The role of gaze in momentary teacher-student scaffolding interaction

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Honored Custos, honored Opponent, dear friends and colleagues.

Year 2020 exceptional in all of our lives, and among many other upheavals, it changed our attitudes towards many things. Several phenomena around us that we were used to take for granted, unexpectedly became limited and longed-for. Face-to-face interaction with other people was among the most significant of these phenomena, not least in the context of education. During the obligatory distance teaching, many teachers have told how they have become aware of the importance of being able to see the students and to perceive where the students pay attention to.

The forms of visual interaction, such as joint attention, are crucial skills in human interaction. However, we learn them in early childhood, and therefore we do not pay attention to the use of them in our everyday lives, until we cannot access them anymore. Visual interaction is well researched in the field of development of children with special needs, such as autism, who often lack skills of visual interaction.

However, in the context of general education, these topics have remained unaddressed until the very recent years. We lack knowledge on many basic aspects of teachers' use of gaze in the classroom. Especially, the reciprocal teacher-student eye contact and its role in classroom interaction is an uncharted territory in educational research. Specifically, in the context of collaborative mathematical problem solving, where the social interaction is at the center of learning.

Measuring gaze behavior is a promising method for examining teachers' intentional attention and visual teacher-student interaction. Based on my PhD research and doctoral dissertation, *Understanding the role of gaze in momentary teacher-*

student scaffolding interaction during collaborative problem solving, I believe that there are three reasons for the lack of educational eye-tracking research.

Primarily, the issues in data collection methodology have affected eye tracking not being attractive for educational researchers. Eye-tracking devices have been clumsy, expensive, and available only in laboratories. Today, the research community shares the conception on the importance of conducting the eye-tracking data collection in teachers and students' authentic learning environments. This improves the reliability of making pedagogical interpretations on the data. Fortunately, in our research project we had the possibility to visit participant classes in real mathematics lessons. We collected data with mobile eye-tracking glasses and on several participants simultaneously.

The second reason for the lack of the eye-tracking research ensues from the first one. The tradition of physiologically measuring embodied cognition is strong in the research field of psychology. In educational sciences, we have more tradition on investigating the participants or observers' interpretations on the research topic than measuring their physiology. The methods of data collection affect the research paradigm and vice versa. As a result, theoretical differences exist between psychological and educational research traditions. In my research, I have chosen to complement educational scaffolding theory with psychological interpersonal theory to draw comprehensive conclusions from our data.

The third reason was already mentioned in the beginning of this speech. The fact that visual interaction is partly automatic and unconscious can make teachers and researchers think that they are able to use gaze purposefully without paying any attention to it. Additionally, this causes difficulties in investigating this with traditional methods of educational research. However, we know that good teacher-student contact and relationship are essential for the learning and well-being of both teachers and students. Therefore, we have wanted to make this invisible part of teacher-student interaction visible to the research community. I hope that with the knowledge gained with this research, the teachers could learn to better communicate with the students.

From these premises, my main research question was:

1. How are teachers' momentary scaffolding intentions and interpersonal behaviors manifest in their gaze behaviors and what is the role of student gaze in momentary teacher-student eye-contact communication?

Theory

As mentioned, I wanted to explore teacher attention from both pedagogical and interpersonal perspectives. First, I chose to use the concept of scaffolding to investigate the teachers' situational intentions when guiding the mathematical collaborative problem solving. In other words, to find out *why* the teacher looks at certain targets. The scaffolding theory is based on the concept of the Zone of Proximal Development, where the teacher's role is to scaffold the students' learning process so that they can reach their goals. However, it is important that the teacher gives the students enough autonomy and does not funnel the student collaboration too much.

The teacher's situational pedagogical intentions in scaffolding interaction can be divided into three categories. These are cognitive, affective, and metacognitive. Cognitive scaffolding refers to teacher's actions to restructure and adapt the problem task to correspond with students' competences. Affective scaffolding is for to prevent students' frustration and increase their motivation. Metacognitive scaffolding means helping students to direct their attention and interaction towards the learning process.

In addition to the teachers' pedagogical intentions, I wanted to examine teacher gaze in relation to the momentary verbal and nonverbal interactions to understand, *how* the interactions with students and gaze behavior affect each other. For this, Interpersonal Theory (Leary, 1957) was very useful. Interpersonal Theory conceptualizes human interaction through a two-dimensional representation of initiatives and responses between people.

These dimensions form a Cartesian coordinate system. Axis y refers to acts of Agency and axis x to acts of Communion. Agency refers to actions of control, power, and status that convey a person's urge to be differentiated as an individual. Communion connotes love, union, and affiliation that manifest a person's strive for belonging in a social entity. Originally, this theory was used to examine traits of human personalities. Later, a questionnaire of teacher interaction was developed to understand teachers' interpersonal style in instruction interaction. Quite recently, the interpersonal theory has been used from the perspective of momentary adaptation of interpersonal behaviors in the classroom. The last one was the approach I adopted for my analysis.

To summarize the theoretical approach of this dissertation, teachers create their momentary scaffolding interaction together with students. This interaction is based on the teachers' intentions, and conducted by means of interpersonal behaviors.

Teacher visual attention reflects their pedagogical knowledge, values, and expertise and teachers make continuous decisions on their gaze direction and distribution. We already know that direct gaze and eye contact conveys a person's agency and communion. We also know that students need the feeling of being noticed. Teacher attention to students can improve classroom interaction and student engagement. Next, I will tell you how I started to unravel the patterns of momentary teacher visual attention and teacher-student eye contact interaction in the context of collaborative problem solving.

Methods

To make sense of these complex phenomena, using data triangulation and mixed-method approach to the analyses was crucial. First, I will introduce you to the research setting very briefly. The data I used included gaze data from three lessons and altogether three teachers and eleven 9th grade students. We recorded the gaze of four students and the teacher simultaneously with self-made gaze trackers and the corresponding software, and the classroom conversations and activities with microphones and stationary video cameras. After the lesson, the teachers participated in stimulated recall interviews.

The data collection had taken place on mathematics lessons, where the same collaborative problem task was solved in student groups of four. The task was to connect four imaginary cities located in the vertices of a square with a cable that is as short as possible.

Before the analyses, the gaze data had to be coded and organized. I coded all the teacher gazes according to their targets and durations. I chose to analyze the data in terms of dwells to capture the conscious attentional behaviors of the teachers, and thus their pedagogical vision. A dwell means one visit to the gaze target, and can consist of several fixations.

Based on the teachers' verbal interactions with students, I coded teachers' scaffolding intentions qualitatively. For this I used the classroom videos, and in unclear situations the teacher interviews. For the teacher's interpersonal behaviors, we used quantitative method of Continuous Assessment of Interpersonal Dynamics to capture the continuous and contextualized flow of the teachers' interpersonal behaviors. Complementing the statistical analyses with qualitative descriptions helped me with understanding the situational context of the gaze behavior in relation to the lessons' pedagogy.

Findings

Now let us move on to the main findings of the three studies I conducted with these methods. I will present the findings as a summary instead of going through each sub-study at a time. First, the findings showed that teacher's visual attention was relative to his momentary scaffolding intentions. During cognitive scaffolding, student solution papers were in teacher's focus. Some of the gazes at papers were very long, which indicates that the teacher really paid attention to understanding the drawn mathematical representations on student papers.

During cognitive scaffolding, the teacher also looked at student gestures. Student gestures were rare, but whenever they appeared, the teacher really concentrated at observing them. During cognitive scaffolding, the students often initiated eye contact with their teacher. Additionally, these eye contact gazes were relatively long. This indicates that reciprocal visual interaction is significant also when the verbal interaction concerns mathematical contents.

Student faces received most attention during affective scaffolding. When the teacher encouraged or persuaded the students, he looked them in the eye. In this scaffolding intention category, the students often responded to teachers' gaze initiatives, and dyadic eye contact were formed. In these moments, negative emotions were often present. The teacher attention cohered with the scaffolding intention. With face-to-face contact, the teachers were able to convey the intention of encouragement and prevention of frustration.

Metacognitive scaffolding raised similar gaze behavior as the moments of teacher monitoring the students with no verbal intervention. In these moments, the teacher paid attention to student hands and bodies. By looking at students hands, the teacher was able to observe quickly, whether the students where engaged with the task, that is, holding a pen and writing, or with something else, like playing with a phone. During metacognitive scaffolding, the teacher also tried to direct the students' attention towards the task. This means that the students were often averted away from the shared working space and from the teacher. This forced the teacher to look at the students' backs instead of their faces without response to his initiatives of eye contact. This is one of the many aspects that indicate teacher attention to be reciprocal by nature.

Another perspective to the main findings is the relation of visual interaction and teachers' interpersonal behaviors. In the last of the sub-studies, I compared the occurrence and durations of eye contact gazes to teacher's momentary behaviors of agency and communion. Especially, student attention to teacher was reactive to teachers' behaviors of communion. In other words, when the teachers conveyed friendliness in their behavior, the students tended to look at them often and with long gazes.

However, in this study, strong between-individual variations occurred. It seemed that the classroom's social climate influenced on whether high teacher agency enhances reciprocal eye contact interaction or not. In one classroom, where the teacher-student relationship seemed to be well-functioning, the students replied to the teacher's agentic gaze initiatives. On the contrary, in another class, where the student behavior was more contradicting, the students challenged the teacher's authority with gaze behavior.

To summarize the findings, teachers seem to seek for joint attention and social togetherness during affective scaffolding. This was also the case in short periods of high teacher agency and low communion. Students, on the other hand, seek for eye contact during cognitive scaffolding and low teacher agency and high communion. I suggest that cognitive scaffolding is what the students are willing to concentrate on during scaffolding interaction. In these moments they wish for interaction with the teacher. On the contrary, affective scaffolding often takes place when the students are frustrated or unmotivated, and the teacher tries to persuade them to persist with their task.

Conclusions

The purpose of this dissertation was to understand the situational patterns of gaze behavior that happen in the micro-level social interaction in real classrooms. The findings open up new perspectives to the micro-level building blocks of teacher-student relationships. The participant teachers and classes represented common Finnish lower secondary schools. Therefore, I hope the results could be transferred to other contexts.

I hope the results could help teachers and teacher educators in developing fruitful and intentional nonverbal interaction. This research helps teachers to acknowledge the visual interaction that happens in the classrooms. Reflecting on one's own or someone else's gaze behavior with stimulated recall could benefit

professional learning. It could also help creating interaction that supports the formation of vital teacher-student relationships. Noticing the visual interaction also makes it possible to pay attention to the formation of joint attention. Joint attention is essential in collaborative learning, and we need further research on how to support it among the student groups.

This dissertation combines theories and methods from educational and psychological traditions. Most importantly, it underlines the importance of conducting the data collection in real school environments, analytical and data triangulation, and paying attention to the micro-level interactions. Teacher's visual attention is intentional and contextual. Therefore, it includes between-individual and even within-individual variance. The methodology should aim for using equipment that can collect acute and fine-grained data. Further, this data should be analyzed with methods that do not lose its special characteristics or possibilities for making pedagogical interpretations.

Finally, back to the start. From these studies, I learned that gaze is the way to provide individual support for each student in the middle of social group or class level interaction. I found numerous student initiatives for eye contact with the teachers. Findings also indicate that visual student attention to teachers occurs in the moments of high teacher friendliness. The students need teacher attention for cognitive and affective learning and well-being. Additionally, teachers can direct students towards joint attention that can enhance the collaborative learning. How these challenges are covered in distant teaching, is an aspect that sets challenges to teachers all over the world today. In future, I wish to explore, whether seeing each other's faces in online meetings can create social togetherness and communion in the circumstances of social distancing.

Honored Opponent, Professor Hans Gruber, I now call upon you to present your critical comments on my dissertation.

References

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