UNIVERSITY OF CAMBRIDGE

Raspberry Pi Foundation

The need for discipline-specific use cases: Computing teachers' views of LLM programming error messages explanations in the classroom

Jane Waite

Cambridge Generative AI in Education Conference 2024

https://bit.ly/FeedbackLit

RASPBERRY PI
COMPUTING EDUCATION RESEARCH CENTRE

Our paper

Feedback Literacy: Holistic Analysis of Secondary Educators' Views of LLM Explanations of Program Error Messages

Veronica Cucuiat
veronica.cucuiat@raspberrypi.org
Raspberry Pi Foundation
Cambridge, United Kingdom

Jane Waite
jane.waite@raspberrypi.org
Raspberry Pi Foundation
Cambridge, United Kingdom

ABSTRACT

The implications of using large language model (LLM) tools for learning to program at secondary school level are largely unknown, and yet there is pressure for teachers to engage with these. To start addressing this gap, we investigated: *RQ1: What are secondary educators' views on the potential classroom use of LLM program error message explanations? RQ2: In what ways can a feedback literacy perspective support the analysis of educators' views of potential classroom use of LLM program error message explanations?* The re-

1 INTRODUCTION

The use of large language models (LLMs) to support learning to program has generated ideas and debate in the computer science education research community [30], in IT developer discussions [37], and emerging classroom practice advice [35]. This reveals a complex landscape for educators to navigate and heralds potential changes of what might be taught and how. Academic research has used LLM tools, for example, to generate code explanations for use in teaching activities [21], to assist beginner programmers' trou-

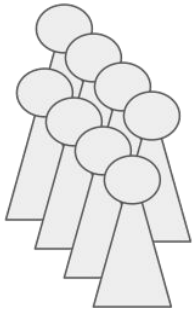
https://computingeducationresearch.org/research/

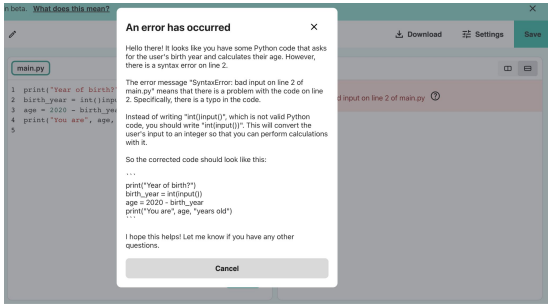
Our context

8 expert secondary computing educators

Explored LLM enhanced programming error feedback

We correlated findings to theories of:





Enhanced program error guidelines

Feedback Literacy Theory

RQ1: What are secondary educators' views on the potential classroom use of LLM program error message explanations?

Our Findings

Reporting Groups	Themes
Content of explana-tions	1. Possible code solution is always included
	2. Key concept words are generated inconsistently
	3. The explanation is detailed and avoids jargon
Format and style	4. Lengthy and verbose explanation
	5. Program language elements are hard to distinguish from explanation
	6. Tone is positive and encouraging
	7. Student and explanation code solution should be displayed side-by-side
Validity	8. Occasional invalid explanation could negatively affect students
	9. Explanation learning objectives are not always related to the error
Learning process	10. Explanation effectiveness depends on student level and motivation
	11. Explanations are better than original PEMs but may cause dependency
	12. Students may fix more errors independently
Teaching process	13. Educator PD needed on how LLMs work and implications for classroom use
	14. Opportunities for additional debugging teaching
	15. Student-educator interactions may be reduced

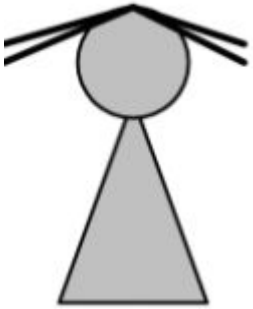
Are these common LLM feedback findings across disciplines?

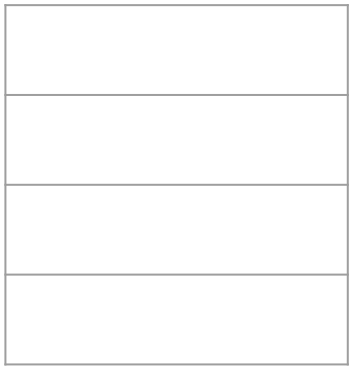
Theory we drew on: feedback literacy

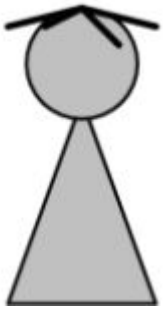
Teacher feedback literacy

Feedback types

Student feedback literacy



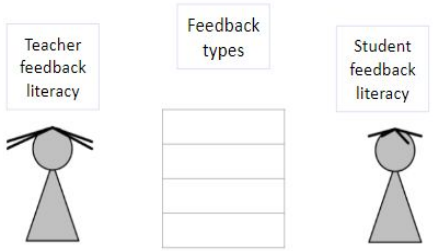




Providing feedback (an explanation) is a social interaction.

Feedback types

Feedback type	Educator role	Student role
Telling	unidirectional transmission of ‘correct’ information	passive
Guiding	point in the right direction	active as applies knowledge
Developing understanding	targeted teaching	active as constructs or adjusts knowledge
Opening up	presenting new perspectives	active as interprets and evaluates new knowledge



(McLean, Bond & Nicholson, 2015)

A discipline specific case study may:

- Uncover unique challenges and opportunities within particular subject areas
- Inform the development of specialized LLM applications tailored to specific educational contexts
- Provide empirical evidence to guide policy and practice in integrating LLMs into specific curricula

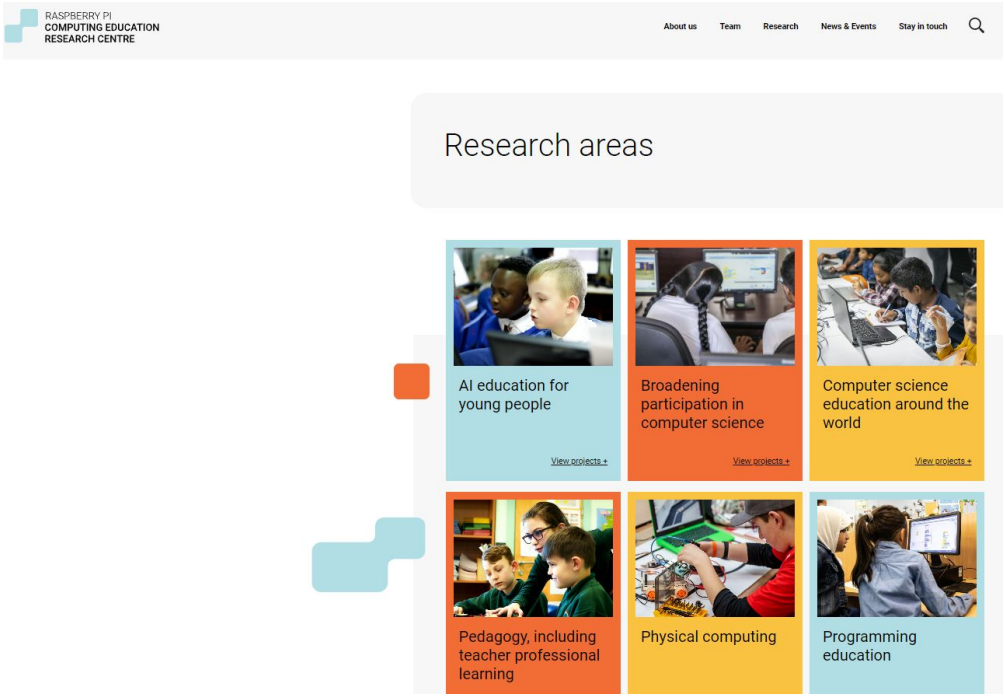
- Contribute to the refinement of general theories about LLM use in education by providing concrete, contextual examples

UNIVERSITY OF CAMBRIDGE

Raspberry Pi Foundation

RASPBERRY PI COMPUTING EDUCATION RESEARCH CENTRE

Find the paper and more here



https://computingeducationresearch.org/research/

UNIVERSITY OF CAMBRIDGE
Raspberry Pi Foundation
THE UNIVERSITY OF SYDNEY
Queen Mary University of London
Science and Engineering

The need for discipline-specific use cases: Computing teachers' views of LLM programming error messages explanations in the classroom

Jane Waite

Cambridge Generative AI in Education Conference 2024

https://bit.ly/FeedbackLit

RASPBERRY PI
COMPUTING EDUCATION RESEARCH CENTRE

UNIVERSITY OF CAMBRIDGE

Raspberry Pi Foundation

RASPBERRY PI COMPUTING EDUCATION RESEARCH CENTRE

References and our related work

David Carless and David Boud. 2018. The development of student feedback literacy: enabling uptake of feedback. Assessment & Evaluation in Higher Education 43, 8 (2018), 1315–1325. https://doi.org/10.1080/02602938.2018.1463354 arXiv:https://doi.org/10.1080/02602938.2018.1463354

David Carless and Naomi Winstone. 2023. Teacher feedback literacy and its interplay with student feedback literacy. Teaching in Higher Education 28, 1 (2023), 150–163

Paul Curzon, Jane Waite, Karl Maton, and James Donohue. 2020. Using semantic waves to analyse the effectiveness of unplugged computing activities. In Proceedings of the 15th Workshop on Primary and Secondary Computing Education (WiPSCE '20). Association for Computing Machinery, New York, NY, USA, Article 18, 1–10. https://doi.org/10.1145/3421590.3421606

Veronica Cucuiat and Jane Waite. 2024. Feedback Literacy: Holistic Analysis of Secondary Educators' Views of LLM Explanations of Program Error Messages. In Proceedings of the 2024 on Innovation and Technology in Computer Science Education V. 1 (ITiCSE 2024). Association for Computing Machinery, New York, NY, USA, 192–198. https://doi.org/10.1145/3649217.3653595

John Hattie. 2010. Visible learning: a synthesis of over 800 meta-analyses relating to achievement (reprinted ed.). Routledge, London.

Martina van Heerden. 2021. (How) do written comments feed-forward? A translation device for developing tutors' feedback-giving literacy. Innovations in Education and Teaching International 58, 5 (2021), 555–564. https://doi.org/10.1080/14703297.2020.1788411

Karl. Maton. 2013. Making semantic waves: a key to cumulative knowledge-building. Linguistics and Education 24, 8-22 (2013).

Angela J. McLean, Carol H. Bond, and Helen D. Nicholson. 2015. An anatomy of feedback: a phenomenographic investigation of undergraduate students' conceptions of feedback. Studies in Higher Education 40, 5 (2015), 921–932.

K. J. Rohlfing *et al.*, "Explanation as a Social Practice: Toward a Conceptual Framework for the Social Design of AI Systems," in *IEEE Transactions on Cognitive and Developmental Systems*, vol. 13, no. 3, pp. 717-728, Sept. 2021, doi: 10.1109/TCDS.2020.3044366.

Jane Waite, Eirini Kolaiti, Meurig Thomas, and Karl Maton. 2024. Constructing feedback for computer science MCQ wrong answers using semantic profiling (Discussion Paper). In Proceedings of the 23rd Koli Calling International Conference on Computing Education Research (Koli Calling '23). Association for Computing Machinery, New York, NY, USA, Article 39, 1–9. https://doi.org/10.1145/3631802.3631803

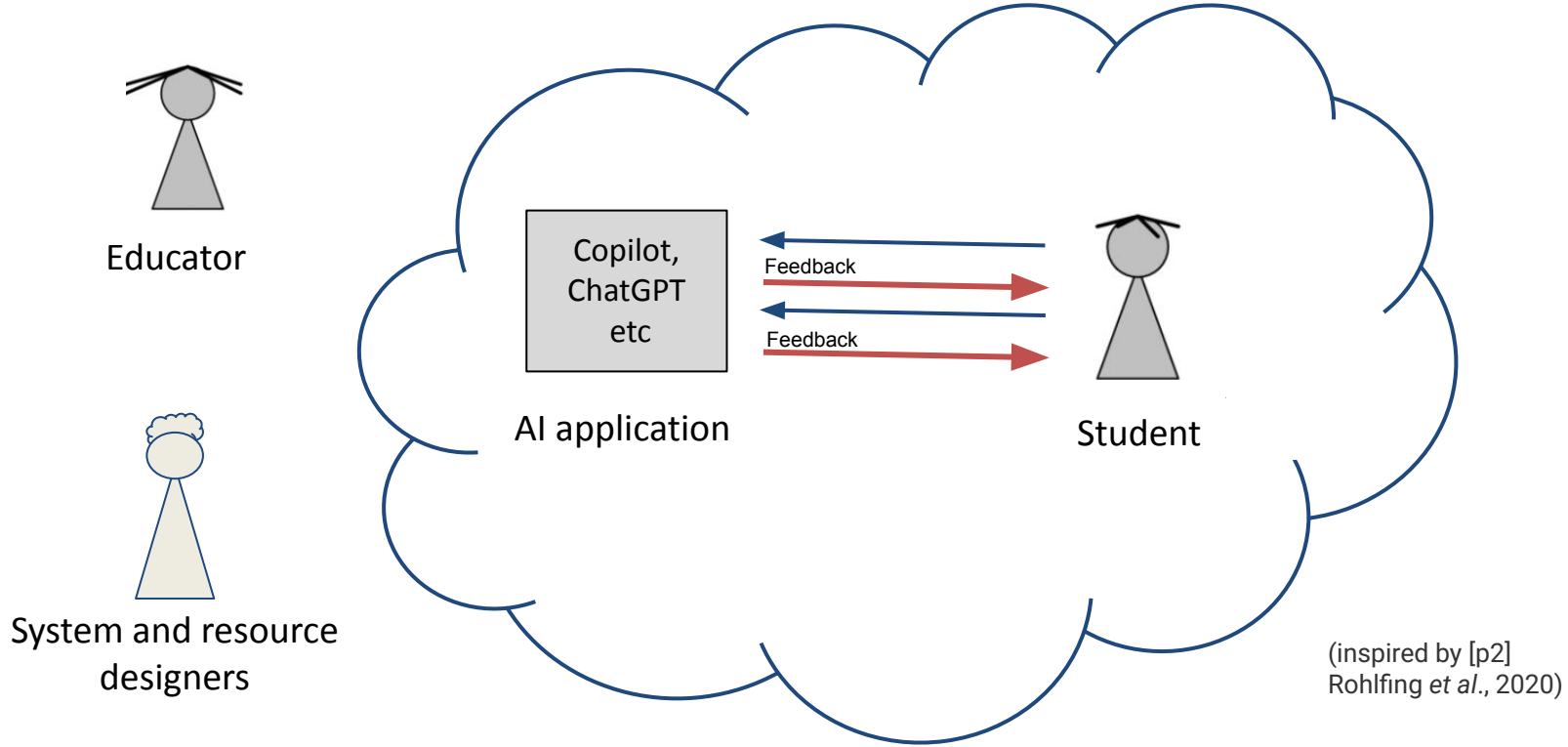
Jane Waite, Karl Maton, Paul Curzon, and Lucinda Tuttiett. 2019. Unplugged Computing and Semantic Waves: Analysing Crazy Characters. In Proceedings of the 2019 Conference on United Kingdom & Ireland Computing Education Research (UKICER '19). Association for Computing Machinery, New York, NY, USA, Article 4, 1–7. https://doi.org/10.1145/3351287.3351291

Research questions

RQ1: What are secondary educators' views on the potential classroom use of LLM program error message explanations?

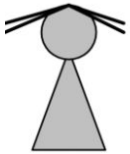
RQ2: In what ways can a feedback literacy perspective support the analysis of educators' views of potential classroom use of LLM program error message explanations?

Our context: An ecosystem for AI interaction in education



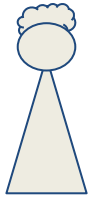
(inspired by [p2] Rohlfing *et al*., 2020)

AI interaction literacy in education - Feedback literacy

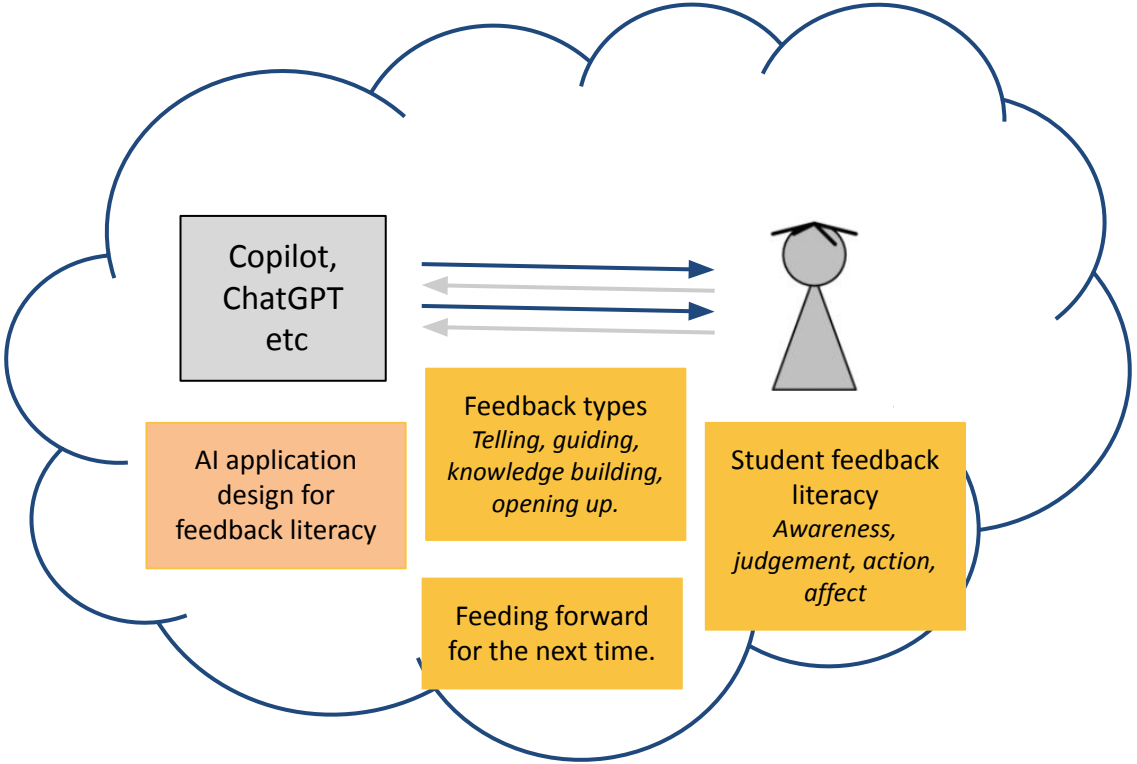


Educator

Educator and designer feedback literacy
Design, relational, pragmatic



System and resource designers

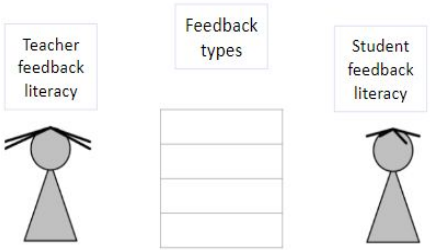


Teacher feedback literacy

Teacher feedback literacy requires the teacher to

- design the feedback within the learning context
- take account of the relational aspects
- be pragmatic about feedback

(Carless & Winstone, 2023)



Student feedback literacy

Student feedback literacy requires students to

- appreciate feedback processes
- make judgements
- take action
- manage affect

(Carless, 2018)