Iyer, S. et al. (Eds.) (2022). Proceedings of the 30th International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

# Motivation Estimation Method for Computer Supported Collaborative Learning Using Tablet Computer

**Ryo FUNABASHI[*a], Kohei NABETANI[a], Takeo NODA[b], Masataka KANEKO[c] & Hironori EGI[a]**

[a]*Graduate School of Informatics and Engineering, The University of Electro-Communications, Japan*

[b]*Faculty of Science, Toho University, Japan*

[c]*Faculty of Pharmaceutical Sciences, Toho University, Japan*

**f2230121@edu.cc.uec.ac.jp*

**Abstract:** In Computer Supported Collaborative Learning (CSCL), it is difficult to objectively grasp learners' understanding progress and how they contribute to the group learning activities. Therefore, we propose a method to estimate learners' level of understanding and motivation to participate using a tablet computer that can acquire touch operation logs. We define motivation level based on learner's situation. By using a depth sensor to observe learning, learners' movements that are not logged in the touch operation logs are measured, and the motivation level is estimated. An experiment was performed to verify the usefulness of the system. The results of analysis and the opinions of the experts who observed the learning agreed partly. The results of the experiment confirmed the possibilities of the system.

**Keywords:** CSCL, depth sensor, learner analysis, tablet computer

## 1. Introduction

We propose a method to estimate learners' understanding and willingness to participate in CSCL by using a tablet that can acquire touch operation logs and information on the work area obtain from a depth sensor. The target is CSCL in which multiple people use a single shared tablet cooperatively. The work area is defined as the combination area on the tablet and the area on the desk where the learner moves his/her hands. By acquiring information on the work area with the depth sensor, it is possible to measure the learner's actions that are not logged in the touch operation log. This enables us to estimate the learner's willingness to learn step by step.

## 2. Related Work

A method for the automatic evaluation of CSCL that is similar to this study has been proposed (Ruiz et al., 2018). However, the automatic method differs from ours in that it assumes online CSCL and focuses on student message exchanges.

Moreover, the assessment of collaborative learning has been addressed (Strijbos, 2011). It was reported that teachers and students require adequate computer-supported and intelligent tools for monitoring and assessment.

Users have been identified in a tabletop environment by capturing images of the system from the ceiling direction using a depth camera (Masuda, Maekawa, & Namioka, 2016) The advantages of shooting from the ceiling direction are noninterference with the user's activities and low possibility of obstacles between the user and the camera. In this study, we mounted a depth sensor in the ceiling direction to estimate the learner's motivation based on touch operations and hand movements.

## 3. Research Method

We propose a method for estimating learner motivation based on touch operation logs and work area conditions acquired by a depth sensor during CSCL using a tablet. Learners can directly contribute to learning outcomes through touch operations. In addition, by pointing and hand movements without touch, it can be judged that the user is participating in learning activities such as explanations and instructions. We develop a system that defines the learner's motivation level and estimates the motivation level as shown in Figure 1 and Table 1. There are four motivation-levels (from 0 to 3), wherein the higher the level, the more motivated the learner is.

*Table 1*. The learner's motivation levels and conditions

| | |
|---|---|
| Level 0 | The situation is that the body cannot be detected in the work area. The learner's hands are not on the desk and the motivation is at the lowest level. |
| Level 1 | The hand is detected in the work area. The learner's hands are on the desk and the motivation is at the second-lowest level. |
| Level 2 | The situation in which a hand is detected over a tablet in the work area. For example, the learner is pointing at the tablet. |
| Level 3 | The situation in which a hand is detected on the tablet and touch operation logs are obtained. The learner is performing operations on the tablet, and the motivation is at the highest level. |

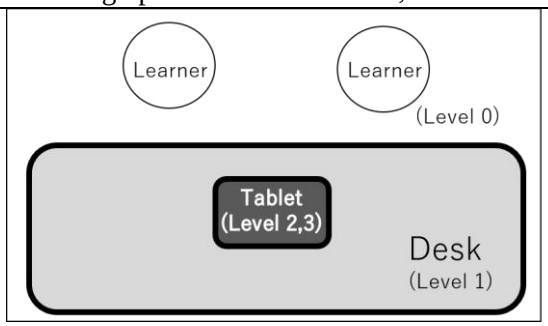


*Figure 1*. Estimation of motivation level by learner's hand position

A graph is plotted from the changes in motivation level with the elapsed time during CSCL on the horizontal axis and the measured motivation level on the vertical axis. This will not only evaluate the process of CSCL but also can be used to provide support, such as identifying groups with low motivation levels or providing individualized instruction.

## 4. Analysis in CSCL

We asked three groups of two students per group (Group1-3) to operate tablets collaboratively among members of a group and to think about a solution to a problem for about 40 min. One mathematics learning material on correlation coefficients on a tablet is introduced for first-year students at university of science. The learning material is composed based on a result of discussion by two teachers. The two teachers observe all the sessions. Motivation levels were visually judged and tabulated, averaged over 20s and graphed. An analysis of voice during the study was also performed.

Here we talk about the results of Group 3. The graph of Group3 is shown in Figure 2, and the graph of dialog percentage for group3 is shown in Figure 3.

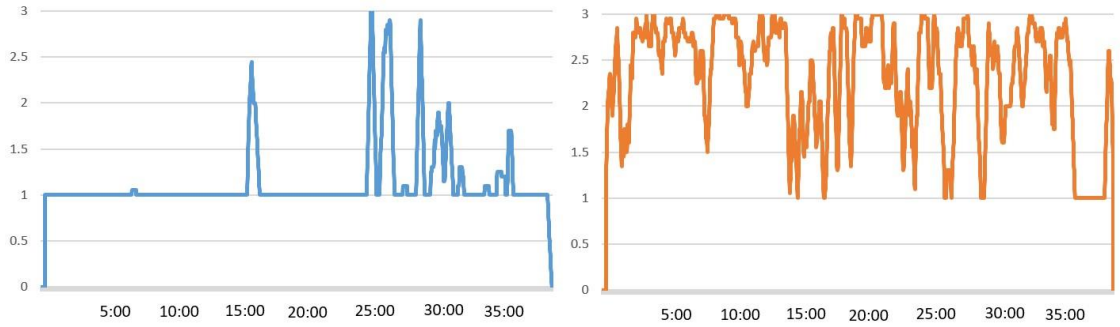


*Figure 2*. The average motivation levels of Learners A (left) and B (right) in Group 3
(The vertical axis represents level. The horizontal axis represents time)

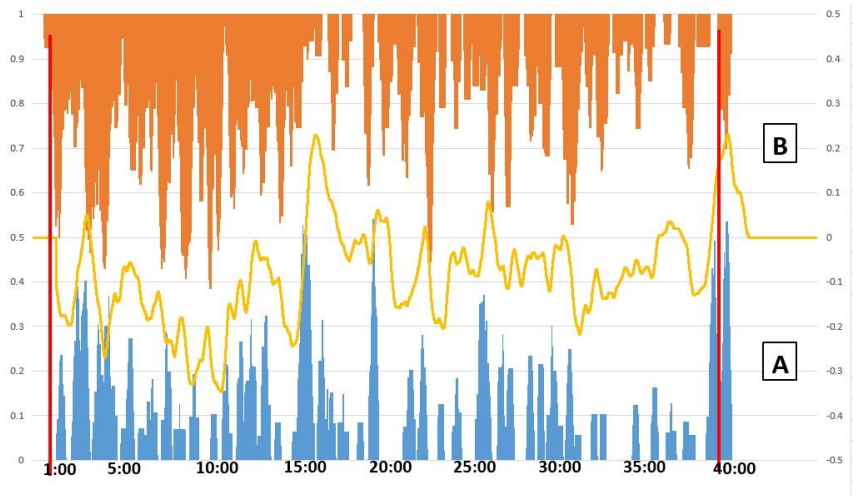


*Figure 3.* Percentage of dialogue in Group 3 (The vertical axis represents dialog percentage. The horizontal axis represents time)

The level of motivation of Group 3 shows that Learner B's motivation level is high throughout the study. Learner A's motivation level is almost constant at 1 in the first half, but it is high in the second half, mainly when Learner B's motivation level becomes low. It can be inferred that they were alternately operating the tablet. From the dialog analysis, it is estimated that the dialog rate and motivation level of Learner B were both high from the start until 14:00 and that Learner B was leading the study. From 14:00 to 19:00 when Learner A's dialog rate is high, there are points where Learner A's motivation level is momentarily high. However, the motivation level of A is not as high as the dialog rate. The dialog rate in the second half is dominated by Learner A in some cases, but Learner B is dominant in most cases. Learner B's motivation level is also higher in most cases, although Learner A shows a higher value in some cases. For Group 3, the system produced results similar to those from the independent observation by the two teachers who developed the material.

## 5. Conclusion

The result of analyzing CSCL using tablets were used to establish a method for estimating motivation in CSCL. In the future, we will develop a system that calculates the coordinates of learner's hands by information acquired by the depth sensor and outputs a graph of motivation level in real time.

## Acknowledgements

This work has been partly supported by the Grants-in-Aid for Scientific Research (Nos. 21K02752 and 22K02951) by MEXT in Japan.

## References

Ruiz, L. M., Nieves, D. C., Popescu-Braileanu, B. and González, C. S. G. (2018) Methodological proposal for automatic evaluation in collaborative learning, *2018 IEEE Global Engineering Education Conference (EDUCON)*, 2018, pp. 1414-1418, doi: 10.1109/EDUCON.2018.8363395.

Strijbos, J. -W. (2011) Assessment of (Computer-Supported) Collaborative Learning, in *IEEE Transactions on Learning Technologies*, 2011 vol. 4, no. 1, pp. 59-73, doi: 10.1109/TLT.2010.37.

Masuda, A., Maekawa, T. and Namioka, Y. (2016) Preliminary investigation of unconstrained person identification for tabletops using soft biometrics, *2016 IEEE International Conference on Pervasive Computing and Communication Workshops (PerCom Workshops)*, 2016, pp. 1-4, doi: 10.1109/PERCOMW.2016.7457063.