

ONLINE DISCUSSION: EFFECTS OF IDENTITY VERSUS ANONYMITY AND INTERACTION WITH PEDAGOGICAL AGENTS

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Received: 24/02/2022 **Accepted:** 16/06/2022

ABSTRACT

This study investigated: (a) how the task relevance of postings differed between anonymous versus identified online discussions in elementary school, and (b) how game-like conversations with story characters impacted the task relevance of postings. A total of 342 fourth graders in Slovenia participated in the study. During one and a half-hour, synchronous online sessions, students read short web-based eBooks with small group online discussions and game-like conversations with characters. We employed a mixed-method approach, combining both qualitative and quantitative research data. All discussion postings were qualitatively coded in terms of discussion relevance, and other functionalities. The frequencies of the qualitative codes were computed statistically. The results revealed that students in name-identified group discussions were significantly more on-task than those in anonymous discussions. Furthermore, students who engaged in game-like interactions with story characters were also significantly more on task than those who did not. The effective design of small-group synchronous online discussions within an interactive eBook has great potential in promoting engagement in reading, and making reading more social, in times of pandemic-caused remote education, or at any time.

Keywords: Online discussion, elementary school, distance education, pedagogical agents.

INTRODUCTION

The popularity of threaded discussions as a learning tool in online courses increased for several decades (Allen & Seaman, 2013). They are ubiquitous in online learning and Learning Management Systems (Chen, Wang, & Hung, 2009). Online discussions allow students to extend dialogue beyond the time and space of the classroom (Bertera & Littlefield, 2003), giving them more time to process information and compose meaningful responses (Schoech, 2000), helping them to actively co-construct the knowledge (Kanuka & Anderson, 1998) and to engage in critical thinking (Garrison, Anderson, & Archer, 2001). Online discussions allow students more equitable opportunities to engage with their peers and with the content, while potentially offering anonymity, which enables them to freely participate without fear of judgement or being recognized by others (Baglione & Nastanski, 2007). Although there are numerous benefits of online discussion in education, there are also problems. Low quality postings can frustrate students and discourage them from participating (Murphy & Coleman, 2004). To some extent, these limitations can be resolved when online discussions are carefully designed (Chin, Sum, & Foon, 2008). However, keeping students

on task in online discussion challenging (Dooley, & Wickersham, 2007). Dooley & Wickersham (2007) compared full-class versus small group online discussions in an online graduate course. They found that close to 50% of the postings in the full-class discussions were off-topic, while far less of the small group discussion postings were off-topic. It seems common sense that, in discussions, whether face-to-face or online, “the most direct indicator that students may be learning about class topics is that they are talking about [the] class topic,” (p 441, Guzdial, & Turns, 2000). However, the authors found no empirical studies that being on-task, versus off-task, improves learning. However, apparently instructors feel strongly that discussions being on-topic is important to them (Dooley & Wickersham, 2007).

The current study of online discussions is set in fourth grade. Executive function improves developmentally from childhood, to adolescence to adulthood (Piper et al., 2012). Thus, fourth grade students may find it more challenging to stay on-task (Montroy et. al, 2016) than other populations, such as university students who often participate in studies of online learning. While so-called “off-task” postings and communications often have important social and even educational functions, off-task behavior leading to a loss of instructional time is a well-established problem in elementary school (Godwin, et al., 2016). Therefore, understanding what factors influence being on-task, is worth investigating.

Anonymity

Online discussion allows students to interact anonymously, which helps students control their personal information and minimize cultural and gender bias (Chester and Gwynne, 1998). Most studies on anonymous versus user identified discussions suggest advantages for anonymity (Bertera & Littlefield, 2003; Bowen, Farmer, & Arsenault, 2012; Miyazoe & Anderson, 2011; Roberts & Rajah-Kanagasabai, 2013). Participants in Bertera & Littlefield (2003) suggested advantages for both anonymous discussion (more honesty in responses), and for identified discussion (learning benefits related to cultural competency). We found only one study suggesting disadvantages, i.e., weaker learning outcomes, for anonymous discussion participants (Landers and Callan, 2014).

However, almost all studies of anonymity versus identity in online discussion focus on university students and asynchronous courses, not blended learning (Bertera & Littlefield, 2003; Bowen, Farmer, & Arsenault, 2012; Miyazoe & Anderson, 2011; Roberts & Rajah-Kanagasabai, 2013). With the recent covid-19 pandemic, social distancing and the resultant remote-schooling, we should consider how to make online discussions effective with K-12 students. How does anonymity play out in online discussions in K-12 populations, such as elementary school students? We need to better understand how online learning environments should be designed for K-12 populations.

Online Interaction

Another potential advantage of online discussion, in distance education, is the possibility of providing different types of interaction. Moore’s theory of transactional distance, posits three forms of interaction vital to online learning: learner-instructor, learner-learner and learner-content (Moore, 1989). Online discussion is one of the most common forms of learner-learner interaction in distance learning and blended learning. Perhaps because learner-content is hard to measure, studies on learner-instructor and learner-learner interaction are much more common than studies on learner-content (Xiao, 2017). Researchers sometimes investigate learner-content interaction as an intervention, inclusion or exclusion of a learner-content interaction treatment. In this study, we take a similar and literal approach to learner-content interaction, where the content is personified by interactive pedagogical agents. We represent characters in eBook stories as simple interactive pedagogical agents, where students interact with the content by clicking pm words to form sentences, in game-like conversations with characters in stories. This solves a methodological problem of verifying that some minimum amount of interaction with content has occurred.

For elementary school children, who are recently moving into distance and blended learning, exploring some more engaging forms of learner-content interactions might be warranted. Since much, if not most, of course content today is represented on the computer, one might think of learner-content interaction as learner-computer interaction. There are some precedents for interaction with computer entities stimulating

more human-human interaction. Valkenburg & Peter (2007), to test the displacement hypothesis (online communication displaces time spent with existing friends) versus the stimulation hypothesis (online communication stimulates time spent with existing friends and the quality of these friendships), surveyed 1,210 teenagers on time spent with friends, quality of relations and online communication. Instant messaging, which was mostly used to communicate with existing friends, positively predicted time spent with existing friends. Other forms of social media were less predictive of time with friends.

According to Twenge, Spitzberg, & Campbell (2019), social media use and in-person social interaction are positively correlated. Teenagers spending more time on social media also spend more time with friends in person. However, teenagers low in in-person social interaction and high in social media use reported the highest levels of loneliness.

Pedagogical Agents

Pedagogical agents are virtual characters with human-like qualities of speech, gestures, or movement (Sweller, Ayres & Kalyuga, 2011) used in education. According to a meta-analysis, pedagogical agents can significantly motivate learning (Schroeder, & Adescope, 2014) and generally improve learning (Davis, 2018).

With motivation to learn, there is a difference between short term effects and longer learning trajectories. There is a distinction between current motivation to read a particular text versus habitual motivation to read regularly (Schiefele et al., 2012). Since there is a literacy crisis linked to declining independent reading (Mol & Bus, 2011), it is worth exploring various motivational effects of media. In digital texts, pedagogical agents promoting high inquiry arousal (asking intriguing or paradoxical questions) can increase germane cognitive load (Drobisz, 2017), improving schema acquisition (Kalyuga, 2010).

Blended Learning to Online Learning

Before 2020, much of K12 schooling was blended, or hybrid learning (Horn, & Staker, 2011), with most K12 classrooms in the United States and in European countries, periodically taking their students to the computer lab or using hand-held computers in the classroom. However, with the Covid-19 pandemic in the spring of 2020, K-12 schooling moved entirely online. Results were mixed. Students who ordinarily were motivated and excelled in school, did fine, while less motivated students, who generally struggle, struggled even more. Students whose families did not have effective internet fell back. Thus, the educational digital divide was exacerbated across a number of countries (Hall et al., 2020; Iivari et al. 2020).

For Fall 2020, (Education Week, 2020; Lieberman, 2020) “73% of the 100 largest school districts [nationwide] have chosen remote learning only as their only back-to-school instructional model, affecting over 8 million students.” Also, 51% of districts offered blended learning.

Despite Covid-19 vaccines, probably online learning variants, including blended-learning, will remain more popular than pre-Covid-19, for K-12 learning, including elementary school. Thus, research programs about K-12 online learning are more relevant than ever. Research exploring how multimedia design factors influence social interaction in blended and online learning are vital. The current study focuses on how two such specific design factors influence being on-task in online discussions in elementary school: (1) anonymous versus identified online discussion, and (2) the influence of pedagogical agent-based learner-content interaction.

Research Questions

Research question one: How does anonymous versus participant-identified affect the task-relevance of online discussions in fourth grade blended classes?

Research question two: How does learner-content interaction affect task-relevance of online discussions in fourth grade blended classes?

METHOD

Research Design

We used a mixed-method approach, combining qualitative and quantitative research data (Creswell, 2014). Our primary qualitative data was transcripts of small group discussions, downloaded from the eBook database. The researchers read and reread these discussion postings, and discussed them. We recognized multiple dimensions of the qualitative aspects of the discussions and created a coding scheme accordingly. Appendix shows the full coding scheme. The primary quantitative data was frequency counts of qualitative codes.

Participants

Participants were 342 fourth graders in 21 classes, in eight public schools in Ljubljana, the capital of Slovenia. We selected fourth graders because, by then, the vast majority of Slovenian students can read fairly well, and because fourth graders tend to have “incredible energy and emotion, industriousness and curiosity, increased awareness of the world around them” (Anderson, 2011), and thus would be open to experiencing a new technology for reading. We sampled schools in Ljubljana - population approximately 290,000 - by networking the contacts of our ten student researchers, pre-service teachers some of whom had interned in schools across Ljubljana. In other cases, our pre-service student teachers “cold-called” school principals, who recommended specific teachers. We further selected schools to get a broad range of areas in the extended Ljubljana metropolitan area, including schools close to the city-center, in the suburbs and just outside the official border of the city.

Because of privacy issues, we could not gather information on gender or age. We conducted three related studies: Study one with 42 participants, study two with 40 participants and study with three 260 participants. The studies had different numbers of participants, because studies one and two were lead-up studies to the larger study intended for another purpose. The results reported in this paper, much like Fleming’s discovery of the value of penicillin, were fortuitous, yet worthwhile, discoveries.

Materials

We used web-based interactive eBooks in Slovenian, each drawn from a story, not yet read by students, from 4th grade language textbooks. In addition to text pages, these eBooks contained: (a) group discussions, “book clubs,” of four to six students randomly grouped. Students read text pages, until a pop-up informed them a discussion was available. When they clicked on a talk balloon icon, they entered the discussion interface (see Figure 1). Typically, three or four students synchronously texted in the discussion, a group size most successful for collaboration (Dobao, 2012; Morgan, Allen, Moore, Atkinson, & Snow, 1987). (b) For learner-content interaction, they encountered game-like conversations with characters (pedagogical agents). See Figure 2, translated into English. Students arrived at a page with a pedagogical agent, i.e., an image of a character from the story, a question to respond to, and a lexicon of words on buttons to click on to form sentences to respond to the question. Students received automated text feedback to their answers and changes in the character’s facial expression. We used this minimal form of game-like interaction, also used in Smith et al., (2013) for ESL learning, because a meta-review of using games for learning suggests that excessively rich game scenarios often result in less learning (Wu, Zhang, & Wang, 2020). (c) Learner-content interaction also included open-ended questions (see Figure 3): students typed in their response and either clicked on the “submit” button or return key. They received a polite response, “Thanks for your response. You teacher will read it.” and were instructed to read on.



Figure 1. Interface for discussion



Figure 2. For learner-content interaction, game-like conversation with character, translated into English.



Figure 3. Interface for open-ended questions.

Procedures

All students participated in a one and a half-hour synchronous online discussion session. The activities in the online discussions aligned with their language arts curriculum, drawn from their language arts textbook. The teachers regularly asked their students to participate in online activities, so the study was part of their regular learning routine. A Slovenian pre-service teacher used a PowerPoint presentation, delivered online, to appraise students of study procedures. Students: (1) opened the web-based interactive eReader site up on a browser, (2) logged into the eReader with a username and password and (3) read through three short eBook stories online.

We conducted three such studies, with slight variations. In study one, the students' usernames were their first and last names, e.g., JohnDoe. In each eBook, they experienced both individual learner-content interaction (conversation with characters and open-ended questions) and small group discussions). In study two, the usernames were anonymous, a combination of the school and a number, e.g., Smartno1, Smartno2, etc. Otherwise, there were no significant differences between study one and study two. In study three, there were anonymous usernames and only the social learner-learner interactions (small group discussions), with no individual learner-content interaction.

Data Collection and Data Analysis

We used each posting as a unit of analysis, since in these fourth-grade discussions, each posting was invariably one thought unit. While fourth graders were excited to work with interactive online eBooks, they were also distracted by this situation. The game-like interactions in the eBooks could potentially distract or engage them from the story. Further, the presence of other students in an online discussion, could distract them from the story and the discussion topics. The fourth graders were easily distracted from being on task. Therefore, as per the dependent variable on our research questions, being on task, the first, high level coding dimension for discussion postings was Book Relevance (with two values, yes or no).

Secondly, we noticed a dialectic, or dialogic aspect, to these fourth-grade discussions. There was a pattern of questions, answers, follow-up questions, interspersed with statements. This pattern held true when students discussed the eBook discussion question, or matters not relevant to the book. Thus, we employed a second coding dimension, "Type: Question, Answer or Statement" (Q, A or S for short). Next, we created a third coding dimension, category, which was a description of the posting, providing more detailed coding of text postings. All codes are explained with examples in Appendix. For our quantitative data, we computed statistics on the frequencies of the different qualitative codings.

Reliability

We had at least two researchers (pre-service teachers) independently code all postings. For Category, the Kappa measure of inter-rater reliability was .935, or 93.5% ($T = 80.11$), which is certainly acceptable. For book relevance (one proxy for staying on-task), our Kappa measure of inter-rater reliability was 1.0 or 100% ($T=36.15$).

FINDINGS

To compute inter-rater reliability, two of our student researchers independently coded a subset of the discussion postings, specifically 1,293 postings or one third of the total postings. Our Kappa (McHugh, 2012) inter-rater reliability as per was 0.95, or an agreement of 95.8%. Kappa values of over 0.6 are considered acceptable, while values over 0.81 are considered almost perfect agreement (McHugh, 2012).

Quantitative Data

For the purposes of answering our research questions related to task relevance, we initially used book relevance. The difference in rate of book relevance, as determined by a Chi-square test, between study one, using student names as usernames, ($M = 0.69$, $SD = 0.46$) and study two, using anonymous usernames (M

= 0.53, SD = 0.5) was significant, $F = (1, 14.9)$, at the 0.001 level. With first and last names as usernames, 69% of the postings were book relevant; while for anonymous usernames, 53% were book relevant. The Phi and Cramer's V effect sizes were 15.8%, i.e., small but significant. Therefore, 15.8% of the difference in discussion relevance was explained by anonymous versus identified usernames. Figure 4 shows a graph of the differences.

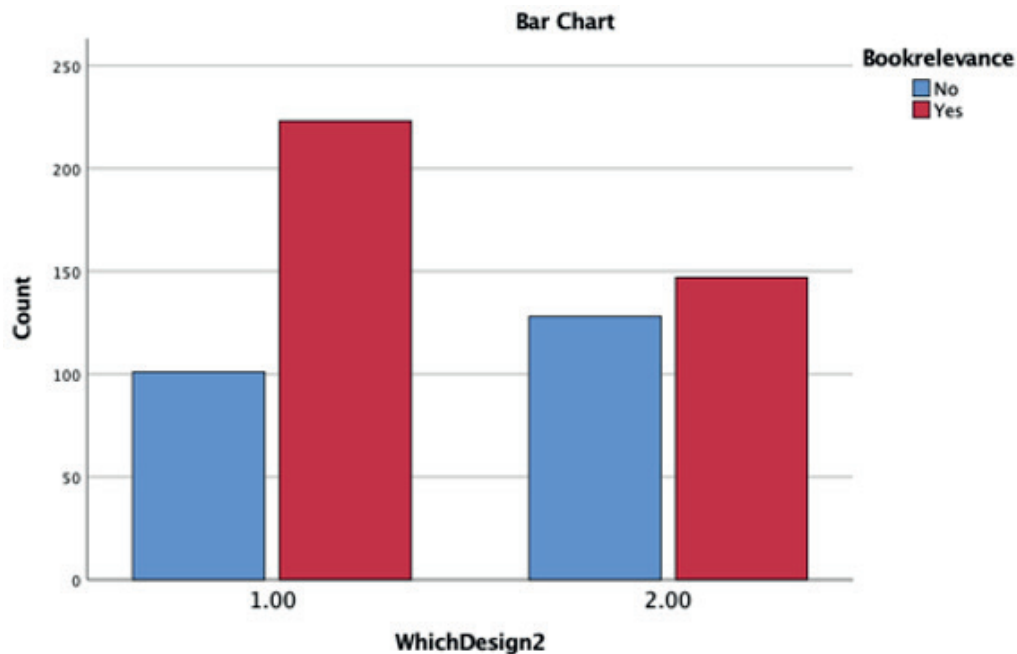


Figure 4. Book relevance for study 1 versus study 2

However, we decided that in terms of online discussion, discussion relevance more directly pertained to “task relevance” in online discussions, than did book relevance. Discussion relevance was a computed variable, i.e., whether, or not, Broad Category was “discussion.” The analyses for book relevance was virtually identical with the analyses for discussion relevance. See Table 1.

Table 1. Descriptive statistics for Discussion Relevance

Study	Number postings	Mean	Std. Dev.
Study 1	324	.633	.483
Study 2	275	.505	.501
Study 3	2,942	.290	.454

The first and second studies differed only in terms of username anonymity and identity. The difference in rate of discussion relevance, as determined by a Chi-square test, between study one, with student names as usernames, ($M = 0.633$, $SD = 0.483$) and study two, with anonymous usernames ($M = 0.505$, $SD = 0.501$) was significant, $F = (1, 9.85)$, at the 0.002 level. With student names as usernames, 63% of the postings were discussion relevant, while with anonymous usernames, 50% were discussion relevant. See Table 1 and Figure 5. The Phi and Cramer's V effect sizes were 12.8% or small, meaning that 12.8% of the difference in discussion relevance was explained by anonymous versus identified usernames.

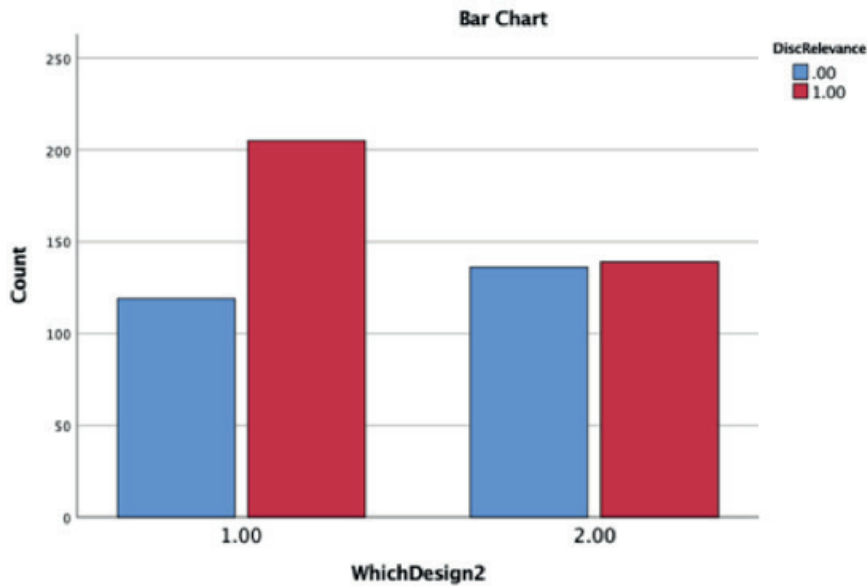


Figure 5. Discussion relevance for all discussions in Study 1 and Study 2

The difference in rate of discussion relevance between study two, anonymous usernames with learner-content game-like interaction ($M = 0.505$, $SD = 0.501$) and study three with anonymous usernames but without learner-content game-like interaction ($M = 0.290$, $SD = 0.454$) was also significant, $F = (1, 14.68)$, at the 0.0001 level. See Figure 7 and Table 3. Here the Phi and Cramer's V effect sizes were both 11%, also small, meaning that 11% of the difference in discussion relevance was explained by the inclusion of learner-content interaction, such as game-like conversations with characters and open-ended questions. This does provide evidence that name identified usernames and learner-content interaction promote task relevance in online discussions.

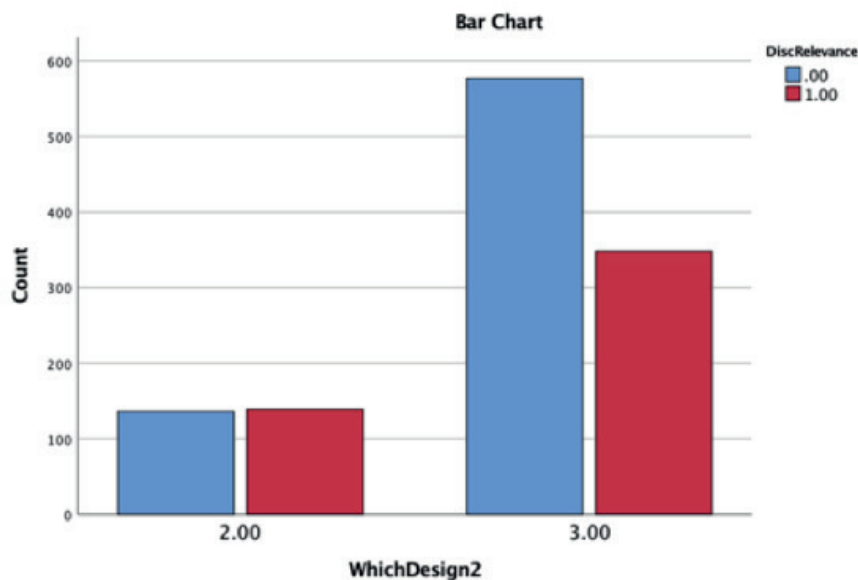


Figure 6. Discussion relevance for all discussions in Study 2 and Study 3

To keep our analysis complete, we also compared the difference in rate of book relevance between study two, anonymous usernames with learner-content game-like interaction ($M = 0.53$, $SD = 0.5$) and study three with anonymous usernames and without learner-content game-like interaction ($M = 0.34$, $SD = 0.47$) was also significant, $F = (1, 10.7)$, at the 0.001 level. Phi effect size was 9.5% or small. See Figure 7.

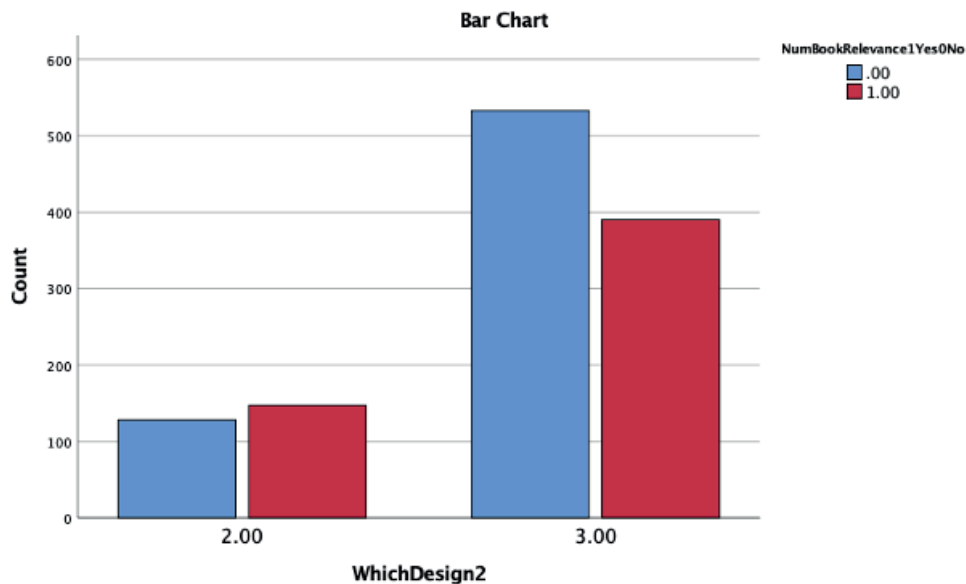


Figure 7. Book relevance for all discussions in Study 2 and Study 3

Qualitative Data

In the quantitative results above, task-relevance (discussion relevance) was significantly higher in study one, where usernames were students' actual names, than in study two where usernames were anonymous. Example discussions illustrate how anonymity versus identity exert these differences. In studies one and two, some of the discussions were based on the book *Kekec in Pehta*, by Josip Vandot and Andrej Rozman Roza. Overall, the students in study one provided both discussion relevant and irrelevant postings. However, in the sample discussion from study one in Table 2, all the postings were discussion relevant. In the story, a young boy, Kekec, has been temporarily living with another family whose daughter is blind. Kekec deliberately lets himself be captured by the "witch" Pehta, because Kekec wants to steal the medicine Pehta has made, and then escape and use the medicine to cure the daughter's blindness. The discussion question asks, "In what other way could Kekec get the medicine?" meaning in what way, besides stealing could Kekec obtain the medicine. The discussion starts with Anna suggesting, "He could ask her for the medicine." In the rest of discussion, the students discuss how Kekec asking Pehta for the medicine might play out, in terms of causal consequences and motivations of the characters. This is an ideal educational outcome. The students demonstrate their comprehension of the story and the empathy with the characters and an aesthetic approach (Rosennblatt, 1994, 1995) to reading, imaginatively experiencing the story.

Table 2. Discussion Study 1 (identity with pseudonyms), In what other way could Kekec get the medicine?

NAME	MESSAGE	TASK-RELEVANCE	TYPE	CATEGORY	CATEGORY BROAD
Anna	He could ask her for medicine	Yes	A	DA	D
Anna	He could secretly steal it	Yes	A	DA	D
Tom	He could ask her	Yes	A	DA	D
Anna	Yes, he could also do it like that	Yes	A	DAA	D
Anna	Why can't Pehta just give it to him?	Yes	Q	DQ	D
Tom	But she would catch him because she would notice that the medicine is gone	Yes	A	DA	D
Anna	Yes, but he could lie and say it wasn't him	Yes	A	DAA	D
Tom	Because Pehta wants to be the one who heals Mojca	Yes	A	DAA	D
Tom	But he could search the apartment	Yes	A	DAA	D
Anna	That is also true but why Pehta, why not Mojca's parents	Yes	Q	DQ	D
Tom	Because she is the only one with the medicine	Yes	A	DAA	D
Anna	Yes, but Pehta could give the medicine to the parents	Yes	A	DAA	D
Tom	No, because she doesn't want to	Yes	A	DAA	D
Anna	Yes, but doesn't she want to?	Yes	Q	DQ	D

The same discussion in study two features important differences. See Table 3. The discussion starts with smartno8 suggesting "He could sneak into Pehta's home." This reflects either a low level of involvement with the discussion or low level of comprehension of the story, since the discussion question actually asks "In what other way could Kekec get the medicine?," meaning other than stealing it (he actually steals the medicine in the story). Smartno3 asks for a clarification, "What?," perhaps because s/he understands that smartno8's suggestion runs counter to the discussion question. Smartno16, perhaps imitating the researcher's comment, chimes in with "I think so too." Agreement in an online discussion is sometimes an easy way out. Over the next postings, the discussion proceeds on track, if at a low level, "I think he could take Pehta and then find the cure and then run away," "Nooo I wrote that wrong," and "He could find it on his own." The rest of the discussion gets hijacked by identity issues, such as asking who other discussants are and talking about changing their avatar images, until smartno3 finally gets fed up and decides to move on to the next story, Videk. As in study one, the students in study two also made relevant postings. The main difference was that the relevant answers were not of as high a quality as in study one - students mainly gave different short answers and did not move the discussion forward. Also, when comparing the irrelevant answers in study one versus two, the ones in study two were mainly connected to students' unknown identities and wanting to know who was who.

Table 3. Discussion Study 2 (anonymity), In what other way could Kekec get the medicine?

NAME	MESSAGE	TASK-RELEVANCE	TYPE	CATEGORY	CATEGORY BROAD
Smartno8	He could sneak into Pehta's home	Yes	A	DA	D
SmartnoT	That is one way to do it, I agree	Yes	A	DAA	D
Smartno3	What?	No	Q	M	M
Smartno16	I think so too	Yes	A	DAA	D
Smartno24	I think first he should take Pehta and then find the cure and run away	Yes	A	DA	D
Smartno24	No, I wrote that wrong	No	S	CO	C
Smartno3	He could find it on his own	Yes	A	DA	D
Smartno8	I have a new face	No	S	CO	C
Smartno24	I have a new profile picture	No	S	CO	C
Smartno3	Yes, I am constantly changing it	No	S	CO	C
Smartno8	j	No	S	O	O
Smartno24	What j?	No	Q	CO	C
Smartno3	What j?	No	Q	CO	C
Smartno8	I have a new profile	No	S	CO	C
Smartno3	Who are you Smartno24?	No	Q	IQ	I
Smartno8	I made a mistake	No	S	CO	C
Smartno3	What???????????????	No	Q	CO	C
Smartno3	I'll just move on to Videk	Yes	S	S	S
Smartno4	Who are you?	No	Q	IQ	I

We can understand the flow of these online discussions better by examining a state-transition graph visualizing the dynamic distribution of postings by most common categories, in the entire dataset (see Figure 9). The left part of Figure 8 shows two “clusters.” The first cluster focuses on the discussion topic (categories DQ, Discussion Question, DA, Discussion Answer, and DAA, Discussion Answer Answer or elaboration of a Discussion Answer) while the other cluster focuses on identity-related categories (IQ, Identity Question and IA, Identity Answer) and its subsidiary offshoot to off-discussion topics (categories CO, Comment Other and O, Other). Based on this, it is clearly visible that on-topic and off-topic conversations are not intertwined, but participants rather discuss one topic at a time and then drift to another one. On the right side of Figure 9, this is more evident. If we know the categories of the last two messages, we can predict the category of the next one. For instance, if there are two postings in the Other category (often nonsense), the probability of the next posting being Other is 75%. Two successive postings of Discussion Answer category, are 51% likely to be followed by another.

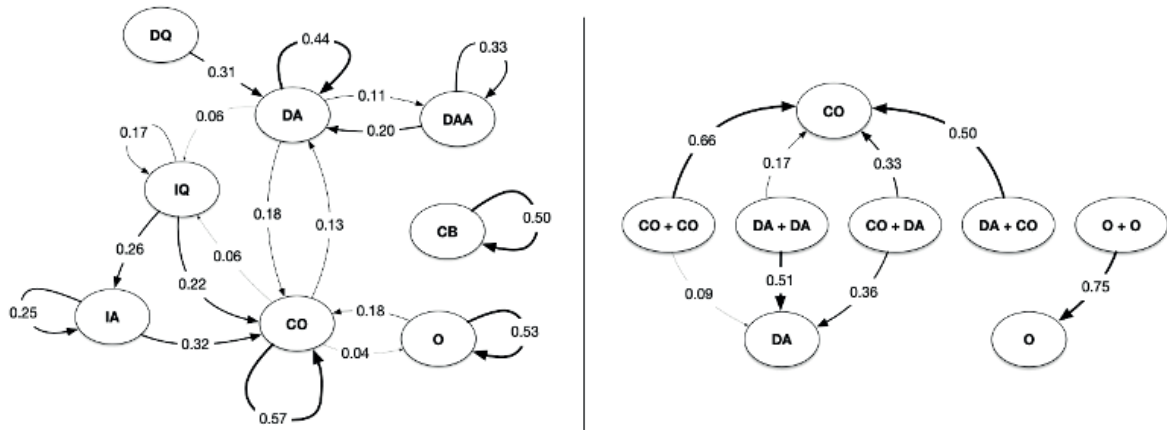


Figure 8. State-transition graph showing dynamic distribution postings by category

Learner-Content Interaction versus no Learner-Content Interaction

The difference in rate of discussion relevance between study two, anonymous usernames with learner-content game-like interaction and study three, anonymous usernames without learner-content game-like interaction, was significant. However, we could not find dialog in the transcriptions of the discussions suggesting any causal mechanisms.

A closer examination of several sessions from sample game-like conversations with character might provide some insight. Figure 2 shows a screenshot of a conversation game with a character, translated into English. It turns out that - with some exceptions - these conversation games with characters were fairly easy for the fourth graders in terms of making inferences from the story. The greater challenge was figuring out what sequence of words, or what sentence, would be accepted by the game. This was slightly challenging because Slavic languages like Slovenian allow for considerable flexibility in word order. Table 4 shows a typical interaction. It was difficult for the game designers to anticipate every possible correct permutation. Thus, the fourth graders had to try several combinations to find the winning sentence. Nevertheless, the fourth graders enthusiastically embraced this challenge. The simple feedback of changing facial expressions and text feedback apparently engaged fourth graders. The biggest difference between study two and study three, was that study two participants experienced these conversations with character games and open-ended questions, while those in study three did not. Participants in study two were also significantly more on task in discussions.

Table 4. A sample session from a conversation with character game

Student input	True/Try again
Because than policeman is faster	Try again
Because is faster	Try again
Because is more resourceful	Try again
Because is more resourceful than policeman	True
Because is smarter than policeman	True

DISCUSSIONS AND CONCLUSION

Our results suggest that using actual names as usernames allows elementary school students in a hybrid/blended learning class to discuss online with fewer distractions (e.g., fewer inquiries about identity). These students actually knew each other from the earlier face-to-face classes and were thus curious who they were conversing with online. However, since relationships between elementary school students are important in general, whether in hybrid courses or fully online courses, one might also expect similar significant results, but perhaps smaller in scale, in fully online courses. In any case, the advantage of identified usernames might stem from higher levels of social presence increasing user involvement.

Pragmatically, more on-task comments should result in more and better learning of the actual curriculum. Transcripts in the current study seem to confirm this. For this age group (fourth graders), anonymity is not helpful in online discussions. This also suggests that the research practice of using samples of convenience, such as college undergraduates and graduate students (e.g., Bertera & Littlefield, 2003; Bowen, Farmer, & Arsenault, 2012; Miyazoe & Anderson, 2011; Roberts & Rajah-Kanagasabai, 2013) can skew the results. If more studies of online learning included other populations, such as K-12 students, and in more situations, besides threaded discussions in online courses and in Learning Management Systems, the advantages of anonymity in online discussions would be shown to be less, and the advantages of identified online discussions would be revealed to be greater.

Our results also suggest that learner-content interaction, in the form of simple pedagogical agents, game-like conversations with story characters and open-ended questions, results in more discussion relevant postings. We propose a theoretical idea, we call the interaction bleed-over hypothesis, i.e., that increased interaction in one of Moore's (1989) three forms of interaction (student-content interaction) may stimulate higher quality interaction in another modality (student-student interaction). Moreover, this provides an easily quantifiable method to include learner-content interaction in research about online learning. If pedagogical agents, in the form of "conversations with character" games are used, download of the logs of such interactions provide a precise measure of such learner-content interaction. Methods like this could help to address the dearth of research on learner-content interaction in online learning noted by Xiao (2017).

However, since the coded discussions made no direct reference to the conversation with character games, we can only speculate on the causal mechanism. The data from the conversation with character games suggest that the inferences students needed to make were easier than finding the right form of phrasing that the game required. Perhaps, the students were excited by this simple game-like interaction, which provided feedback via simple two-dimensional pedagogical changing facial expressions. Moreover, there was, by design, similarity in the interface and interaction between the game-like conversations with characters and the small group discussions (see Figures 1 and 2). As part of the learner-content interaction, students also typed answers to open-ended questions. Perhaps both these open-ended questions also primed students to interact in the discussion? Or perhaps, the text-based interaction with virtual characters engendered greater involvement with the story, much as interaction with non-player characters in multi-player games might stimulate interest in the game, in turn engendering more interest in discussion of the story? This seems to imply that individual game-like interactions that are similar to online discussions can stimulate productive discussion in this age group. However, these are speculations that need to be specifically investigated with experimental research isolating these variables more carefully.

Hosting small-group synchronous online discussions within an interactive eBook, a text/multimodal narrative, is itself an innovative idea. It might be a way to promote interest in reading, and make reading more social, in times of pandemic-caused remote education.

Suggestions for the Future Research

We suggest, in future studies, the use of easily quantifiable learner-content interaction, such as interactions with pedagogical agents. This could help to increase the research on learner-content interaction, to balance out the data investigating Moore's paradigm of transactional distance with its three forms of interaction vital to online learning: learner-instructor, learner-learner and learner-content.

Further, as the Covid-19 pandemic trails off, completely remote K-12 learning will trail off from its highest during the pandemic. However, it is a fair guess that blended and online learning may remain higher than in the pre-covid period. Therefore, more studies of online discussions in K-12 situations, including in elementary, would be helpful for education.

Educational Implications

We suggest that K-12 teachers consider the use of small group online discussions in the context of blended learning, particularly with identified usernames. We acknowledge that access to computers in classrooms and/or computer labs is potentially a limiting factor that schools should continue to address. However, the learning affordances of online discussions in online textbook have great potential.

Limitations

Limitations are: (a) in the studies with learner-content interaction, there were two forms of interaction, pedagogical agents and open-ended questions. Therefore, it was difficult to parcel out the effects of each of these forms of interaction, and (b) the study was conducted with fourth graders, so may not generalize completely to other grade levels.

Acknowledgement: The research was largely funded by a Fulbright U.S. Scholarship from the United States and Slovenian governments. Great thanks go to the IIE Fulbright organization to make this uniquely rewarding experience possible.

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APPENDIX

Coding Scheme for the Dimension

Name	Abbrev	Description	Example
Chatting*	C	Not related to the discussion question	
Chatting, greeting	CG	greeting their classmates	Heeeeeeyyyyy!
Chatting about books	CB	Chatting about which books they liked and what parts were their favourite	What book do you like the most?
Encouragement	CE	encouraging others to join the chat	Let someone write somewhere.
How they feel	CF	chatting about how they feel	How are you? I'm bored.
About other things	CO	chatting about other things, such as their next class, what they want to do etc.	Let's go out.
Curse words	CC	using curse words or being mean to someone, responding to them in a mean manner	You're an ass.
Switching*	S	talking about where in the system they currently are, what tasks they are working on, asking about how to move on from a task etc	How do you move to ...?
Discussion*	D	Related to the discussion question or discussion content	
Discussion, question	DQ	posing a question that somehow relates to the discussion question	Do you think this is the correct answer?
Encourages further discussion	DE	posing a question that directly encourages further discussion about the discussion question	Will anyone answer me?
Answering discussion question	DA	answering the discussion question directly	So that he would somehow eat
Commenting on the answer	DAA	answering a question or commenting on the answer of someone else, that is still somehow related to the discussion question	Maybe also
Moderating*	M	Serving the purpose of moderating the discussion	
Encouraging	ME	encouraging the students, giving praise	Very good thinking.
Leading questions	MQ	Asking questions relevant to the discussion question, to encourage further discussion	What else could you do?
Technical answers	MA	answering the students' questions, related to how the eBook works, or anything else – the answer can also be a question	You click on the greater than sign to read on.
Identity*		Related to who someone was, either question, answer, anything related to personal identity, or even virtual identity such as choice of avatar or changing of avatar	
Identity question	IQ	Asking a question about someone's identity	Franca15, who are you?
Identity answer	IA	Answering a question about who you are someone is.	I am Janez.
Both identity question and answer	IQA	Answering a question about who you are & asking who another person is.	I am Janez. Who are you?
Other	O	any typo, any message that was sent too fast, anything that does not make any sense at all and/or can not fit into any other category	dsfhjkl;lkffds

Note: * These codes fit into Category Broad