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Students' feelings of social presence when creating learning-by-teaching educational videos for a potential audience

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ABSTRACT

Audience is emphasized in learning by teaching. This article focuses on 44 sixth-grade students who cooperatively created video-tutorials in pairs. It analyzes: 1) self-reported perception of the audience; 2) personal references in the video-tutorials; 3) audience-based verbal actions throughout the creation process. First, self-reported perception is high, especially in video production. Second, 2.23% of words are personal references, with differences between explanation (1.73%) and questions (2.91%). Third, script elaboration and video production gather most audience-based verbal actions (108 utterances): 76 come from the question part; 58 were task-based and 50 were content-based; 13 indicate knowledge building. Two contributions are underlined: attention to the audience can fluctuate; inducing social presence can trigger elaboration, but it is often not materialized.

1. Introduction

This study focuses on the social presence hypothesis of learning by teaching, which needs further exploration (Lachner et al., 2022). In the introduction, a literature review is presented, focusing on the concept of audience, how this concept has been affected by Information and Communications Technology (ICT), and the role of audience in learning by teaching. This last section considers the role of audience in learning by expecting to teach, in learning by presenting, explaining, and questioning, in learning by non-interactive teaching, and the social presence hypothesis. The introduction is concluded by reviewing the research gaps and presenting the aims of the study.

1.1. The concept of audience

Receiving social attention is known to have far-reaching effects on people (Steinmetz & Pfattheicher, 2017). In educational contexts, the impact of having an audience has gained special attention in the research field of writing instruction. Although cognitive and sociocultural frameworks have approached the role of the audience in writing differently, both perspectives can be integrated if a double mediating role of the audience is considered: an internal, cognitive role, consisting of the writer's mental representation of the audience; and an external, social role, given by a group of readers, who may interact with the writer (Magnifico, 2010). According to Magnifico (2010), an audience can be defined as follows:

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An audience—or audience members, or readers, however they are positioned in the environment and seen by the writer—is an often-abstract group of people whose real (in the case of an active, participatory audience) or imagined (in the case of a more distant audience) characteristics and reactions can help the writer plan and assess the shape and style of her writing. (p. 175)

1.2. *The role of ICT in the concept of audience*

The incorporation of ICT into society and people's lives has importantly changed the learning ecology (Barron, 2004; Coll, 2013; Collins & Halverson, 2010). Not only does ICT multiply the amount of information people have access to, but also the languages and formats for input and output, as well as the number and diversity of contexts people participate (Coll, 2013). Thus, ICT has both changed the products students can create and how they can be shared with different audiences (Gray et al., 2010; Magnifico, 2010; Ribosa & Duran, 2022b).

Videos—and, more broadly, audio/visual materials—are the most frequently-created products as student-generated teaching materials (Ribosa & Duran, 2022b). The role of the audience has been emphasized in student video creation as well (Kearney, 2011; Kearney & Schuck, 2006). Here, having an audience has been reported to cause both positive and negative emotions. On the one hand, students report emotions of eagerness and satisfaction because of the usefulness of their materials for others (Azman et al., 2016; Campbell et al., 2019; Hoban & Nielsen, 2012; Kearney, 2013; Lee et al., 2008; Macdonald & Hoban, 2009; Olivier, 2019; Pirhonen & Rasi, 2017; Ryan, 2013; Schuck & Kearney, 2006). On the other hand, they report emotions of worry, fear and nervousness about sharing materials, making mistakes and others' opinions (Engin, 2014; Lawrie & Bartle, 2013; Macdonald & Hoban, 2009; McClean et al., 2016; Ryan, 2013; Urstad et al., 2018). The presence of an audience may encourage extra effort and engagement (Engin, 2014; Kearney, 2013; Macdonald & Hoban, 2009; Norton & Hathaway, 2010), and lead students to consider the audience in how they design the video and present the content (Bruce & Chiu, 2015; Doerr-Stevens, 2016; Hafner, 2014; Jensen et al., 2012; Nielsen et al., 2020). This consideration of the audience might also be reflected in the products students generate (Anderson et al., 2017; Doerr-Stevens, 2016; Hafner, 2014; Pirbhai-Illich et al., 2009; Soto, 2015) and traced back to its creation process (Hoban & Nielsen, 2014; Nielsen & Hoban, 2015; Pirbhai-Illich et al., 2009). Moreover, a considerable number of studies refer to the audience effect to interpret their findings (Ribosa & Duran, 2022b).

1.3. *The role of the audience in learning by teaching*

The role of the audience is considered in learning by teaching because the features of the addressee (e.g., real or imaginary, active or passive) determine the way of teaching and, thus, the learning opportunities for the person who teaches (Duran & Topping, 2017). The learning-by-teaching framework has been organized into four levels (Duran, 2017), from less to more complex and bidirectional: 1) learning by expecting to teach, 2) learning by presenting, 3) learning by explaining, and 4) learning by explaining using questions.

1.3.1. *The audience in learning by expecting to teach*

Research carried out in the 1980s showed that the expectation to teach—without later actually teaching—fostered a better retention of content than studying (Bargh & Schul, 1980; Benware & Deci, 1984), which opened the door to further research on expectancy (Fiorella & Mayer, 2014). Expectancy is the expectation of a person who learns a content thinking that he or she will later teach others, that is, who prepares to teach with an imagined audience in mind (Bargh & Schul, 1980; Fiorella & Mayer, 2013). Subsequent studies found similar results that point to better retention as well as better organization (Nestojko et al., 2014) and increased comprehension and metacognitive processes (Muis et al., 2016). However, other studies found no significant learning gains for expectancy (Ehly et al., 1987; Kobayashi, 2021; Renkl, 1995). It seems that at least under certain conditions the expectation to teach alters cognitive processes, leading to revising the content, organizing it for presentation, and identifying its basic structure (Duran & Topping, 2017), and it fosters higher motivation as well (Fiorella & Mayer, 2013, 2014). Benware and Deci (1984) attributed this higher motivation to the will to avoid the situation of not knowing how to respond to the audience. Although expectancy may play an important role in creating a teaching material, it is likely that other processes connected to the other levels of learning by teaching are involved: presentation of the content, knowledge building, and use of questions.

1.3.2. *The audience in learning by presenting, explaining, and questioning*

Presenting the content to a real audience is a way of analyzing how one's own mind revises and reformulates information to transform it into knowledge (Duran, 2017; Duran & Topping, 2017). This potential remains when the audience is passive, which is known as audience effect (Zajonc, 1966), and even when the audience is not physically present (Hoogerheide et al., 2016). According to Hoogerheide et al. (2016), being aware of the addressee and perceiving it as real—although not physically present—can generate what is known as productive agency, that is, the belief that our own actions can affect others (Schwartz & Okita, 2004). Presenting the content to the audience may involve transmitting information—knowledge telling—but also engaging in metacognitive processes to assess learning and comprehension, as well as the coherence of the explanations—knowledge building—(Roscoe & Chi, 2007, 2008). These knowledge-building processes are connected to deeper understanding (Roscoe, 2014) in the learning-by-teaching situations. Moreover, when the degree of interactivity between the presenter and the audience allows for formulating and answering questions, the learning benefits are heightened because of the potential of questions to promote knowledge building (Roscoe & Chi, 2008). The more complex the questions, the more beneficial they become, especially when they require integrating prior and new knowledge, reorganizing mental models, generating inferences, and carrying out metacognitive self-regulation (King, 1998). Providing

higher-quality explanations—both in a first expository explanation before the addressee and in a later interaction stage asking and answering questions—seems to have an impact on conceptual knowledge, inference, and transfer (Kobayashi, 2021).

1.3.3. *The audience in learning by non-interactive teaching*

Creating teaching materials can be considered an indirect or non-interactive way of teaching (Kobayashi, 2019a, 2019b; Lachner et al., 2022). When comparing direct face-to-face teaching with indirect non-interactive teaching, a meta-analysis carried out by Kobayashi (2019a) showed that the learning benefits are larger in the case of direct teaching, both in the situation of teaching expectancy only and in the act of teaching with preparing-to-teach. Lachner et al. (2022) developed a model of non-interactive teaching, which considers different boundary conditions: modality of the explanations, induced social presence, timing, teaching expectancy, prior knowledge, ability beliefs, and features of the source material.

There is plenty of evidence that back up the effect of presentation modality on learning outcomes. It seems that explaining on video enhances learning when compared to written explanations (Hoogerheide et al., 2016; Jacob et al., 2020; Lachner et al., 2018, 2021). A meta-analysis on student-generated teaching materials shows considerable differences between audiovisual and textual materials (Ribosa & Duran, 2022a). In primary education, Hoogerheide et al. (2019) compared the effect of generating an instructional video as homework to restudying and summarizing the source material. In terms of enjoyment, students perceived that teaching on video was more enjoyable than restudying or summarizing. As regards conceptual knowledge, no significant differences were found between teaching on video and summarizing. However, the latter did not improve test performance compared to restudying, but video-based teaching did show improved test performance compared to the restudy condition.

1.3.4. *The social presence hypothesis in learning by teaching*

The modality effect is discussed in light of the students' feelings of social presence (Hoogerheide et al., 2016, 2019; Jacob et al., 2020). Compared to writing, the authors consider that generating an oral explanation on video increases the students' feelings of social presence of an addressee, which in turn may trigger distinct generative processes during explaining (Hoogerheide et al., 2016, 2019; Jacob et al., 2020).

Based on the social presence hypothesis, Jacob et al. (2021) tried to increase social presence in written explanations by using a simulated messenger chat with an addressee who had a profile picture and sent a message asking for an explanation on the topic. They found that this influenced the number of personal references compared to a standard written explanation condition and a video-based explanation condition, but not the self-reported social presence ratings. It should be noted that the instructions given to the three conditions were different: while in the standard written explanation and the video-based explanation conditions students were explicitly presented with an imaginary scenario, the chat condition did not present the addressee as imaginary. This may raise the question regarding the distinction between the mental representation of an imaginary and a real addressee (Ribosa & Duran, 2022a; Magnifico, 2010), which might have influenced the results of the experiment. As regards learning outcomes, Jacob et al. (2021) did not find any differences between the experimental conditions—neither when compared to a control retrieval condition. Here, it should be noted that the design of the procedure hindered teaching expectancy. Students first read the study text without the intent to explain or retrieve the material afterwards, and then they were assigned to one of the four experimental conditions. There, they were asked to carry out the learning activity—generating an explanation for the three intervention groups or doing the open recall task for the control group. Thus, students did not read the materials with the expectation of teaching, which might have influenced the results of the experiment, considering the role of expectancy in preparing-to-teach when it is combined with actually teaching (Hoogerheide et al., 2016; Kobayashi, 2019b; Lachner et al., 2022).

1.4. *Research gaps and aims of the study*

In view of the relevance of the audience throughout the learning-by-teaching framework, this study focuses on students' perception of potential audience in a cooperative learning project in which pairs of students create video-tutorials for a potential audience on the internet, as a way of learning by teaching. The social presence hypothesis of learning by teaching needs further exploration (Lachner et al., 2022). Prior studies that gathered students' perceptions of the audience generally focused on students' qualitative comments—only Jacob et al. (2021) quantitatively measured the self-reported degree of attention to the addressee. However, none of them have addressed how this attention to the audience can fluctuate throughout the video creation process. Moreover, only few studies have reported the consideration of the audience by examining students' video creation processes (Hoban & Nielsen, 2014; Nielsen & Hoban, 2015; Pirbhai-Illich et al., 2009), but these insights come from anecdotal rather than systematic, purposeful analyses. In this study, three aims are addressed to focus on how students creating a teaching material (i.e., an educational video) think about its addressee during the creation process:

- 1 To analyze students' self-reported perception of the potential audience in the video-tutorial creation process.
- 2 To analyze personal references in the video-tutorials as an indicator of perceived social presence.
- 3 To analyze students' verbal actions that refer to the audience in the pair interaction while creating the video-tutorial.

2. Method

2.1. Participants

In the school year 2018–2019, *Bikos Project* (Ribosa & Duran, 2021, 2022c) was implemented in two primary education schools from Catalonia. The schools were selected via convenience sampling, since they had previously participated in other projects from the research group. The school management teams were presented with the project and voluntarily chose to participate. A total of 44 sixth-grade students (i.e., 23 girls and 21 boys) took part in the project.

2.2. Description of the task

Students cooperatively worked in pairs to create a video-tutorial to answer a scientific question of their interest, with two complementary roles: responsible for content and responsible for technology. In a video-tutorial, which lasts for a maximum of 4 min, students answer a question they wonder about the world, guiding the audience's understanding by formulating prior knowledge questions at the beginning, comprehension questions during the video, and one global comprehension question at the end. Two support materials were given to help them structure their joint activity—a role guide and an activity sheet—, based on five stages to create the video-tutorial: 1) defining the inquiry question, where each pair of students formulates a question for their video, led by the responsible for content; 2) prior knowledge, where each member elaborates a conjectural answer to the question, without consulting information sources; 3) information searching, where students define key concepts, search, select, and contrast different sources, to elaborate a shared answer to the question; 4) script elaboration, where they write the video script, including the voice-over, the visual aids, and the questions for the potential audience; and 5) video production, where they generate the resources, technically edit the video, and add the interactive questions using an app, such as EDpuzzle. Two rounds of video-tutorial creation were carried out. Between the first and second round, the students' roles were exchanged, so that each student had the chance to address the question he or she was interested in, with the help of the partner. Each round lasted between 9 and 14 h of class. Video-tutorials are to be organized in a virtual space so that other potential students and schools have access to them.

2.3. Data collection and analysis

2.3.1. Students' self-reported perception of the potential audience

At the end of the project implementation—after the two creation rounds—, a questionnaire was administered to the students through an online form, which contained the following requirement: "Assess to what extent you thought of the people who are going to watch the video-tutorials in each stage of the *Bikos Project*". Before answering the questionnaire, students were asked whether they understood the statement, to make wording changes if necessary, and they were reminded what each stage referred to. In the questionnaire, students were asked to assess each stage in a 4-level Likert item, from 1 (Not at all) to 4 (To a great extent). Descriptive statistics were first reported. After significant results in the Shapiro-Wilk normality test (i.e., suggesting a deviation from normality), a related-samples Friedman's two-way analysis of variance by ranks was carried out. Pairwise comparisons with significance values adjusted by the Bonferroni correction for multiple tests were reported. The significance level was set at $p < .05$.

2.3.2. Personal references in the video-tutorials

The video tutorials were examined to identify personal references as an indicator of the perceived social presence. This approach has been used in prior learning-by-teaching studies (Jacob et al., 2020, 2021; Lachner et al., 2018). The number of first-person and second-person pronouns and determiners (e.g., I, me, my, mine, you, your, yours, we, us, our, ours) in Catalan and Spanish—the two languages students used in the task—were counted in the transcribed explanation from the video. Elided personal pronouns in elliptical clauses, which are typical in Catalan and Spanish, were identified by the verb form and counted as well if no other personal indicator had been found in that verb. It needs to be considered that students cooperatively created the videos in pairs, and each pair developed two videos exchanging the two roles. Descriptive statistics were reported. The percentage of personal references over the number of transcribed words was calculated, for the overall transcription and separating between the audiovisual component (i.e., voice-over and superimposed text) and the questioning component (i.e., questions and feedback for the potential audience). After significant results in the Shapiro-Wilk normality test (i.e., suggesting a deviation from normality), the Wilcoxon signed-rank test was used to compare both components. Pearson correlation coefficient was calculated between the two components. The significance level was set at $p < .05$.

2.3.3. Students' verbal actions that refer to the audience in the pair interaction

A sample of 8 students (i.e., 4 pairs) were audio recorded throughout all the creation process of the second video-tutorial, with informed consent from their parents. Purposeful sampling was used with the aim of selecting information-rich cases (Palinkas et al., 2015). Based on teachers' knowledge of the students, those pairs who were more prone to verbalize their ideas aloud were selected. Total time of recording is 47 h 37' 35". The audios were analyzed in Atlas.ti 22 by coding utterances based on the identification of keywords (e.g., audience, addressee, viewers, people) and unspecified personal pronouns (e.g., "he/she" or "they", but also "I" and "you" when adopting the addressee persona) referring to the potential audience. An utterance is defined as "a simple sentence, an independent clause, a nonrestrictive dependent clause, an element of a compound predicate, or a term of acknowledgement, evaluation or address" (Stiles, 1992, as cited in Reed et al., 2018, p. 212). A descriptive analysis was carried out by calculating absolute and relative

frequencies of utterances. To characterize these utterances, different analyses were carried out. First, the utterances were screened to recognize how many of them happened in the context of students creating comprehension questions for the audience. Second, they were examined to determine how many were task-based (i.e., referred to the video creation process or video features independently of the content of the question) and how many were content-based (i.e., referred to the content of the question). Third, focusing on content-based utterances, they were analyzed to identify how many evidenced knowledge building (i.e., utterances in which a student shows metacognitive monitoring or elaboration upon the source materials, or encourages his/her partner to do so). The two researchers coded the utterances independently, and cases of disagreement were discussed until consensus was reached.

3. Results

3.1. Students' self-reported perception

The perception of the potential audience reported by students is considerably high in all the stages (Fig. 1), especially in stage 5 (i.e., video production), which is also the stage that shows the lowest standard deviation ($M = 3.50$; $SD = 0.79$) compared to the other stages: stage 1 ($M = 2.91$; $SD = 0.94$), stage 2 ($M = 3.00$; $SD = 1.03$), stage 3 ($M = 3.02$; $SD = 0.95$), stage 4 ($M = 3.02$; $SD = 0.88$).

A related-samples Friedman's two-way analysis of variance by ranks revealed significant differences in terms of the distributions of the different stages ($p < .001$). Pairwise comparisons with significance values adjusted by the Bonferroni correction for multiple tests (Table 1) showed that the self-reported perception of the audience in stage 5 was significantly higher compared to stage 1 ($p = .007$), stage 3 ($p = .046$), and stage 4 ($p = .027$). When stage 5 was compared to stage 2, no significant differences were found after Bonferroni correction ($p = .167$). No other pairwise comparisons showed significant differences.

3.2. Personal references in the video-tutorials

From every 100 transcribed words, 2.23 are personal references: 1.73 in the audiovisual part and 2.91 in the question part. Given that according to the results of a Shapiro-Wilk test the data is not normally distributed, neither in the audiovisual part ($M = 1.48$; $SD = 1.94$; $W = 0.69$; $p < .001$) nor in the question part ($M = 3.30$; $SD = 3.48$; $W = 0.85$; $p < .001$), the Wilcoxon signed-rank test was used to compare them. The difference between the percentages of personal references in the audiovisual part and the question part is statistically significant ($MD = -7.47$; $W = 156$; $Z = -3.56$; $p < .001$). The percentage of personal references in the question part is found to be statistically higher than in the audiovisual part. There is a significant ($p = .005$) but moderate correlation ($r = 0.41$) between the percentages of personal references in the two parts.

3.3. Students' verbal actions in the pair interaction

The analysis of student interaction shows that stages 4 and 5 (i.e., script elaboration and video production, respectively) gather nearly all the verbal actions that explicitly refer to the audience of the video. In terms of relative frequency per hour of interaction, stage 4 (i.e., script elaboration) is salient (Table 2).

First, the analysis of the coded utterances shows that 75 out of 108 come from students working on the comprehension questions for the audience (i.e., creating the question and response options, and anticipating audience's answers and actions). Three examples are provided below.

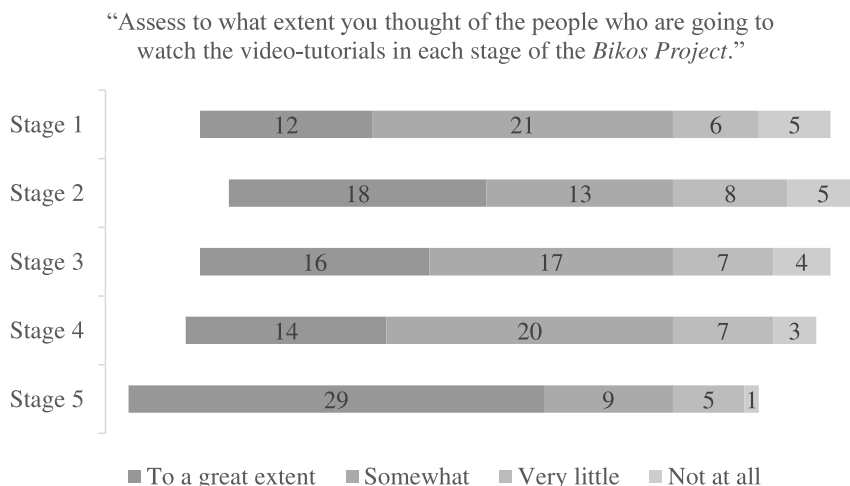


Fig. 1. Frequencies of answer for self-reported perception per video creation stage.

Table 1

Pairwise comparisons for related-samples Friedman’s two-way ANOVA by ranks regarding students’ self-reported perception of the audience in the video creation stages.

Sample 1–Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Stage1–Stage4	–0.136	.337	–0.405	.686	1.000
Stage1–Stage3	–0.193	.337	–0.573	.567	1.000
Stage1–Stage2	–0.341	.337	–1.011	.312	1.000
Stage1–Stage5	–1.148	.337	–3.405	.001	.007
Stage4–Stage3	.057	.337	.169	.866	1.000
Stage4–Stage2	.205	.337	.607	.544	1.000
Stage4–Stage5	–1.011	.337	–3.000	.003	.027
Stage3–Stage2	.148	.337	.438	.661	1.000
Stage3–Stage5	–0.955	.337	–2.832	.005	.046
Stage2–Stage5	–0.807	.337	–2.393	.017	.167

Note. Significance level was set at $p < .05$.

Table 2

Frequencies of utterances referring to the audience from student interaction.

	Stage 1		Stage 2		Stage 3		Stage 4		Stage 5		Total	
	f	f/h	f	f/h	f	f/h	f	f/h	f	f/h	f	f/h
Pair A	0	0.00	0	0.00	1	0.18	11	5.15	5	1.09	17	1.25
Pair B	1	1.90	0	0.00	1	0.54	11	5.41	23	4.98	36	3.84
Pair C	1	0.66	0	0.00	1	0.22	27	16.13	10	1.79	39	2.83
Pair D	0	0.00	0	0.00	0	0.00	4	2.22	12	2.96	16	1.46
Total	2	0.58	0	0.00	3	0.18	53	6.93	50	2.66	108	2.27

Note. f/h stands for relative frequency per hour of recording.

[talking about the different options in a multiple-choice question] I’m telling you people are not that stupid to say that a galaxy is a planet. (Pair A, stage 4)

[thinking of the focus for a comprehension question] Something that they know of light rays, right? Because we’re talking all the time about light rays or Rayleigh scattering. (Pair B, stage 4)

[talking about the different options in a multiple-choice question] If you click on [option] A, it would be right. (Pair D, stage 5)

Second, from the 108 utterances, 58 were task-based and 50 were content-based. As for task-based utterances, they mainly referred to question format and interaction with the app (i.e., EDpuzzle) that enabled its addition to the video (36 utterances). Few utterances referred to formal sentences directly addressed to the audience (10), who is going to or has already watched the video (7), and visual features of the video (5). One example for each kind of comment is provided below.

[talking about the app] That little box that they clicked, and it didn’t say anything, and there were groups that didn’t put it. So now we must do that. (Pair D, stage 4)

Sh... She’ll watch the video! [interrupted by the partner when explaining the answer to a classmate, who is a potential viewer] (Pair B, stage 4)

Whoever is watching it [a picture that is too big] will be overwhelmed. (Pair C, stage 5)

"Thank you very much for listening to our video." (Pair A, stage 4)

As for content-based utterances, 13 out of 50 indicate knowledge building. These knowledge-building utterances are provided below.

I know it is nearly in our words, but we must explain it in our words even more. How would we say it? If you explain it to your mother, or someone, whoever, how would you explain it? (Pair B, at the end of stage 3)

[after the partner suggest using another word for *inherent*] Yes, to understand it. Because if it is difficult for us, it will be more difficult for other people. (Pair C, at the end of stage 3)

What [questions] could we ask them? (Pair A, stage 4)

[talking about possible comprehension questions] Something that they know of light rays, right? Because we’re talking all the time about light rays or Rayleigh scattering. (Pair B, stage 4)

[talking about the feedback for the open comprehension question] We must change that, because it’s the same it tells you here... this, that is, it’s the same, the only thing is that it’s divided here, and not here. It’s the same, really. (Pair B, stage 4)

[talking about the answer options for a multiple-choice question] We can put something tricky, the rods, so that people get confused. (Pair C, stage 4)

Which questions would you ask yourself? (Pair C, stage 4)

You'd better not say that, because then they will think that the sun... maybe they think there are four reasons for the sun. (Pair B, stage 5)

"Act", let's write "act" instead, as the teacher said. Because if not you can get confused. (Pair B, stage 5)

It's already good for me. Let's see, if you hear... (Pair B, stage 5)

If you hear: "On color light Rayleigh scattering acts, which is in the atmosphere and eliminates the shorter wavelengths". (Pair B, stage 5)

What if we say: "On color light... We will tell you why it is color light later." (Pair B, stage 5)

[checking a comprehension question and a picture from the audiovisual explanation] They will get confused here, because in the picture it is actually a triangle. (Pair B, stage 5)

The other 37 content-based utterances were not coded as knowledge building. Three examples are provided below.

No, let's say that, okay? Then it gives them more information. (Pair A, stage 4)

[pretending to directly talk to the audience] "Or you don't know? Come on, what a fool." (Pair C, stage 4)

Oh! And it won't be noticed... And they will fail! [after the partner suggests misarticulating a word]. (Pair D, stage 4)

4. Discussion

The main aim of this article is to elaborate upon the social presence hypothesis for learning by teaching. There is evidence that even when the audience is not physically present being aware of the addressee and perceiving it as real can generate productive agency—the belief that our own actions can affect others (Hoogerheide et al., 2016; Schwartz & Okita, 2004). Students' self-reported perception of the audience was significantly higher in stage 5 (i.e., video production) compared to the other stages—although the difference with stage 2 (i.e., prior knowledge) was not significant after Bonferroni correction. It seems that the final stage of video creation process (i.e., in which students had to record the voice-over, insert pictures, upload the video to a virtual platform, and introduce the comprehension questions) boosted their feelings of social presence. The analysis of audio recordings from student interaction backs up this high level of perceived social presence in stage 5 (i.e., video production), but shows proportionally more explicit references to the audience in stage 4 (i.e., script elaboration), which had obtained a lower score in student self-reported perception. A mismatch between measures of feelings of social presence was already found in Jacob et al. (2021), who reported that an increase in the number of personal references in the explanation was not associated with higher self-reported social presence ratings.

Both the personal references in the video-tutorials and the analysis of student interaction suggest that comprehension questions for the audience play an important role in enhancing the feelings of social presence. The proportion of personal references in the question part of the video-tutorials is statistically higher than in the audiovisual part, and nearly three quarters of the explicit references to the audience throughout the creation process come from students working on these questions. Compared to the video explanation part, which is expository, the interactive nature of comprehension questions may lead students to think more about how the audience is going to engage with the teaching material. Online platforms that enable the creation and use of student-generated questions may play an important part in making question generation and answering more interactive (Yu, 2011). In this study, as illustrated by some task-based utterances from student interaction, the app that was used to introduce the questions within the video (i.e., EDpuzzle) provided the students with the opportunity to interact with the questions as the audience would do (e.g., see what happens when someone gets a question right or wrong).

The analysis of what students say in the knowledge-building utterances suggests that feelings of social presence can encourage them to reformulate the information, assessing the coherence of the explanations with the audience in mind. However, the limited number of knowledge-building utterances suggests that students do not make the most of knowledge-building opportunities when they think of the audience. In a review on peer tutoring, Roscoe and Chi (2007) found that tutors tended to summarize the source materials with little elaboration, despite the privileged situation that peer tutoring offers for knowledge building. In the video creation task that is analyzed in this article, the content-based utterances that explicitly refer to the audience but were not coded as knowledge building illustrate how students miss most of these opportunities (e.g., when creating the questions and response options, or anticipating the audience's answer). A prior study on *Bikos Project* found that most comprehension questions that students included in their video-tutorials showed a low level of complexity (Ribosa & Duran, 2021). This points to the need for scaffolding strategies (e.g., explicit instruction, models, questions stems), since inducing social presence may not be enough for eliciting elaboration and improving learning outcomes, as pointed out by Jacob et al. (2021).

All in all, this study provides two main contributions to the field of the audience effect in learning by non-interactive teaching. First, it shows that the attention to the audience can fluctuate throughout the non-interactive learning-by-teaching situation, as indicated by self-reported measures and student interaction throughout the process. If feelings of social presence are central to boosting productive agency (Hoogerheide et al., 2016; Schwartz & Okita, 2004), detecting when the perception of the audience decreases is paramount. It

seems that the initial stages of the video creation process, in which students prepare the content for later teaching, elicit less feelings of social presence than the later stages, in which students plan and create the video. Students' self-reported perception in stage 5 (i.e., video production) was backed up by the analysis of student interaction. However, stage 4 (i.e., script elaboration) proportionally gathered more explicit references to the audience, although students' self-reported perception was lower than in stage 5 (i.e., video production). The mismatch between the two measures (i.e., self-report and interaction analysis) poses some methodological issues that should be tackled in future studies. Self-reported perception of the audience in the different stages would better not be gathered at the end of the whole process, but at the end of each stage, considering the possible memory issues related to retrospective data collection. Moreover, researchers should consider the limitations of these measures to assess actual feelings of social presence. For instance, when analyzing student interaction in this study, the codification based on the identification of keywords and unspecified personal pronouns explicitly referring to the potential audience may have missed utterances in which students were thinking of the audience more implicitly (e.g., impersonal sentences in which they assess issues in the explanation). These and other measures, such as arousal levels via electrodermal activity (Hoogerheide et al., 2019), can be complementary and should be further explored.

As for the second contribution to the field, this study suggests that feelings of social presence have the potential to trigger elaboration, but students do not make the most of these opportunities. The qualitative evidence from students' verbal actions in the pair interaction may help explain why Jacob et al. (2021) found that inducing social presence might not necessarily improve learning outcomes. Further research is still needed to measure the effect of perceived social presence on the quality of the student-generated teaching materials and on student learning, especially considering some preliminary findings that suggest that too high levels of social presence may even be detrimental (Lachner et al., 2022). The kind of audience (e.g., real or imaginary) may play an important role. In this study, students were aware of a potential audience through the internet, because they were told that their videos would be uploaded to a virtual platform. Comprehension questions for the audience seem to play an important role in perceived social presence, likely due to their interactive nature. From the verbal actions in which they explicitly referred to the audience during the video creation process, it seems that having this kind of addressee in mind has the potential—although often not materialized—to trigger elaboration on the content. Having students work in pairs allowed to record and analyze their verbal actions, but not their thoughts. Future studies could make use of think-aloud protocols during learning-by-teaching tasks. The analysis of the process for creating the teaching material in non-interactive learning-by-teaching situations can provide further insights not only to the social presence hypothesis, but also to other potential mechanisms underlying the learning-by-teaching effect.

In a nutshell, the contributions of this study involve some practical implications for educational interventions. The findings suggest that the role of the audience in non-interactive learning-by-teaching situations is complex, not only because its perception fluctuates through the process, but also because students' verbal actions show a bias towards not using audience perception to trigger elaboration. Thus, educational interventions based on learning by non-interactive teaching seem to require scaffolding to support students' optimal feelings of social presence throughout the creation process, especially in the first stages that involve preparing-to-teach rather than the creation of the teaching material itself. For instance, in the script elaboration stage, having students generate questions for the audience seemed to play a very important role in their feelings of social presence. This kind of tasks that foster student thinking of the features of their intended audience might be useful. It is likely that progressing towards less imaginary and more real audiences (e.g., younger or future students, same-age students from other schools, families) can help students have a more precise mental representation of the features of their audience when creating the teaching material. The main challenge has to do with achieving that these tasks where students are encouraged to think of the audience are not only useful for generating feelings of social presence, but also for offering opportunities to adjust the explanation to the features of the audience (e.g., using different words or providing appropriate examples) and thus trigger elaboration.

5. Conclusions

Social presence has been postulated as one of the potential underlying mechanisms of learning by teaching (Lachner et al., 2022). The purpose of the study was to further explore this view, elaborating upon the hypothesis by analyzing three proxy measures of students' feelings of social presence: self-reported perception, personal references in the video-tutorials, and verbal actions referring to the audience in the creation process. First, self-reported perception was high, especially in video production. Second, 2.23% of words were personal references, with differences between explanation (1.73%) and questions (2.91%). Third, script elaboration and video production gathered most audience-based verbal actions (108 utterances): 76 came from the question part; 58 were task-based and 50 were content-based; 13 indicated knowledge building. Two main contributions were underlined. First, it seems that the attention to the audience can fluctuate throughout the non-interactive learning-by-teaching situation. Second, feelings of social presence have the potential to trigger elaboration, but students do not make the most of these opportunities. Both personal references in the video-tutorials and audience-based verbal actions throughout the creation process indicated that having students create comprehension questions for the audience plays an important role in inducing feelings of social presence. Further research is needed both to quantitatively measure the effect of feelings of social presence on the quality of explanations and learning, and to qualitatively examine the role of the audience throughout the creation process of teaching materials in non-interactive learning-by-teaching situations.

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Declarations of Competing Interest

None.

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