Exploring the Framing Effect of Drawing Task Instructions on Science-Major Novice Preservice Teachers' Technology-use Knowledge

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Abstract: Digital technology-assisted teaching and learning is a trend in schools at all levels around the world, and beliefs about technology use are one of the predictors to see if, and to what extent, teachers would adopt technology in their classes. In the field of educational research, drawing tasks are one of the potential research tools that have been shown to reflect participants' educational beliefs. We propose that the instructions for a drawing task would frame participants' thinking, as it is difficult for participants to depict images outside the direction of instruction. In the current study, 44 science-majors entering preservice teachers were recruited, and a two-round drawing task along with a random-assigned experimental design were introduced to evaluate this hypothesis. The instruction of the first-round drawing was used to disrupt the framing effect of the instruction of the second-round drawing by activating the participants' target knowledge. The results indicated that the participants depicted more images of technology use in the second-round drawing after their technology knowledge had been activated, but the pedagogical theme was not significant. Methodological, theoretical, and practical implications of the results are discussed.

Keywords: digital technology-assisted teaching and learning, beliefs about technology use, a drawing task, framing effect, preservice teachers

1. Introduction

Digital technology-assisted teaching and learning is a trend in schools at all levels around the world, as it can not only make teachers' teaching more varied and effective, but students' learning can also be more profound due to the multi-modality characteristic of digital technology (e.g., Ertmer et al., 2015). In addition to research on how meaningful, effective, and efficient digital technology helps teachers' teaching and students' learning, researchers have also established theoretical frameworks to measure teachers' understanding and capabilities, such as TPACK (Mishra & Koehler, 2006). In another line of research, researchers are interested in beliefs about digital technology use and the relationship between technology-use beliefs and instructional effectiveness (Ertmer et al., 2015). Moreover, it has been shown that beliefs held by preservice teachers would influence their learning of how to teach in teacher education programs (Richardson, 2003).

Different terms have been alternatively adopted, such as beliefs (e.g., Ertmer et al., 2012), conceptions (e.g., Yeh et al., 2019), perceptions (e.g., Inaltekin, 2020; Minor et al., 2002), and knowledge (Mishra & Koehler, 2006) to represent the thoughts about technology-assisted teaching and learning. These terms tend to be used alternatively as the needed, but beliefs are used primarily in the current study since it is the most frequently used term to express teachers' thoughts about technology in drawing-based research.

Teachers' beliefs are defined as teachers' mental constructs, propositions, or premises about teaching issues (Richardson, 2003). One of the functions of educational beliefs is to serve as a filter for teachers to deal with educational issues or information they encounter (Skott, 2015), which in turn would affect how well, deeply, or creatively they adapt technology to their teaching practices (Ertmer et al., 2015). Furthermore, it has been argued that beliefs about technology use are one of the predictors of whether teachers adopt technology in their classes (Hermans et al., 2008; Hew & Brush, 2007), and it can be adjusted by teacher education programs (e.g., Funkhouser & Mouza, 2013).

To assess teachers' beliefs, drawing tasks are a relatively new yet potential method (Chang et al., 2020). Besides, it has been proven that drawing can reflect the drawers' concepts, knowledge, or beliefs about things researchers would like to know (e.g., Elmas et al., 2011). A drawing task can bypass the condition in which subjects find it difficult to express themselves verbally or orally (Schraw & Olafson, 2015). Although there has been an increase in the number of drawing studies on preservice science teachers' beliefs about science teaching (e.g., Alkış Küçükaydın & Gökbulut, 2020; Minogue, 2010; Tatar, 2015) and on preservice teachers' beliefs about technology use (e.g., Funkhouser & Mouza, 2013), research on novice preservice science teachers' beliefs about digital technology integrated into science teaching that uses drawing as a form of assessment is still in its infancy. A recent and relevant study was conducted by Lin (2022). The researcher found that, as revealed by their drawings, the preservice mathematics teacher participants in his study seldom used technology as pedagogical tools. However, the results of Funkhouser and Mouza's (2013) study showed that preservice teachers had beliefs about teacher-centered technology use. The reason why the results of these two studies seem contradictory may have been due to different drawing instructions. Lin's drawing instructions (Lin, 2022) did not ask the participants to depict technology integrated into their teaching directly, i.e., "what are you doing in the mathematics classroom?", but the instructions in some other studies did (e.g., Funkhouser & Mouza, 2013; Yeh et al., 2019). There is a parsimonious explanation why the participants in Lin's study seldom depicted technology in their drawings, which is that they merely did not think of it due to the framing effect (e.g., Kahneman, 2011) derived from the instructions of the drawing task. According to this argument, it is plausible to infer that, in the situation where the drawing instructions do not direct participants to depict technology images, as in Lin's study, participants would not depict technology images in their drawings unless their technology-relevant knowledge is activated. In the current study, therefore, a two-round drawing task were adapted to investigate whether there was a framing effect in a drawing instruction and how to disrupt it.

2. Methodology

2.1 Participants

A total of 44 (21 female, 23 male) science-major sophomores at a normal university in southern Taiwan, who were enrolled in and had begun educational programs, were recruited in this research. Of the 44 participants, 14, 15 and 15 had majored in chemistry, biotechnology, and physics, respectively. In the coding period, it was found that one drawing in each group was irrelevant to the theme of the drawing task and so was removed from the data set.

2.2 Research Design

A two-round drawing task along with a random-assigned experimental design were adapted to investigate the hypothesis described above. The drawing task was conducted in groups at the end of the "Introduction to Education" course in the 2022-2023 academic year. The drawing time was unlimited. There were two groups in our study, the Technology group and the Experience group. Participants were divided into two groups and were asked to complete two drawings. They were randomly assigned to each group, and the assignment was counter-balanced based on participants' gender and departments. The drawing instructions of the two groups in the first-round drawing task were different. The first drawing instruction for the Technology group played a role in disrupting the framing effect derived from the second-drawing instruction and was: “Please try to imagine the scene where technology or digital technology is integrated into a science course and try to depict it.”; in contrast, the first drawing instruction for the Experience group was: “Please try to recall the most impressive science course you attended in your high school and try to depict it.”, which was a controlled treatment.

Participants were asked to raise their hand when they finished the first drawing, and the researcher would deliver the second drawing paper to them. The instruction for the second drawing task was the same for the two groups: “Please try to imagine what you will do in a science course if you are a science teacher and try to depict it.” The second-drawing instruction played a role of framing effect on both groups because there were no words about technology in the instruction of the second drawing for both groups, and it was expected that participants whose technology knowledge was not activated, i.e., the Experience group, would depict less technology items in their drawings than those in the Technology group. See Figure 1 as an illustration of the research design.

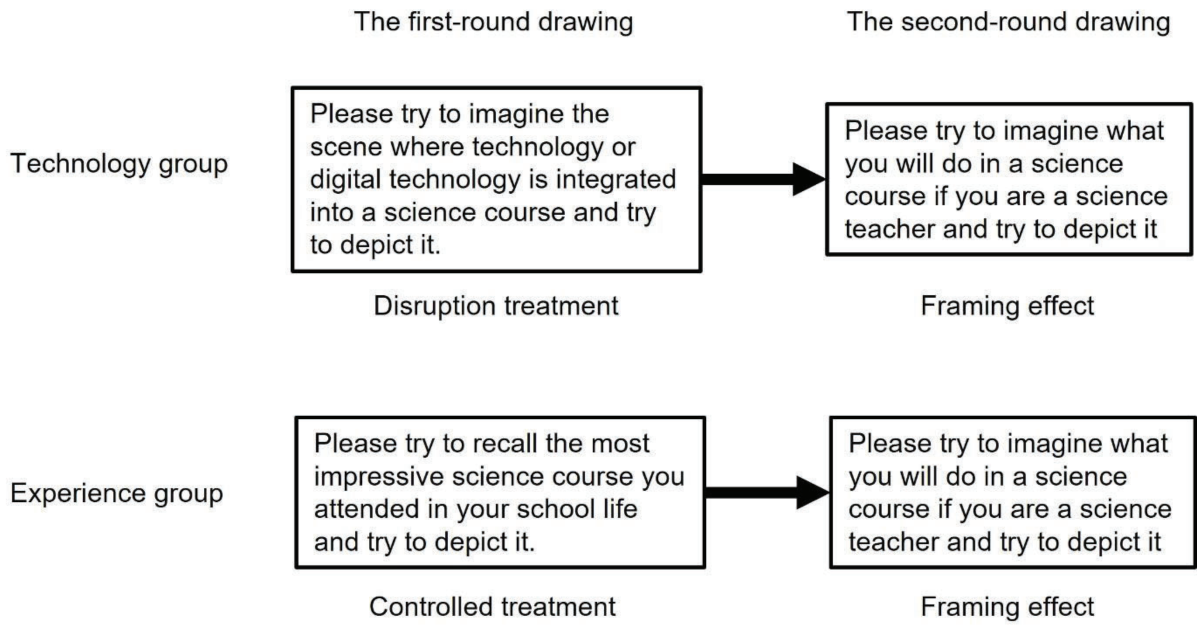

Figure 1. The research design of the current study. Square frames show the instructions in the two drawing situations where there are different instructions in the first-round drawing but the same in the second round.

2.3 Data analysis

There were three different types of information we attempted to extract from the drawing data. The first index was how many types of technology items were displayed in the second-round drawing in each group, which was to evaluate if our treatment in the first-round drawing worked. Statistically, to evaluate the difference between the Technology group and the Experience group in terms of how many technology items were depicted in the second-round drawing, the Mann-Whitney *U* Test was utilized.

To echo the definition of technology-use belief (e.g., Ertmer et al., 2015) or technology knowledge from TPACK (Mishra & Koehler, 2006), how many participants depicted images of technology use in the second-round drawing is applied as the second index. The definition of technology use in the current study is that teachers or students were depicted by the participants as using technology or digital technology to teach or learn. For example, a teacher uses an interactive whiteboard to present physics equations in a class, or students wear AR devices to experience the learning content. If a participant expresses such images described above in the second drawing, then the code for this participant would be 1; if not, then the code would be 0 (see Fig. 2 for an example). Accordingly, a chi-square test of independence is performed to examine the relation between groups and numbers of participants depicting technology use in the second-round drawing.

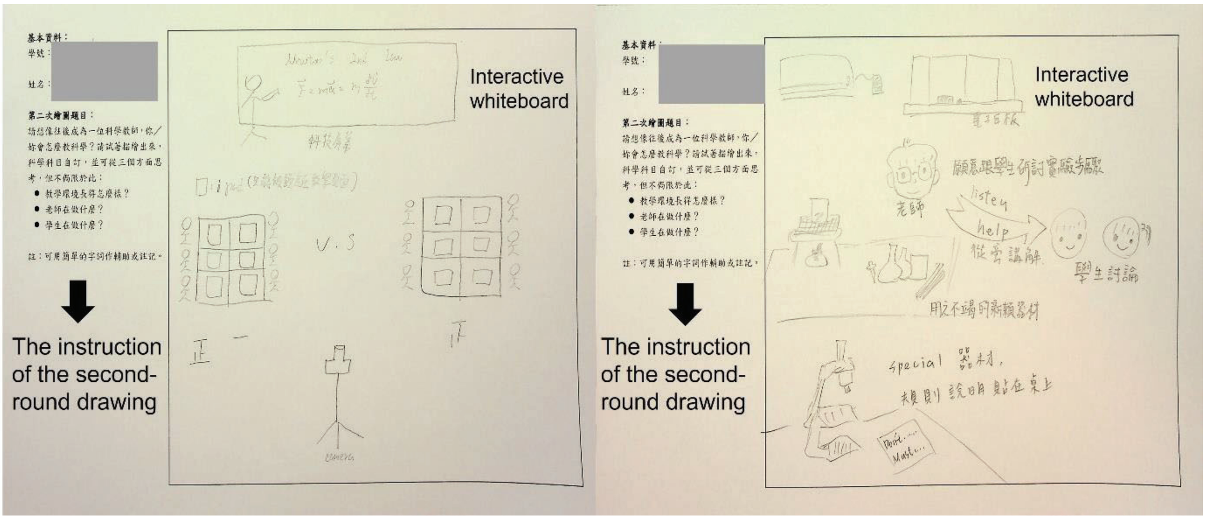

Figure 2. Examples of whether characters in the second drawings used technology in the class. Two drawings by different participants are depicted. In the left-hand drawing, because a teacher is using an interactive whiteboard (IWB) to present a physics equation, the code of technology use in this drawing would be 1. On the contrary, although an IWB is shown in the right-hand drawing, the teacher and students are discussing the steps of experiments without using IWB, and nor is there any information on the IWB. The code of technology use in this drawing would therefore be 0.

In the third index, we examined, at the within-subject level, whether the pedagogical theme displayed in the second-round drawing resembled the first-round drawing by utilizing a chi-square test of independence. The coding rule is as follows. One participant, for example, depicted a teacher-centered pedagogical theme in the first-round drawing and depicted a student-centered pedagogical theme in the second-round drawing, then the code for this participant would be 0, which means non-match of pedagogical belief for this participant; on the other hand, if what a participant depicted in both the first- and second-drawing is, say, a student-centered pedagogical theme, then the code for this participant would be 1, meaning there was a match in pedagogical belief for this participant. The three indices were coded by the two independent coders as well. When inconsistency was found, the two coders with the senior coder would negotiate to reach a consensus.

3. Results

3.1 Is there a significant difference in the numbers of technology items depicted in the second-round drawings of the Technology group and the Experience group?

The test revealed significant differences in number of technology items depicted by the Technology group (Median = 1, n = 22) and the Experience group (Median = 0, n = 20), U = 293.000, z = 2.048, p = .041, and r = .316, meaning that the effect size of the result was medium. The result indicated that the Technology group depicted more types of technology items in the second-round drawing than the Experience group.

3.2 Is there a significant difference in the number of participants in the Technology group and the Experience group who depicted technology-use images in the second-round drawing?

As for technology use, the result of a X^2 test indicated that the relation between groups and numbers of the participants who depicted technology-use images in the second-round drawing was significant, Pearson's X^2 (1, N = 42) = 5.301, $p < .05$ ($p = .021$), meaning that more participants in the Technology group depicted technology-use images than those in the Experience group. The cross tabulation is shown in Table 1.

Table 1. *Cross tabulation of the relation between groups and numbers of technology use displayed in the second-round drawings.*

	Technology use	No Technology use	Total
Tech group	12	10	22
Exp group	4	16	20
Total	16	26	42

3.3 Is there a significant difference in the number of participants in the Technology group and the Experience group who depicted similar pedagogical themes in both the first-round and second-round drawings?

As for pedagogical beliefs, the result of a X^2 test indicated that the relation between groups and numbers of participants who depicted similarity of pedagogical theme in the first- and second-round drawing was not significant, Pearson's X^2 (1, N = 42) = 0.105, $p > .05$. In other words, the similarity of pedagogical belief in the first- and second-round drawings did not differ by groups. The cross tabulation is shown in Table 2.

Table 2. *Cross tabulation of the relation between groups and similarity of pedagogical theme in the first- and second-round drawings.*

	Congruent	Incongruent	Total
Tech group	11	11	22
Exp group	9	11	20
Total	20	22	42

4. Discussion and Implications

In the next section, three issue are discussed, the methodological, theoretical, and practical implications.

4.1 Methodological Implications

As the 3.1 result shows, when their technology knowledge was activated by the instruction of the first-round drawing, the Technology group would depict more technology items in the second-round drawing than the Experience group whose technology knowledge was not activated, which means that, in the Experience group, the instruction of the second-round drawing would frame the participants' thoughts; in the Technology group, however, the instruction of the first-round drawing help the participants disrupt this framing effect.

Hence, when utilizing a drawing task to investigate preservice teachers' technology-use beliefs, researchers should make the content of drawing instructions pertinent to research questions and interpret the results of a drawing task with caution since instructions of a drawing task would frame subjects' thoughts. If the content of drawing instruction must be neutral because of the research needed, making positive interpretations is recommended; yet if negative interpretations are necessary, it is suggested to use the two-round drawing task to decrease possible confounding. There is an exemplar in the Technology group (see Fig. 3). The participant did not depict technology-use images in their second-round drawing even when their technology knowledge had been activated in the first-round drawing. In this scenario, we could be more confident in inferring negatively that this participant thinks that they need not use technology or digital technology to assist their classes since we had activated their technology knowledge in the first-round drawing.

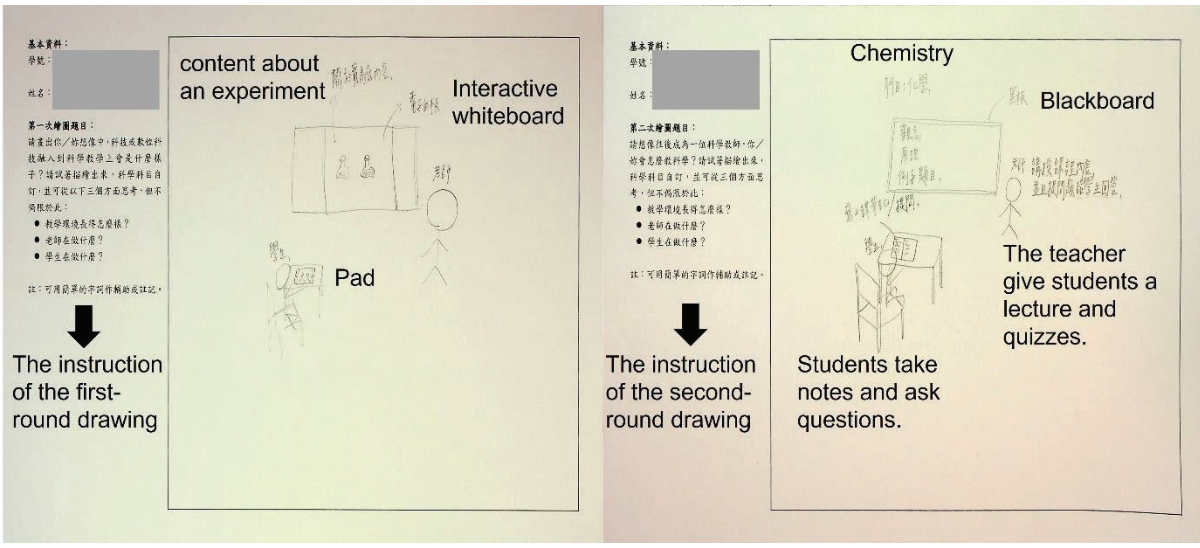

Figure 2. Exemplar drawings of the Technology group. These two drawings were produced by the same participant. The participant depicted what s/he thinks about technology or digital technology integrated into a science course in their first-round drawing and depicted what s/he will do in their science courses in their second-round drawing. This participant depicted technology-use images in the first-round drawing but not in the second-round drawing. We can confidently infer that s/he did not think that it is necessary to use technology in the science course.

4.2 Theoretical Implications

As noted in the Introduction, Skott (2015) argued that teachers would use their educational beliefs to deal with educational issues or information they encountered, like a knowledge filter. Similarly, Richardson (2003) clarified the definitions of beliefs and knowledge by proposing that beliefs are thought to be subjectively true for the individual, whereas knowledge is not. For example, educational philosophy of pedagogy, like traditional lecturing and student-centered constructivism are usually demonstrated in educational textbooks. For novice preservice student teachers, the pedagogical philosophy is a kind of knowledge, but when preference is involved, if the individual prefers the pedagogy of constructivism to traditional pedagogy, it becomes a belief for them. By applying the belief-as-a-filter theory to explain the result in 3.2, it looked as if the preservice teachers whose technology knowledge was activated had let the activated knowledge flow into their second-round drawing compared to those whose technology knowledge was not activated. It seemed that what digital technology assisted in teaching and learning means to the preservice teachers is a kind of knowledge not beliefs.

On the other hand, it is reasonable to expect the 3.3 result that pedagogical belief displayed in both the first- and second- round drawings would be more consistent in the Experience group, in which the participants' pedagogical memory had been activated than the Technology group, as with the result in 3.2. It was, however, not the case. No more participants in the Experience group depicted similar pedagogical scenes in both the first- and second-round drawing than those in the Technology group. It seemed that the Experience group would not totally accept the pedagogical information or memory activated by the instruction of the first-round drawing. That is, they might depict the images about pedagogy based on their educational beliefs regardless of the activated pedagogical memory. Thus, what images of pedagogy depicted by participants in the Experience group reflected would be their beliefs about pedagogy.

4.3 Practical Implications

Taiwan Ministry of Education (2023) has been cultivating the project of digital technology integrated into teaching and learning for about thirty years. The result of the current study echoes the project and would provide a way to promote in practice. In some traditional classrooms, there are less, even no, digital-technology devices for a teacher and students to use, which can be seen as a framing effect of a classroom. Similarly, Ertmer (1999) also argued that lack of access digital technology is an external barrier for teachers to integrate digital technology into their classroom. As it can be seen in the current study, the participants whose technology-use knowledge were activated would depict more technology-use images than those who were not. It implied that we could and should establish a sound digital-technology-use environment for teachers and students. As noted in Wood (2019), preference is for what people are used to seeing, which also called mere exposure effect. As long as teachers and students are getting familiar to digital technology embedded in their classroom, they would be inclined to utilize it to teach and learn.

5. Conclusion and Future Study

To the best of our knowledge, our study is one of the pioneers in utilizing a two-round drawing task along with a random-assigned experiment design to investigate beliefs or knowledge about technology-assisted teaching and learning. One of the advantages of this research design is that it can provide empirical data to refine the theory of educational beliefs, which might still be the subject of philosophical debates (e.g., Richardson, 2003). Work on two-round drawing tasks has, however, just begun; further cultivation is required. For instance, when it comes to beliefs about technology-assisted teaching and learning, it would be interesting to make a comparison of preservice and in-service teachers to uncover if there are indeed different levels of these beliefs since in-service teachers may build their beliefs about technology-assisted teaching and learning through teaching experience, which preservice teachers do not yet have.

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