THE ROLE OF EMOTIONS IN SIMULATIONS OF PRACTICE

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Technology-mediated simulations of teaching practice are becoming a more common way to introduce teachers to the dilemmas of teaching during professional development. In this paper, we show that the inclusion of markers of student emotions in cartoon-based scenarios of teaching changes teachers' appropriateness rating of the actions that the teacher took in the storyboard. Our results show that the inclusion of markers of student emotions in representations of practice could cue teachers into a particular judgments of action.

Keywords: Instructional activities and practices; Affect, Emotions, Beliefs, and Attitudes; Technology

Computer-based virtual environments, using avatars to represent students, have grown in popularity in both teacher education and educational research (Gibson, 2007; Herbst, Chazan, Chen, Chieu, & Weiss 2011; Ma et al., 2016; Straub, Dieker, Hynes, & Hughes, 2014). While such environments have been used to engage teachers in the cognitive and rational aspects of teaching, they are not frequently used to elicit teachers' reasoning related to more affective aspects of teaching (Lehtonen, Page, Miloseva, & Thorsteinsson, 2008). However, similar technology, using avatars in virtual environments, have been shown to be effective in helping individuals gain increased understandings of social situations (e.g. Cheng & Ye, 2010; Tettegah, 2005). This suggests the potential for such environments for supporting teachers' engagement with the more emotional aspects of teaching.

This is good news, given that emotions arguably play an important role in teachers' decision making (Demetriou, Wilson, & Winterbottom, 2009; Hargreaves, 1998; Zembylas, 2005). For some time now, we have known that emotional intelligence —the ability to perceive one's own emotional state—has evident value in professional circumstances (e.g. Jaeger, 2003; Lopes et al., 2006), including playing an important role in teacher's job satisfaction and organizational commitment (Naderi Anari, 2012). Beyond the many studies on teacher's emotional intelligence, there is reason to believe that the broader construct of emotional competence—the ability to recognize and understand the emotions of others—may be highly related to improved outcomes for student learning (Jennings & Greenburg, 2009). This hypothesis seems reasonable in light of recent findings that the relational aspects of teaching are as important as the cognitive aspects for student outcomes (Battey & Neal, 2018). Knowing how teachers' emotional competence shapes their work is particularly important given they often have to know what people are feeling without having to directly probe them to report their feelings—e.g., reading students' emotions when in the midst of teaching. However, learning to effectively read facial expressions is non-trivial and particularly challenging during instructional transactions where there exists a power differential between the individuals, as is the case with teachers and students (Galinsky, Gruenfeld, & Magee, 2003). Yet, little work in the field has aimed to gauge or support teachers in gaining such competencies (Hargreaves, 1998).

We see the work we describe in this paper as adding to this literature about the role of emotions, in particular teachers' emotional competence, in teaching. We have been designing

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scenario-based assessments to understand teachers' reasoning about mathematics instruction. In that work, we have been cautious about using facial expressions because of our own lack of certainty about how facial expressions might impact the ways in which participants' judge the instructional actions represented within such items. More specifically, we have been uncertain whether the addition of facial expressions might bias the items for individuals more capable of reading facial expressions (in both human faces as well as within cartoon representations). In that context, we have been wondering whether and how emotions represented on cartoon-based representations of students in classroom scenarios of practice play a role in the ways that teachers appraise the scenarios of teaching.

Theoretical Framework

Digital simulations of teaching use a variety of semiotic resources to represent the individuals and settings of practice. Icons, language, and dashboards (e.g., in SimSchool, Gibson, 2007) are three kinds of semiotic resources frequently used for students to respond to instruction, but for each of those a limited variety of systems of choice are available. Herbst et al. (2011) argue that graphic representations of teaching practice using two-dimensional, nondescript icons to represent teacher and students can display nonverbal aspects of teaching practice. They argue that comic-based representations can represent the same meaning as, for example, textual accounts of practice. Herbst and Chazan (2015) suggest that ***lean***, ***nondescript*** graphic elements allow the designer to easily represent practice as emergent in mathematics classroom interactions and enable viewers to project into those characters their own settings and clients—in contrast with avatars whose graphical features are used to mark high individuality. In a follow-up study, Herbst, Boileau, Clark, Milewski, Chieu, Gürsel, and Chazan (2017) show that this lean cartoon-based semiotic system can be expanded to include signifiers for complex social constructs such as race and ethnicity. In their comparison of the written story and the storyboard for the Case of Mya (Chazan, Herbst, & Clark, 2016), Herbst et al. (2017) conclude that the storyboard representation encouraged a plurality of interpretations of the same case, both expected and unexpected.

Following this line of inquiry, our lab has begun exploring whether emotions can be encoded using a similarly lean semiotic system when representing professional scenarios of teaching. One crucial foundation for that work is the well-established line of research from Ekman and colleagues who developed the facial action coding system (FACS) (Ekman & Friesen, 1978)—an analytic scheme for precisely describing various configurations of human faces as functions of muscle movements. The FACS has made possible the cataloging of human facial expressions for reliably representing human emotion interpretable by humans across cultural boundaries (Ekman & Friesen, 1986). The reliable interpretation of emotions based on facial expression representations suggests that the ability to interpret facial expressions is an important aspect of emotional intelligence (Keltner, Sauter, Tracy, Cowen, 2019). The FACS has also been used to inform the development of animated and cartoon facial expressions (McCloud, 2006; Thórisson, 1996; Spindler & Fadrus, 2009).

In this paper, we leverage the FACS to modify the default expressions of a set of cartoon characters we call the Thexpians B (Herbst & Chieu, 2011) to include lean semiotic markers of emotions (Dimmel, Milewski, & Herbst, 2015). For example, Figure 1 shows the affordances of the facial expression semiotic system to represent student emotions. In both panels of Figure 1, a student disagrees with a peer who has critiqued his shared solution. In the left panel, the student's eyes and mouth express a neutral state. In the right panel, we added to the eyes

triangular-shaped eyebrows that slope inward and changed the shape of his mouth from round to triangular to represent the emotional state of anger. These changes are meant to communicate the emotions associated with that specific moment.

In previous work, we have compared these kinds of lean renderings of facial expressions with that of facial expressions as represented by human actors and demonstrated that participants are, in fact, able to interpret the cartoon-based representations of emotion with similar levels of accuracy to that of photos (see Dimmel et al., 2015). Here, we build on that work to ask how the addition of such expressions into scenarios of teaching make a difference for participants' judgment of the instructional actions taken within such scenarios. To that end, we ask: To *what extent* and *how* does the representation of emotions on student avatars in a cartoon-based representation of practice change the way that practicing teachers judge the appropriateness of instructional actions of teacher avatars?

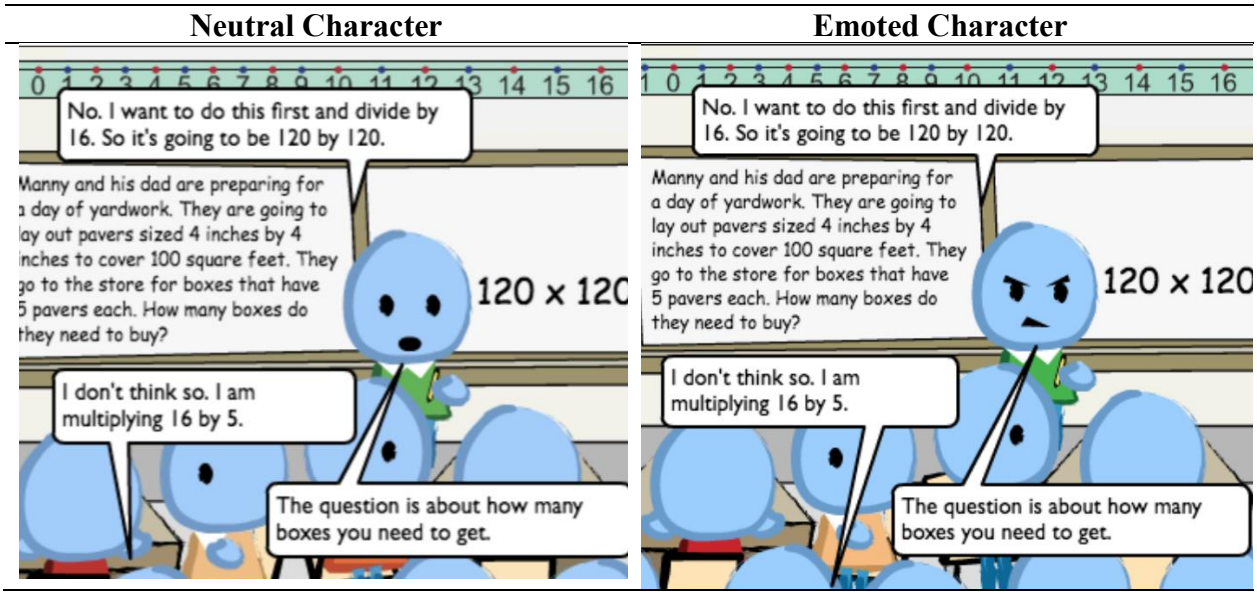

Figure 1: Neutral and Emoted Characters

Methods

Participants

In this study, we use a randomized control trial design to assess the extent to which representations of emotions impact teacher interpretations of scenarios of teaching. We recruited 69 participants from the respondent pool for the validation study of the PROSE instrument (Herbst & Ko, 2018). We randomly assigned participants to either the emoted or neutral experimental conditions. For the emoted condition, we edited the original PROSE items to include relevant facial expressions at the scenario turning point (as shown on the right pane of Figure 1). For the neutral condition, we removed all facial expressions from the original PROSE items. Instead, we represented all characters in the scenario using the neutral eye and mouth shapes (as shown on the left pane of Figure 1). Intuitively, comparing the responses to the emoted and neutral scenarios allows us to assess the extent to which the explicit representation of facial expressions in scenarios of teaching has an impact on teachers' interpretation of instructional actions.

Outcomes

The main outcome for this study is teachers' reactions to scenarios of instruction. To this end, we adapt the PROSE instrument (Herbst & Ko, 2018) to include facial expressions. The main outcome of interest of the unadapted PROSE instrument is teachers' recognition of professional obligations as a source of justification of instructional actions. In that instrument, teachers are asked to assess the extent to which a teacher instructional action was justified on the grounds of professional obligations (Herbst & Chazan, 2012). In the adaptation of this instrument to our study, we selected nine items[1] from the overall battery of twenty-four PROSE items for two possible reasons. First, following Milewski and Erickson (2015), we located items where a sizable number of participants indicated that their rating of the item depended on some assumptions they needed to make about the scenarios—we call these *high construal items*. We scanned teachers' responses to high construal items to locate items for which participants professed needing more information about the emotions of the student avatars—we call these *high emotional construal items*. For example, participants indicated their rating depended on whether or not a student in the scenario was upset. Accompanying these responses, we also found many participants that assumed that the represented student was in fact upset (even though the expression on the student's face was neutral in the item). That said, not all responses contained references to emotion and presumably some participants did not construe emotion into the item and thus the inclusion of emotional cues into the item might alter the way that participants respond to the item. Using this heuristic, we located seven items for inclusion in the study. Second, some items in the original PROSE instrument included some facial expressions which participants could have interpreted as emotions. We call these items *PROSE emoted items* and for the purposes of this study selected two such items. For all of these items, either the data or the original design of the item led us to believe that emotion may have been part of the way that participants were reasoning about their judgments. Our main outcome of interest with these adapted items from the PROSE instrument was to understand more about how the inclusion of facial expressions as markers of emotion was affecting the ways in which participants' rated the items. Figure 2 reports a brief synopsis of each item and whether it was selected for its high emotional construal or PROSE emoted items.

Participants also completed an emotion recognition questionnaire (Keltner et al., 2019). This instrument shows participants photographs of trained actors displaying emoted facial expressions and asks participants to identify the corresponding emotion. We also administered a parallel version of this instrument (developed by Dimmel et al, 2015) that uses our cartoon characters—using cartoon-based shapes for eyes, eyebrows, and mouth as well as changing their location in relation of the overall face to reproduce the facial expressions in the photographs. These two instruments allowed us to measure the extent to which our participants are able to recognize emotions in both photographs and cartoons. We use this information as a robustness check of our results.

Table 1: Description of Selected PROSE Items

Item	Description	Type
a1012	A/n (embarrassed) student shares a solution to a problem on the board. The teacher asks others to build on that solution strategy.	High Construal

[1] One item was removed from these analyses because of a mistype in the question prompt.

a3012	A student is sharing her/his solution on the board. Another student in the classroom suggests another solution strategy and the student at the board responds (with anger). The teacher compliments the students handling the disagreement.	High Construal
a3022	The teacher is asking questions to the class. One student answers all the questions, while other (frustrated) students look on. The teacher calls on students by pulling names from a cup.	High Construal
a3032	A (confused) student privately asks the teacher a question. The teacher asks the student to ask the question out loud to the class.	High Construal
a3102	A student tells the teacher that she/he is done with her work. The teacher asks her/him to help other students instead of working on the homework and she/he (begrudgingly) complies.	High Construal
a3112	A teacher ignores volunteering students to cold-call a (confused) student to publicly share a definition of a term.	High Construal
a3152	A student is solving a problem on the board. The teacher asks her/him to start over because other (frustrated) students cannot read the writing.	High Construal
a3162	Teacher offers magnets to (excited) students. When many students volunteer, the teacher decides to raffle the magnets.	Emoted PROSE

Analysis

Our data is nested both within respondent and item. That is, we asked the same participants to answer multiple items. As we are interested in the effect of facial expressions on the overall evaluation of the instructional action, we use a multilevel linear model to account for the nesting of responses within participants and items. In detail, we use a mixed effects model (Raudenbush & Bryk, 2002) with crossed participant and item random effects. We fit the equation

$$Y_{pi} = \beta_0 + \beta_1 \cdot Emoted_{pi} + u_p + u_i + e_{pi}$$

where u_p is the participant-level random effect accounts for participant-level differences in the assessment of the instructional action that is unrelated to our experimental condition, u_i is the item-level random effect accounts for item-specific differences in the assessment of the instructional action that are due to contextual factors embedded in the specific PROSE instrument. The coefficient of interest is β_1. This coefficient estimates the causal effect of including facial expressions (i.e., the difference between seeing an emoted item versus a neutral item) on participant assessment of the instructional action represented in the PROSE items.

Results

Effect of Emotions on the Assessment of Instructional Actions

Table 1 reports the estimates of the effect of facial expressions on teachers' assessment of instructional actions. Column 1 reports the results of the unconstrained mixed effects model, column 2 reports the effect on the raw assessment score (1-6 Likert scale), column 3 reports the same effect in standard deviation units. Columns 4 and 5 report the results of robustness checks testing whether our main results are sensitive to participants' recognition of emotions in photographs or cartoons.

We find that the inclusion of facial expressions in scenarios of teaching has an impact on teachers' assessment of instructional actions of, on average and in absolute value, 0.356 points on a 1-6 Likert scale or 0.280 standard deviation units. This result appears to be robust against participants' recognition of emotions in photographs or cartoons. That is, the magnitude of the effect does not change after controlling for participants' emotion recognition in photographs and cartoon images. This allows us to conclude that participants' change in their assessment of the instructional actions in emoted items is due to the emotions that are represented in the characters facial expressions. If this was not the case, we would observe a change in the estimated effect once controlling for participants' emotion recognition.

Table 2: Average Effect of Facial Expressions on the Assessment of Instructional Actions

	(1) Unconditional	(2) Pooled	(3) STD	(4) STD + Cartoon Rec	(5) STD + Photo Rec
Emoted		0.356**	0.260**	0.262**	0.267***
		(0.111)	(0.081)	(0.082)	(0.081)
Constant	1.798***	1.583***	0.000*	0.022	0.121
	(0.239)	(0.247)	(0.063)	(0.185)	(0.213)
Var(Resp)	0.014	0.000	0.000	0.000	0.000
Var(Item)	0.430	0.430	0.000	0.000	0.000
Var(Residual)	1.633	1.617	0.844	0.841	0.840
Observations	544	544	544	544	544

Note. The unconditional model reports the results of a cross-effect mixed model that controls fro respondent- and item-level variance components. Pooled results report the difference between treatment and control groups on raw item scores. Standardized results use the control group mean and standard deviation to center the raw scores. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

How Facial Expressions Affect the Assessment of Instructional Actions

We explore how facial expressions affects teachers' assessment of instructional actions by estimating the effect of the inclusion of facial expressions on each individual PROSE item. Figure 3 visually presents the differences between the emoted and neutral conditions in their assessment of the instructional actions in each of the eight PROSE items.

We note three main findings. First, in three items (a3022, a3012, a3101) the emoted scenarios received higher agreement with the normative actions than the neutral items. For the rest of the items, participants agreed less with the normative actions in the emoted items than in the neutral items. This finding suggests that facial expressions can both increase and decrease agreement with instructional actions. Second, we notice that all the 95% confidence intervals cross the red line at zero. This suggests that none of the differences that we observe are significant at the 95% level. This result likely indicates that our experiment was underpowered to detect significant differences in participants' assessment on each individual item. Third, even if these differences are not significant, we can still make inferences about the direction of these

differences. That is, most of the confidence intervals for the negative point estimates are to the left of the dashed vertical line and most of the confidence intervals for the positive intervals are to the right of the dashed vertical line. This gives us evidence that the direction of the effect of emotions on participants' assessment of instructional actions is in the same direction as the sign of the point estimate for most items.

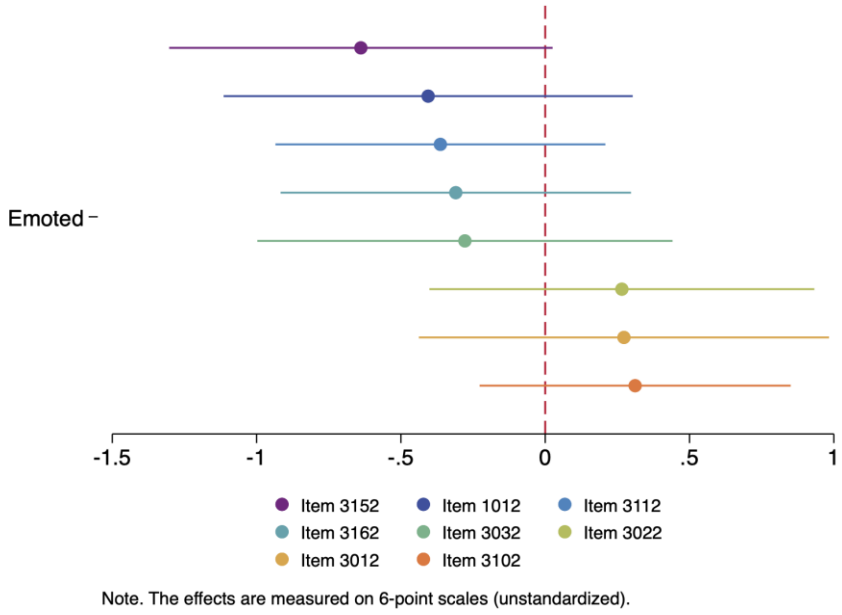

Figure 2: Effect of Facial Expressions on Each PROSE Item

Future Directions

Together these two analyses suggest that: (1) the inclusion of facial expressions for representing emotions can impact the overall participant agreement with instructional actions and (2) the direction of that effect is not uniform—that is it can cause participants to agree with the actions of the teacher more or less favorably. With that, we suggest that more work will need to be done to understand exactly how the addition of emotions makes a difference for participants overall rating of an item. To begin this work, we examine some of the more qualitative differences between the items for which the addition of emotional cues had differing effects. To frame our quantitative results, a positive difference between the emoted and neutral items means that participants who saw emoted items deemed the teacher resolution of the teaching dilemma as more appropriate than the teacher's normative (expected) action. Conversely, a negative difference between the emoted and neutral conditions means that the inclusion of emotions in the items made participants view less favorably the teacher's follow-up action.

With this in mind, we notice that the emotions in items where we have a negative difference are the direct result of the teacher's initial action, either (1) the teacher ignoring or being insensitive to a student's emotions (a1012, a3032, a3112) or (2) failing to anticipate students' emotions (a3152, a3162). For these items we see participants casting judgment on the represented teacher's actions. For example, after viewing a scenario in which a teacher overlooks students who are volunteering and cold calls a non-volunteering student with a confused expression, one participant reacted by saying "I prefer to acknowledge those who are willing to

contribute *rather than embarrass those who are not. The students who did not raise their hands in this scenario look confused*." (*emphasis ours*, a3112, 4356). Similarly, after witnessing the teacher offer mementos to volunteers only to change her mind and draw sticks once students demonstrate excitement about the mementos, one participant commented "Teacher should have *planned in advance* to draw sticks, and told the students that's how they would determine who gets one" (*emphasis ours*, a3162, 5095).

For the items for which we observed a positive difference, student emotions are a consequence of other students' own actions and the represented teacher could be understood as resolving these situations (a3012, a3022, a3102). For these items, we see participants' responses supporting the teacher's actions, in spite of the students' emotional state. For example, in the context of an item in which a student prefers to move on to other homework rather than help his peers and the teacher insists he help his peers, one respondent said, "*This student is also being rude* by being bold enough to state that they are sure they are correct. I have had students like this is[sic] the past and they have often benefited from checking answers when they thought they had done all their work correctly. The idea of working in groups is so that everyone can benefit." (*emphasis ours*, a3102, 4571). These differences across the teachers' reactions to emotions in the items makes us wonder whether the source of the emotional reaction plays a role in how teachers develop an agreement with instructional actions. We plan to explore this insight in future work.

Discussion and Significance

With the increase in interest in student non-cognitive outcomes (Battey & Neal, 2018), it has become more important to understand the role of emotions in teacher decision-making (Hargreaves, 1998). In this paper, we explored how emotions play a role in teacher decision-making. We found that facial expressions communicate emotions in scenarios of teaching and that teachers are responsive to these emotions when reacting to a scenario of teaching. While the effect size of the inclusion of emotions in PROSE items is small to moderate (a quarter of a standard deviation), this effect is non-negligible. Unaddressed emotions in items, either construed or represented, could bias participants' assessment of instructional actions in ways that are difficult to predict a priori because facial expressions can both increase and decrease the direction of these assessments.

Our previous work suggests these facial expressions perform as well as photographs of emotions (Dimmel et al., 2019) This highlights the affordances of the semiotic system (composed of eyebrows, eyes, and mouths) in enabling the reading of facial expressions while dramatically reducing the number of tokens used for such denotation. This can help in designing new instruments to assess teachers' emotional competence. with the goal to support teacher professional development around the role of emotions in teaching.

These findings have important implications for the use of cartoon-based scenarios of teaching in teacher professional development. We can use facial expressions to include the role of emotions in instructional decisions. Different teachers might interpret the emotions differently. This could help in describing the variation in instructional actions due to response to emotions.

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