Effects of Perspective-Taking Through Tangible Puppetry in Microteaching and Reflection on the Role-Play with 3D Animation

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Abstract. Perspective-taking of a wide variety of pupils or students is fundamental in designing a dialogic classroom. As a vehicle of perspective-taking, a tangible puppetry CSCL can create a learning environment that reduces the participants' anxiety or apprehension toward evaluation and elicits various types of pupils or students, allowing them to learn various perspectives. The CSCL also provides a 3D animation that records the puppetry for prompting perspective-taking of a variety of pupils in mutual feedback discussions. A comparative experiment, which comprised of a self-performed, a puppetry, and a second self-performed microteachings, showed a relatively stable impact of the puppetry microteaching in the mutual feedback discussions on the second self-performed. This paper discusses the potential effectiveness of puppetry as a catalyst of perspective-taking to learn a variety of pupils' viewpoints through their possible reactions in undergraduate teacher education.

Keywords: CSCL · Perspective-taking · Puppetry · 3D reflection animation

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1 Introduction

Designing an effective lesson leveraging dialogic pedagogy is an essential skill for schoolteachers [1]—but it is difficult even for experienced teachers to operationalize in a classroom. In the dialogic classroom, teachers need to design a dialogue to stimulate the students' thinking and advance their learning and understanding through structured and cumulative questioning and discussion, without monologic knowledge transmission. To prepare for designing a dialogue that ensures various students' participation, the teachers need to imagine a wide variety of voices of their students and possible reactions and questions [2].

Microteaching is one way to practice the implementation of dialogic pedagogy in teaching; however, it is not easy to achieve. One of the reasons discussed in the "apprenticeship of observation" framework [3] is that student teachers and novices had experienced monologic teaching as students themselves. However, we argue that there is another difficulty – excessive self-consciousness [4] or evaluation apprehension [5] during microteaching sessions. The role-play requires (student) teachers to act out young pupils roles in a realistic way in which they may find difficult, which creates a tendency to play "honest students" who follow the teacher's instructions without question.

Our past studies indicated that puppetry can serve as a powerful device for allowing people to overcome emotional or interpersonal obstacles in face-to-face role-plays and for eliciting reactions including inner emotions or unconscious experiences that they had in a problematic situation [6]. Then we developed a tangible puppetry CSCL system to help microteaching role-play in a puppetry format [7]. The system records the actions and conversations of the participants (hereinafter, the "character") on top of a transparent table (Fig. 1(a)). In Fig. 1, photo (a) shows the system ready to be implemented. Each puppet or prop is attached to a transparent box with an AR marker on the bottom. Each character can express his or her puppet's conditions (such as distracted or concentrated) by manipulating a switch to change the color of the LED in the box to either red or blue (Fig. 1(b)). These functions allow participants to elicit a variety of voices from possible pupils even in the self-performed role-play after the puppetry role-play (Fig. 1(c)) [8]. After the role-play, the participants can view the recorded puppetry to inspire reflection (Fig. 1(d)). This function provides a 3D animation movie of the recorded role-play. This 3D animation function was developed to foster deep perspective-taking by completely shifting a person's viewpoint, based on Lindgren's [9] argument that experiencing a first-person perspective in a virtual world can generate a person-centered learning stance and perspective-taking. This process enables the learner to see through the avatar's point of view and as a result blurs the boundaries between the self and the other; hence, the learner can gain novel perspectives. Thus, this animation movie allows participants to reflect upon their role-play by combining their wide and thorough (bird's-eye) view for all the dialogues and the various participant views (character points of view); the participants can examine the overall situation from the bird's-eye view, whereas, from the character points of view, they can consider the possible reactions (communication and behavior) of specific characters. The participants can switch the interface, while watching the role-play animation; as a result, they can consider the first-person perspective of each character, when necessary.

The present study aims to examine the effectiveness of 3D animation for reflection that the system generates to foster perspective-taking. We demonstrate a preliminary evaluation of the system by comparing mutual feedback discussions with the 3D animation and those with normal video recording of the puppetry (i.e. as similar to the self-performed microteaching). Then we discuss how an immediate transfer of perspective-taking training emerges.

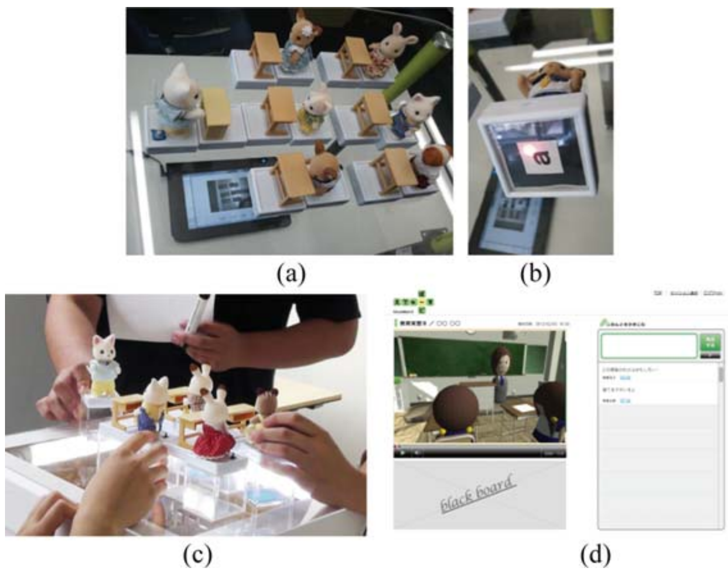


Fig. 1. The CSCL system for tangible puppetry.

2 Method

2.1 Participants and Design

We conducted a comparative experiment with participants that totaled 30 undergraduate student teachers (normal video only: 24; 3D animation introduced after the puppetry microteaching: 6; Female 86.7%) at a private university in Japan studying to become elementary school teachers and taking a pedagogy course. The participants in each condition participated in a part of the course in different years. Those students in each condition were randomly assigned to groups of three forming 8 and 2 triads, respectively.

Each microteaching session included a role-play and a mutual feedback discussion for reflection. Each participant in both conditions conducted a self-performed microteaching role-play or a puppetry microteaching for 10 min. To examine the effectiveness of perspective taking in the puppetry role-play and its 3D animation reflection, each participant enrolled in one puppetry microteaching and two self-performed microteachings; the first and third participants played the teacher in the self-performed role-plays, and the second participant played the teacher in the puppetry role-play. The rest of the participants played the pupil's role in every session in the same way (i.e., puppetry or self-performance) as the student teacher. Regardless of the form of microteaching, students playing the pupil's role were asked to act realistically, as though they were in an actual classroom. Thus, the first session was designed as the pretest, the second as the intervention, and the third as the posttest to examine the immediate transfer of the puppetry microteaching. Then the participants had a mutual feedback discussion for reflection according to instructions saying that the students needed to consider how to improve the lesson from the pupils' viewpoints, lasting for 20 min.

All the students in each group were video-recorded during the self-performed microteaching, as well as during the puppetry microteaching in the normal video only condition, then the triad students reviewed the corresponding video in each mutual feedback discussion. The 3D animation described above was used for recording and reflecting on the puppetry microteaching in the 3D animation condition; the triad students reviewed it instead of the video in the mutual feedback discussion for the puppetry microteaching.

2.2 Assessment

All the mutual feedback discussions were video-recorded and transcribed. Two of the authors coded all of the utterances in the student discussions for mutual feedback, adapting slightly modified Rosaen et al. [10] 's coding scheme (Table 1) in order to examine how the students reflected on their role-playing in both conditions (κ = .729). If an utterance contained several codes, the coders coded the corresponding categories. We did not code the microteachings utterances because previous studies showed that the puppetry changed the discourse patterns of the microteaching; the puppetry elicited a variety of informal discourse that is rarely used in self-performance, and those positive effects were also seen in the self-performance when made just after the tangible puppetry (see Mochizuki et al. [7] and Wakimoto et al. [11] for more details).

Table 1. Definition of codes for utterances in the mutual feedback discussions.

Code	Definition
Focus on Teacher-Management (TM)	Managing students' behavior, role in organization for a smooth lesson flow
Focus on Teacher-Instruction (TI)	Instructional strategy that facilitates the cognitive and social interaction around the goals of the lesson; focuses on the teacher's role
Focus on Student-Management (SM)	Managing students' behavior, organization for a smooth lesson flow; focuses on the children's behavior or attitudes
Focus on Student-Instruction (SI)	Instructional strategy that facilitates the cognitive and social interaction around the goals of the lesson; focuses on how the students responded to the instruction

2.3 Analysis

In this study, we applied Epistemic Network Analysis [12, 13] to our data using the ENA1.5.2 Web Tool [14]. We defined the units of analysis as all lines of data associated with a single value of session IDs (IDs for each microteaching session in each condition such as Video1, Video2, Video3, 3D1, 3D2, or 3D3), subsetted by group IDs (triad's IDs) and student IDs (participant's IDs).

The ENA algorithm uses a moving window to construct a network model for each line in the data, showing how codes in the current line are connected to codes that occur within the recent temporal context [15]. The moving window in this study was defined as four lines (each line plus the three previous lines) within a given conversation. The resulting networks are aggregated for all lines for each unit of analysis in the model. In this model, we aggregated networks using a binary summation in which the networks for a given line reflect the presence or absence of the co-occurrence of each pair of codes.

Our ENA model included the following codes: TM, TI, SM, and SI shown in Table 1. We defined conversations as all lines of data associated with a single value of group IDs subsetted by the session IDs, turn numbers in a conversation, and follow numbers within each turn.

The ENA model normalizes the networks for all units of analysis before they are subjected to a dimensional reduction, which accounts for the fact that different units of analysis may have different amounts of coded lines in the data. For the dimensional reduction, we used a singular value decomposition, which produces orthogonal dimensions that maximize the variance explained by each dimension.

ENA visualizes networks using network graphs where nodes correspond to the codes, and edges reflect the relative frequency of co-occurrence, or connection, between two codes. The result is two coordinated representations for each unit of analysis: (1) a plotted point, which represents the location of that unit's network in the low-dimensional projected space, and (2) a weighted network graph. The positions of the network graph nodes are fixed, and those positions are determined by an optimization routine that minimizes the difference between the plotted points and their corresponding network centroids. Because of this co-registration of network graphs and projected space, the positions of the network graph nodes—and the connections they define—can be used to interpret the dimensions of the projected space and explain the positions of plotted points in the space. Our model had co-registration correlations of 0.95 (Pearson) and 0.95 (Spearman) for the first dimension and co-registration correlations of 0.97 (Pearson) and 0.97 (Spearman) for the second. These measures indicate that there is a strong goodness of fit between the visualization and the original model.

ENA can be used to compare units of analysis in terms of their plotted point positions, individual networks, mean plotted point positions, and mean networks, which average the connection weights across individual networks. The networks may also be compared using network difference graphs. These graphs are calculated by subtracting the weight of each connection in one network from the corresponding connections in another.

To test for differences, we applied Mann-Whitney tests to the location of points in the projected ENA space for units in the first sessions in both conditions, those in the second sessions in both conditions, and those in the third sessions in both conditions.

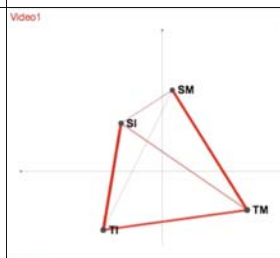
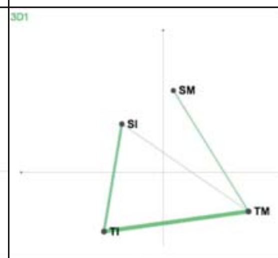
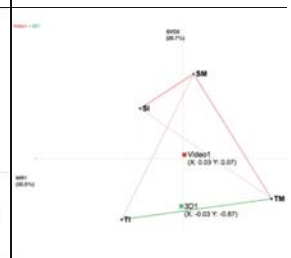
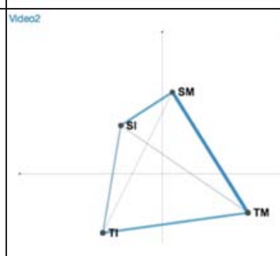
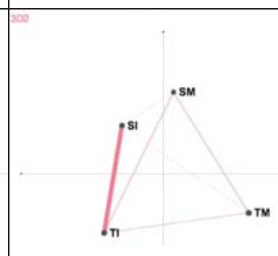
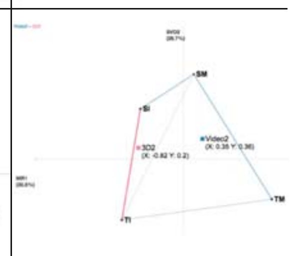
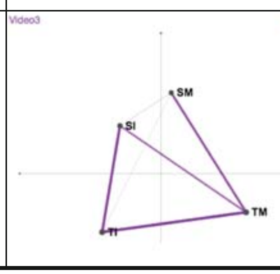
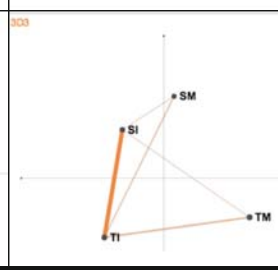
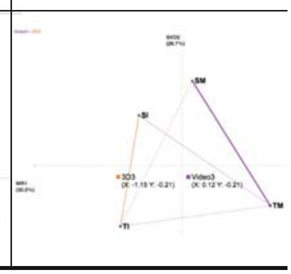
3 Results

3.1 Results of the ENA

Table 2 shows epistemic networks of each session in each condition, as well as comparison plots between the conditions. There were significant differences between the video-only condition and the 3D animation condition in the first session (along the *Y* axis, the video-only: $Mdn = -0.19$, $N = 24$; the 3D: $Mdn = -0.77$, $N = 6$; $U = 116.00$, $p = .02$, $r = -.61$), as well as in the second and third sessions. We interpret the first session's differences to have been caused by the new curriculum standard that emphasizes student-centered teaching introduced in the video-only class condition. However, in the second session, the mean of the plotted points of the 3D animation condition moved up dramatically on the *Y* axis compared to the video-only condition where we did not observe a significant change on the *Y* axis. The strength of the connections between TI-SI was higher in the second session in the 3D animation condition, while that of TM-SM was higher in the video-only condition. There are significant differences along the *X* axis with a fairly large effect size (for the *X* axis, the video-only: $Mdn = 0.37$, $N = 24$; the 3D: $Mdn = -0.82$, $N = 6$; $U = 11.00$, $p = .00$, $r = .85$). These results indicate that the participants in the 3D animation condition made more instruction-centered connections during their reflection on the puppetry microteaching; that is, the participants tended to discuss how they should teach pupils who showed unexpected reactions (for example, they discussed the problem of pupils not understanding the instruction) in the puppetry microteaching in the 3D animation condition, while participants in the video-only condition discussed how they should use utterances of pupils and how they should ask pupils to do something (such as how to take a note, how many characters the pupils should take notes for preventing irregular actions such as chatting, and the like). This suggests that the 3D animation condition elicited more student-centered utterances that considered pupils' learning from the viewpoint of their understanding, which is important for achieving teaching objectives [16].

Furthermore, we also observed a significant difference between conditions in the third session along the *X* axis with a fairly large effect size (the video-only: $Mdn = 0.18$, $N = 24$; the 3D: $Mdn = -1.41$, $N = 6$; $U = 20.00$, $p = .01$, $r = .72$). The comparison plot between the two conditions in the third session shows that the co-occurrence connections of TI-SI-SM in the 3D animation condition are stronger than those in the video-only condition, which implies that the participants used more instruction-centered utterances as well. In addition, along the *X* axis, a Mann-Whitney test showed that the first session ($Mdn = 0.91$, $N = 6$) was statistically significantly different from the third session ($Mdn = -1.29$, $N = 6$; $U = 3.00$, $p = 0.02$, $r = 0.83$) with a substantive effect size when we examined within the 3D animation condition. This suggests that the 3D animation's effect that elicits utterances with student-centered connections remains even in the feedback discussion the third session.

Table 2. Epistemic networks of the mutual feedback discussions in each session in each condition and comparison plots between two conditions in each session.

	Video only	3D animation introduced in the 2nd (puppetry) session	Comparison plots between two conditions
1st			
2nd			
3rd			

3.2 Content Analysis for the Third Session

The ENA results described above show that the positive effects of perspective-taking persisted even in the mutual feedback discussion after the second self-performance when the student teachers watched the 3D animation for their reflection on their puppetry. In order to examine the characteristics of the differences between the video-only condition and the 3D animation condition, we qualitatively examined the reflective discourse. The ENA webtool extracted eight pieces of discourse in SI-TI and two pieces of discourse in TI-SM.

3.2.1 SI-TI: Discussion on How Possible Pupils Felt the Instructions

All eight discourse excerpts extracted by the ENA webtool for the stronger connection of SI-TI in the third session in the 3D animation condition contain the same pattern of participants discussing how pupils could feel in response to their instruction during the self-performed microteaching. The following is one representative excerpt:

C (pupil role):	I think it was a good idea to provide 3 × 5 at this point. [TI] In some ways, the teacher asked, "how many?" and wanted to answer in a multiplication. [TI] However, even without numbers, pupils who are good at math can answer it, but those who do not understand students are not making any sense. So only by providing 3 × 5. [SI] Yeah. [SI] I thought it would be easy to answer because pupils would probably understand that you are asking for a 3 × 5. [SI]
A (teacher role):	I wanted to do this in the other way, but I wrote 3 × 5 (on the blackboard) at first. [TI] Because the topic of the class was division. [TI] After confirming the multiplication, I will delete a number of one side, but I forgot to do so and left it for a while. [TI]

Before participant A, in the role of the teacher, explained their original intention of instruction as a teacher, participant C, in the role of a pupil, said that the flow of A's instruction was good, imagining that various pupils would exist in an actual classroom. Other episodes also showed that the participants discussions were based on the assumption of various pupils' perspectives and focused on improving their instruction from the viewpoints of possible pupils.

3.2.2 TI-SM: Discussion on Their Possible Instructions with Imagining Possible Slow Pupils

Two excerpts extracted by the ENA webtool for the TI-SM connection showed that the student teachers discussed how they should manage the pupils who are not good at math. The following is a representative example of the TI-SM connection:

E (teacher role):	Honestly, I do not know how to cope with pupils who are not good at math. [SM] I did not say anything but "that's true". [SM]
F (pupil role):	I think it's difficult. [SM] What should the teacher do for pupils who cannot understand? [SM] I think they would probably keep going uneasy for a long time. [SM] So what a kind of message should the teacher talk to? [SM] To the pupils who do not understand our instruction [SM] There are so many children who don't like math … [SM] To pupils feeling uneasiness [SM]

D (pupil role):	Anyway, was it the first time for the pupils to learn division? [TI]
E:	Yup. [TI]
	The unit has just started and it's the first class for the unit. [TI]
D:	I thought that it would be easy for pupils to understand even if the instruction started from a small number from 4 or 6 or so. [SI]
	I thought there would be two pupils, and it would seem like it would be easy to understand if you put the example, as it would be like dividing the four bonds into two. [SI]

The example began what participant E, who played a teacher role, sharing their anxiety surrounding their teaching in light of pupils' viewpoints, such as whether their students are participating in their class with feeling of uneasiness or low confidence, and how to respond to them. Participant F, who played a pupil role, showed sympathy, and participant D was trying to propose an actual solution which considered pupils' perspectives. Another excerpt also showed that the participants imagined how pupils would use mathematical manipulatives, their textbook, or other provided resources. As such, the student teachers considered how pupils would behave while learning math in their classroom during their reflective discussion of their performance.

4 Discussion and Conclusion

This study shows how the use of puppets—as transitional objects that elicit the projection of self (puppeteer) to non-self (puppet)—elicited a variety of informal utterances, enabling student teachers to achieve perspective-taking of a variety of possible pupils in actual classrooms even when the student teachers reflected on their performance. We introduced a 3D animation that records the puppetry to prompt perspective-taking of a variety of pupils in the mutual feedback discussion when student teachers reflected on their microteaching performances. The comparative experiment revealed that the positive effects of perspective-taking were maintained even in the mutual feedback discussion after the second self-performance when the student teachers watched the 3D animation for their reflection on their puppetry. The qualitative analysis of the discourse in the third reflective discussion showed that the student teachers maintained pupils' perspective while they discussed their performance.

Our past study, which introduced 2D animation for reflection on puppetry [7], showed that the effects were lost in the mutual feedback discussions after the second self-performed microteaching. The current study showed that the 3D animation, which allows a first-person view [9], is powerful enough to elicit student teachers' discussion of diverse perspectives. This may enhance the student teachers' perspectives in imagining possible pupils' voices for achieving dialogic teaching.

Further research is needed to investigate the effectiveness of the perspective-taking that the system and its 3D reflection movies prompted in this study, by examining dialogues in a more qualitative manner, after getting more data in additional experiments. In addition, other contexts such as nursing or disaster prevention should also be studied [6] to generalize the effectiveness of the tangible puppetry CSCL.

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