Coding Scheme for "Generative Artificial Intelligence in Secondary STEM Education in the Light of Human Flourishing: A Scoping Literature Review"

General Information

Publication Type

Code	Category	Short description
J	Journal	Publication published in a journal
C	Conference	Publication published in a conference proceeding or presented at a conference and published elsewhere online
P	Preprint	Publication not yet published, but available online

Publication type is coded at the time of full-text reading, i.e. publications might have been retrieved as preprints initially, but are coded as J or C here.

Journal/Conference Type

Only applicable for J and C

Code	Category	Short description
1	Education in one STEM discipline	Journal/conference focusses on education in one STEM disciplines (e.g. *Journal of Mathematics Education*).
2	Education in several STEM disciplines	Journal/conference focusses on education in several STEM disciplines, including journals and conferences on science education (e.g. *Science Teacher*)
3	Education in general	Journal/conference focusses on education in general (e.g. *Frontiers in Education*)
4	Education & Technology	Journal/conference focusses on education in conjunction with technology (e.g. *International Journal of Artificial Intelligence in Education*) If journals/conferences focus on one or several STEM disciplines in conjunction with technology, do not code here, but code 1 or 2 respectively.
5	Technology	Journal/conference focusses on technology, including Human-Computer-Interaction (e.g. *Informatics*).
6	Other	

Countries of Authors

The country of each author of a publication is coded.

Month/Year

For journal publications, month and year of (online) publication are coded. For conference publications, month and year of the conference are coded. For preprints, month and year of the last update on a preprint publishing website (mostly ArXiv) is coded.

Methodology

Publication Type and Research Method

Code	Category		Short description
1	Original Research		Publication includes collection and analysis of data with the methodology outlined in the publication.
	1a	qualitative	Publication uses qualitative methods.
	1b	quantitative	Publication uses quantitative methods.
	1c	mixed or multi-method	Publication uses both qualitative and quantitative methods.
2	Theoretical analysis		Publication elaborates on a theoretical or philosophical argument.
3	Review		Publication reviews (and synthesizes) existing research.
4	Editorial		Publication denoted as editorial
5	Position Paper		Publication denoted as position paper
6	Report		Publication reports on the development of a generative AI tool or on the implementation of a teaching unit without a systematic methodology, data collection and analysis.

Data Source

Code	Category	Short description
1	Survey	Publication collects data through a survey.
2	Interview	Publication collects data through interviews or group discussions.
3	Questionnaire	Publication collects data through a questionnaire.
4	AI-generated content	Publication collects data from AI-generated content.
5	Test	Publication collects data through a test.
6	Observation	Publication collects data through observations.
7	Audio/Video Recording	Publication collects data through audio or video recordings.
8	Student work	Publication collects data through student work (e.g., prompts, reflection diaries, filled out worksheets).
9	Log data	Publication collects data through interaction logs. Only quantitative log data is coded here; Chatlogs are coded as 4+8
10	measurements	Publication collects data through other measurements.

Participants

Code	Category	Short description
1	Students	Publication involves students as participants.
2	Teachers	Publication involves teachers as participants.
3	Pre-service teachers	Publication involves pre-service teachers as participants.
4	other humans	Publication involves other participants (e.g., parents).
5	no humans	Publication does not involve human participants.

Other

Discipline

Code	Category	Short description
S	Science	Publication focusses on science education without mentioning a specific science domain (e.g. physics).
B	Biology	Publication focusses on biology education.
C	Chemistry	Publication focusses on chemistry education.
P	Physics	Publication focusses on physics education.
ES	Earth Science	Publication focusses on earth science education.
T	Technology	Publication focusses on technology education, including computer science education.
E	Engineering	Publication focusses on engineering education.
M	Mathematics	Publication focusses on mathematics education.
STEM	STEM	Publication focusses on STEM education with no further specification of disciplines. If a contribution focusses on, e.g. mathematics and physics, do not code here, but code M and P

AI Tool

Code	Category	Short description
1	Standard AI Tool	Publication uses a publicly available, standard AI tool (e.g. ChatGPT) or does not refer to a particular AI tool.
2	Non-standard AI tool	Publication uses a fine-tuned or self-developed AI tool or a tool using retrieval augmented generation (RAG).

Research Directions

Code	Category	Short description
1	Theoretical frameworks	Publication develops and/or analyzes theoretical frameworks regarding generative AI in STEM education.
2	Evolution, future directions & trends and philosophical considerations	Publication explores the development of generative AI in STEM education so far or addresses future trends, prospects and directions or philosophical issues.
3	Pros & cons	Publication analyzes different pros and/or cons, i.e. potentials and/or challenges, of generative AI in STEM education or within a particular aspect of STEM education from the perspective of research (i.e., not teacher or student perspectives on pros and cons).
4	Tool development	Publication develops and possibly tests/evaluates a generative AI system, algorithms/technical approaches, or a STEM educational dataset or fine-tunes an existing generative AI system for STEM education. This may include testing with human participants, but only for the sake of evaluating the tool.
5	Performance	Publication evaluates the performance of a publicly available generative AI system for STEM teaching and learning purposes. There may be implications drawn for the application of generative AI in STEM teaching and learning settings, but they are based on the performance evaluation and not on the interaction of participants (i.e., students, teachers, PSTs) with the tool.
6	Ethical considerations & academic integrity	Publication investigates ethical issues of generative AI in STEM education or potential threats of generative AI to academic integrity, including the presentation of theoretical guidelines.
7	Awareness, attitude & acceptance	Publication explores teachers' and students' awareness and acceptance of generative AI in STEM education as well as their attitudes towards generative AI in STEM education.
8	Application & impact	Publication explores and elaborates on one or more applications of generative AI for teaching and learning in STEM classrooms as well as their impact on various factors, including changes in teacher roles, learning outcomes and students' perceptions of a concrete application.
9	Educational research	Publication explores possibilities to use generative AI in research on STEM education, e.g., for data analysis.

SWOT Analysis

Category	Short description
Strength	Property of generative AI systems that is conducive to the teaching and/or learning of the respective STEM discipline(s) in secondary education
Weakness	Property of generative AI systems that is obstructive to the teaching and/or learning of the respective STEM discipline(s) in secondary education
Opportunity	Influence of generative AI systems on teachers and students that fosters the teaching and/or learning of the respective STEM discipline(s) in secondary education
Threat	Influence of generative AI systems on teachers and students that inhibits the teaching and/or learning of the respective STEM discipline(s) in secondary education