

Aligning Multiple Sources of SRL Data in MetaTutor: Towards Interactive Scaffolding in Multi-Agent Systems

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Abstract: 100 undergraduate participants were randomly assigned to one of two experimental conditions (Prompt and Feedback [PF] and Control), and used MetaTutor (a multi-agent hypermedia intelligent tutoring system [ITS]) to learn about a challenging science topic (i.e., the human circulatory system) for two hours. During the session, we collected product (e.g., pretest, posttest, quizzes, summaries), and process (e.g., concurrent think-alouds, eye-tracking, log-files, face videos, physiological data, screen recordings, metacognitive judgments, and notes and drawings) data to analyze the roles of cognitive and metacognitive processes during learning about the topic with the system. Aligning trace data from eye-tracking and system-generated log-files, we investigated the occurrence of the SRL strategy coordination of informational sources (COIS), text and diagram inspection time, as well as the occurrence and accuracy of metacognitive judgments (JOLs, FOKs, and CEs). Results indicate that learners in the PF condition performed significantly higher number of COIS compared to those in the control group, and had significantly more accurate metacognitive judgments. We will illustrate and describe how these data, methodology, and findings can be used in augmenting current models of SRL, and ultimately in the design of ITSs which can provide adaptive scaffolding for interacting learning of challenging science topics, such as the human circulatory system.

Objectives/Purposes: The purposes of this study are to understand the complex nature of cognitive and metacognitive processes during learning with intelligent tutoring systems, and to find behavioral signatures for those SRL processes among data collected from different sources. In order to find these signatures, we temporally align trace data from eye-tracking and system-generated log-files while students learn interactively with MetaTutor (an intelligent hypermedia multi-agent learning environment). We also use product measures (i.e., post-test and quiz scores) in order to investigate the effects of SRL scaffolding on learners' performance.

Theoretical Framework: We adopt Winne & Hadwin's (1998, 2008) information processing model of SRL as the guiding framework for conceptualizing SRL processes enacted by students learning with MetaTutor. One of the important assumptions of Winne & Hadwin's (1998, 2008) model is the conceptualization of SRL as an event, which leads to the assumption that cognitive, metacognitive, motivational, and affective processes can be detected, traced, and modeled during learning (with MetaTutor; Azevedo et al., 2012, in press). Another assumption of their model is that SRL events unfold dynamically over time, which emphasizes the importance of use of on-line measures of SRL in order to trace learners' interactions during the learning session.

Methods/techniques: 100 undergraduate students participated in a two-day experiment with MetaTutor to learn about the human circulatory system. They were provided the option to deploy several key SRL processes during their learning session (e.g. take notes, make content evaluations) and were also prompted by pedagogical agents at appropriate times to deploy them. Participants were randomly assigned to one of two conditions—control and prompt and feedback. In the prompt and feedback condition, students received timely prompts by the embedded pedagogical agents to use appropriate SRL processes and then received feedback regarding the accuracy or effectiveness of their use of these processes. On the other hand, those in the control condition did not receive any prompts or feedback from the agents.

Data sources: During the two-hour learning session with MetaTutor, we collected several streams of trace and product data from each participant: concurrent think-alouds, eye-tracking, video recording of the face (for affect detection and classification), system-generated log files (e.g., quiz scores, time on content, navigation paths, as well as time-stamped trace of deployed SRL processes) and notes and drawings. We also collected pretest and posttest data in order to measure learning of content by participants.

Results: Results focus on the measurement of SRL processes by triangulating trace data from different sources collected while participants learning with MetaTutor. We will provide findings on learners' use of the learning strategy coordination of informational sources (COIS), amount of time spent on inspecting multimedia content in the form of text and diagrams by aligning and triangulating eye-tracking and log-file data as well as content understanding, as indicated by in-session quiz scores and learners' performance in the post-test at the end of the session. In addition, we will also present findings on learners' use and accuracy of metacognitive judgments (i.e., judgments of learning [JOLs], feeling of knowing [FOK], and content evaluation [CE]), to investigate their metacognitive calibration and its influence on their learning outcomes.

Scientific contribution: The results will demonstrate how ITSs can assist in adaptive scaffolding of interactive learning of challenging science topics by using data collected from different sources, temporally aligning them, and making inferences about learners' use of SRL processes, which will lead to more adaptive prompts and feedback from the ITS, and ultimately better learning gains. From the point of view of measurement of SRL processes, this study will provide researchers with ways of measuring particular SRL processes using data from particular sources, by identifying signatures of those processes. Ultimately, the findings will be used to enhance the design of MetaTutor so that it can provide adaptive scaffolding of interactive learning.