps develop critical thinking, improve communication skills (Miao & Koper, 2007), enhance a sense of judgment, objectivity, develop autonomous thinking and metacognition (Divaharan & Atputhasamy, 2009), and raise the confidence level and understanding of the subject matter involved (Akanmu, 2016). It also gives impetus to every member of the group to participate and prevents free riders (Divaharan & Atputhasamy, 2009). During the peer-rating process, quality feedback needs to be appropriate to the task's specificity that subsequently improves learning (Gielen, Peeters, Dochy, Onghena et al., 2010). Such feedback includes justifications, suggestions for improvement and thought-provoking questions (Gielen et al., 2010) can bring about collaborative knowledge improvement (Ng, Looi, Chen, 2008; Chen, Wen, Looi, & Ooi, 2011; Wen, Looi & Chen, 2011). As a result, the tension to provide constructive feedback yet maintaining harmonious can be challenging.

Past research studies on computer-supported collaborative learning (CSCL) have claimed that CSCL scripts can mediate communications and resolve the above-mentioned tension (Bouyias & Demetriadis, 2012). Scripts aim to "structure the collaborative learning process by constraining interactions, defining a sequence of activities and specifying individual roles" (Dillenbourg & Jermann, 2007, p. 275). Leveraging on the five-phase Spiral Model of Collaborative Knowledge Improvement (SMCKI) (Chen, Zhang, Wen, Looi & Yeo, 2019) collaborative script, the SMCKI intergroup peer-rating phase 3 was micro-scripted to unleash the potential cognitive and metacognitive benefits of peer-rating had on collaborative knowledge improvement. The research questions of the study are: 1) How does the

script help with the intergroup peer-rating? 2) How does the scripted intergroup peer-rating help to promote social-metacognition? 3) How does the intergroup peer-rating enhance collaborative knowledge improvement in the collaborative lesson design?

2. Literature Review

In this study, the collaborative learning process was supported via the five-phase SMCKI (Chen et al., 2019). To overcome the challenges faced in the collaborative learning environment, scripts act as instructional prompts that help participants use the affordances offered in new learning spaces (Kollar et al., 2014). The five-phase SMCKI commenced with phase 1 individual ideation which encourages diverse ideas creation. Phase 2 intra-group synergy taps on this idea diversity to seek synergy of ideas. Phase 3 intergroup peer-rating brings collaborative knowledge improvement to the class level, where participants contribute to other groups' idea by giving constructive feedback (Chen et al., 2019). SMCKI completes with a phase 4 intra-group idea refinement and a final individual achievement phase 5.

The focus of this study is on peer-rating phase 3. Frith (2012) claimed that students' metacognition can be enhanced via social interactions. Past studies of social metacognition suggest that agreements, disagreements, and correct evaluations during interactions can influence subsequent discussions and increases correct new ideas (Chen, Chiu & Wang, 2012). Micro-scripting the peer-rating phase can enhance and develop individual and shared cognition critically (Järvelä, Kirschner, Hadwin, Järvenoja et al., 2016). Hence, the quality improvement of lesson ideas through the phase 3 feedback uptake which resulted with phase 4 lesson idea refinement would be examined to better understand collaborative knowledge improvement that arises from scripted peer-rating.

3. Methodology

A quasi-experimental time-series design was applied in this study. The participants were 20 female pre-service Chinese language teachers enlisted in a one-year Postgraduate Diploma in Education (PGDE) programme from the National Institute of Education, Nanyang Technological University Singapore (NIE, NTU). They were enrolled in a course titled "The use of ICT in Character and Citizenship Education and Chinese Language Learning". The lecturer, who is the first author of the paper, has three years of experience in teaching pre-service teachers in designing TEL for teaching and learning the Chinese language. Time series analysis was used to analyze the lesson design artefacts.

3.1. Lesson Design and Implementation

The participants were grouped into 5 small groups of 4 members each. Group composites were decided by the students themselves as self-selected groups may simulate "real-world" workgroups more closely and yield better group dynamics and collaborative work results (Chapman, Meuter, Toy & Wright, 2006). The course was carried out from August to October 2019. Participants were tasked to collaboratively design TEL for Chinese language teaching and learning based on primary schools curriculum in Singapore. Before the course, participants were taught content knowledge of their subject mastery. Before the collaborative lesson design (CLD), each group selected one text within the primary school syllabus of the Singapore national curriculum for the Chinese language for their CLD task. Participants underwent two rounds of CLDs. SMCKI Phase 1 to 4 were conducted for both CLDs, which was a 1.5 hours face-to-face class session. After the second CLD, a Phase 5 individual achievement task of a lesson plan was completed out-of-class. Table 1 shows the scripted SMCKI Phase 3:

Table 1. Scripted SMCKI Phase 3 intergroup peer-rating.

Social Metacognitive Rules	Cognitive & Metacognitive Guide (Design Theory/principles)

- No personal emotive appeal	- TPACK
- Each member adopts 1 or 2 design theory/principle	- Self-Directed Learning
- Opinions include: Agree, disagree must be elaborated objectively with design theories/principles	- Assessment for Learning - Blooms Taxonomy
- Suggestions must be associated with TPACK	- Student-centred learning environment principles

4. Data Analysis and Results

The generated artefacts during the two CLD sessions were coded by the first author using the two coding schemes. The first coding scheme, TPACK coding scheme (adapted from Oner, 2019; Zhang, Liu & Cai, 2019) was developed to analyze the quality of the lesson design artefacts from phase 2, 4 and 5. The second coding scheme, Peer-rating coding scheme was derived by adopting the explanatory variables of the statistical discourse analysis (SDA) suggested by Chiu (2013). Additionally, this peer-rating coding scheme incorporated the concept of cognition (opinions, anecdotes, elaborations) and social metacognition, in the form of questions and different opinions to analyze the cognitive and social metacognitive aspects of each rating comment given to each group during phase 3 peer-rating.

To answer the first two research questions, the total number of comments generated from phase 3 over the two rounds of CLDs were counted. There is an increase in the number of quality comments from CLD1 to CLD2 (CLD1 M = 3.0, SD = 3.8; CLD2 M = 3.6, SD = 2.9). This result suggests that participants were able to abide by the role distribution script to prevent social loafing. Figure 1 shows an increasing trend for cognitive and social metacognitive feedback over the two CLDs. Figures 2 and 3 show a further breakdown of the classification of comments into the cognitive and social metacognitive domains of the TPACK framework. There is an increasing trend for both domains from CLD1 to CLD2. This result suggests that participants engaged in the design theories/principles within the script to provide constructive feedback. The significant increase for the social metacognitive domain suggests that social metacognitive can be improved over time. Figure 4 shows the distribution of comments across the seven TPACK dimensions. There is a significant improvement of constructive feedback over the seven TPACK dimensions over time, except for technology. This trend demonstrates that the participants were able to consider a more balanced TPACK application during TEL design instead of just concentrating on technological tools as the means to TEL. The surge with the "Learning theory at the cognitive domain" for CLD2 suggests the participants' competency improvement in this aspect, which subscribed to the design theories/principles within the script. Based on these results, the first and second research questions were answered.

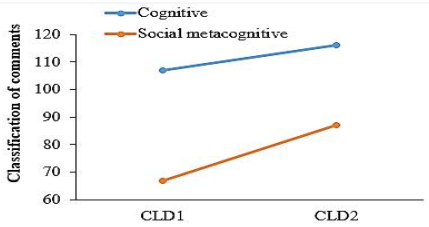

Figure 1. Cognitive and Social metacognitive feedback over the two CLD.

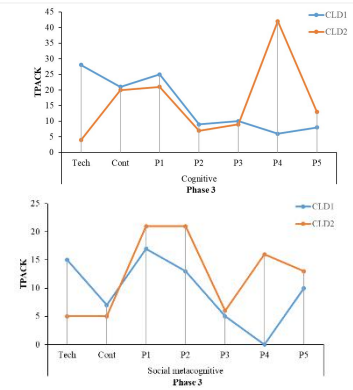

Figure 2. Phase 3 TPACK (Cognitive)

Figure 3. Phase 3 TPACK (Social Metacognitive)

Note: T=Technology; C=Content;P1=Teaching strategies; P2=Assessment; P3=Learning Outcomes; P4=Learning Theory; P5:Learners

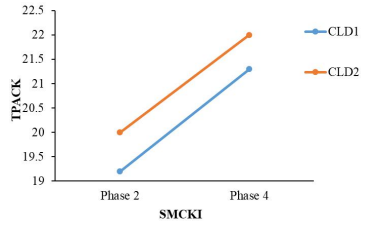

Figure 4. TPACK competency between CLD1, CLD2 phase 2 and 4.

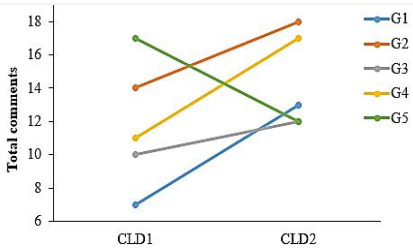

Figure 5. Phase 3 comments over the two CLDs.

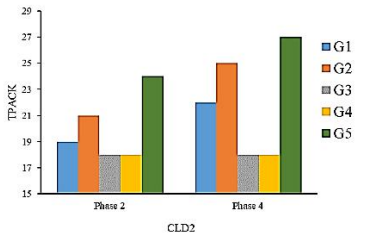

Figure 6. CLD2 Phase 2 and phase 4 TPACK TEL.

To answer the third research question, we examine the quality of lesson design between phase 2 and 4 for both CLDs. Figure 4 and 6 report a significant improvement with the TEL design across phase 2 and 4 for both CLDs. The improvement in the TPACK scale further suggests that intergroup peer-rating did enhance collaborative knowledge improvement in the collaborative lesson design. Figure 5 shows two different trends, with the highest increment of 46% for G1 and a decline in comments for G5. Further analysis was conducted to examine how peer feedback affects lesson design quality. Of the number of comments for G1 in CLD2, 54% were coded within the social-metacognitive domain. 50% of the feedback was taken up. Table 2 shows the feedback given by G3, G4, and G5 and their uptake by G1.

Table 2. Improvement of lesson design in response to peer feedback (G1).

Social Metacognitive comments (Translated Chinese to English)	Improvement to lesson design at Phase 4 (G1)
How to achieve authentic learning? (G5 → G1) Bloom's taxonomy: Did not achieve high cognition. Maybe let them create own scenario, describe an unforgettable day. (G3 → G1)	Students to relate to their daily activities, e.g., what time do what activity
How to ensure or support weaker students so that they can complete the different parts of the writing task? (G4 → G1)	Include differentiated instructions. Teacher to facilitate and guide weaker students.

The above findings concur with past studies which suggested that disagreements and correct evaluations can influence the direction of subsequent discussion and increases the likelihood of correct new ideas (Chen, Chiu & Wang, 2012). This result suggests that the intergroup peer-rating did enhance collaborative knowledge improvement in the collaborative lesson design.

5. Discussion and conclusion

The results from this study corroborate with past findings that peer-rating affects collaborative learning and collaborative knowledge improvement (Chen et al., 2019; Kollar & Fischer, 2010; Strijbos & Sluijsmans, 2010). The benefits of peer-ratings should be considered from the perspective of a rater and a receiver. From the viewpoint of a rater, he/she has to deep process the artefacts when he/she rate others' artefacts. This increases the opportunities to be stimulated by the other party's artefacts (Kohn, Paulus, & Choi, 2011). From the receiver's viewpoint, he/she would recognizes areas for improvement when he/she receives the ratings from others (Chen et al., 2019). Taken together, peer-rating could widen students' perspectives and facilitate their learning in collaborative settings.

To the best of our knowledge, scripting the process of peer-rating is an area less studied even though the challenges faced were well reported (Briñol & DeMarree, 2012; Divaharan & Atputhasamy, 2009). Prior research has attested that when pre-service teachers engage in peer-rating, they develop metacognitive skills to critique and evaluate their practice, as well as that of their peers (Lynch, McNamara & Seery, 2012). Therefore, scripting the peer-rating process in the context of collaborative lesson design in pre-service teacher education is a focus area worthy for future research (Van Zundert et al., 2010). We propose future studies to be conducted with a control group with unscripted intergroup peer-rating to compare the experimental and control groups to find out the impact of scripting. Future research with a larger sample size can also help to generalize the findings to a wider context.

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Literary Studies from the Perspective of Big Data

——Exploration of data visualization and sharing platform with four famous books as examples

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Abstract: *With the advent of the era of big data, all areas are inevitably affected by the wave of big data. Different from the digital and information ages in the past, the field of literary research has also benefited from the development of big data, and the trend of Internet + literature has become more and more obvious. From the perspective of data visualization, we use four famous books as data sources to complete the combination of literary text and data visualization and use social network visualization tools to explore the development model of data visualization + literary text, and to construct a data visualization interactive platform. Our research results show that the application of big data in literary research is feasible, and it can carry out richer research based on current literary research.*

Keywords: literary research, big data, data visualization, "Dream of Red Mansions"

1. Literary Text and Data Visualization

Literature is one of many art forms. With the advent of the era of big data, when big data collides with literature, when literary figures meet data visualization, we may be able to see a new direction of literary research.In the era of big data, more and more literary researchers are beginning to focus on the new development of big data-oriented literature. Searching for the knowledge network of "Big Data and Literature" as a key word, we can find that this topic is also in the literary research with a rising trend (Table 1) (Wang, 2018). Although more and more literary researchers are beginning to think about the impact of the big data storm on literature and come up with many forward-thinking ideas, at present, there are only a few cases in which big text analysis texts are used.

Table 1. Annual volume of papers with big data as the theme.

Years	2011	2012	2013	2014	2015	2016	2017	2018
Amount	185	1167	5441	12674	21114	28311	32285	6532

In the context of this research, we try to combine big data and literary texts from the perspective of data visualization. In order to ensure the stability, scientific and guarantee of data volume, we choose the traditional Chinese cultural treasures "Dream of Red Mansions", "Journey to the West", "The Romance of the Three Kingdoms" and "Water Margin" as the data source, with the relationship between the characters in the four famous works. Analyze the object, combined with the professional social network visualization tool, data, record and visual analysis of the

characters and social relations in the four classical classics, and achieved certain results (Figure 1). The tool we took was NodeXL.

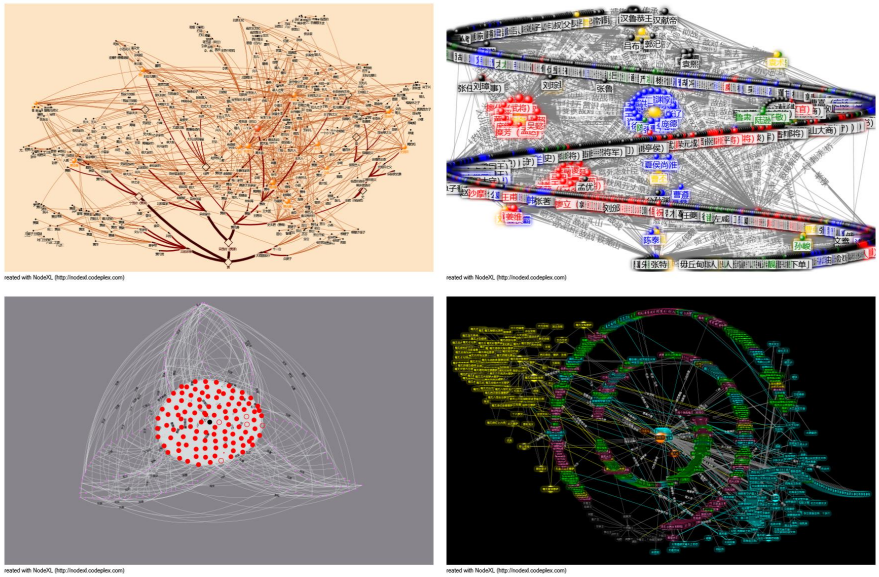

Figure 1. Visualization of the relationship of characters in the four famous books.

We read through the text, straighten out the relationship and enter the data. Due to the particularity of the literary text, some character relationship machines are not well interpreted, so we choose to manually enter. At present, our data has accumulated to more than 10,000 and is still being updated. We also chose different layouts based on the different content features of the four classics. In the data entry process, whether it is the integrity of the persona or the construction of the relationship of the characters, we strictly follow the text. At the same time, since our visual works cover all the characters of the four famous masterpieces and the social relationships extended by each character, any one of the characters in the book can be a subject of individualized research in a dynamic and pluralistic perspective. Regardless of whether the research interests of the four famous masters and researchers are the main characters or the supporting roles, they can all obtain a data visualization result centered on their own research subjects. According to the term “broadcasting”, foreign scholars have elucidated the concept of “narrowcasting” (Chen, 2016). Such a novel perspective is used to outline the ideological needs of the “small” groups in the “big” era. Obviously, this kind of literary research in the context of big data has subverted the research mode of traditional literary texts and provided new thinking for the academic community.

On the other hand, based on the contributions made by current big data technologies in forecasting applications, we can propose such a thinking: if the amount of data reaches a certain level, can we use the existing data to visualize the data development in the atlas Trends to infer the development status of character relationships? Franco Moretti used quantitative literary analysis to analyze the content and plot of "A Dream of Red Mansions". Li Xianping used statistical analysis to prove the authenticity of the author of the Red Mansion (Wang, 2018) (Li, 1987, p.16). Apart from these two people, there are few scholars Using big data thinking to explore "A Dream of Red Mansions", it is rare to get involved in research. In addition, at present, no scholar has produced a complete data visualization of the four major works from the perspective of data visualization. Although the digitization of ancient books and the research and development of ancient poetry databases have brought great convenience to scholars' research(Cao, 2018) at present, the relationship maps of the four masterpieces that we can obtain from various channels such as the Internet and books are still extremely simple. Therefore, our research on the four masterpieces provides new ideas for future humanities and social science research, and also provides a substantial example for the big data exploration of literary research.

2. Take "Dream of Red Mansions" as Example

We selected the data visualization map of "Dream of Red Mansions" as an example to introduce the analysis object in detail. The design process of the work is as follows:

2.1. Determine the Main Frame

First determine several important nodes, and then expand social relations centering on important nodes. For "Dream of Red Mansions", we choose to use the relationship of the clan relationship as the main branch, and the relationship between the character event and the blood relationship is the tree structure connecting the nodes. For several important points we chose different colors as special signs (Figure 2).

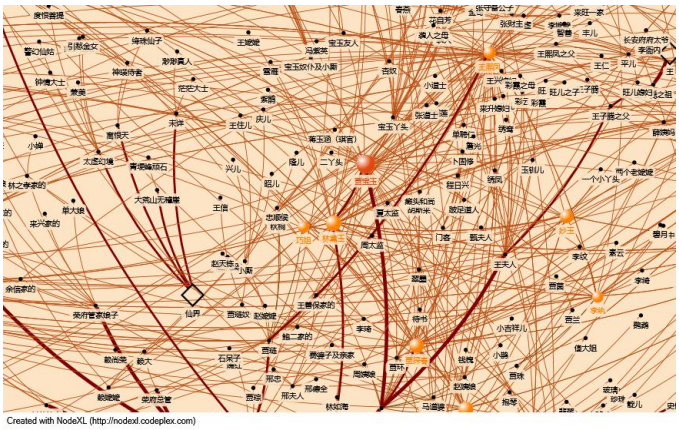

Figure 2. Details of Dream of the Red Missions.

2.2. Build a Network

Compare books and improve the relationship between each character and indicate it. We rely on the textual basis of "Dream of Red Mansions" to record all the characters in the book into the software. First of all, we use the relationship between the blood of the ancestor and the relationship between the master and the servant as the benchmark, and enter most of the characters, and then compare the events in the book to supplement the relationship between the characters.

2.3. Adjust the Layout

Adjust the position of each node in the chart to ensure the aesthetics and integrity of the work. In order to create a practical and dynamic chart, we abandoned the automatic layout and chose manual layout. At the same time, we also use the analysis and calculation function of the social relationship visualization tool to automatically adjust the size of the points according to the amount of data connected to each point. This makes the comparison of points with different data quantities clearer and the user can be more Visually see the different roles and different social status of different people in the same social network.

2.4. Data Analysis

Based on the completed visualization chart, better analyze and observe the relationship between the characters. First of all, there are many researchers in "Dream of Red Mansions", and their research has become a theory of "red learning". Such a dynamic map undoubtedly provides a new perspective for researchers and is more conducive to deepening potential person relationships. Secondly, this data visualization map allows users to conduct research from

both micro and macro perspectives and can view the entire book from a macroscopic system. The relationship between the characters can also be enlarged and selected to observe the contact of the person centered on it. Finally, the comprehensive development trend of the data presented by all the data in the whole map can help predict the future relationship of the characters after the data reaches certain conditions. The development trend has greatly promoted the development of "Dream of Red Mansions".

3. ‘Big’ Data and ‘Small’ Readers

For the study of "Big Data + Literature", the ultimate client of big data is all researchers and readers. "Big" data is for "small" readers. Researchers can publish their own visualizations to the platform, supplemented and improved by other researchers; users of the platform can also freely download data visualization maps composed of character nodes of their own interest, so that the resulting dynamics the diversified and open platform not only perfects the volume of big data, but also satisfies the individualization of research groups with different needs.

The data visualization research based on the four famous books is an exploration of the social and human domain in the field of NodeXL. It is also an attempt to apply the big data visualization in the direction of literary research. At the same time, we have also been inspired and thought in the production process: From what perspective can we better play the role of big data in the field of humanities research? What else can we do under the tide of convergence between tradition and technology? We also give some preliminary thoughts on these issues: Big data plays an auxiliary role in the field of humanities research, such as text analysis, corpus, language model, statistics and speculation. For example, the digitization of ancient books and the establishment of a database of ancient poetry, big data helps researchers advance research progress better and faster. Therefore, in such an era of rapid technological progress, we should not separate the development of technology from the study of humanities, go out of the study to see the world, try and apply new technological achievements, and make them a help on the road of social and humanities research.

Acknowledgements

This study is supported by the Undergraduate Training Program for Innovation and Entrepreneurship, Soochow University, 2019xj002

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Data Mining Perspective of Educational Big Data

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Abstract: *Educational Big Data (EBD) is coming due to the emerging of large amount of learning data in the education field, and promotes a research hotspot called Educational Data Mining (EDM). This paper focuses on current researches from the data mining perspective, summarizes the traditional applications scenes, classifies the data mining algorithms into descriptive and predictive ones, and designs a framework for educational big data. The proposed approach gives a clear vision and points out challenges and directions for further research in EBD.*

Keywords: educational big data, educational data mining, applications scenes, data mining algorithms

1. Introduction

With the continuous development of science and information technology, educational big data (EBD) has come and promotes a new research area called educational data mining (EDM). EDM applys data mining algorithms in the educaton field, and devotes to exploring the unique growing data and having a better understanding of the students as well as their learning environments. Existing research provide valuable foundation but have disadvantages, such as unclear about the application scenes, lacking of formal framework , confusing about the data mining algorithms, et al. To tackle these, this paper gives an insight into EBD from the data mining perspective.

2. Brief Summary of application scences

2.1. Analysis and Visualization of Data

Research (Goyal M, &Vohra R, 2012) stated that, analysis and visualization can reflect the information beneficial for learning and apply the feedbacks. Analysis can be done from the statistical learning perspectives, while the former reflects the information about the learning resources and the latter focuses on analyzing the problems encountered to guide the learning. Visualization uses graphical methods to vividly show the results and promote the understanding.

2.2. Learning Performance Prediction

To predict students' future learning performance, different classification algorithms are used to predict the grade of students in senior high school (Asif R, Merceron A, & Ali S A, 2017), and are compared with various algorithms based on student scores in college preparatory courses. Using MOOC online data, classification models are established to predict whether or not students can obtain certificates (Jiang Zhuoxuan, Zhang Yan, &Li Xiaoming, 2015). Research (Okubo F,Yamashita T,Shimada A, &Ogata H, 2017) used the circulation neural network to predict the final grade of students, and achieved a model with 93% accuracy in the first six weeks .

2.3. Personalized Learning Service

Personalized learning service is usually provided for the online learning by two main services called recommendation and early warning system. (Wu Dianshuang, Lu Jie, & Zhang Guangquan, 2015) proposed a fuzzy tree matching system to recommend learning activities for learners. (Dorça F. A., Araújo R. D., &Carvalho V. C., 2016) proposed an automatic learning content recommendation method based on the least square algorithm to match students'

learning style. (Goga M, Kuyoro S, &Goga N, 2015) recommended teaching links and appropriate courses to improve the students' academic performance. As was pointed out (Waddington R. J., Nam S. J., Lonn S, & Stephanie D., 2015), early warning focused on giving prompt alert to at- risk learners so as to guide them complete the learning smoothly .

2.4. Drop Out Prediction

Drop out prediction uses algorithms to identify the students with high lerning risk, so that the educators could intervene just in time to reduce the drop out rate. A drop out prediction model is proposed based on deep learning with high prediction accuracy, and compared with some benchmark algorithms (Xing Wanli, & Du Dongping, 2016). To predict the dropout high school students, literature (Márquez Vera Carlos, Cano Alberto, & Romero Cristobal, 2018) proposed a genetic iterative rule learning method. Thammasiri used data balancing techniques as well as combining various algorithms to get the best classifier for freshmen attrition(Thammasiri D, Delen D, &Meesad P, 2014).

2.5. Students' Behavior Analysis

Analyze students' behavior can help educators get a better understanding of the learners. Rabbany used social network analysis to evaluate students' participation in the forum from the course management system, so that the teachers can quickly grasp the hot content of students' discussions (Rabbany R, Elatia S, & Takaffoli M, 2014). Literature used two-step clustering analysis to divide the students into three categories and then set corresponding learning strategies (Ruipérez Valiente J A, Muñoz-Merino P J, & Delgado C, 2017). A descriptive statistical analysis is proposed to gain an insight using public school data from the capital of Brazil, and found the most relevant factors and potential indicators for predicting the academic outcomes.

3. Data Mining Perspective

To realize various purposes, EBD introduces data mining algorithms to exploring the hidden value based on data collected from the education environment. This section analyses the algorithms and gives the framework .

3.1 Descriptive and Predictive Data Mining algorithms

Descriptive data techniques are sometimes referred to as unsupervised learning, they focus on finding human-interpretable patterns and relationships describing the data without knowing any priority. Clustering identifies a finite set of natural groupings or called clusters based on the similarity matrices, proximity considerations and probability measures. Generally speaking, samples in the same class have high similarity and samples in the different class have distinct differences. Association analysis is one common approach, it tries to discover the association rules showing attribute-value conditions that occur frequently. Support and confidence are two probability assessment measures, the associations rules are considered interesting and strong with minimum support threshold and confidence .

Predictive data mining algorithms mainly refer to classification and regression, to forecast the future values of input patterns based on storing historical data. Classification has discrete predicted values and regression has continuous ones. The widely used algorithms will be briefly explained. Decision tree finds a set of decision tree structure, representing a corresponding relationship between the independent and dependent variables. K Nearest Neighbor (KNN) predicts the label according to the majority of some neighbors based on distance metric, and is very easy to implement. Neural Network (NN) can be briefly described as a family of massively parallel architectures to solve difficult problems by some artificial neuron, it assigns weights to connect the input with output, as well as adjust the weights by iteration. Support Vector Machine is proposed with margin maximation principle, has the merits of strong generalization, high precision and few parameters; so it gains wide applications in various fields.

3.2 Framework of Data Mining

The educational data has features such as fast updating speed, multi-source, high dimension and strong correlation. The framework of applying data mining algithms in this field are illustrated in figure 1.

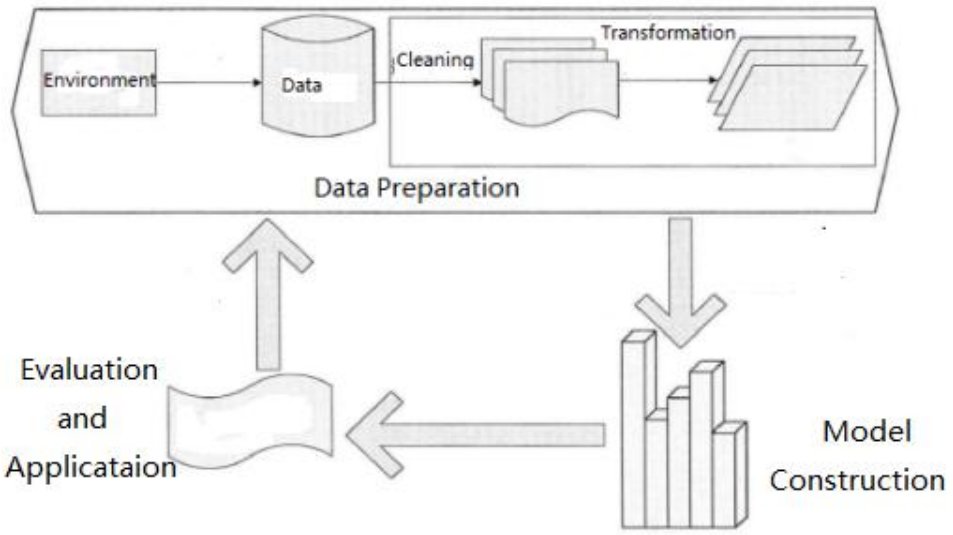

Figure 1. Framework of Data Mining

3.2.1 Data preparation

To prepare data for further study, the first and foremost step is collecting the education data from the information management system or online platforms. Since data are of different structures, pre-processing is carried out with three main steps called cleaning, transformation and normalization. By cleaning, the erroneous, uncomplete or irrelevant data are deleted. By transformation, data are formulated into appropriate forms by feature design and data reduction. Normalization are usually introduced to prevent the measurements influence on the weight.

3.2.2 Model construction

Models are classified into the descriptive and predictive kinds corresponding to the algorithms used. For specific problems, we can construct the model with single or combine both kinds, and utilize the results to give interpretable guidance for the educators. The main differences between various models are illustrated in Table 1.

Table 1. Differences between Various Models

Models	Focuses	Algorithms	Purposes
Descriptive	Finding patterns or relationships	Link Analysis, Clustering Analysis	Analyze learners, Recommend courses, etc
Predictive	Predict the label or the value of the data	Nearest Neighbor, Decision Tree, Neural Network, Support Vector Machine	Predict the learning performance, Drop out prediction, etc

3.2.3 Evaluation and application

Usually, a model with high accuracy is prefered. The chief goal of evaluation is to judge whether the obtained model can achieve the expected effects using various metrics, such as sensitivity and F-score. Applying the obtained results, it can enable the educated to pay full attention to their advantages by correcting shortcomings, and also it can enable the educators to carry out intervention to students on the danger brink and improve their performances.

4. Conclusion

Educational data mining (EDM) has currently come into the rapid development stage, which focuses on providing scientific evidences for the encountered problems in educational field. A framework is designed from the data mining

perspective, where the descriptive and predictive algorithms can be individually used or combined together in the model construction process. EDM brings challenges for researchers due to the lacking of available public dataset, the need to establish data standards and the innovation of data mining algorithms. Future rork will follow these research directions.

Acknowledgements

This paper is funded by the project “Resource construction and application of teacher information ability training platform (No. 2015ET001)”. Gratitude gives to my postdoctoral mentor, for his generous encouragement and suggestions on the writing of this paper. Sincere thanks give to the anonymous reviewers for providing me with valuable comments and pointing out access to the related resources. Without their earnest work, the present paper would not have been accomplished so fully.

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Deep Learning-Based Emotion Analysis from the Comments of the Online Courses

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Abstract: *Intelligent education is an important component of the national strategy of artificial intelligence. Using artificial intelligence to change the way of education has become an important research direction in the future. Online courses are one of the teaching methods in Modern Distance Education. The evaluation of the online courses from emotions of comments can get more accurate teaching feedback, which is of great significance for teachers to not only improve teaching methods and teaching quality but also optimize the teaching process. This paper proposes a text emotion analysis method based on deep learning to evaluate the emotions from the comments of the online courses. The bidirectional Gated Recurrent Unity (BiGRU) neural network layer was used to extract the text features from the comments. Then, we use the attention mechanism (ATT) layer to calculate the weight of the networks. Finally, the linear input layer and softmax layer were introduced for the non-linear operation to obtain the emotions of the comments. The experimental results show that the accuracy of the proposed neural network model is 90.28% on the data set, the loss rate is 0.23 and the time cost is 2469s and the validity of the BiGRU-Attention model is verified. Therefore, the proposed method can be applied to the emotional analysis of the online courses.*

Keywords: intelligent education, emotional analysis, BiGRU, attention

1. Introduction

The rapid development of artificial intelligence, big data, blockchain, and other technologies will profoundly change the demand for talent and the form of education according to the "*Education Informatization 2.0 action plan*." (LeBlanc, 2019). The intelligent environment not only changed the way of teaching and learning but also began to profoundly influence the concept, culture, and ecology of education. The field of education is undergoing a profound change under the impact and influence of artificial intelligence. Artificial intelligence is reshaping the form of education. Online courses have become a mainstream teaching method, which plays a significant role in promoting teaching (Martin, Rebecca, & Ochsner, 2016). Online courses can promote the reform of teaching mode, enrich educational resources, and improve teaching quality. However, there are many problems to be solved. They cannot choose appropriate online courses for students in online courses. Therefore, in the face of the new situation of educational reform and development, teachers must strengthen learning, enrich and improve themselves constantly.

The traditional feedback analysis method of online courses adopts the feedback data of online courses in the form of a questionnaire survey and then gets the analysis results through tedious sorting. This method requires a significant amount of time and material resources, and there are some problems, such as inaccurate data collected in a particular questionnaire survey. To solve this problem, this paper proposes a method to obtain the feedbacks of online courses automatically from the comments of the online courses by a deep neural network framework to infer the emotions of the

comments. The emotions of the comments not only can be used as the basis for teachers to change learning methods and improve teaching quality, but it can also provide some data support for students' personalized learning recommendations. Emotion analysis also can be used to understand students' learning preferences and teach students by their aptitude, which can improve the pertinence and efficiency of learning to a large extent and give full play to the role of students' learning subjects.

In the paper, we propose GRU (Tang, Qin, & Liu, 2015) based bidirectional gated recurrent unity (BiGRU_ATT) framework to predict the emotions from the comments of the online courses (Wei et al., 2019). We use the attention mechanism (ATT) layer to calculate the weight of the networks. Finally, the linear input layer and softmax layer are introduced for the non-linear operation to obtain the emotions of the comments. In the GRU deep neural network model, the oblivion gate and the input gate are combined into a single update gate and mixture of cellular states and hidden states. The advantages of the GRU model lie in fewer parameters and easy convergence in the long training process so that it suits the training of emotional text data.

2. Framework of the BiGRU_ATT model

The framework of the BiGRU_ATT model consists of four parts, as shown in figure 1: preprocessing part, input layer part, hidden layer part, and out layer part. The preprocessing part preprocesses the comments of the online courses obtained from websites. The input layer part converts the text of comments into a word vector matrix with a skip-gram model by word2vec toolkit. The hidden layer part inputs the word vector matrix into the BiGRU model by adding the input characteristics of forwarding GRU and backward GRU. In this part, we employ the attention mechanism for weight calculation before entering the liner layer. The weight represents the degree to which important data is selected, the larger the weight, the more important the emotional data. The output layer inputs the data into a softmax layer to predict the emotions.

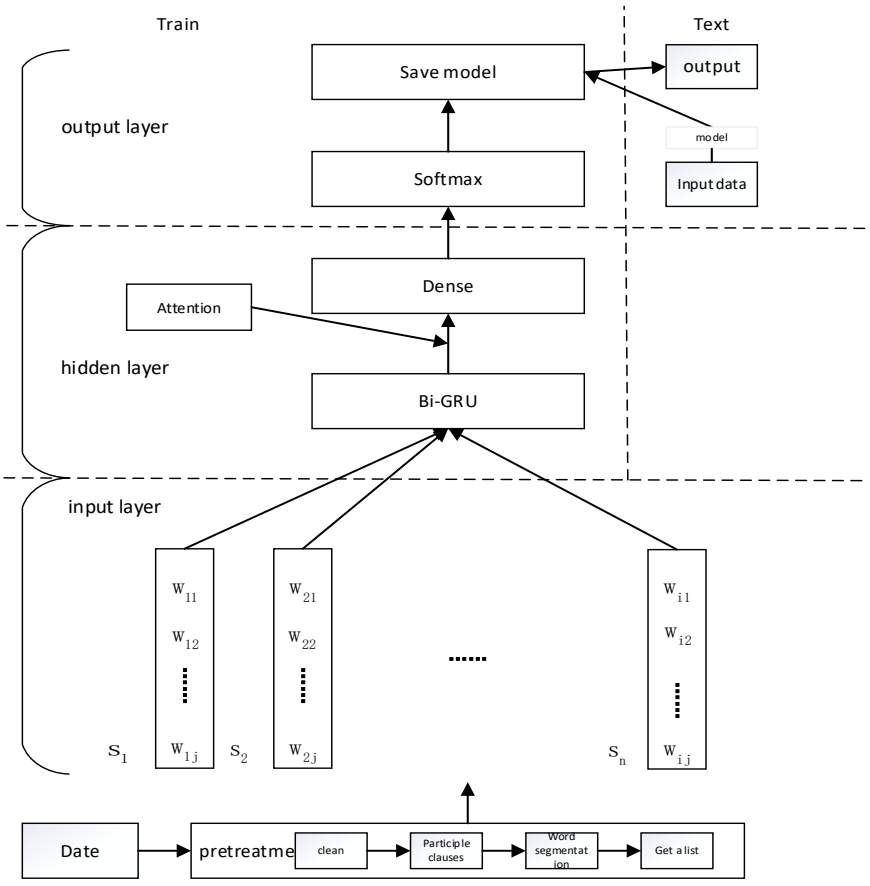

Figure 1. Framework of the BiGRU_ATT model

2.1. Preprocessing

We collect the comments of the online courses from some educational websites. The comments are firstly filtered out to remove unnecessary web page labels to form a text file. Then the text file is segmented into sentences and words. Because the number of comment words for online courses will be limited and to ensure that real emotions can be analyzed, we choose the longest comment length in the dataset as the appropriate length. If a sentence shorter than the length, we use some special symbols to pad the sentence. Finally, each sentence sets a corresponding index. Each index corresponds to a word vector. The whole vectors form a word matrix according to the corresponding word vector of the index.

2.2. Input layer

After the word is converted into the corresponding vector, we construct a word vector matrix model based on the skip-gram model with the word2vec toolkit (Kusiak, 2017). The model is mainly composed of an input layer, a projection layer, and an output layer, as shown in figure 2.

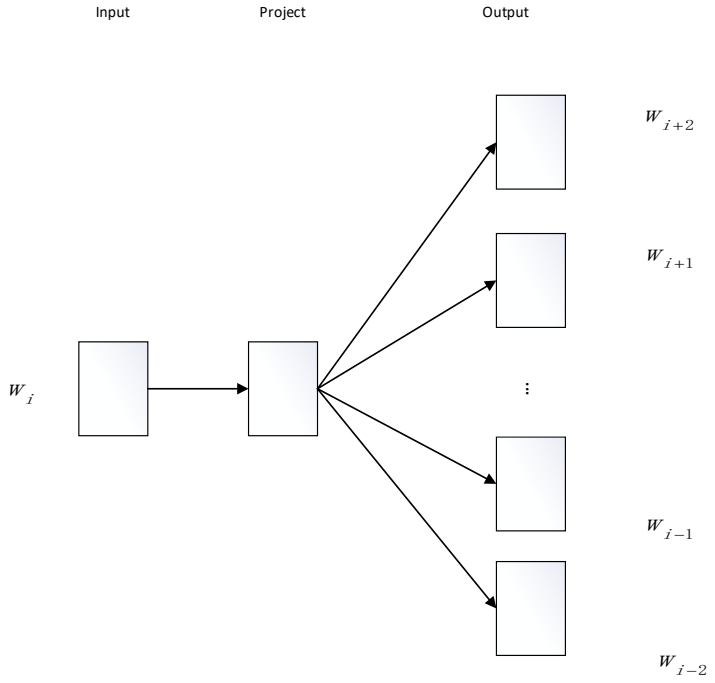

Figure 2. Skip-gram language model

The skip-gram model trains the word vector based on the context of the current word. Each word reflects the weight of the preceding and following words. To express the semantic information of words, word vector needs to be obtained through training. The input layer W_i distributed representation to predict $W_{i+j} \dots W_{i-j}$.

2.3. BiGRU Model

The GRU is a time recursive neural network by improving cyclic neural network model (RNN) (Cho et al., 2014). The structure of the GRU is shown in figure 3. Firstly, two gates are generated with X_t and h_{t-1}, and then spliced with the new input X_t. Then we form hidden layer variables $\tilde{h}_t$ activated with tanh. Finally, we linearly combine of h_t at the last moment and h_t in the hidden layer with the sum of weights is 1. Although GRU networks perform well in

emotional analysis, the state is a one-way output during transmission. In the sentence, the weight of the preceding word is smaller than that of the following word. For the text emotion analysis, the weight of each word should be the same. Therefore, we adopt the BiGRU network (Feng, Xuanzhen, & Xiaohong, 2019) for modeling in order to facilitate the extraction of deep features of the text.

$$r_t = sigm\left(w_{xr}x_t + v_{hr}h_{t-1} + b_r\right) \tag{1}$$

$$z_t = sigm\left(w_{xz}x_t + v_{hz}h_{t-1} + b_z\right) \tag{2}$$

$$\tilde{h}_t = \tanh\left(w_{xh}x_t + (v_{hh}h_{t-1} \otimes r_t + b_n\right) \tag{3}$$

$$h_t = z_t \otimes h_{t-1} + \left(1 - z_t\right) \otimes \tilde{h}_t \tag{4}$$

$$h_t = w_t\overrightarrow{h_t} + v_t\overleftarrow{h_t} + b_t \tag{5}$$

where, sigm() represents the activation function, tanh() represents the hyperbolic tangent activation function. r_t, z_t, x_t, $h_t, \tilde{h}_t$ represents reset gate, update gate, input vector, output vector and hidden layer vector, respectively. $\overrightarrow{h_t}$ represents the forward GRU. $\overleftarrow{h_t}$ represent the reverse GRU. w and v represent the weight matrix. b represent the bias vector.

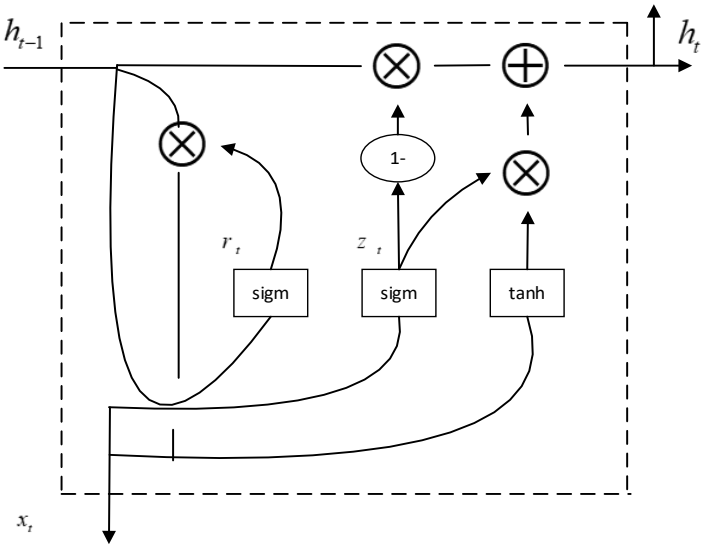

Figure 3. Structure of GRU model

2.4. Attention

Attention mechanism (Rush et al., 2016) is a method that allocates enough attention to key information and highlights important local information. This paper adopts a time-attention objective to reduce the loss of crucial information in text sequence, and select a small number of relevant data. The convergence speed and accuracy of the model are improved.

$$s_t = \sum_{i=1}^{T} \alpha_{ti} h_i \tag{6}$$

$$\alpha_{tj} = \frac{\exp\left(e_{tj}\right)}{\sum_{i=1}^{T} \exp\left(e_{ti}\right)} \tag{7}$$

$$e_{tj} = v_{tj} tanh\left(w_{tj} h_{ijk} + b_{tj}\right) \tag{8}$$

where, h_{ijk} is the vector output by the BiGRU of the previous layer. w_{tj} represents the weight coefficient. b_{tj} is the dimension coefficient. α_{tj} for random initialization of the attention matrix.

2.5. Output layer

The input of the output layer is the output of the previous layer's attention mechanism layer. Utilize the input of output layer is calculated by softmax function the specific formula of this classification is as follows:

$$y_i = softmax\left(w_{tj} s_t + b_{tj}\right) \tag{9}$$

where w_{tj} represent the weight coefficient moment to be trained from the attention mechanism layer to the output layer array. b_{tj} indicate the offset corresponding to the training. y_i is the forecast label for the output.

3. Experiment

3.1. Experimental Data and Parameters

In order to verify the validity of the BiGRU_ATT model, we use python to crawl English comment data from Youtube (Because there is no public data of educational comments, we choose Youtobe educational related video English comments).The training and test were divided into 8:2, the data settings are shown in table 1. BiGRU_ATT requires parameter tuning and configuration. The parameter setting and adjustment are completed in each iteration and adjusted according to the loss rate and accuracy rate of the experiment. The parameter settings are shown in table 2.

Table 1. Data set

Data	Train data	Text data
Comments	25550	10200

Table 2. Model parameters

Parameter	Value
Loss	Categorical_cross entropy
Optimizer	rmsprop
Batch_size	64
Word vector dimension	50
BiGRU hidden layers	100
epochs	50

3.2. Experimental results and analysis

In the experiment, accuracy, loss and iteration time were used as evaluation criteria. To verify that the BiGRU_ATT is more suitable for text emotion analysis, experimental comparison will be conducted with MLP, BiLSTM, BiGRU, BiLSTM_ATT. Table 3 shows the experimental results.

a) MLP (Qureshi et al., 2013). The MLP model consists of three layers: the input layer, the hidden layer, and t he output layer.
b) BiLSTM (Yan et al., 2015). The BiLSTM model is composed of forward LSTM and backward LSTM.
c) BiGRU. The BiGRU model is to replace the LSTM layer in the BiLSTM model with the GRU layer. Other experimental settings are the same.
d) BiLSTM_ATT (Ling et al., 2016). A hybrid experimental model based on BiLSTM and one layer attention mechanism is proposed.

Table 3. Experimental results

Experimental results of Online Course review			
Model	Accuracy /%	Loss	Time /s
MLP	71.30	0.25	1502
BiLSTM	88.38	0.38	986
BiGRU	89.47	0.26	1237
BiLSTM_ATT	89.91	0.24	2256
BiGRU_ATT	90.28	0.23	2469

The BiGRU_ATT model proposed in this paper is slightly better than other models in accuracy and loss, but it takes a long time. In general, accuracy, loss, and time consumption of each group of experimental models are relatively close. The Attention layer is used to assign the corresponding weight to highlight the key features of the text. Adding the attention mechanism can improve the accuracy rate. The attention layer has better performance in highlighting important information than the maximum pooling layer of convolution for improving the accuracy and reducing the loss rate. However, the function of the attention layer to highlight information is to carry out the continuous weighted calculation, which will increase the time compared with the maximum pooling. In order to verify whether the attention model could only improve the accuracy of the BiGRU model, the BiLSTM model was added to the attention. Compared with the two groups of experiments that added attention model, although the accuracy was slightly improved, the time consumption was significantly increased. According to the data of emotion test results of different models, it can be concluded that the BiGRU_ATT model is more suitable for text emotion analysis.

3.3. Emotional Analysis of Online Courses

We apply the trained BiGRU_ATT model to the emotion analysis from the comments of the online course, as shown in figure 4. The flowchart consists of a data capture layer, a data cleaning layer, an emotion analysis layer, a data sorting layer, and a visual interface layer. The details are as follows.

(1) Data capture layer. In this layer, we collect the comments of the online courses from the public websites of the online course and store the data into the text file.

(2) Data cleaning layer. In this layer, we clean the collected data by removing jump links, blank characters, labels, and other characters. Then we segment the text file into sentences. The sentences are then converted into word sequences with word segmentation.

(3) Emotion analysis layer. In this layer, we input the word sequences of the comments of a certain online course into the trained BiGRU_ATT model for emotion analysis.

(4) Data sorting layer. In this layer, we use the results of the BiGRU_ATT model to obtain the values of positive emotional tendency and negative emotional tendency (Tokhisa, Inui, & Matsumoto, 2008).

(5) Visual interface layer. In this layer, the emotional analysis results of a certain online course review will be sent to the front-end display, as shown in figure 5, figure 6, and table 4.

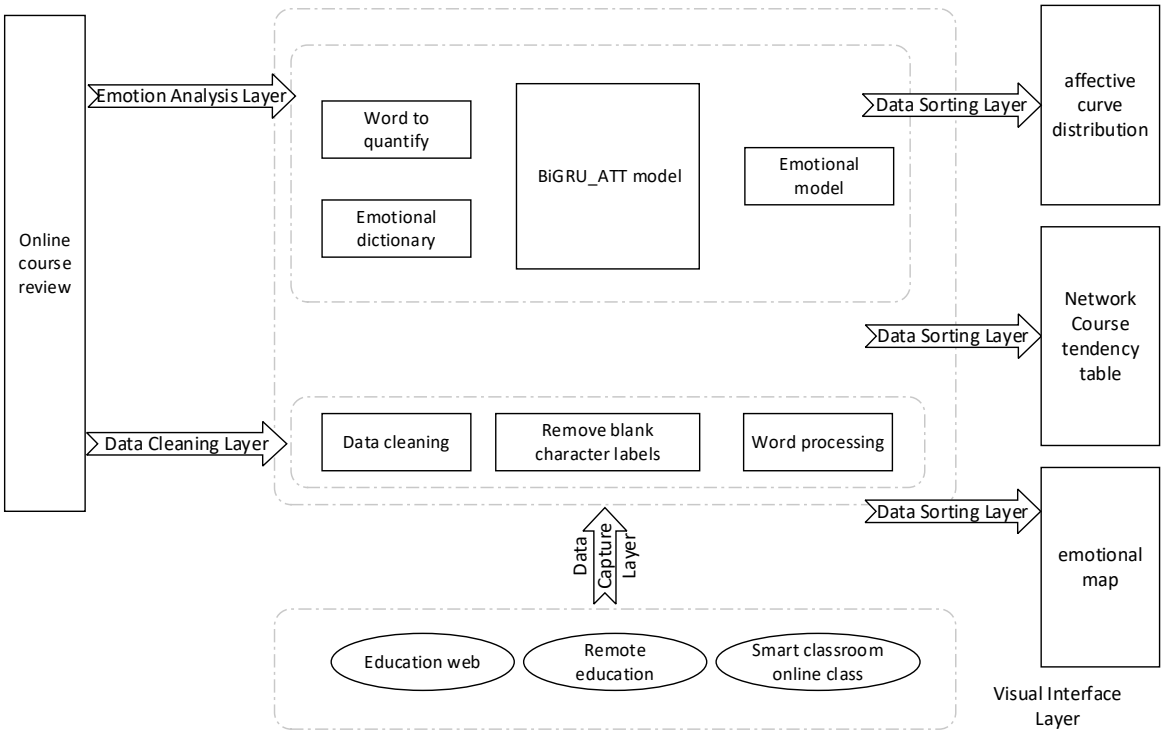

Figure 4. Flowchart of the emotion analysis of online courses

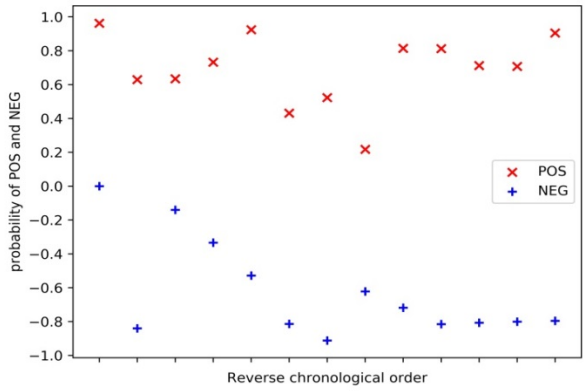

Figure5. Affective curve distribution

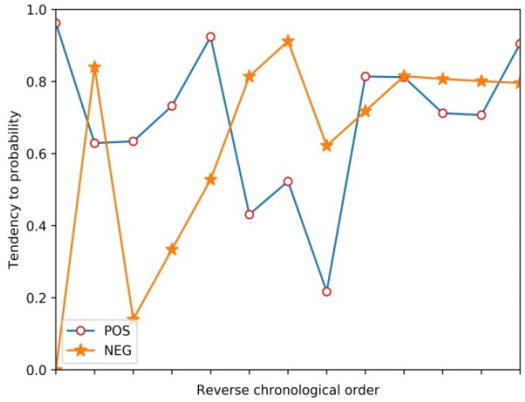

Figure6. Emotional map

Table 4. Emotional tendency of 14 online courses

Online Courses	Student	Comments	Emotional Tendency
Online Courses(one)	Student A	[‘It felt like opening the door to a new world…’]	pos0.87
Online Courses(one)	Student B	[‘Don't know that yet...I didn't learn the basics’]	pos0.23
Online Courses(one)	Student C	[‘I don't like this class. It's boring’]	neg0.96
Online Courses(one)	Student D	[‘I like this teacher's lecture very much’]	pos0.96

Teachers can establish communication channels between "teaching" and "learning" according to the visual results of online course feedback data and students' emotional tendency towards online courses, and Choose suitable online courses for students, so as to further improve the teaching quality of teachers.

4. Conclusion

In this paper, we proposed a method for emotion analysis from the comments of the online courses by a BiGRU_ATT model. We apply the model to the emotional analysis of online courses to generate visual, emotional curve distribution, emotional trend map, and emotional tendency table. It provides a new reference object for the analysis of teachers' teaching evaluation. The emotional tendency towards real-time monitoring network course. At the same time, the emotional analysis results also help teachers understand students' feedback more directly to improve personalized learning further. However, there are still some shortcomings in this paper, such as the lack of a unified corpus of English comments. The above deficiencies will be further studied.

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An Instrument Design to Measure Impacts of South Asian Parental Behavior on Children's Academic Achievement in USA

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Abstract: *Over the past few decades, researchers and educators strongly suggest that families have a major influence on their children's achievement in school and through life. Scarce research is available on parental behaviors based on various ethnic beliefs which play a critical role in children's academic achievement. The researchers designed an instrument to investigate the impacts of parental behaviors on children's education of South Asian Americans residing in Southwest Florida. The findings may help educational stakeholders to compare parental behaviors, cultural differences, and language barriers in order to develop policies and programs across various ethnic and racial groups to enhance students' educational achievement. A minimum of 0.70 Cronbach alpha coefficient of reliability was duly satisfied. Prior to undertaking a mixed methods study on parental behaviors in children's academic achievement in the United States, a pilot study was conducted to assess the feasibility of survey questionnaire, participants' recruitment for face-to-face interviews and data collection processes. The purpose of the study was to describe the pilot testing processes, explore feasibility issues, and to improve the instrument and methodology before commencing the main research project on South Asian parental behaviors and children's academic achievement.*

Keywords: Instrument Design, Mixed Survey Methods, Parental Behavior, Academic Achievement

1. Introduction

A growing corpus of research has demonstrated that parental involvement has been a focus of school administrators, educational researchers and policy makers to close ethnic gaps in achievement and maximize students' success (Dearing, Kreider, Simpkins, & Weiss, 2006). Parental involvement and effective school-family relationships have contributed to the development of children's social/emotional skills, improved school attendance, higher student academic success and reduced educational disadvantages (Desforges & Abouchaar, 2003; Higgins, Kokotaski, & Coe, 2012; Roy & Giraldo-Garcia, 2018). Roy and Giraldo-Garcia (2018) were convinced that defining parental involvement is not a simple task, as parental involvement can be viewed by various behaviors displayed by parents both within home and school environments. Despite the highest growth rates, and significant signs of economic, and educational achievement (Pew Research Center, 2017; US Census, 2010), South Asian Americans including Bangladeshis, Indians, and Pakistanis have remained understudied population. A very little scholarly research in education can be found on South Asian Americans as they are typically studied in a general pool of Asian Americans which hinders their experiences, achievements, and distinguishing features (Rahman & Witenstein, 2014). Similarly, a very limited educational research is available on the impact of parental behavior on children's academic achievement. Prior to undertaking a descriptive study on the impacts of parental behavior and children's achievement, a pilot test of survey instrument was conducted to assess the effectiveness of survey questionnaire and data collection processes. The purpose of this pilot study was to produce a suitable instrument to measure the impacts of parental behavior of South Asian families on their children's educational achievement. The study also aimed at understanding outside-school factors in addressing the educational, social, cognitive, moral, and emotional needs of children to achieve academic success.

2. Literature Review and Theoretical Framework

The first step in developing an effective survey instrument is to understand the nature of research problem and objectives of the research project (Forman & Nyatanga, 2001). Researchers have concluded that pilot studies can help answer methodological questions and could test the instrument to identify and minimize risks associated with future study design, data collection and data analysis processes (Jairath, Hogerney & Parsons, 2000). Over a number of years, school administrators, educational researchers and policy makers have recognized the value of parental involvement because of its tremendous effects on the academic achievement of children across all ethnic groups. According to Lau (2013), despite consistent encouragement by federal and local education agencies and policies, schools are still facing challenges in defining and measuring parental involvement that would assist in the development of parental involvement policies and programs. Parental involvement depends a great deal on family characteristics and parents' behavior when intended to support their children's educational progress along with their social/emotional skills (Benzies & Mychasiuk, 2009; Sheldon & Epstein, 2007). Choi, Chang, Kim, and Reio (2015) added that parents are eager to be involved in their children's education but are unaware of the aspects they should consider in supporting their children's education.

A diverse South Asian American population traced their roots to Indian subcontinent regions, each with unique characteristics, languages, religious beliefs, and cultural background. South Asian American population was identified

as the fastest growing racial group in the US, surpassing the number of Hispanic immigrants and grew 46% from 2000 to 2010 (Pew Research Center, 2017; US Census, 2010). In the same context, South Asian Americans have the highest median annual household income among all the U.S. households and have the highest level of educational attainment with 51% holding a bachelor's degree or more in 2015 compared with 30% of all Americans 25 and older (Pew Research Center, 2017). Despite the highest growth rates, and significant signs of economic, and educational achievement, South Asian Americans including Bangladeshis, Indians, and Pakistanis (BIP) have remained understudied population. Similarly, a very limited educational research is available addressing the relationships between parental behaviors and children's academic achievement. The target group was selected due to close similarities in language, cultural, and religious beliefs. Paik, Rahman, Kula, Saito, and Witenstein (2017) acknowledged that structural and cultural factors such as beliefs, values and behavioral patterns have significant impact on the economic and academic success of various ethnic groups.

Cabus and Aries (2017) defined parental involvement in terms of student achievement through its determinants. For instance, if children have learning difficulties, parents can contribute by helping children with their homework. Durisic and Bunijevac (2017) stated that parental contribution in their children's education starts at home by providing students a safe home environment, meaningful learning experiences, financial support, and an effective parent-school relationship. Wilder (2014) concluded that the most critical elements of parental involvement were communication between parents and children related to school, helping with homework, parental educational aspirations and expectations for their children, and participation in school programs and activities. In the same disposition, Fan and Chen (2001) added that parents' aspirations for their children's education were one of the strongest predictors of their involvement in students' academic attainment and it was positively associated with mathematics self-efficacy in middle and high school levels.

The theoretical framework of this study is grounded in Ajzen's Theory of Planned Behavior (TPB) which is versatile enough to account for the dynamic and complex nature of paternal engagement. The study of parents' attitude is relevant in this domain because a parson's attitude is associated with making a choice towards a certain behavior (Ajzen, 2002, 2015; Ajzen & Fishbein, 1973). Ajzen's (1991) theory of planned behavior explained the motivation for Parental Involvement and the factors that affect parents' levels of involvement. The theory of planned behavior sets a model for understanding and predicting humans' intentional behaviors which is determined by: (a) attitudes and beliefs, referred to parents' beliefs about their roles in children's educational activities both at home and school, (b) subjective norms are contributing factors that shape parental behaviors to engage in children academic activities including parents' culture and neighbors that may or may not influence their children's academic activities, and (c) perceived behavioral controls referred to control over one's own level of engagement because of access to resources and flexible work hours.

3. Research Methods

A survey is a tool to collect data from a large group of people and an instrument is a mechanism for measuring phenomena to gather information (Colton & Covert, 2007). The research design included item design, questionnaire delivery data, collection and data analysis, and advanced improvement of survey items and the questionnaire. For our pilot study, the researchers developed a survey questionnaire as an instrument to obtain feedback on clarity, errors, impartiality and test the type and format of questions. Our target population included families from South Asian region especially Bangladeshis, Indians and Pakistanis living in Southwest Florida. The researchers used both traditional and online modes of data collection by administering the survey instrument "live" to some participants of this ethnic group. We used Qualtrics, a popular Web-based survey company that allowed us to design our own surveys. It is estimated that up to 53% of surveys started on Qualtrics happen on mobile devices (Qualtrics XM, 2019). Direct administration to a large sum of participants belonging to BIP was done at weekly community gatherings for three consecutive weeks in which people completed the survey questionnaire during these events. Fraenkel, Wallen, and Hyun (2014) highly recommended this direct administration method due to the high rate of response (often close to 100 percent).

In order to make sure people understand the directions, pilot study of this instrument was conducted for three weeks to obtain feedback on clarity, errors, and impartiality of questions; it can also help identify ethical and practical issues that could halt the main study (Doody & Doody 2015). Fink (2013) recommended that all surveys must be pilot tested before launching the project to ensure methodological rigor and content and face validity. The researchers used multiple approaches to analyze this instrument such as descriptive analysis, cross-tab analysis, and factor analysis. The survey questionnaire consisted of three main sections that collected specific data on different variables pertaining to parental behaviors in relation to children's academic activities at home and at school. The structure of the questionnaire design for each section is shown in the table below:

Table 1.
The structure of the questionnaire design

		Goals	Number of questions	Type of questions	Question samples
Section 1	Demographics	Basic family information (gender, income, children, ethnic origin, education)	10	Multiple choice	Family's country of origin?

Section 2	Parental Behaviors pertaining to children's academic activities both at home and at school	Home Support	10	Likert-scale	Did parents assist with homework?
		Parental Behavior	8	Likert-scale	
		Control & Monitor	5	Likert-scale	Did parents enforce screen time/ social time?
		Contact School	13	Likert-scale	
		Activity Participation	5	Likert-scale	Did parents attend parent teacher meeting?
					Did parents Volunteer at school/attend school activities?
Section 3	Qualitative Phase of Research	Influences and Justifications for Parental Involvement	5	Open-ended	What are the justifications of parental involvement?

4. Preliminary Results

The pattern of survey responses for this pilot study provided useful feedback to improve the instrument for future research project. As a result of the pilot study, few questions were re-ordered under demographic and parental behavior sections. Wording on two questions were amended for clarity, jargon removed where possible, and questions were shortened to facilitate ease of completion. In the qualitative section, one question was reworded to eliminate biases, and another was added to collect information of volunteers to participate in a face-to-face interview for phase two of our main project. Furthermore, the researchers decided to activate "the back button" if a participant desires to modify any answer. Additionally, it was agreed to add questions to elicit feedback about the survey that may be useful for future studies. A brief summary of the findings and revised questions are shown below in table 2:

Table 2.
Preliminary findings, revised questions and Cronbach's alpha

	Goals	Cronbach's alpha, α	Original questions	Revised questions
Section 1	Family Demographics		What is your age?	Which category below contains your age? Provided categories for various age groups to choose a range. Some people may be reluctant to tell their exact age.
Section 2	Home support Parental behavior Control & Monitor Contact school Activity participation	.88 .82 .77 .89 .84	Did parents discuss plans and preparations for the ACT and SAT tests?	"Not Applicable" choice was added for parents with children in elementary/middle schools
Section 3	Qualitative phase		Participants' recruitment question was missing. A question was added to recruit volunteers for face-to-face interviews	Please provide your contact information to participate in face-to-face follow-up interviews. The time and location will be agreed upon to accommodate your schedule

Data were collected using a printed version of instrument and an online questionnaire for personal information along with questions to measure parental behavior of each respondent. The total response was encouraging as 68 out of 80 families participated and registered a response rate of exactly 85%. The response pattern was worth noting as 54% female parents with young children completed the survey questionnaire than male parents. Sampling improvement will help more feedback from male parents with college going children. The rate of answered quantitative questions was high without any sign of ambiguity; however, in six open-ended questions, nine people did not respond to one or more. There were four incomplete surveys; one participant completed one out of three sections while three others partially completed each

section. We could not determine if some participants encountered difficulties or navigation problems as they took longer than expected completion time. Overall, The pattern of survey responses for this pilot study provided useful feedback to improve the instrument for future research project.

5. Limitations

There are several limitations to the study. The survey participants may fail to provide honest responses pertaining to income levels, marital status and educational background which would invalidate data. A potential limitation includes the focus on a specific geographical region in Florida. Another limitation is that this study focused on families belonging to three countries (Bangladesh, India and Pakistan) from South Asian region; expanding the sample size and including parents from several other South Asian countries could further improve the generalizability and precision of the results.

6. Significant Contributions

This instrument design was developed as a first step to conduct a future study. For the future project, the researchers will use mixed methods approach to collect data through survey questionnaire to measure the impacts of South Asian parental behavior on their children's academic education. In addition to the survey questionnaire, narrative/cognitive interviews will be conducted from this group which could help us to further improve this instrument. The research project can also provide a platform to explore the impacts of parental behaviors on children's educational outcomes over a period of time. Future studies should compare cultural differences, language barriers, and gender differences across various ethnic and racial groups in order to find multiple factors in each group to help students improve their learning outcomes.

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The effects of a learning activity supported by VR technology on intercultural competence in Chinese students

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Abstract: *We applied immersive virtual reality (VR) technology to support intercultural learning in this study. To this end, we design learning activity supported by VR technology, during which students from different countries introduce and experience culture by recording and watching 360-degree video. Data were collected from Chinese students' reflections, two questionnaire surveys and interviews, and analyzed. The results indicate that Chinese students have a positive perception toward the VR technology and intercultural immersive and authentic learning experiences, which can stimulate the motivation of learning the target cultural knowledge and can promote intercultural competence (IC). Based on our results, we discuss some implications and give suggestions about technology-supported intercultural learning.*

Keywords: intercultural learning, cross-cultural learning, intercultural competence, VR technology, 360-degree video

1. Introduction

In China, many educational policies, such as *Outline of China's National Plan for Medium and Long-term Education Reform and Development* (2010-2020) issued by the Ministry of Education, have made concrete requests of the development of the college students' intercultural communication competence (ICC). Therefore, the cultivation of students' ICC has become one of the objectives of language (e.g., English) learning and teaching in college. However, some problems in teaching practice (e.g., the absence of authentic experience) urge educators and researchers to continuously explore new ways of intercultural learning (Shadiev & Huang, 2016).

With the development of technology, many researchers (e.g., Shadiev, Wu, Sun, & Huang, 2018) have carried out research on technology-supported intercultural learning (Çiftçi &Savaş, 2018), in which learners from different cultural background can acquire cultural knowledge and absorb new attitudes and values from different cultures (Yamazaki & Kayes, 2004). In addition, some researchers have also begun to explore the use of emerging technologies (e.g., telepresence robot) to support intercultural learning in order to provide an immersive learning environment. However, the learning environment provided by researchers to students in previous is virtual rather than real, which is not conducive to the transfer of what students have learned or experienced to the real world (Dede, Jacobson, & Richards, 2017); the experience of students in previous studies is short, and cannot be experienced after the study. The immersive VR technology can help to provide immersive and authentic experience by situating users in realistic environment that they are inconvenient to visit in real life (Chien, Hwang, & Jong, 2020). 360-degree video is an immersive type of video content that allows viewers to choose and control what they see to look around (Walshe & Driver, 2019). Due to the popularity of 360-degree cameras (e.g., Samsung Gear 360), people can now easily create 360-degree videos by themselves (Jung, Kim, Lee, Kim, & Lee, 2017). However, to the best of our knowledge, not many studies have been

carried out using the immersive VR technology to support intercultural learning. In particular, whether a learning activity supported by such a technology facilitates IC or not has not yet been tested. Therefore, this study is an attempt to address the existing gaps in the related research. That is, we designed intercultural learning activity supported by VR technology and examined its effectiveness with regard to IC and then tested the technology perceptions. The research questions, which are guide this study, are as follows: (1) can a learning activity supported by VR technology facilitate IC, and (2) what are participants' perceptions towards VR technology during the intercultural learning activity?

2. Method

2.1. Participants

A total of 21 students (20 females and 1 male) participated in the intercultural project at a university in China. The 10 participants, who were graduate students, were from school of education science. Another group students (11 females) from a Uzbek university were invited to participate in the intercultural project. Students from both countries were assigned to groups based on similar interests or hobbies.

2.2. Research procedure

As shown in Figure 1, before the intercultural learning activity (one week), we collected demographic information using a paper-based questionnaire. After that, the participants were taught about how to use the VR technology and practiced using it. Next, the students participated in the learning activity. Each of these three steps lasted for one week. Participants watched and experienced video on mobile-based Samsung Gear VR device, during which time they were free to ask the researchers for help. After the learning activity (one week), we surveyed the participants' perceptions toward the VR technology using a paper-based questionnaire and carried out interviews with the participants.

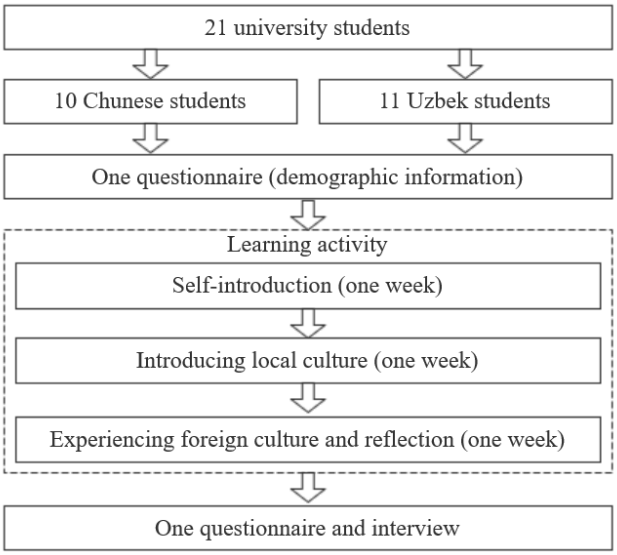

Figure 1. Research procedure

2.3. Date collection and analysis

We collected the participants' reflections and interviews for the first research question; we tested participants' perceptions of the technology using a questionnaire using based on the TAM (Davis, 1989) and interviews data for the second research question. Each interview lasted approximately 30 minutes, in which the students were asked open-ended questions: (1) what was your development of IC in four dimensions with participating in the intercultural learning activity? (2) what do you think about the VR technology in the use for intercultural learning? (3) how do you feel about participating in this intercultural learning activity? Ten valid answer sheets to every questionnaire were

obtained out of the 10 students, and the quantitative data was analyzed using SPSS 25. Based on Byram's (1997) IC model, the qualitative data such as students' reflections and interviews were closely examined using content analysis method. To be specific, the data were read through and text segments in the data that relevant to Byram's IC model were highlighted and coded by two researchers individually. An inter-rater agreement of 90% was achieved and then they discussed their coding decisions to reach a consensus for data coding.

3. Results and discussion

3.1. Assessment of Chinese students' IC in intercultural immersive learning experience

Based on Byram's IC model, we found that the Chinese students demonstrated their IC in five dimensions: knowledge of their own and the interlocutors' country and culture; curiosity and openness to learn about their own and interlocutors' culture, and respectful for the cultural differences; skills of acquiring new knowledge of a culture; skills of interpreting an event from their interlocutors' culture, and relating it to their own culture; critical cultural awareness to evaluating cultures. In interviews and reflection reports, most students indicated that they had no knowledge of foreign cultures and traditions before participating the program. Through this immersive and authentic cultural experience, all students mentioned that they learn some important facts about the interlocutor's culture. In the process of preparing to introduce cultural knowledge, all students also have a better understanding of some cultural knowledge of their own country. For example, "I learned more about the history of our school by looking up some materials" said by S9. All the students mentioned their interest in different aspects of foreign culture and their desire to introduce their own culture to others. In addition, some (40%) students mentioned their openness learn about their own culture and the foreign culture. Most (80%) students confirmed that they could discover additional cultural knowledge in the VR environment. For example, "I can compare the information I get from the scripts with the narration of my partner, as well as the things I see and feel one by one, so as to enhance my understanding" said by S7. What's more, students used to compare their own culture with the other's. As for cultural differences, many (70%) students indicated they would respect and understand them, and they also used some strategies to interpret and explain the cultural difference. Lastly, many (70%) students developed their cultural awareness through cross-cultural comparison and contrast. Based on our results, students developed their IC in five dimensions after the intercultural learning, which is consistent with previous studies (Hsu & Beasley, 2019; Shadiev, Hwang, & Huang, 2015).

3.2. Students' perceptions toward the VR technology

Based on data collected about the students' perceptions, the participants had positive perceptions toward VR technology. Totally, they found it was useful for their learning (Mean=4.15; SD=0.515) and easy to use (Mean=4.33; SD=0.601). In addition to the usefulness and ease of use, from the interviews and reflective reports, students mentioned other feelings of the technology and the intercultural learning. First, it is interesting to experience foreign cultures through 360-degree video. For example, "I can see the 360-degree environment around the partner, which is more interesting than the normal 2D video" said by S4. Second, it is meaningful for learning by using the VR technology. While computer technology has long been able to break down time and space constraints and distance learners can have synchronous or asynchronous communication supported by it, the technology used in previous studies is not sufficient to provide a truly immersive cultural experience. The immersive device is relatively economical and available compared to other expensive devices, and it can also provide an authentic and immersive experience, which is also confirmed in the interviews. Lastly, students felt satisfied with the intercultural learning supported by the VR technology and they mentioned that they would like to use the technology in the future.

4. Conclusion

The purpose of this study was to look into the learning activity supported by VR technology to the development of students' IC. Meanwhile, the students' perceptions toward the use of VR technology were explored. The findings show that students have positive perceptions toward the VR technology and intercultural experience. As a result, they developed their IC on five dimensions, which indicate that the learning activity supported by VR technology is useful for developing students' IC. Based on these results, several implications and suggestions may be made. First, it is suggested that researchers and educators utilize the VR technology to support long-distance intercultural learning. To be specific, 360-degree video can be used as learning materials, which can assist cultural and language learning (Chien et al., 2020). Second, the following suggestions are proposed for the design and record the 360-degree video: don't shake camera to reduce the likelihood of motion sickness; when recording 360-degree video, it should not be too long to avoid viewers' fatigue; choose a topic that is easy for users to observe so as to play the advantages of 360-degree video. However, as in other studies which focused on the same research topic, this study also has some limitations. First of all, we recruited 21 participants from two countries and the vast majority of them are female. It is recommended that future studies be conducted to increase the sample size and balance the sample distribution. Secondly, the improvement of IC was only judged by the feedback of interviews, whether it is achieved by VR technology still needs evidence to prove. Therefore, both qualitative and quantitative data will be collected and the comparison between VR-supported learning activities and general teaching methods in intercultural learning is recommended in the further exploration. Thirdly, this study only analyzed the impact of intercultural learning on Chinese students. In order to further explore the impact of intercultural learning on students, it will be beneficial to collect data of students from different countries.

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Using Epistemic Network Analysis to Explore STEM Learning Design Competence in Online Collaborative Discourse

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Abstract: *Involvement in well-scaffolded collaborative curriculum design contributes to teachers design high-quality STEM learning plans. It remains unclear how we can evaluate STEM learning competence effectively and then stimulate a productive design process. This study utilized 12 STEM learning design activities in an online collaborative learning environment, and collected 9686 utterances of 33 pre-service teachers during the design process. The present study aimed to: (1)uncover links between elements of STEM learning design competence and the differences between high and low-performing pre-service teachers; (2) explore how pre-service teachers' STEM learning design competence changed over time during activities. We aligned Epistemic Network Analysis method to analyze discourse data. The findings revealed that there are significant differences in the networks between high and low-performing groups. By analyzing the discourse that contributed to each of the connections in the network representation, we can see that this difference leads to the quality of their lesson plans. To further explore the competence development trajectory, we modeled the networks of the two groups at different design stages. The findings show that these two groups represent two learning design patterns, similar to traditional learning design and backward learning design.*

Keywords: STEM learning design competence, Epistemic network analysis, Discourse analysis, Collaborative design

1. Introduction

The preparation of quality teacher candidates is critical for successful STEM education (Ben, Dan, Whitney, Kate, & Melissa, 2018; Stohlmann). One way of effective teacher professional development is to involve teachers in collaborative curriculum design (Voogt et al., 2015). It is important to explore the cognitive development of teachers in the process of collaborative curriculum design for the design and evaluation of teacher education. In this study, pre-service teachers jointly develop STEM learning plan through active, constructive, experiential, collaborative learning under the guidance of an online tutor. We aligned epistemic network analysis (ENA) method to provide new qualitative and quantitative insights into the teachers' development of learning design competence, which can provide evidence for teacher educators to design STEM teacher curriculum and provide effective instructional scaffolds. More specifically, ENA was used to answer two research questions: (1) what are the differences between high and low-performing pre-service teachers' learning design competence networks; (2) How pre-service teachers' STEM learning design competence changed over time during activities, and how these changes contribute to design outcomes.

2. Theoretical Framework

2.1. STEM Learning Design

To develop student 21st century skills, STEM learning designer must understand and be able to apply design theories to practice, which indicate design thinking is the core competence of teachers (Wu, Hu, & Wang, 2019). Studies have shown that involvement in well-scaffolded collaborative curriculum design contributes to the professional development, and teacher learning needs to be situated in authentic contexts which connect to practice (Putnam & Borko, 2000).

Therefore, we developed an online collaborative environment, which provides teachers an authentic practice opportunities, and allows teachers to apply their discipline knowledge and instructional theories to the learning design practice. Compared with "instructional design", learning design focus more on learners' learning experience. Many organizations have proposed several frameworks (MacLean & Scott, 2011), such as AECT standards, IBSTPI competencies, STEM teacher competency standards and STEM Education Quality Framework.

2.2. Discourse Analysis for Competence Modeling

Modeling the development of competency is a significant challenge. Epistemic Network Analysis (ENA) provides a quantified approach to analyze the structure of connections in discourse, through observing the co-occurrence of concepts within the conversations. Within ENA, connections among codes are derived for each unit of analysis based on the code co-occurrences in the data subsets called stanzas. From code co-occurrences, ENA first iterates through the data to create an adjacency (co-occurrence) vector corresponding to each unit, and then computes a dimensional reduction (projection), and calculates node positions in the projected ENA space. Returns location of the units in the projected space, as well as locations for node positions, and normalized adjacency (co-occurrence) vectors to construct network graphs. At the end, the output of ENA is a series of graph models which capture the relationships between the different codes (Shaffer, Collier, & Ruis, 2016). ENA has been successfully applied to analyze collaborative learning and scientific reasoning of pre-service teachers and explore teachers' technological pedagogical content knowledge (TPACK).

3. Method

3.1. Participants

The participants for this study included 33 students from a university in eastern China, they formed 8 groups. This study uses a STEM learning design system to improve pre-service STEM teacher's design thinking. During a 12-week learning (2h per week), pre-service teachers had to collaborate on a series of interrelated tasks to design a STEM learning plan. The virtual tutor sent the requirements of each sub-task and related learning resources by email. Participants learnt the relevant resources independently and discussed each task with other pre-service teachers and tutor. After each task, pre-service teachers submitted their discussion results to the tutor.

3.2. Data Collection and Data Analysis

The system automatically records students' (a) learning lesson plans and other products, (b) conversations with peers and tutors via email and instant message. A total of 9686 utterances and 8 group lesson plans were collected. Referring to the STEM learning design frameworks, a rubric was developed for analyzing lesson plan in this study. The scoring reliability (Cohen's kappa) between the two researchers was 0.77, and we used the average score of the two researchers as the final score for each lesson plan. We use grounded theory to identify six codes from chat data of online design meetings (Table 2). After coding, this study performed ENA to analyze the coded data. For a more detailed discussion, we selected one group from the high-performing groups (the groups that scored above average) and one from the low-performing groups (the group that scored below average) for ENA analysis, hereinafter referred to as H1 group and L1 group.

Table 2. The coding scheme of STEM learning design competencies.

Code	Description	Example
subject basic knowledge	Competency to integrate knowledge of science, technology, engineering, mathematics	Teachers integrate knowledge of filtration and data analysis into water filtration activities.
techniques and methods	Competency to provide appropriate techniques, tools, and methods	Teachers encourage students to use questionnaires to collect data and use data analysis software to analyze data.
thematic context	Competency to design authentic, ill-structured learning situations	Teacher design a water pollution learning situation to engage students to learn oil and water separation.
design of	Competency to design, develop and integrate	Teachers design activities suitable for students, such as

activities	student-centered learning activities	the collaborative learning, inquiry learning.
design of products	Competency to design scheme, prototype, et cetera to solve problems	Teacher encourage the students to design a prototype of an amusement park.
objectives and evaluation	Competency to design inter-disciplinary objectives and performance-based assessments	Teacher design a rubric to evaluate the students' solutions.

4. Results and Discussion

4.1. Research Question 1

During the STEM learning design online meetings, the mean epistemic network of H1 and L1 groups were shown in Figure 1. The t-test result shows that there is statistically significant difference between the two groups. In the epistemic network of pre-service teachers in H1 group, there are more connections between thematic context and design of products, design of activities and design of products, design of products and objectives and evaluation. While in L1-group average network, there are more connections between design of activities and objectives and evaluation, design of activities and thematic context, design of activities and subject basic knowledge, design of activities and design of products. To interpret this statistic difference of the centroids of the network according to the network structure, we reviewed the discourse that contributed to each of the connections in the network representation. We found that H1 group triggered STEM learning from describing an authentic learning context, took problem solving as the learning orientation, designed solutions, prototypes or models around the problems or user needs, and emphasized the assessment of learning products. However, in L1 group, pre-service teachers tended to design STEM learning experience around conceptual understanding and knowledge construction, and activity and evaluation were strongly related to the knowledge contents of subjects.

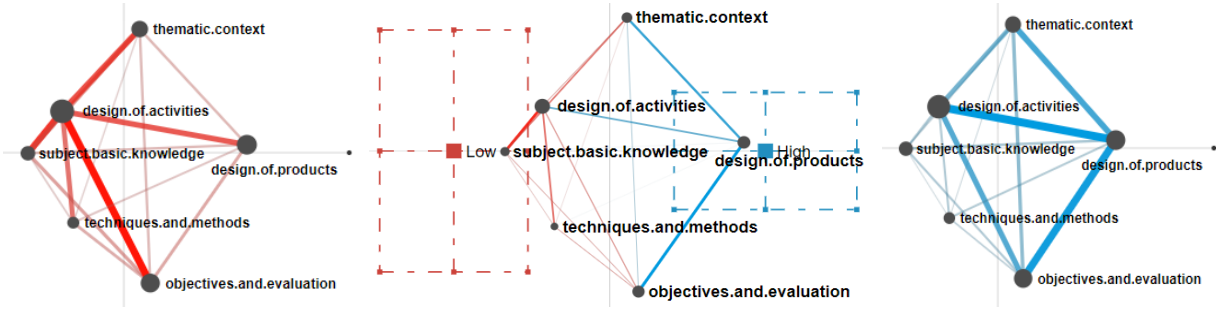

Figure 1. Mean discourse networks of L1 group (left, red) , H1 group (right, blue), , and a subtraction network graph.

4.2. Research Question 2

From the average epistemic network graph of H1 group and L1 group in three stages in Figure 2, it can be seen that the learning design features of the two groups are significantly different. The H1 group first identified the expected learning outcomes, the connections between objectives and evaluation, design of products, design of activities are strong. Then they designed the learning context, and determined the evidence that could prove that students achieved the expected learning objectives, the network show the strong links between learning products and context, activities, and evaluations. And finally H1 group designed relevant activities, it can be seen that they attach great importance to the generation of learning evidence in the design of activities. The different is that the L1 group first focused on the learning objectives and relevant subject content, rather than associating learning objectives and evaluation with students' learning performance. In the second stage, after defining the teaching contents and objectives, L1 group began to design learning activities. We can see that the L1 group design activities take into account the relationship between activities and knowledge, context, learning products, objectives. Finally, L1 group returned to the evaluation of the original objectives.

These two groups represent two classical learning design patterns, namely, traditional learning design and backward learning design (Wiggins & McTighe, 1998). Analyzing the STEM learning plans of the two groups, we found that H1 group tied to multiple national curriculum standards, carried out inquiry activities around inter-disciplinary issues, and

designed rubric-based performance assessments that require students to demonstrate knowledge and skill in completing authentic tasks. While in L1 group lesson plan, there were some inconsistencies in learning objectives, activities and evaluations, and the design of activities lack of diversity and challenge. This suggests that L1 group was lack of iterative design process that aligns learning activities with objectives and expected outcomes.

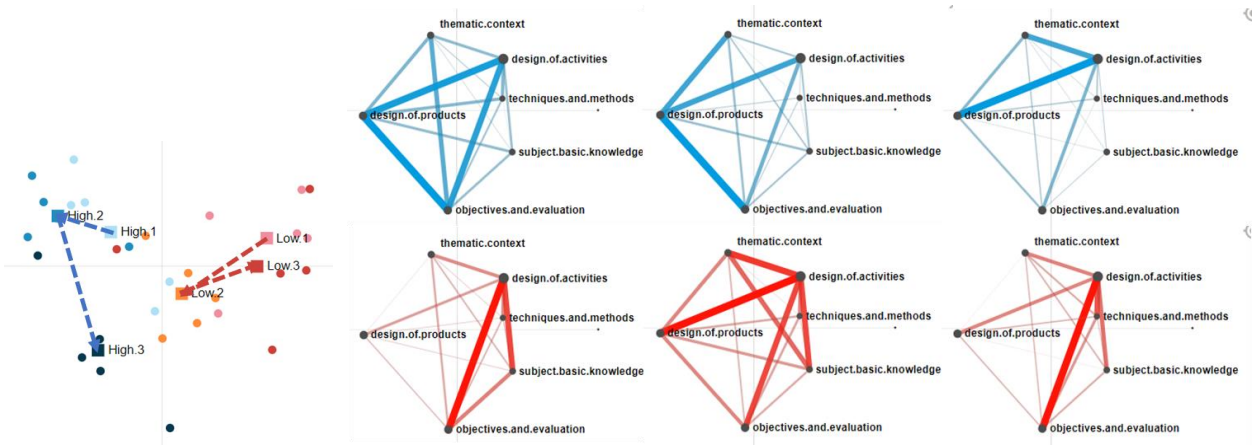

Figure 2. The epistemic trajectory of H1 group (blue) and L1 group (red).

5. Conclusion

This present study used ENA to model STEM learning design competence, and aligned discourse analysis with lesson plan assessment to explore the characteristics of pre-service teachers' design thinking in online design meetings. The findings revealed that the high-performing group designed an open-ended authentic STEM learning experience including crosscutting concepts, encouraged students to develop higher-order thinking through design solutions, prototypes or models, and emphasized rubric-based, performance assessments. They adopted a backward design mode of (a) learning objectives and learning context, (b) learning evidences and evaluation, and (c) learning activities and learning scaffolds. The low-performing group paid more attention to the connection between subject knowledge and learning activities, whereas learning objectives, learning activities and learning evaluation were not always consistent.

This study only analyzed the characteristics of pre-service teachers STEM learning design structure in a preliminary stage, lacking detailed and in-depth analysis. In future research, we will combine the ENA and text mining to explore modeling approach of pre-service teachers' learning design competencies.

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The Design and Implementation of a Performance-Based Assessment Platform for Computational Thinking Development: EasyCode

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Abstract: *Assessing the development of Computational Thinking (CT) is one of the critical issues in CT education in K-12. Current assessment tools for CT are in general programming-environment-specific and based on static code analysis. In this study, we design a generic performance-based assessment platform for CT development, the EasyCode system. This system provides a block-based visual programming environment with an online judgement of the performance of students. There is a support mode in the EasyCode system to support students to develop CT in the programming process. The support facilitates students on learning core CT concepts. Different from current automatic assessment tools, the EasyCode system conducts dynamic code analysis on students' submitted programming codes and records students' programming processes and the codes involved in the process. These codes will be used for conducting learning analytics.*

Keywords: computational thinking, online judgement, performance-based assessment, primary school, programming

1. Introduction

In this paper, we present the EasyCode system, an online judgement platform with a generic block-based visual programming environment for conducting a performance-based assessment for Computational Thinking (CT) development. The EasyCode platform aims to provide students with an online judgement system that can conduct dynamic code analysis and can provide timely feedback to the student in testing and debugging. Programming tasks can be directly designed on the platform. Programming tasks can be designed in open-ended format and need to be well-structured with at least one possible computational solution. There are two modes in solving programming tasks in the platform: normal mode and support mode. In the normal mode, students need to work out the programming solution in the workspace of the platform without any support. In the support mode, blocks other than essential one for learning core CT concepts are already placed in the workspace and the toolbox is also tailor-made with just-needed-blocks for students to select and use. One of the functionalities of the platform is to verify the submitted program deploying the black box test approach. The output of the codes submitted by a student will be compared with the answer of the correct program of the programming task. The support mode can reduce the task difficulty by enabling students to focus on designing the core parts of the program which are related directly to the core CT concepts. Besides assessing the CT concepts, this platform will record students' operations in the platform which can be used later for conducting learning analytics. The behavior of students' operations provides opportunities to assess CT practices of students such as testing and debugging.

2. Background of Study

The research interest of CT in K-12 education has arisen since 2006 with the seminal work of Jeannette Wing (Wing, 2006). Then CT is promoted widely in K-12. One important challenge in CT education in K-12 is the assessment of CT development of students. A popular framework of CT in programming education is proposed by Brennan and Resnick (2012). This framework consists of three dimensions. They are computational (CT) concepts, computational (CT) practices, and computational (CT) perspectives. This framework has been widely adopted for curriculum development. However, there is not yet any consensus on a standardized approach for assessing CT development. This study adopts this framework to assess the CT development of students in the area of CT concepts

and CT practices using the performance-based approach. In other words, students are assessed when they are performing the programming tasks in this platform.

A few assessment tools have been developed for analyzing students' programming projects automatically. These assessment tools usually are developed for a specific block-based visual programming environment such as Dr. Scratch is designed for supporting the assessment of Scratch programming. Dr. Scratch (Moreno-León & Robles, 2015), an online automatic assessment tool, provides web-based services that facilitate the analysis of Scratch programming projects. Code Master (Von Wangenheim, et al., 2018) is a free web application that can automatically assess and grade projects programmed with App Inventor (Wolber, Abelson, Spertus, & Looney, 2011) and Snap! (Harvey, Garcia, Paley, & Segars, 2012).

Although these assessment tools are automated and user-friendly, they are limited in assessing only CT concepts and unable to support their development. Most of these analysis tools focus on assessing CT concepts because it is relatively easy to locate the concepts for assessment in these programming environments and achieve automation. Limited attention has been paid to automate the assessment of CT practices because most of these assessment tools are based on static code analysis and evaluates students' understanding of CT concepts by counting the frequency of related blocks used. Whether the blocks are properly used is not considered in these assessments. These assessment tools can be easily deceived with programming projects that dump a few related blocks without proper usage in the context. These tools do not consider whether the programming project can be properly executed. In addition, students' programming process and their progression in programming generally are not recorded. In this study, we attempt to build a performance-based assessment platform to assess both CT concepts and CT practices by recording the programming processes in the platform.

3. EasyCode: The Performance-Based Assessment Platform

3.1. System Architecture

The system architecture of the EasyCode platform is shown in Figure 1. The EasyCode platform consists of four modules: a CT Programming Tasks Database, an Interface Agent, a Judge Agent, and a Learning Analytics Agent. The CT Programming Tasks Database stores open-ended and well-structured computational questions with referenced answers. The Interface Agent provides an interactive block-based visual programming environment in the browser and a code submission entry. The Judge Agent compiles and executes the submitted codes. The submitted code is tested with prepared testing cases to verify its functionality. The test results will be forward to the user and recorded in the learning analytics agent. The Learning Analytics Agent not only records the final solutions but also records users' operation and intermediate steps on the platform. Details of each module are discussed in the following sections.

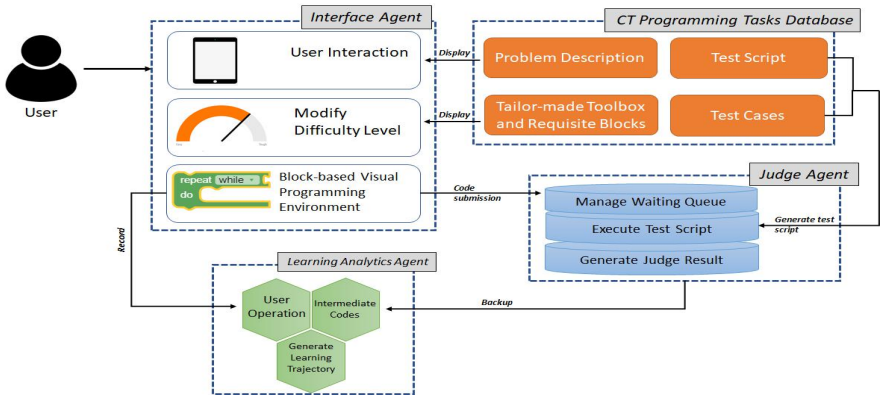

Figure 1. System Architecture of the EasyCode platform.

3.1.1. CT Programming Tasks Database

The programming tasks in the database are designed based on a CT curriculum derived from the CT framework proposed by Brennan & Resnick (2012). A sample question is provided in Section 4. Different from traditional programming tasks that only focus on testing students' programming concepts, the CT tasks are designed to examine students' understanding of the CT concepts such as loop, conditionals, and sequencing of lines of codes and the ability to solve the problems with CT. This platform support CT development by providing support in solving the CT tasks when students need the support. A tailor-made toolbox would be provided with just those blocks in need will appear in the toolbox if students ask for this support in solving a particular programming task. The other support is to provide blocks other than those blocks involving core CT concepts in the workspace of solving the programming task. These two types of support enable students to focus on learning the core concepts of programming without distraction in putting effort into the input/output processing and those blocks that are not directly related to the core CT concepts.

3.1.2 Interface Agent

The Interface Agent is the front-end part of the platform. It is responsible for user interaction and code submission. A screen capture of the interface is provided in Figure 2. Users can select a programming task and then start the coding process in the generic block-based visual programming environment. Users can submit their codes and test their solutions with test cases prepared by the system. The platform will return the results of the program submitted by the user and inform the user whether his/her programming solution fulfilled the requirement of all the testing cases. If the programming output is not equivalent to the output of all the prepared testing cases, the system will present those incomplete test cases as well as the output generated by the users' code as feedback. Users can also prepare their own test cases before submitting their programming codes.

3.1.3. Judge Agent

The Judge Agent is responsible for executing the submitted code and comparing the outputs with the programming solutions of the system of a programming task. User's codes in block format are converted into textual programming language such as Python before uploading to the server. The uploaded codes will be stored in a queue before execution and judgement. The Judge Agent will fetch the users' code from the waiting queue and embed the code into a test script for execution. The test script is then executed using prepared test cases fetched from the CT Programming Tasks Database as input. The execution output is compared with the correct answers. The result of the comparison will be written back into the queue and the Interface Agent can access the queue to obtain the results and display them to the users.

3.1.4. Learning Analytics Agent

The Learning Analytics Agent tracks and records user's behavior on the platform. For each task that the user attempted, every submission to the Judge Agent will be backup in the Learning Analytics Agent. When a user finally accomplished a complete solution after several attempts, not only his/her last submitted codes in the Learning Analytics Agent, but also the codes in his/her previous attempts will be recorded. In addition, users' operation such as clicks, add/delete blocks, connect/disconnect blocks on the platform is also recorded in our Learning Analytics Agent. These records provide researchers with a comprehensive picture of how students tackle programming tasks.

4. Sample Question and Future Work

Figure 2 provides a sample question in the EasyCode platform. The sample question is developed based on the study by Kong (2019), which is an example of CT development through primary mathematics learning. In this example, the learning task is to develop an algorithm to determine whether an input number is a composite number or a prime number. Instead of formulating the task into one single task and directly transplanting the complete app into the

platform, this study decomposes this task into three subtasks: (1) "Is it a factor?" (2) "Find all the factors of a number", (3) "Is it a Prime Number?". In each subtask, students only need to tackle a small part of the task by writing the core part of the program which directly related to a CT concept. For example, in the subtask "Is it a factor?", as shown in Figure 2, the student only needs to implement the conditional statement, which determines whether a number is a factor of another number according to the output of the remainder function. In addition, in the support mode, the toolbox is tailor-made with only those blocks in need to be selected.

This study will expand the existing database to more programming tasks for beginners to develop CT. For beginners, the introduction of core CT concepts such as loops, conditionals, and sequencing are important. This study will design programming tasks that require students to demonstrate their understanding and hence able to assess their CT development in CT concepts. The programming tasks will be designed that can only be solved with certain types of blocks and the blocks are related to specific CT concepts. Learners can then be assessed by asking them to perform the task. The Learning Analytics Agent will be developed to generate users' learning trajectories. A visual interface for displaying the learning trajectories will be designed for assessors to understand CT practices development of learners such as whether testing and debugging are carried out in the programming process. Machine learning techniques will be developed to extract patterns of learners in their user logs. A user study will be conducted to verify the system.

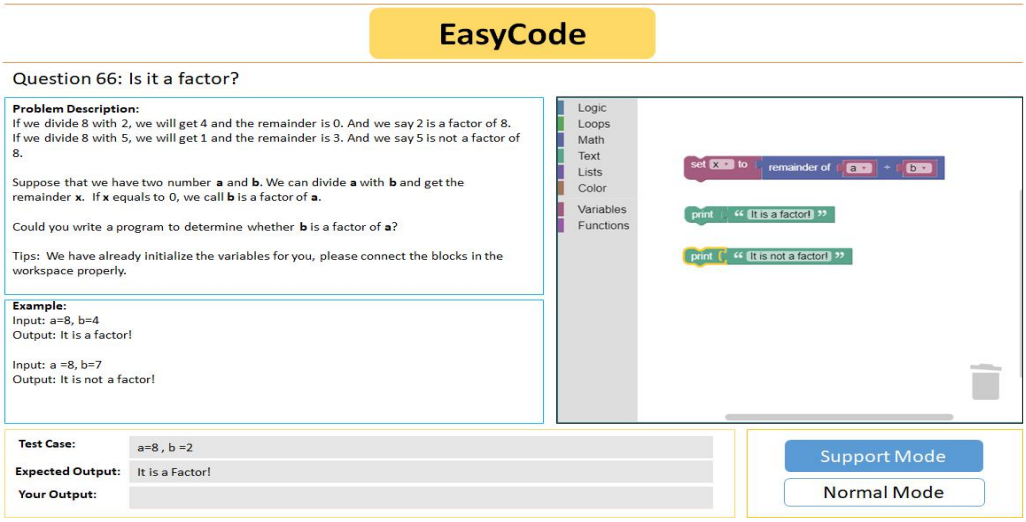

Figure 2. Screen capture of a sample question on the EasyCode platform

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Designing Games to Enhance Cybersecurity Awareness

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Abstract: *With the growth of the daily online activities, the issues of high-tech crime arise. It is important to improve people's awareness of the importance of cybersecurity as well as encourage more students dedicating their efforts in cybersecurity industry. This research has organized a game-development activity to help high-school and college students understand the concepts of cybersecurity through developing cybersecurity educational games. A semi-structured interview designed in this study will be conducted in the following semester.*
Keywords: cybersecurity, STEM, maker, game development

1. Introduction

There is a current and growing demand for professionals with the skills needed to confront cybersecurity threats with the Herjavec Group estimating 3.5 million unfilled positions by 2022. Forbes magazine reported that in the first six months of 2019, there were more than 4.1 billion records exposed in data breaches. The 2019 RSA Conference projected that worldwide annual spending on information security products and services will exceed $124 billion. Coordinated attacks against states are on the rise with 22 Texas towns hit with Ransomware in August 2019. These few cybersecurity statistics show why cybersecurity education and awareness are critical.

After President Obama encouraged American students to enhance their science and math achievement (The White House, 2009), the White House formalized the campaign as the maker movement with an annual White House Maker Faire and National Week of Making (The White House, 2016). The maker movement aims to motivate students' enthusiasm in learning scientific knowledge with a do-it-yourself approach (Dougherty, 2012). It is usually executed through STEM courses to help students improve their interest in STEM and creativity (Margin, 2015; Clapp & Jimenez, 2016). The research team would like to use the maker education movement to improve the awareness of the importance of cybersecurity and encourage more students to work in the cybersecurity area.

To reach this goal, the research team organized a game-development activity in a four-year college in the southwestern United States. Section 2 explains the research methods, including the game-development activity and the hypotheses made by the research team. The process of the game-development activity as well as the competition outcome are described in Section 3. Section 4 summarizes the work of this study and lists the future work.

2. Research Method

The term Game Jam describes the collaborative act of producing something with no prior preparation in an effort to develop new game material or simply to practice the art of coding. Our Game Jam brought together the student community to work over a weekend to make video games. It was a unique opportunity for students to create, collaborate and practice their game-making skills, and we invited everyone, CS and non-CS majors alike with any skill level to participate.

The research team worked with the Cybersecurity Education Center funded by the state government to host the Game Jam in a four-year college in the southwestern United States in the weekend before the Thanksgiving break in 2019 Fall. The theme of the games was cybersecurity education. The Cybersecurity Education Center proposed to fund

the winner in Game Jam to complete the game development in order to use the game in cybersecurity outreach activities in the future. The Game Jam process is listed in Table 1.

Table 1. The Game Jam process.

Time Spending	Activity	Details
3 weeks	Promotion	Game Jam posters were posted in the library and student center. Interested students submitted an application form online. We also invited eight high school girls from a multimedia class and two of their teachers to join the activity, record the event, and develop promotional material for the program.
44 hours	Game Jam	Students were gathered in a computer lab. The Game Jam lead explained the theme of the game and the rules of the activity. Students started discussing in groups regarding the software they wanted to use, the game background story, and the cybersecurity issues involved. Game development commenced.
2 hours	Judgement	There were three judges: one is computer science faculty in cybersecurity; one is computer science faculty in learning technology area; one is CLASS faculty in game design area.
2 weeks	Interview	The research team will reach out to the students who gave final presentations. We will explain the purpose of the research and ask them to sign the consent form. The interview will take 20 minutes for each student.

*CLASS Department: Communication, Liberal Arts, and Social Sciences Department

The research team has the following hypotheses for the Game Jam:

- H1: Students have learned some basic concepts of cybersecurity after participating in Game Jam
- H2: Students have better awareness of the importance of cybersecurity after participating in Game Jam
- H3: Non-CS major students have more interest in taking CS related courses after participating in Game Jam
- H4: CS major students have more interest in cybersecurity topics after participating in Game Jam

Based on the hypotheses, the research team has designed a semi-structured interview to understand students' awareness of the importance of cybersecurity, students' understanding of cybersecurity concepts gained from Game Jam, and students' intention of learning CS/cybersecurity in the future. The questions are listed in Figure 1.

1. What is your school class standing?
2. What is your major?
3. Have you learned the concepts of cybersecurity? Which concepts you have learned?
4. Do you have better awareness of the importance of cybersecurity? What you will do differently, since Game Jam, to secure your personal information?
5. (Only for non-CS major students) Do you have more interest in taking CS related courses?
6. (Only for non-CS major students) Would you consider to taking a CS major or minor in the future?
7. Do you have more interest in investigating cybersecurity related topics than before Game Jam?
8. (Only for CS major students) Do you have more interest in studying cybersecurity as an undergraduate course topic or graduate research topic in the future?

Figure 1. Questions in the semi-structured interview

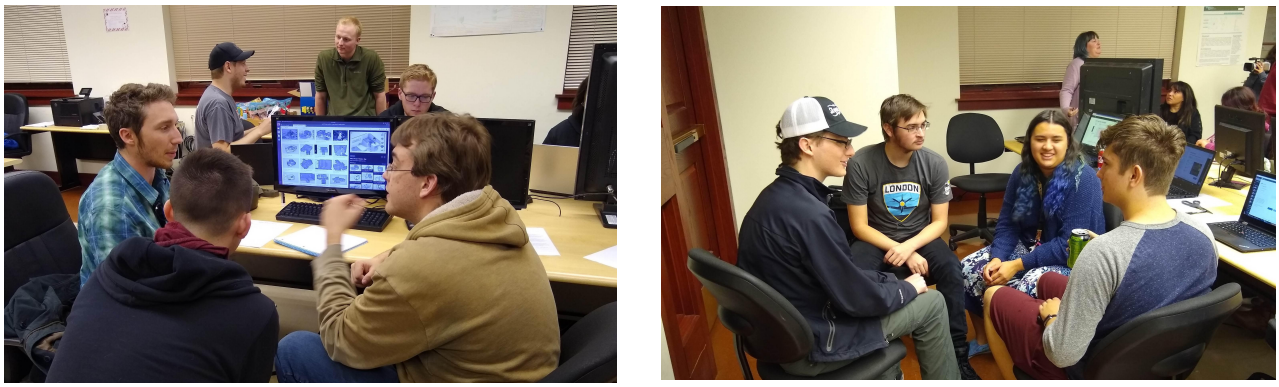
3. Game Jam

There were about 35 students who came to Game Jam in the beginning, but some students participated through to the end. In the end, there were 8 groups with 25 students (12/13 female/male students versus 20/166 in the Computer Science program this fall) who built game prototypes and did the final presentation. The students' class rank was from high school to graduate college students; 15 of them were CS majors and 8 of them were not. Table 2 shows group demographics.

Table 2. Participant demography in Game Jam.

Group #	Number of team member	Gender	School Standing	Majors
1	4	1 Female + 3 Males	College seniors	CS
2	4	Males	College seniors	CS
3	5	Females	College freshmen	CS and non-CS
4	1	Male	College sophomore	CS
5	1	Female	College freshman	CS
6	2	Males	College freshmen	CS
7	4	Females	High school Jr/Sr	Non-CS
8	4	1 Female + 3 Males	College freshmen	CS and non-CS

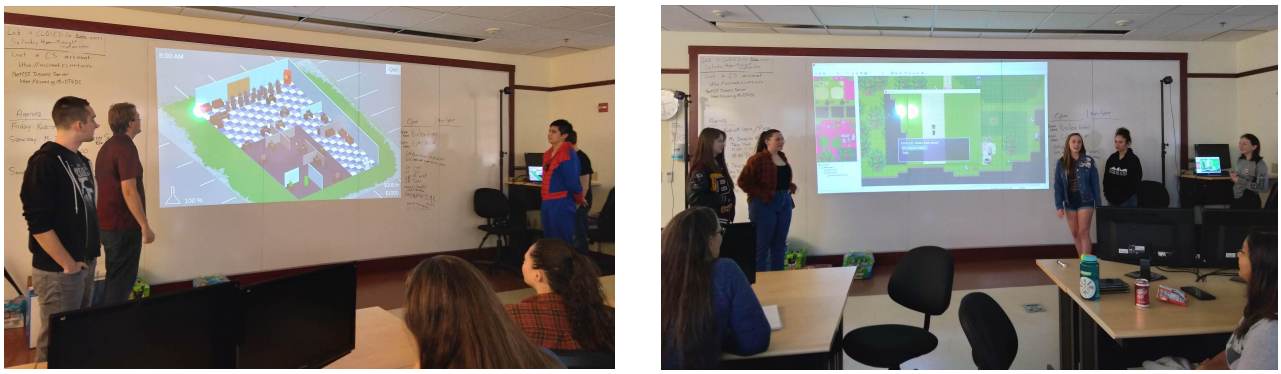
After the instructor explained the game theme and competition rules in the beginning of Game Jam, students started discussing how to develop the games with their team members. Figure 2 shows how students planed the game development in groups. Students in Figure 2(a) were senior students who are majoring Computer Science. All of them had experience in developing games with Unity, and they had learned basic cybersecurity concepts taking CS-related courses. Students in Figure 2(b) were freshmen; two of them were CS-major students and the other two were not.



(a) (b)

Figure 2. Group discussion in Game Jam: (a) group discussion with CS-major senior student group; (b) group discussion in freshmen group with CS and non-CS major students

Students kept working on the game development in the following 44 hours and then did the final presentation as Figure 3 shows.



(a) (b)

Figure 3. Final presentation in Game Jam: (a) the winning group; (b) one of the selected groups.

The rank one group was Group #2. The Cybersecurity Education Center is funding the team to complete their game. The judges also selected three other groups (Group #1, Group #3, and Group #8) for awards and encouraged them to keep developing their games; the Cybersecurity Education Center will buy the completed games if they are well developed for use in cybersecurity education awareness and outreach.

Since the Game Jam was hosted before the Thanksgiving break and was close to final exams, the research team was unable to interview the student immediately after Game Jam. The research team will conduct the interview in the beginning of Spring 2020.

4. Conclusion

This research described the Game Jam hosted in a four-year college in the southwestern United States. The goals of the activity are improving students' awareness of the importance of cybersecurity, understanding basic concepts of cybersecurity, and encouraging students working in CS/cybersecurity in the future. The research team has designed a semi-structured interview to understand whether or not the Game Jam activity could reach the stated goals. The interview will be conducted in the following semester; the research team will analyze the collected data after the interview.

Besides the interview, the research team would like to know whether or not the game developed by the winners and selected groups can improve player's awareness of the importance of cybersecurity. The research team would also like to know what game elements or mechanism could effectively help students understand basic concepts of cybersecurity.

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Facial Emotion Recognition model under the Trusted Execution Environment energizes traditional education strategies

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Abstract: *Distraction decreases the efficiency of work, especially for students in secondary school without specialized training. Since the knowledge taught in class is the key to understand different courses, it is necessary to avoid distraction; however, which is almost impossible to vanish but decrease. To reduce the adverse impact of distraction, this project explored the research question of how to improve the in-class quality by using facial recognition technology under the environment of trusted execution(TEE) with consideration for privacy protection. A case study of analyzing the questionnaire 300 teachers in the elementary school, 50 for each grade of the situation about primary students' distraction, showing teachers' need for AI application to improve in-class efficiency. This proposal will focus on using two Convolutional Neural Network algorithms, Alex-net and Google-net, on analyzing and discuss the final result. Directions for future research are discussed to improve the efficiency of privacy protection and the accuracy of equipment design.*

Keywords: Education efficiency; FER; TEE; Machine Learning

1. Introduction

In a traditional class, teachers of elementary school take the responsibility to both teach and remind absent-minded students. Assuming this cannot fix on each student during the whole time, which is helpful to know when and which part of the content they missed. Tracking students' emotions is an appropriate way to test the quality of the study since facial expression can directly reflect on whether students are listening, thinking, or distracted. This proposal is aiming at providing a solution for using the Facial Recognition System to monitor and give feedback on students' situations in the classroom without invading students' privacy.

2. Situation Analysis

To know the actual situation about students' distraction in the primary school, a questionnaire was made which collected data from 300 teachers in the primary school, 50 for each grade. Graph 1. shows the detail of the questionnaire. As far as we can see, students' distraction happens in each grade with a high ratio, 92 percent on average. Besides, the teacher's neglect appears in all the grades.

Grade	Students_number	Distraction happens		negligence		Number of ignored students(mean)
G1	18.45	90%	45	0.06	3	1
G2	19.74	96%	48	0.16	8	2
G3	22.33	94%	47	0.16	8	3
G4	19.2	78%	39	0.46	23	2
G5	20.32	98%	49	0.74	37	3
G6	22	98%	49	0.76	38	5
Average	20.34	92%	46.16666667	0.39	19.5	2.666666667

Graph 1. Questionnaire

3. Design

3.1. DataSet selection

With the standard pixel of 64*64, The Japanese Female Facial Expression (JAFFE) Database(1998) will be used to train and learn. With only three levels of emotions: positive, negative, and neutral.

Compared with most of the algorithms applied in dealing with graphs, the algorithm based on Google-net CNN and Alex-net CNN are selected to collect, and output results with the JAFFE database considered the graphic's pixels, layers several models, possibility to achieve it in the highest accuracy. After deep-learning stages, photos from the real class should be used to test and return the information about students' learning rank and notice for "special" one to be low-efficient study (negative or neutral with negative trend).

3.2. Data pre-processing

To both analyzing data of facial emotion and protecting students' privacy from easily abuse, this project used TEE structure with the following details.

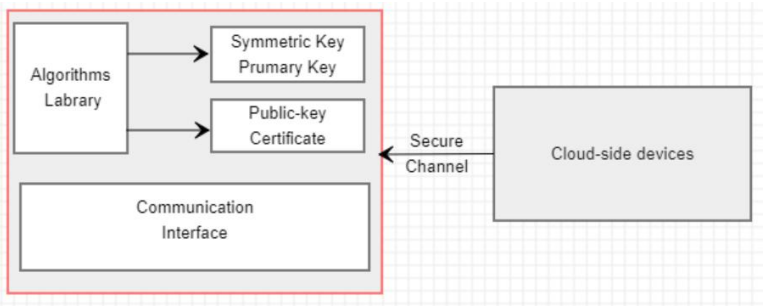
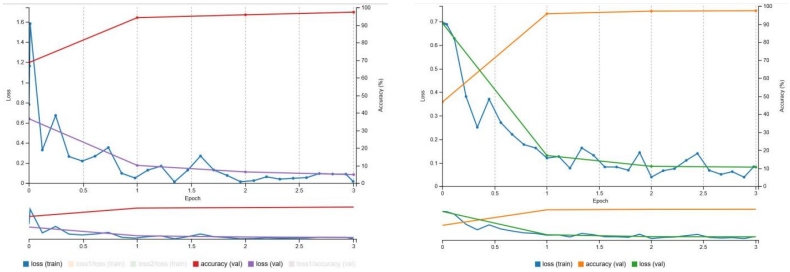


Figure 4. Pre-design of security modules

3.3. Data processing and result



Graph 3. The algorithm based on Google-net and Alex-net Result

With the training Epoch of 3, in graph 3, the accuracy is nearly 98.6%, and another is approximately 98.4%.

The research found that except for the excellent leaning learning capability, the converging speed of Google-net was faster, which indicates high computational efficiency.

4.4. Discussion

The condition of varies seat styles such as a circle or small group, may influence the output. Still, there would be a need that teachers help to check the feedback list whether students' are distracted or just the reasonable action. With the milestone with high accuracy of using two classifications, the study of students' emotions in class would be classified with more types in the future; TEE performs well in privacy protection. However, more encryption methods will be tested to improve efficiency combining the field of facial recognition technology.

5. Conclusions

Comparing with the Teacher group, using the FER system is accurate and convenient to catch students' bad behavior in class and give the feedback directly to improve. The system has high accuracy in the clarification of positive and negative emotions.

In conclusion, the facial emotion recognition system help releases the burden of teachers' by watching students' behaviors automatically without privacy leaks. It contributes to improving the quality of each class by analyzing, giving feedback before the next class, and noticing the teacher pay attention to the students whose name is underlined.

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How to Measure the Relationship between Online Learning Anxiety and Technology Acceptance among Undergraduate Students

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Abstract*: The evolution of online learning within higher education has elicited an emergence of new expectations for students. These exceedingly high standards can potentially impact students' emotions and attitude towards online learning. Anxiety and technology acceptance are two influential constructs that can highly affect academic performance throughout virtual courses. Therefore, this project seeks to measure the relationship between online learning anxiety and technology acceptance among undergraduate students. Through the development of an online survey, we explored these constructs, collected preliminary data and aim to reveal initial results and procedures of this pilot study.*

Keywords: Anxiety, Online Learning, Undergraduate Students, Technology Acceptance, Online Survey

1. Introduction

Higher education institutions in the United States are resorting to online learning and new technologies that facilitate course delivery and elicit controversy about its viability and effects on students' academic performance and anxiety (Reese, 2015). Anxiety in online learning is defined as "a feeling of fear from misuse of information technology compromising course performance" (Saade, Kira, Mak, & Nebebe, 2017, p.148). The upsurge of anxiety among college students demands for an increase of awareness of anxiety and technology acceptance levels. Due to limited research exploring these constructs, this study explored: 1. What is the current status of undergraduate students' online learning anxiety and technology acceptance levels? 2. What factors affect their online learning anxiety and acceptance levels?

2. Literature Review and Theoretical Framework

Distance education is a learning experience in which instruction transpires in a different place than the learning process, entailing interaction through technologies (Moore & Kearsley, 2012). Whiteside, Dikkers, Swan and Gunawardena (2017) ascertain that in 2014, 2.85 million students in the United States completed all of the required courses online because of its elevated desirability and flexibility with time, location, and accessibility. Criticism surrounds online learning due to students' experiences with increased pressure associated with self-discipline and self-evaluation.

In 2017, 60.8% of college students felt overpowering anxiety and 24.2% conveyed the negative impact anxiety had on their ability to process (Cooper, Downing, & Brownell, 2018), thus diminishing their academic performance (Saade et al. 2017). Students' anxiety levels can be correlated with technology acceptance. To predict and determine technological systems acceptance Fred Davis developed the Technology Acceptance Model (TAM) (Lala, 2014), which states that a new system's characteristics can generate stimulus that allows users to shape attitudes and alter motivation levels in regard to its usage. Predictive factors include "perceived usefulness, ease of use, user's attitude towards using, behavioral intentions to use, and actual used of computer systems" (Sivo et al., 2018, p. 74). These factors can significantly impact the online learning experience as some can determine students' retention and future reluctance of online learning if they experience challenges (Al-Azawei & Lundqvist, 2015).

3. Research Methods

We designed an online instrument to measure the connection between undergraduate students' technology acceptance and anxiety level in online learning. This fragment of the quantitative approach facilitates the analysis of trends, group comparison, variables association, statistical analysis and the interpretation of results (Creswell & Guetterman, 2019). Thus, this paper will focus on the instrument pilot study.

3.1. Instrument Design

Our instrument is the result of the combination of the Technology Acceptance Model (TAM) (Abu-Dalbouh, 2013; Lala, 2014), the Mobile Learning Readiness Scale (MLLRS) (Lin, Lin, Yeh, & Wang, 2016), the State-Trait Anxiety Inventory for Adults (STAI-AD), and a personality self-evaluation questionnaire founded on the principles of Jung's theory of psychological types and the Myers-Briggs Type Indicator (MBTI) (Myers, 2016). Items from the first three instruments were combined in order to assess the accuracy of the aforementioned definition of anxiety in online learning. The items belonging to MBTI were included to obtain the respondents' personality baseline to further evaluate if personality traits correlate with anxiety levels. Our survey has three different sections addressing background information, online learning preferences and experiences, and open-ended questions. The first section focuses on acquiring background information. Section two includes items exploring preference for online learning, technological skills, perceived ease of use, usefulness, user satisfaction, self-efficacy, self-directed learning, and self-confidence. The last section included open-ended questions that extract further details about the challenges and benefits of online learning.

3.2. Pilot Study

The instrument was published and delivered via Qualtrics (Carpenter et al., 2019). The targeted population were undergraduate college students at one southwest regional university in the United States. The emails were sent from a non-descript email address for two consecutive weeks. To complete a comprehensive study, we modified the survey items based on the pilot study's results. Accordingly, we have an Institutional Review Board (IRB) application to be approved in order to continue with the research and expand on current results.

4. Preliminary Results

In this pilot study, we shared our online survey's link to two undergraduate classes (55 students) at one southwest regional university in the United States to be responded throughout two weeks. At its conclusion, 40 participants had completed it, corresponding to a 72.7% response rate. Of the survey's respondents, 90.63% were females and 6.25% were males with the majority of them identifying as college seniors. This disparity in gender might be due to the fact that the majority of respondents were from the College of Education.

Items' internal consistency (DeVellis, 2012) was measured using the SPSS software (George, & Mallery, 2003). Cronbach's alphas were computed for each construct as follows: the perceived of usefulness and ease of use subscale consisted of 4 items total (.758), the user satisfaction subscale consisted of 6 items (α= .826), the self-efficacy subscale consisted of 3 items (α= .790), the self-directed learning subscale consisted of 4 items(α = .110), and the self-confidence subscale consisted of 6 items(α = .902). The low alpha score in the self-directed construct may be attributed to the phrasing of the items, which shift between negative and positive connotations. After item analysis and feedback, we modified items' phrasing. Additionally, we deleted some items that revealed a high correlation score within the factor analysis.

5. Conclusion

This pilot study provides significant data to help improve our instrument. Following IRB approval, we will distribute the finalized survey at the same university. Results can act as a catalyst for change in higher education as it can help increase awareness about and understanding of students' anxiety as it relates to online learning.

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Effects of Gamification on Undergraduate Students with Different Learning Styles

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Abstract: *Gamification is regarded as a promising strategy to enhance the process of teaching and learning; nevertheless, how students with different learning styles react to gamification is unclear. We are proposing a gamified learning design and will investigate how it affects the learning process of students with different learning styles. In the design development stage, we will use design-based method to work with teachers to design a gamified learning environment. In the design evaluation stage, we will use an experimental approach with pre- and post-tests, together with interviews, to examine the effectiveness of the design and understand how the design fosters different learning-style students' learning. The proposed study aims to enrich the literature in the field and provide insights for researchers' future investigation.*

Keywords: gamification, learning styles, technology, effectiveness

1. Introduction

Researchers have proved the potentials of gamification in enhancing student learning from the perspective of learners' psychological state, knowledge acquisition and behavioral development (e.g., Jong, Chan, Hue & Tam, 2018; Zainuddin, 2018). Learners will have different preferences to collect, absorb, understand and retain information with respect to their learning styles, which refers to the way that they characteristically approach to their learning tasks (Hartley, 2008; Huang et al., 2019). Therefore, designing suitable daily activities, curricula and assessments to match learners' learning styles becomes increasingly important (Jong, 2019). Although many gamification studies have suggested that researchers should connect students' learning styles with gamification (Jong & Shang, 2015; Chen, Liu, & Hwang, 2016), only limited number of studies have explored the effectiveness of gamification on students with different learning styles in the context of higher education. The aim of this research is to investigate the effectiveness and learners' perceptions of using gamification in teaching practice for students with different learning styles.

2. Research questions and method

To achieve the goal, we have two main research questions.

Q1: (a) To what extent does gamification promote student learning motivation/ anxiety/ performance with effectiveness similar among students with different learning styles?

(b) What are the reasons for any similarity or difference detected?

Q2: What are students' perceptions of using gamification as a pedagogical strategy?

3. Research context and procedures

Undergraduate students from the foreign language department of a university in Shaanxi, China will be invited to participate in the study. Students will take the English language education programme to prepare for a national compulsory exam. The ideal student number for each learning style group will be 35; therefore, around 140 students will be involved in the research. The whole programme will last for one semester, involving around 15 weeks, with one

face-to-face class per week. The instructor will use Edmodo as the learning management platform and gamify the virtual learning environment by using the quizzes, discussion boards, post, and group functions of the platform.

Various scales will be adopted in this study. Firstly, Kolb's Learning Style Inventory (LSI) (2014) will be applied to classify students into different groups according to their learning styles, including diverging, assimilating, and converging, accommodating. Besides, related existing instruments for measuring student's learning motivation and anxiety, e.g., the Instructional Materials Motivation Survey (IMMS) (Keller, 2010) and Foreign Language Classroom Anxiety Scale (FLCAS) (Al-Saraj, 2014) will be leveraged and customized. The instruments will be used repeatedly to detect if there are any changes before and after the gamification intervention, Also, the authentic English examination papers will be selected by the English teacher and distributed to students in the pre-test and post-test to evaluate students' academic performance. Semi-structured interviews will be used to probe into the reasons for any similarity or difference of the effectiveness of gamification on students' learning motivation, anxiety and performance among participants with different learning styles. Additionally, semi-structured interviews will be used to explore participants' perceptions of using gamification in their learning environment.

4. Conclusion

This research is significant for providing the field with insights into understanding the effectiveness of gamification on students' learning motivation, learning anxiety and learning performance for learners with different learning styles. However, there are some possible limitations. For instance, the research samples are university students; the effectiveness of gamification on other populations may be different from the research findings obtained by this study.

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Mining the Differential Transitions of Online Learning Behaviors in a Gamified Academic Reading Environment

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Abstract: *In this study, the authors designed a gamified academic reading system and explored the behaviors of Chinese graduate students. The results showed that the reading and testing behaviors in the gamified condition were more likely triggered by forums instead of test results. Besides, the students generated more cautious behaviors before tests and they seemed easily distracted by the leaderboard.*

1. Method

Although gamification has been shown effective in learning (e.g. Goksün, & Gürsoy, 2019; Ding, 2019), some studies reported the opposite effects (Hanus, & Fox, 2015). Apparently, there were still limited understanding of its effects in educational contexts, especially its long-term effects. For this reason, we aim to explore the students' learning behavioral patterns in a gamified learning environment. Furthermore, we examine graduate students' academic reading behaviors.

1.1. Participants

The participants in this study were 31 first-year graduate students (8 males and 23 females), who participated in a course on the theory of digital learning in a university in China. The ages of the participants ranged between 21 and 24.

1.2. Academic reading system

This system was designed for graduate students to read journal papers and do post-reading activities every week before and after classes. More specifically, in the system, students were allowed to (1) read papers by chapters, (2) integrate ideas after reading, (3) share ideas in forums, (4) take tests, and (5) write course essays.

Figure 1. Game property

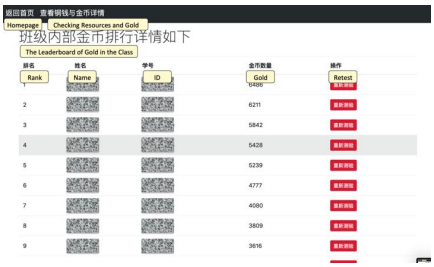

Figure 2. Leaderboard of reward points

In this study, three gamified mechanisms were adopted: game points, betting and a leaderboard. Furthermore, there were two types of game points: resource points and reward points, which were regarded as virtual properties in the game. The students were allowed to check their resources and

rewards in their own page of game property (Figure 1), which was added as a new function in the system. Finally, the third mechanism, a leaderboard (Figure 2) was added as another new function. The leaderboard displayed the rank of their reward points, which only showed how accurately they predicted their scores and how confidently they assured their answers.

1.3. Procedure

This study was conducted in the fall semester of 2019, and the participants' learning behaviors for the first two months were included for analysis. The system was deployed in two stages. Each stage took about one month, in which the students were required to read three journal papers. In the first stage, the original functions of academic reading system were used without gamified mechanisms, while in the second stage, the gamified mechanisms were introduced. By doing so, all students could experience non-gamified (2019/9/16~10/21) and gamified conditions (10/22~11/18). There were 4,658 actions collected in the non-gamified condition, and 4,179 actions in the gamified condition.

2. Results

First, in both conditions, we adopted Apriori algorithms to mine the association rules of actions in sequences. Then, independent sample t tests were carried out for comparing the instance support values of all patterns between two conditions. The results are described as follows.

First, in the non-gamified condition, the students tended to read literature if checking their test results with significantly higher support values. When the gamified mechanism was involved, the pattern became less probable. Instead, they tended to read if browsing the forum in the gamified condition. As a result, it might be the posts that triggered the students to read literature.

Second, in the non-gamified condition, the students also tended to take tests if checking their test results with significantly higher support values. Like the first one, this pattern also became less probable in the gamified condition. In the gamified condition, taking tests was an action that consumed game resources. Instead, they had a pattern of testing given checking game resources in the gamified condition, showing that their attentions shifted from test results to game resources.

Finally, there are the patterns of leaderboard occured given checking game resources, checking note, submitting integration, or browsing forum in the gamified condition. These patterns showed how the students shifted their attentions from reading activities to the game leaderboard. On the bright side, they might be motivated by the leaderboard, but we should still be vigilant that overusing leaderboards might result in distracting students from reading activities.

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The Design and Implementation of a Digitalized Learning Environment to Support the Acquisition of Work Process Knowledge

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Abstract: *Work process knowledge arises from reflective work experience, is incorporated in practical work, and guides practical work. It goes far beyond non-contextual theoretical knowledge. This paper presents the design and implementation of a dedicated digitalized learning environment for the construct of work process knowledge in the work-process-oriented curriculum. It can be used to solve some of the main problems of the learners regarding their accessibility of the work environment and action-oriented learning.*

Keywords: Work Process Knowledge (WPK), Vocational Education and Training (VET), Work-process-oriented Curriculum (WPOC), Digitalized Learning Environment (DLE), Remote Work Environment

1. Introduction

Work process knowledge (WPK) is a form of knowledge, which is directly necessary in the work process, is acquired in the work process itself, and encompasses a complete work process. Neither work experience nor academic knowledge alone lead to skilled work activity. The WPK that underpins action is constructed in the workplace by making links between the two. One way of achieving such knowledge is the 'work-process-oriented curriculum (WPOC)' (Rauner 2007). Such a kind of curricula is called the learning arena (Lernfeld in German), whose structure and content are derived from a "typical professional task" in an occupation. It is normally conducted pedagogically by using the action-oriented learning (Mulder, 2017). This poster presents a technical approach to develop a dedicated digitalized learning environment (DLE), which is suitable for supporting the acquisition of WPK systematically in a WPOC.

2. A Technical Approach to Support the Acquisition of WPK within a WPOC

The approach is inspirited by the ideas of IMS Learning Design (LD) (Koper and Tattersall, 2005), an international digitalized learning technical standard. We propose to develop a scripting language for representing a WPOC. If a WPOC has been described as a formal learning-work process model by using such a scripting language, it can be understood and delivered by the computer. That is, the computer can configure environments and scaffold the learning-work process.

The conceptual model of this scripting language is illustrated in Figure 1. Using this scripting language, a learning arena can be structurally defined as a sequence of learning situations, from simple to complex situations aligning with cognitive development. A learning situation is normally based on and pedagogically transformed from an authentic and concrete work task. From the perspectives of curricular structure, it is consisted of a set of learning phases, a set of learning-work activities, or their combinations. In turn, a learning phase is made up of a set of coordinated learning-work activities. As the elementary unit of a curricula, a learning-work activity is carried out by certain role(s) towards assessable outcomes such as identifying requirements, making a plan, designing a model, taking calculation,

generating a solution, producing a product, writing a report, or operating or controlling devices in real- or virtual work environment. It is important to note that the digitalized outcomes (or artifacts) of an activity are represented and captured by using properties, which can be set values directly by learners or generated by using tools (or services). The outcome of an activity can be transferred into another activity as an input. Sometimes, the outcome can be used as evidence to conduct formative assessment. The assessment result may be used in condition expressions to adjust the learning-work processes and recommend learning opportunities for supporting personalized learning or adaptive learning.

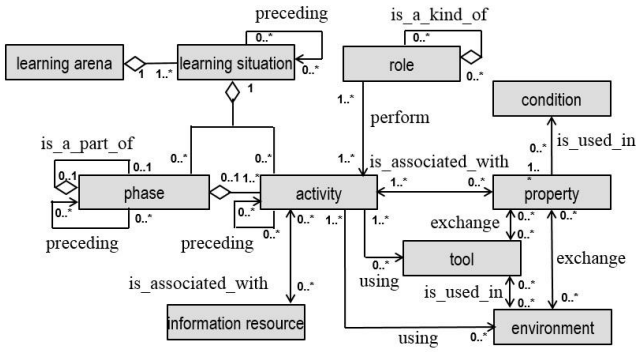

Figure 1. The Conceptual Model.

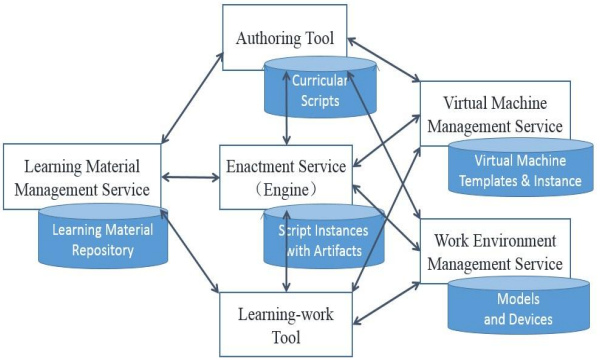

Figure 2. The Implementation Architecture.

3. An Implementation of a Dedicated Digitalized Learning Environment

By adopting this technical approach, we implemented a dedicated DLE for supporting the acquisition of WPK in WPOC. As illustrated in Figure 2, the DLE consists of six modules: curriculum authoring tool, learning material management service, learning-work tool (see Figure 3), enactment service (or engine), virtual machine management service, and work environment management service. It is important to note that the dedicated DLE enables to specify and deliver a work-process-oriented curriculum easily. In particular, the DLE makes it easy to arrange and access associated information in the work context, to define artifacts as properties and transfer forms into data-flow, to integrate application-tools for work and exchanging information between the tools and properties, to integrate a remote work environment (see Figure 4), in which the physical work devices can be observed and controlled remotely for supporting action-oriented learning, to conduct action-oriented learning (Miao, et al. 2018) for constructing WPK.

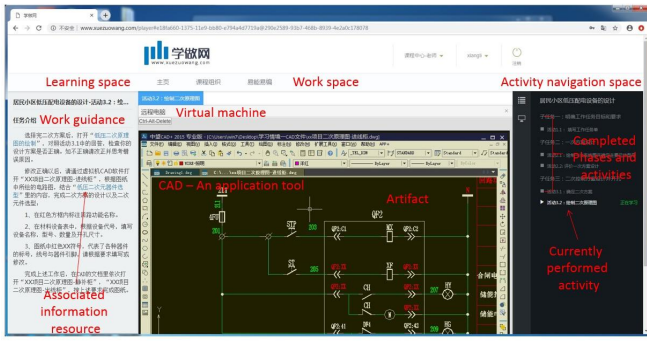

Figure 3. A Screenshot of the Learning-work Tool

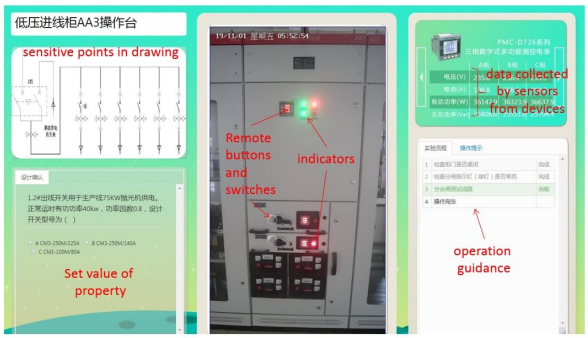

Figure 4. Screenshot of a Remote Work Environment

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