

Multimodal Learning Analytics for Knowledge Building

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KEY IMPLICATIONS

- Teachers can use Multimodal Learning Analytics (MMLA) to gain insights into less observable students' communication and collaboration behaviors such as speech patterns, physical movement and emotions.
- Teachers can foster a more positive classroom culture for collaborative learning by using MMLA feedback to help students reflect on their interactions and engagement.

BACKGROUND

Computer-supported-collaborative-learning (CSCL) was one of the major thrusts in the second masterplan (MOE, 2023), and CSCL has since taken root in Singapore teachers' language and repertoire. Though the

implementation of CSCL in schools in Singapore has increased extensively in recent years, the mode of assessment and understanding of collaborative learning and its environment have continued to lag behind practice. With technological advancement, research is showing potential for Multimodal Learning Analytics (MMLA) as a promising solution to support teachers understand student collaborative interactions. MMLA involves employing new ways of collecting and analysing data using multimodal methods which may include sensors for eye tracking, electrodermal, body movement and gesture. However, research on the development, use and integration of MMLA to support CSCL in classrooms is still nascent. This research project embarked on a comprehensive design and implementation of a MMLA prototype

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for collaborative learning in authentic classroom setting, with a primary focus on understanding and implementing MMLA to enhance teachers' CSCL practices. The overarching goal of the research was to investigate MMLA techniques to uncover complex learning behavioral processes such as cognition and emotion during collaborative activities in unscripted authentic classroom settings. By doing so, the project hoped to provide valuable insights that can inform and improve CSCL teaching practices.

FOCUS OF STUDY

This proposal aims to (i) identify collaborative activities in the Knowledge Building (KB) classroom, then design, enact and analyse embedded units of a single CSCL case study, the KB classroom, with multimodal learning analytic approaches; and (ii) support teachers in practising, interpreting and analysing CSCL with MMLA.

KEY FINDINGS

On quality collaboration and discourse:

1. Based on manual analyses of video data, Knowledge Forum contributions, and emotion surveys, the study identified consistent patterns between productive collaborative discourse with physical movement and emotional engagement. Findings suggested that the students who contributed ideas of higher semantic level to the verbal interaction were those who engaged in a deeper discussion of their ideas on KF. It was noted that young children may not navigate both modes productively simultaneously.
2. In this project, a range of epistemic emotions which included *frustration*, *confusion* and *curiosity* were found to be significantly correlated with participants' perception on their learning during the lessons. Epistemic emotions refer to emotions that are related to knowing. This finding aligns with

those reported in the literature that emotions such as frustration or confusion with ideas may enhance learning and not necessarily deemed detrimental to learning.

3. The teacher's interpretation of the MMLA User Interface (UI) showed an appreciation for the holistic understanding of student engagement as well as the pedagogical use of the tool (e.g., intervention support). Teachers identified the need for clear learning goals (in this case, KB goals) to make sense of data and visualisation.

SIGNIFICANCE OF FINDINGS

Implications for practice

- Multimodal Learning Analytics (MMLA) allows teachers to gain a more comprehensive view of complex dynamic of group collaboration in class, including emotions of learning.
- MMLA can support teachers in gaining insights into communication and collaboration patterns to foster a more positive classroom culture for collaborative learning.
- MMLA can support teachers in reflecting on their interactions and strategies and improve their practice based on data-driven insights.

Implications for policy and research

This Multimodal Learning analytics (MMLA) project has established the process of collecting, analysing, and interpreting data from different modalities to better understand complex collaborative learning activities. This can potentially be key to classrooms of the future. MMLA, with clear theoretical framing, could provide valuable insights into the effectiveness of curricula and teaching methods. Such data-driven decision-making about classroom practice can lead to more targeted and evidence-based policies to enhance 21st century teaching and learning.

Learning gains (for studies involving intervention)

This project has provided a pair of unique lens to understand students' emotional engagement in collaborative learning activities, especially highlighting the positive value of epistemic emotions such as frustration and curiosity. This could be translated to a larger scale study to validate the role of epistemic emotions in learning so that teachers can be encouraged to let their students take on more responsibility and agency in charting their inquiry.

Proposed Follow-up Activities

Subsequent work is recommended to enhance the validation of the MMLA through a larger scale of data collection and to develop this prototype into a stable

and accessible Learning Analytics for integration with classroom practice.

PARTICIPANTS

The study involved 48 primary school students and 17 tertiary students.

RESEARCH DESIGN

Mixed method and model training and testing were conducted in the development of the prototype.

REFERENCES

Ministry of Education. (2023, Sep 20). *Our Educational Technology Journey*. <https://www.moe.gov.sg/education-in-sg/educational-technology-journey>

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