Using Epistemic Synchronization Index (ESI) to Capture the Knowledge Elaboration Process of Students in CSCL

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Abstract: The research used qualitative content analyses on students’ online text-based messages during CSCL. Based on the scoring, we arrived at standardized scores to visualize and measure students’ knowledge elaboration process during CSCL. The method can be applied into various synchronous and asynchronous online dyadic collaborations.

Keywords: Epistemic development, knowledge elaboration, visualization

Higher-order thinking is important for problem-solving in Computer-Supported Collaborative Learning (CSCL) (Weinberger & Fischer, 2006). So far, very little research is able to capture the dynamic progress of the evolvement of individual epistemic engagement in CSCL. Questions such as how to distinguish gifted and regular students regarding knowledge elaboration remains a black box.

Based on three cognitive modes from Kumpulainen and Mutanen (1999), we (Ding, 2009; Ding, Bosker & Harskamp, 2010) developed a coding system to measure students’ epistemic engagement, which was termed as “elaboration values” referring off-task, on-task and elaboration activity. Each piece of student online messages was coded into a discrete numerical value as -1, 0, or +1, see Figure 1.

Table 1: Sample of the coding categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Numerical Value</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-task</td>
<td>-1</td>
<td>Content of the message is not related to the question solving</td>
<td>What is your plan for the Christmas vacation?</td>
</tr>
<tr>
<td>On-task</td>
<td>0</td>
<td>The message only shows an agreement, however, without justification or critical thinking.</td>
<td>- (If we visualize it, each part should be 0.4722. ) - You mean 47.22%?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The message is relevant to the question, however, without any advancement of solution.</td>
<td>- Ok, we know the z score now. Then, what shall we do?</td>
</tr>
<tr>
<td>Elaboration</td>
<td>+1</td>
<td>The message shows a step towards the final solution.</td>
<td>It is a finite population because n/N is 0.2, smaller than 0.5.</td>
</tr>
</tbody>
</table>

In our newly published research paper (Ding, Wei, Wolfensberger, 2015), we refined and standardized the method. The preliminary study explored a method to distinguish the individual dynamic process of epistemic involvement in CSCL. Two female bachelor students from a Dutch university participated in seven online collaboration sessions, solving statistics questions in an online text-only chatting room. The unit of analysis was defined as each message emerging at a recorded timeslot. We used a series of equations to arrive at an Epistemic Synchronization Index (ESI). We segmented the total process of problem-solving equally into several time intervals. For each time interval, we calculated the area between individual CEV curve and the baseline. After that, we used the following formula (Figure 1) to achieve the ESI value.

\[ ESI_0 = \int_{t=0}^{t} A \times |CEV_{S1} - CEV_{S2}| \times dt \]

Figure 1. Formula to calculate Epistemic Synchronization Index (ESI)

\[ A = \frac{1}{\int_{t=0}^{t}(|CEV_{S1} + CEV_{S2}|)\times dt} \]

Figure 2. Formula to calculate the normalizer A
In order to calculate the A, the polygons of the CEV for individual students were defined as CEVs1 and CEVs2. The integral function was applied in this case with the aim to achieve a more accurate comparison.

Furthermore, we used following two formulas, see Figure 3, to measure whether an individual student contributes more to the collaboration than his/her partner.

\[
ESI_1 = \int_{t=0}^{t} A \times \max [0, CEV_{s1} - CEV_{s2}] \times dt \\
ESI_2 = \int_{t=0}^{t} A \times \max [0, CEV_{s2} - CEV_{s1}] \times dt
\]

Figure 3. Formulas to calculate the individual ESI values

Notice that we have ESI0=ESI1+ESI2. If ESI1>ESI2, the first student makes more contribution than the second student to the collaboration, and vice versa. From the Figure 4, we may distinguish students’ knowledge elaboration processes. ESI ranges from 0 to 1. The smaller, the more symmetrical of students’ epistemic engagement.

This methodological exploration will not only contribute to the CSCL theoretical research, but can also be applied into various online learning environments, for example, to provide tailored just-in-time hints to weak students in order to achieve a balance in knowledge elaboration process.

References: