An Experimental Environment for Analyzing Collaborative Learning Interaction

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Abstract. In collaborative learning, participants progress their learning through multimodal information in a face-to-face environment. In addition to conversation, non-verbal information such as looking at other participants and note taking plays an important role in facilitating effective interaction. By exploiting such non-verbal information in the analysis of collaborative learning activities, this research proposes a collaborative learning environment in which the non-verbal information of participants is collected to analyze learning interaction. For this purpose, we introduce multimodal measurement devices and implement an integration tool for developing a multimodal interaction corpus of collaborative learning.

Keywords: Collaborative learning environment, multimodal interaction, gaze target, writing action.

1 Introduction

Collaborative learning is a learning style in which multiple participants study collaboratively to acquire knowledge about their subjects [1]. Since participants progress their learning through the exchange of ideas, many researchers have focused on analyzing and modeling the learning process in collaborative learning using dialogue data [2, 3]. In a face-to-face environment, participants generally interact with others by not only exchanging utterances but also using non-verbal behaviors such as looking at other participants and note taking [4]. By exploiting such multimodal information in the analysis of collaborative learning, collaborative learning support systems are able to intelligently mediate group interactions more effectively.

While several studies have analyzed group interaction based on non-verbal information such as gaze targets and speech intervals [5, 6] in the research field of computer-supported cooperative work, there is little research that deals with multimodal interaction during learning in order to facilitate a collaborative learning environment. In order to analyze the learning situation in detail, an interaction corpus that includes elaborative non-verbal information is of primary importance. However creating a multimodal corpus requires a large amount of labor. Thus, it would be very useful if the corpus could be generated automatically/semi-automatically.
As the first step for analyzing collaborative learning in terms of non-verbal information, the research objective is to propose a collaborative learning environment for collecting non-verbal information using multimodal measurement devices. The non-verbal information we extract consists of the gaze targets, speech intervals, and writing actions of participants. This exhaustive information allows us to analyze the interaction (e.g., mutual gaze). In order to integrate these primitive data, this research introduces an integration tool and attempts to gather the interaction corpus through collaborative learning in a face-to-face environment. We believe that the corpus can be used to detect learning situations such as when a participant is not actively engaged in the learning process or cannot effectively communicate with others.

2 Collecting Non-verbal Information in Collaborative Learning

In this research, we deal with collaborative learning among participants in small groups (three participants) who study/discuss in face-to-face situations. Through collaborative learning, they try to discuss and share their knowledge of the subject. Each participant has a piece of paper (note) for writing answers/ideas freely.

In collaborative learning, participants progress their learning not only by writing down the answers in their notes as individual learning, but also by looking around at others, listening to what someone is saying, and sometimes expressing his/her own ideas. In order to analyze these various types of interactions in learning, we focus on analyzing the non-verbal information that consists of (i) gaze direction, (ii) speech, and (iii) writing action as multimodal data of collaborative learning. Here, we do not target the verbal information such as utterance content. The following sections describe the methods of acquiring each type of non-verbal data.

2.1 Gaze Direction

The gaze directions of participants afford the clues needed to estimate gaze targets; i.e., which participant is gazing at another participant (or their note) at any particular time. The gaze direction of each participant is obtained by eye-tracking glasses. The wearable glasses have a camera that can capture the scene (640×480 pixels, 30Hz) and record what the participant is looking at as coordinate data in the two-dimensional scene into an assistant recording device. In addition, the glasses recognize the identity numbers of infrared (IR) markers based on an IR-ray sensor, when such markers exist in the scene. These data are extracted using the eye-tracking software Tobii Studio.

In our learning environment, IR markers were put on each participant’s neck and on his/her note. According to the aggregated eye-tracking data, the gaze targets were annotated by calculating the distance between tracked eye coordinates and IR coordinates based on the following equation.

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