Majumdar, R. et al. (Eds.) (2025). Proceedings of the 1st International Conference on Learning Evidence and Analytics. Asia-Pacific Society for Computers in Education

Mapping Strategy Shifts with Sankey Diagrams: Insights from AI Logs in Primary CT Education

Yu-Chih HUANG[ab] & Cheng-Hsuan LI[a*]
[a]*Graduate Institute of Educational Information and Measurement, National Taichung University of Education, Taiwan*
[b] *Department of Healthcare Industry Technology Development and Management, National Chin-Yi University of Technology, Taiwan*
* {ntcuhyc, ChengHsuanLi}@gmail.com

Abstract: Although AI learning companions hold promise for enhancing computational thinking education, understanding how students' learning strategies evolve through interaction with these tools remains challenging—highlighting the need for process-oriented analysis to move beyond static outcomes and reveal how learning truly unfolds. This study applied a learning analytics approach to examine interaction logs from 122 third-grade Taiwanese students using the AI learning companion TALPer from the Taiwan Adaptive Learning Platform (TALP) for computational thinking tasks over six weeks. By coding student behaviors and visualizing strategy transitions with Sankey diagrams, we revealed the dynamic evolution of learning strategies within an AI-enhanced environment. The Sankey diagrams revealed a temporal shift in student interactions with TALPer, showing a progression from basic behaviors like information queries (16%) and language practice (24%) toward more metacognitive strategies such as planning (21%) and problem-solving (28%) as the intervention advanced, highlighting the evolving depth of engagement over time. These findings underscore the value of process-oriented learning analytics in complementing traditional assessments and offer practical insights for designing adaptive AI systems that support self-regulated learning in young students.

Keywords: Behavior analytics, Sankey diagrams, AI learning companion, computational thinking, elementary education, learning strategies

1. Introduction

AI learning companions like TALPer are increasingly used to develop computational thinking (CT) skills in elementary education. While previous research mainly emphasizes outcomes, understanding students' interactive processes is essential to optimize AI tools and instructional support (Luckin et al., 2016; Ministry of Education, 2025). Traditional evaluations relying on performance tests or questionnaires offer limited insight into dynamic learning behaviors (Blikstein, 2011). Thus, visualizing strategy shifts with learning analytics techniques like Sankey diagrams can effectively capture these dynamic interactions (Knight et al., 2017; Lee et al., 2022). This study addresses the gap by visualizing temporal transitions of strategies from basic interactions to metacognitive behaviors such as planning and problem-solving using Sankey diagrams..

2. Methodology

Participants included 122 third-grade students engaging with TALPer over six weeks in CT activities based on Bebras tasks integrated into a 6E instructional model. TALPer interaction logs were systematically coded into behavioral categories, including Information Search, Language Learning, Problem Solving Support, Homework Assistance, Study Planning, Emotional Limitations, and Recognition Limitations (Boetje et al., 2024; Darvishi et al., 2024).

Sankey diagrams visualized behavioral transitions across the intervention period, providing aggregate data on strategy evolution.

Results The Sankey diagram (Figure 1) illustrates clear transitions from initial behaviors like Information Search (16%) and Language Learning (24%) towards metacognitive strategies, specifically Study Planning (21%) and Problem Solving Support (28%). This visualization demonstrates a dynamic progression in strategy sophistication, indicating enhanced engagement and strategic competence.

3. Results

The Sankey diagram (Figure 1) illustrates clear transitions from initial behaviors like Information Search (16%) and Language Learning (24%) towards metacognitive strategies, specifically Study Planning (21%) and Problem Solving Support (28%). This visualization demonstrates a dynamic progression in strategy sophistication, indicating enhanced engagement and strategic competence..

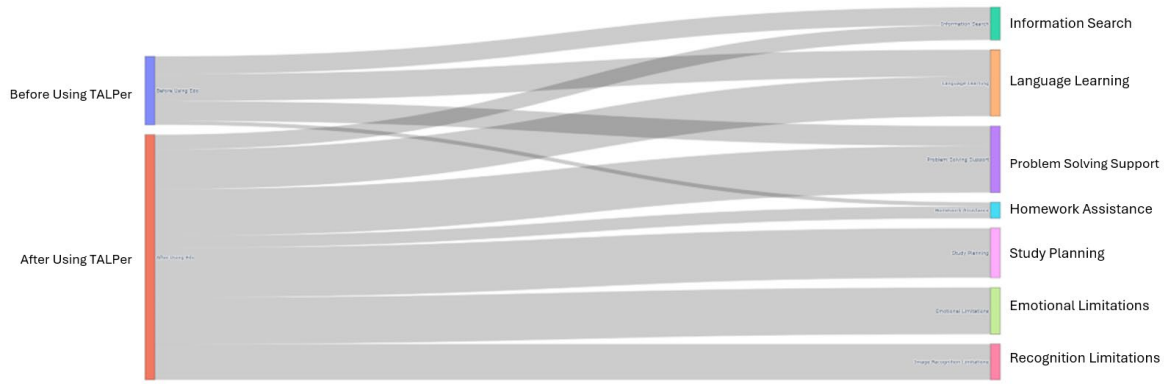

Figure 1. Sankey diagram illustrating aggregate transitions between learning strategies during interaction with TALPer.

4. Discussion and Conclusion

Sankey diagrams effectively revealed shifts towards strategic learning behaviors, suggesting increased metacognitive awareness possibly facilitated by AI-supported interactions (Panadero, 2017). Methodologically, this visualization complements traditional outcome-focused assessments by providing granular, process-oriented insights into learner engagement. This approach informs the design of adaptive AI learning environments sensitive to evolving student strategies. However, further studies should triangulate findings with cognitive data to solidify causality claims. In conclusion, Sankey diagram visualizations offer critical insights into dynamically evolving learning strategies in elementary CT education, enhancing the understanding and effectiveness of AI-mediated educational practices.

Acknowledgements

We acknowledge "The Digital Learning Enhancement Plan for Grades 1–12 Students" and "Taiwan Adaptive Learning Platform" supported by the Ministry of Education, Taiwan, and thank Google Gemini and OpenAI's ChatGPT for manuscript language polishing.

References

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in Psychology, 8*, 422. https://doi.org/10.3389/fpsyg.2017.00422

Blikstein, P. (2011). Using learning analytics to assess students' behavior in open-ended programming tasks. In *Proceedings of the 1st International Conference on Learning Analytics and Knowledge* (pp. 110–116). Association for Computing Machinery. https://doi.org/10.1145/2090116.2090132

Boetje, J., van Ginkel, S. O., Smakman, M. H. J., Barendsen, E., & Versendaal, J. (2024). Information problem solving during a digital authentic task: A thematic analysis of students' strategies. *Computers in Human Behavior Reports, 15*, Article 100470. https://doi.org/10.1016/j.chbr.2024.100470

Boutob, I., Jmad, S., Benmessaoud, S., & Kaddouri, M. (2025). Pedagogy of AI strategies for effective teaching and learning in the age of artificial intelligence: Mohammed First University as a case study. In M. A. El-Bishouty, A. M. Khamis, & A. A. Altameem (Eds.), *Effective instructional design informed by AI* (pp. 55–86). IGI Global. https://doi.org/10.4018/979-8-3693-6527-4.ch002

Darvishi, A., Khosravi, H., Sadiq, S., Gašević, D., & Siemens, G. (2024). Impact of AI assistance on student agency. *Computers & Education, 210*, Article 104967. https://doi.org/10.1016/j.compedu.2023.104967

Knight, S., Buckingham Shum, S., & Littleton, K. (2014). Epistemology, assessment, pedagogy: Where learning meets analytics in the middle space. *Journal of Learning Analytics, 1*(2), 23–47. https://doi.org/10.18608/jla.2014.12.3

Lee, J.-E., Stalin, A., Ngo, V., Drzewiecki, K. C., Trac, C., & Ottmar, E. (2022). Show the flow: Visualizing students' problem-solving processes in a dynamic algebraic notation tool. *Journal of Interactive Learning Research, 33*(2), 97–126.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson Education.

Masiello, I., Mohseni, Z., Palma, F., Nordmark, S., Augustsson, H., & Rundquist, R. (2024). A current overview of the use of learning analytics dashboards. *Education Sciences, 14*(1), Article 82. https://doi.org/10.3390/educsci14010082

Ministry of Education. (2025). *The Taiwan Adaptive Learning Platform (TALP)*. Retrieved from https://adl.edu.tw/HomePage/home/

Osman, S. A., & Ahmed, Z. E. (2024). Navigating AI integration: Case studies and best practices in educational transformation. In M. A. El-Bishouty, A. M. Khamis, & A. A. Altameem (Eds.), *AI-enhanced teaching methods* (pp. 28–47). IGI Global. https://doi.org/10.4018/979-8-3693-2728-9.ch011

Saritepeci, M., Yildiz Durak, H., & Kidiman, E. (2025). Integrating computational thinking via AI-based design-based learning activities. In M. Saritepeci & H. Yildiz Durak (Eds.), *Integrating computational thinking through design-based learning: Strategies for integration in different disciplines* (pp. 45–61). Springer. https://doi.org/10.1007/978-981-96-0853-9_4

Xie, Y. S., Jang, J. H., Kim, S. Y., & Cho, Y. H. (2023). Interaction patterns between learners and AI tools for English writing. In *Proceedings of the 31st International Conference on Computers in Education (ICCE 2023)*. Asia-Pacific Society for Computers in Education. https://doi.org/10.58459/icce.2023.1500