AI Avenues for Future Research and Teaching Practice on Digital Feedback

Jennifer Schluer

Abstract *Recent developments in the field of Artificial Intelligence (AI) have sparked vivid debates in academic discourse and teacher education. To promote a responsible and critical use of AI in education and other areas of life, AI literacy needs to be cultivated among teachers and students. Extending the discourse from the foregoing contributions, this closing chapter explores additional AI avenues for digital feedback, including the assessment of speaking skills, text comprehension, presentations, lesson planning, and teaching performance. Despite ongoing progress, challenges persist, which might be overcome through future work. The chapter therefore not only reviews current affordances and limitations, but concludes by offering suggestions for future research and teaching practice to further seize the potentials of AI for feedback purposes.*

Keywords *artificial intelligence; digital feedback; AI literacy; technology-generated feedback; generative AI*

1. Introduction

The past years have witnessed rapid developments in the field of Artificial Intelligence (AI), which seem to "revolutioniz[e] the realm of education" (Fakher Ajabshir, 2023, p. 107). Especially since the public release of ChatGPT in November 2022, numerous new tools and features have been launched, with progressive improvements to overcome existing weaknesses and limitations. Even though the writing of this book spanned only one year, the evolution has been remarkable, leading to continuous updates of several chapters, notably those on chatbots (chapter 16 by Schluer in this volume) and the present one on additional AI applications. It is likewise possible that several further challenges described in this book will have been solved already when you open this book on your screen or hold it in your hands.

As I had already emphasized in my 2022 book on *Digital Feedback Methods*, "digital developments are dynamic and ongoing" (Schluer, 2022, p. 11) and therefore also the present book merely represents a snapshot of the field. Overall, it serves as an updated comple-

ment to the 2022 book in which I described fifteen digital feedback methods based on existing research papers and teaching practices. They have meanwhile grown to nineteen, as shown on the *Digital Feedback Map* (Schluer, 2023), which can be consulted as a dynamic resource for ongoing developments in the area of digital feedback.

To pave the way for future research and teaching practice, this edited volume contains findings from recent research projects as well as several ideas for incorporating digital feedback in teaching and teacher education. This closing chapter therefore explores some additional avenues of AI usage for feedback purposes. Examples include AI feedback on speaking skills and text comprehension, presentations, lesson planning, and teaching performance. It will also discuss still-prevailing limitations and close with suggestions for future research and teaching practice in the field of digital feedback.

2. Review of AI Affordances and Limitations for Feedback Purposes

2.1. Definition of AI

Originally coined by John McCarthy in 1956, Artificial Intelligence (AI) denotes the science and engineering of creating intelligent machines and computer programs that emulate human behavior and thinking (Stanford University, n.d., para. 2, quoted by Moya & Eaton, 2023, p. 3; see also Iftanti et al., 2023, p. 457; Dogidovic, 2007, p. 100, cited in Zawacki-Richter et al., 2019, p. 10). AI nowadays serves as an umbrella term that encompasses an increasingly growing range of technologies, including natural language processing (NLP), machine learning, neural networks and algorithms (as reviewed by Zawacki-Richter et al., 2019, p. 3). It has given rise to various applications, such as speech recognition systems, automatic writing evaluation (AWE), computerized dynamic assessments or learning analytics as well as chatbots and other virtual tutors or virtual realities (Fakher Ajabshir, 2023).

Accordingly, AI plays an increasingly important role in education (Chen et al., 2020), not the least due to its easier availability since the public launch of ChatGPT (see chapter 16 on chatbots by Schluer in this volume). In that respect, AI tools are often clustered into learner-facing, teacher-facing, or system-facing technologies (Baker & Smith, 2019, pp. 11–14, also cited by Zawacki-Richter et al., 2019, p. 4; see also Rudolph et al., 2023, pp. 350–352). The three terms already hint at the main user groups of these AI tools: Learner-facing AI tools are targeted at learners and offer personalized and adaptive support, such as through intelligent tutoring systems (Baker & Smith, 2019, p. 11). Teacher-facing tools, in turn, are targeted at teachers by providing them with data about students' progress and by automating tasks related to assessment and plagiarism detection, for instance (Baker & Smith, 2019, pp. 12–13). Finally, system-facing AI are intended to support administrative decision-making across courses or institutions (see Baker & Smith, 2019, p. 14).

With regard to assessment and evaluation, Bond et al. (2023) categorized AI support into six subgroups: (1) "the evaluation of student understanding, engagement, and academic integrity", (2) "automated grading and online exams", (3) "automated feedback", (4) "evaluation of teaching", (5) "evaluation of learning material", and (6) "the evaluation of

universities" (preprint p. 24). Thereby, most prior work focused on written assignments, with AI systems offering feedback to the learner, or the teacher using AI technologies to provide feedback to the learner. This contribution, however, explores further avenues in which AI might empower learners and teachers regarding a larger variety of tasks. Beforehand, commonly cited affordances and limitations of AI in education will be reviewed in the next sections.

2.2. Affordances

AI can facilitate feedback processes in various ways for both learners and teachers. One already established way to do so is through automated feedback systems which analyze student work and provide timely, personalized feedback (see e.g. the handbook by Shermis & Burstein, 2013). For example, automated essay scoring utilizes NLP techniques to assess the coherence, organization, and grammar of students' essays (Fakher Ajabshir, 2023, p. 98). These systems allow students to understand their strengths and weaknesses and may thus foster continuous improvement. As AI systems have the capacity to learn from previous input and experiences, the feedback and learning support is highly customized (Hooda et al., 2022, p. 2). The language learning app Duolingo, for instance, adaptively adjusts content difficulty and sequence based on learners' responses and offers tailored feedback to optimize learning outcomes. This adaptive and personalized approach ensures that students are appropriately challenged and receive relevant support.

Indeed, personalized learning was cited as the main advantage of AI in numerous studies (as reviewed by Bond et al., 2023, preprint p. 33). To elaborate, the top six benefits of AI in higher education were personalized learning, greater insight into student understanding, positive influence on learning outcomes, reduced planning and administration time for teachers, greater equity in education, precise assessment and feedback (Bond et al., 2023, preprint p. 28).

To exemplify, instructors can benefit from using AI-powered platforms and tools, e.g. Grammarly, PaperRater, and Turnitin, which help to streamline tasks such as feedback provision, plagiarism checks and grading (Chen et al., 2020; Zawacki-Richter et al., 2019, p. 4). This not only results in reduced paperwork and workload for instructors (cf. Baker & Smith, 2019, p. 15; Zawacki-Richter et al., 2019, p. 4), but also empowers them to devote more attention to their core duties, such as teaching, curriculum (re-)design, and learner support. In that regard, teachers may also use AI to generate lesson plans and course materials, e.g. additional tasks for differentiated instruction to cater for various learner needs (cf. Baker & Smith, 2019, pp. 11, 16). For instance, texts and tasks could be adjusted to different educational contexts, proficiency levels, and learning paces (cf. Fakher Ajabshir, 2023, p. 97). Furthermore, AI can help to monitor student progress and evaluate it more precisely (Grassini, 2023, p. 3; Gutiérrez et al., 2022, as cited in Iftanti et al., 2023, p. 457). In that respect, learning analytics help educators to discern patterns and trends about students' performance and progression as well as their own instructional effectiveness (Fakher Ajabshir, 2023, p. 100; cf. Hooda et al., 2022, p. 8). These insights should be utilized to inform targeted teaching interventions and enhance learning progress (Fakher Ajabshir, 2023, p. 100).

Furthermore, through chatbots and other AI tools, students can test their knowledge and train their competences autonomously, which may give them "a sense of control and ownership over their learning process" (Iftanti et al., 2023, p. 458). These applications offer manifold opportunities for language practice together with real-time responses and guidance for specific tasks and needs (Fakher Ajabshir, 2023, p. 96; Amin, 2023, p. 3; Iftanti et al., 2023, p. 456; Zawacki-Richter et al., 2019, p. 4). This way, AI tools can engage students in dialogues while providing scaffolded feedback and clarifications upon request (see chapter 16 by Schluer in this volume). The immediacy of the feedback can enhance the efficiency of the feedback loop. Moreover, the instant availability and resultant interactive (and often gamified) appeal of AI tools "can induce a state of flow in […] learners" (Iftanti et al., 2023, p. 462), thus encouraging further learning.

2.3. Limitations

However, certain challenges and limitations still prevail. Notably, they encompass concerns about correctness, ethics and academic integrity, equity issues, data security and privacy, overreliance on AI as well as a variety of inherent biases (Amin, 2023, pp. 6, 11; Ray, 2023; Gültekin Talayhan & Babayiğit, 2023, pp. 84, 86).

Despite the increasing amount of input that AI systems can process, they often lack a thorough understanding of the underlying concepts that users want to learn about (cf. Grassini, 2023, p. 6). Additionally, challenges in understanding the "nuances of human language and emotions" can lead to "contextually inappropriate suggestions" (Gültekin Talayhan & Babayiğit, 2023, p. 86, citing Haleem et al., 2022). Hence, the explanations AI tools provide could be inadequate, incorrect and insufficiently tailored to the users' individual needs and the misconceptions they might have (Grassini, 2023, p. 6). Also, the affective support of AI tools is limited, whereas human bonds in the classroom usually feel more genuine and motivating (cf. Kostka & Toncelli, 2023, p. 3).

Furthermore, there are concerns that AI may inadvertently promote dishonesty and threaten academic integrity (e.g. Crowe et al., cited by Chen et al., 2020, p. 75275). Educators also fear an overreliance on AI with severe consequences on learner autonomy and agency. Indeed, an excessive reliance on AI tools may hinder critical thinking, personal creativity, and the development of self-regulated learning skills among students (as reviewed by Gültekin Talayhan & Babayiğit, 2023, pp. 83, 86, 90).

Moreover, users are often concerned about data security and surveillance when AI tools are involved (Baker & Smith, 2019, p. 36). Financial constraints pose additional challenges to the widespread adoption of AI-based methods in education (Welham, 2008, p. 295, cited by Zawacki-Richter et al., 2019, p. 10). Further frequent drawbacks associated with AI in higher education are teachers' lack of AI literacy, the shift in authority, and required changes in curriculum development (Bond et al., 2023, preprint p. 30).

Another critical aspect is that AI systems may not adequately represent cultural diversity (Jeon, 2021, cited by Fakher Ajabshir, 2023, p. 108) and could struggle to provide precise feedback for learners with "non-standard accents or speech patterns" (Fakher Ajabshir, 2023, p. 102). In fact, there are typically many inherent biases pertaining to the types of texts, gender, language variants, cultures and time periods on which an AI system is based (see Ray, 2023; see also chapter 16 by Schluer in this volume). Without suf-

ficient awareness and critical inquiry efforts, such stereotypes could be perpetuated or even reinforced. These challenges underscore the importance of an ethical AI usage as well as the need for an adequate infrastructure and teacher training (Bond et al., 2023, preprint p. 30).

However, with the quick progress that is made in the field of AI, several limitations might be overcome in the near future. So far, AI feedback already seems to work reliably for certain writing tasks (especially regarding grammar, punctuation and vocabulary), but there are also some promising developments for other skill areas, as will be reviewed below (section 3).

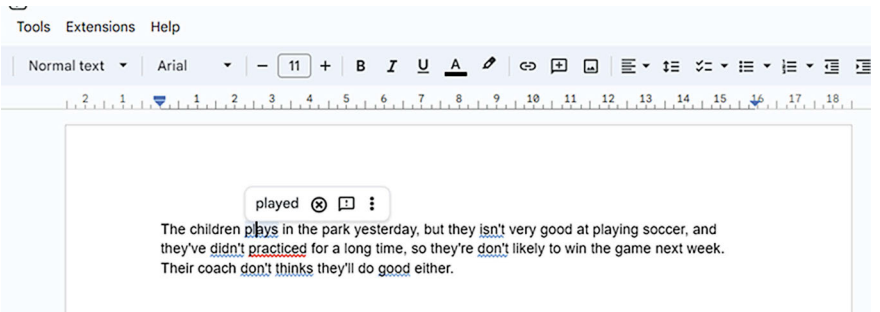
3. Implementation of AI Feedback for Learning and Teaching

So far, most of the existing literature focused on automated writing evaluation (AWE) and written corrections (see Schluer, 2022, pp. 78–91). However, there are also some promising future avenues for AI-powered feedback for a variety of skills, as will be outlined below.

3.1. AI Feedback on Writing

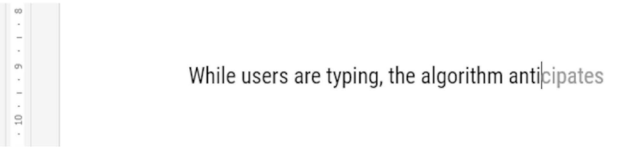
AWE utilizes NLP and AI to provide instant feedback on written compositions (Fakher Ajabshir, 2023, p. 98). Paired with critical reflection on the suggestions, it can be used by writers for self-assessment purposes (Gießler, 2024). While built-in spelling and grammar checkers in writing programs were highly error-prone in earlier years, there have been some noticeable improvements in recent years (Baker & Smith, 2019, p. 41; Schmidt & Strasser, 2022, p. 169). For instance, in writing programs such as Microsoft Word or Google Docs, users can obtain instantaneous suggestions to improve their written texts, including grammar and style (see Schluer, 2022, p. 82). As they type text, incorrect parts are underlined, and recommendations for improvement are shown as soon as users click on the words. An example from Google Docs is provided in Figure 1.

Figure 1: Text Corrections in Google Docs



Another feature that helps to craft texts and avoid spelling mistakes are "text predictions", e.g. in Microsoft Word. While users are typing, the algorithm anticipates the next words or word parts, which users can readily accept by pressing the Tab or Right-Arrow key, or discard by simply typing something else. Figure 2 is a screenshot of the word part that was predicted when I wrote the foregoing sentence.

Figure 2: Text Predictions in Microsoft Word



However, at present, text predictions only work for a limited number of expressions, especially collocations and those phrases that writers recurrently use. It does not predict longer sentences or entire paragraphs. With this restriction, there is still enough freedom for a creative use of language.

For feedback that extends beyond the word and sentence level, generative technologies, such as OpenAI's ChatGPT, can prove valuable (for details see chapter 16 on chatbots by Schluer in this volume). Users can type in a text and formulate a specific feedback request to obtain corrections or suggestions regarding grammar, word choice, coherence and conciseness (Kostka & Toncelli, 2023, p. 3). Moreover, generative AI technologies become increasingly "embedded in word processors and presentation software (e.g., Microsoft Co-Pilot)" (Moorhouse et al., 2023, p. 1). These developments are worth further observation and critical inspection in the near future.

At the time of writing this chapter, however, one of ChatGPT's biggest limitations was the inexistent or faulty incorporation of sources. By contrast, Bing AI (Microsoft Copilot) or Perplexity AI (https://www.perplexity.ai/) might even assist students during literature searches (see also Schluer, in prep.). As soon as users send a command to the system, Perplexity AI links websites and PDF files as references for its output and as suggestions for further reading. The sources are referenced in the output text and users can easily verify the correctness and appropriateness by consulting the hyperlinked resources. Often, these sources stem from websites whose trustworthiness needs to be verified by the users through critical reading. In a pop-up window, then, users can remove non-fitting or irrelevant resources to enhance the quality of the text. Moreover, Perplexity AI provides possible follow-up questions below the generated text to solicit further details and fine-tune the text. Nevertheless, as the output from generative AI is based on computational models, it might not accurately represent the complexities and ambiguities of human language and communication.

For instance, even though DeepL appears to be one of the best-working AI assistants for writing and translations, the suggestions do not always sound fitting or contextually appropriate. For example, when translating texts from German to English via the DeepL translator (https://www.deepl.com/translator/), it frequently preserves the nominalizations of the German source text instead of adopting phrasal sentence constructions in

English. However, the DeepL writing assistant (https://www.deepl.com/write) can help here to a certain extent, as it suggests stylistic recommendations that can be adjusted to different contexts of use (e.g. Academic English or Business English). Hence, by using different applications in concert, their strengths can be exploited and their limitations can be minimized. For this, however, a certain level of language proficiency and critical language awareness seems indispensable (see also Gießler, 2024).

3.2. AI Feedback on Speaking

To some extent, AI programs are already capable of providing feedback on speaking. However, they typically need to convert the spoken content into written form first. Hence, they rely on writing while bearing in mind the characteristics of spoken language. As automatic speech recognition (ARS) and automatic transcription have noticeably improved in the past years, feedback on speaking performance thus represents a promising future avenue. The AI system then "analyzes [learners'] speech patterns, identifies errors, and offers suggestions for improvement" (Fakher Ajabshir, 2023, p. 101).

For example, the app Kansei AI (https://kansei.app/) appears useful for practicing speaking skills and obtaining feedback on oral performance (Stannard, 2023, at https://youtu.be/naiYoRDoHLo). The interface and conversational style strongly resemble an instant messaging app, which allows for spoken and written chats. In this app, users can choose a life-like persona as their conversation partner and select a language as well as a proficiency level (beginner, intermediate, advanced). Moreover, they can choose a scenario to adjust the conversational style according to context (e.g. "as a friend", "as a coworker"). To start a conversation, learners record their speech, which is then automatically converted into writing. On that basis, the AI persona provides a response in writing, which can simultaneously be played back. Moreover, it engages users in follow-up conversations, which can motivate them to practice their writing and speaking skills further (cf. Fakher Ajabshir, 2023, p. 101). Apart from chatting, the persona automatically offers feedback on the learners' performance below the chat box, as depicted in Figure 3 and Figure 4.

Another noteworthy app is Speechmatics (https://www.speechmatics.com/). To facilitate multilingual communication and language learning, Speechmatics automatically transcribes spoken input and additionally offers live translations into another language. The dual coding of their spoken input and the transcription allows for a deeper consideration of their oral performance, as they can revisit it asynchronously. Moreover, by translating the text into a language they are more proficient in, they can check whether their speech conveys the intended sense (while being aware of potential inaccuracies of automated translations).

These technologies thus provide opportunities for (self-)assessment and language practice at different proficiency levels (Fakher Ajabshir, 2023, p. 101). They might also help to track progress over time (Inceoglu et al., 2023, cited by Fakher Ajabshir, 2023, p. 101). Similarly, educators could more effectively evaluate vocabulary usage, grammar, and pronunciation when speech and text are available simultaneously. They could pinpoint linguistic or stylistic errors in the transcript and add further feedback about students' oral performance.

Figure 3: Chat with AI Feedback in Kansei

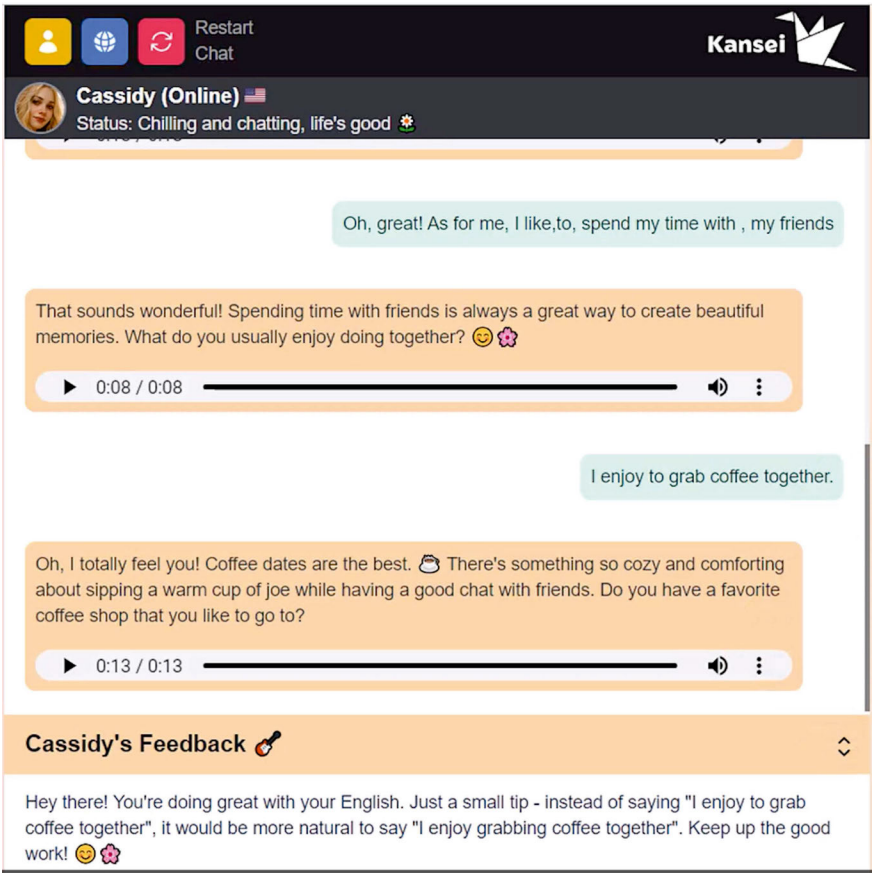
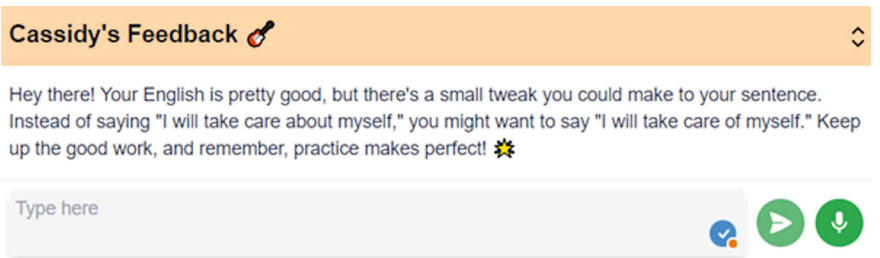


Figure 4: Feedback on Oral Performance in Kansei



However, most spoken AI feedback is still based on "standard" accents, such as British English or American English. There is thus much potential for future research to develop AI persona that are capable of conversing in a rich variety of English accents (see e.g. Ivanova, 2024, on Slavic English varieties, and Albrecht, 2024, on Chinese English varieties). This could help to make feedback dialogues with AI conversational agents sound more natural or authentic to the learners. Moreover, it might also support them in practicing listening comprehension when English is used as a lingua franca by speakers of different linguacultural backgrounds.

3.3. AI Feedback on Text Comprehension

There are also several AI tools available that summarize texts or answer questions about a text, such as DocGPT (https://docgpt.io/) or ChatPDF (https://www.chatpdf.com/). They assist users in understanding difficult texts, including research articles or textbooks. For instance, ChatPDF works directly in the browser and does not require any prior registration. By uploading a PDF of a publication, users are directly offered some guiding questions for text comprehension. This is what learners can use for self-study or what teachers could ask during classroom discussions. Moreover, users can pose these and other questions to the system to obtain relevant answers, as shown in Figure 5.

This AI tool can thus make difficult texts easier to understand. Ideally, learners try to answer their own or the suggested questions themselves before retrieving the responses by the AI system. The tool also works with other file types that can be converted into PDFs, such as presentations or texts that the students have written themselves. Thus, by uploading their own text draft to the AI system and reading the generated answers, writers can assess whether their text has been structured and formulated in a clear manner.

There are also further tools available that incorporate this technology, such as Monica's ChatPDF (https://monica.im/webapp/doc-chat/). In addition to identifying key information, summarizing texts and asking specific questions about it, the app offers translations into other languages. The PDF function, however, is only one feature of Monica (https://monica.im/), which is advertised as an "All-in-One AI Assistant". It relies on the generative technologies used by GPT-4, Claude and Bard, and can be installed as a browser extension. It serves to answer questions about any website, including YouTube videos and emails, as well as documents. It also functions as a "writing agent" to support text composition processes (see York, 2023, retrieved from https://youtu.be/uDXSkjucR3A). Furthermore, it can generate images based on the user's commands (AI painting).

Figure 5: Text Comprehension with ChatPDF

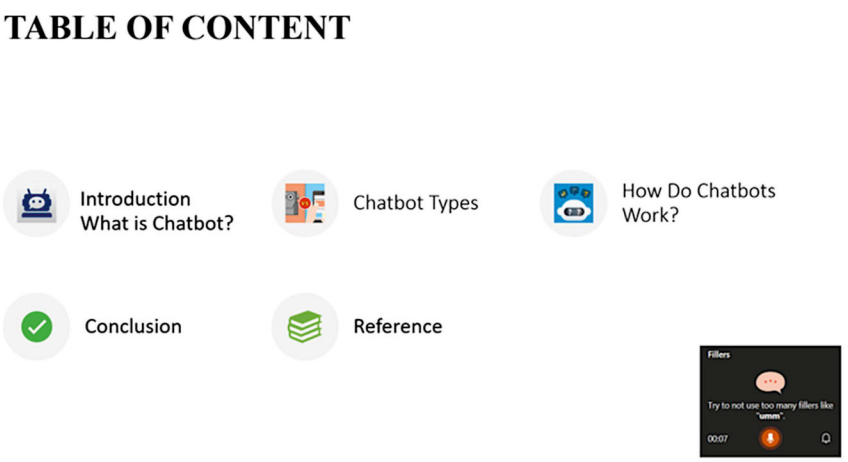
3.4. AI Feedback on Presentations

While presentations slides (or PDFs thereof) can be uploaded to various AI assistants, such as DocGPT, ChatPDF or Claude AI (https://claude.ai), for feedback purposes and text comprehension, there are also specialized tools for slide design and discussion. For example, Visme AI (https://www.visme.co/ai-presentation-maker/) is typically advertised as an effective tool for producing appealing marketing materials (presentations, documents, infographics, social media posts etc.), but it can also be used for enhancing presentations and other teaching materials in educational settings. With its comprehensive template library, intuitive interface and collaborative features, this tool can support teamwork and peer feedback processes during slide design (see Visme, 2020, at https://youtu.be/oQW813hJxsA). Visme AI assists students in the creation process, such as through its integrated tools "AI Writer" and "AI Image Generator". Moreover, creators can share the presentation link with their peers and instructors, who can add comments to specific locations on the slides by using various annotation tools, such as underlining, boxes, arrows etc. The creator and other collaborators can reply to the comments in discussion threads and mark them as resolved once they have been enacted or clarified.

The AI-powered design of presentation slides has also been tested with another application, Beautiful AI (https://www.beautiful.ai/). Through prompting, users can generate presentation slides. Thus, instead of running text, slides with key points and visualizations are created for presentation purposes. It seems to work with different types of charts and other illustrations pertaining to common knowledge. For example, when asked to create a word cloud of the planets in the solar system, it yielded a fitting visualization. Upon closer inspection, however, it also contained several general words that would need to be eliminated from the cloud, such as "gravity", "solar system" or "universe". Moreover, when prompted to generate a slide about digital feedback literacy, it only adduced four general points that did not deal with feedback in particular and also did not include any sources. Overall, it rather seems to be useful for slide design rather than slide contents, at least at the current stage of development.

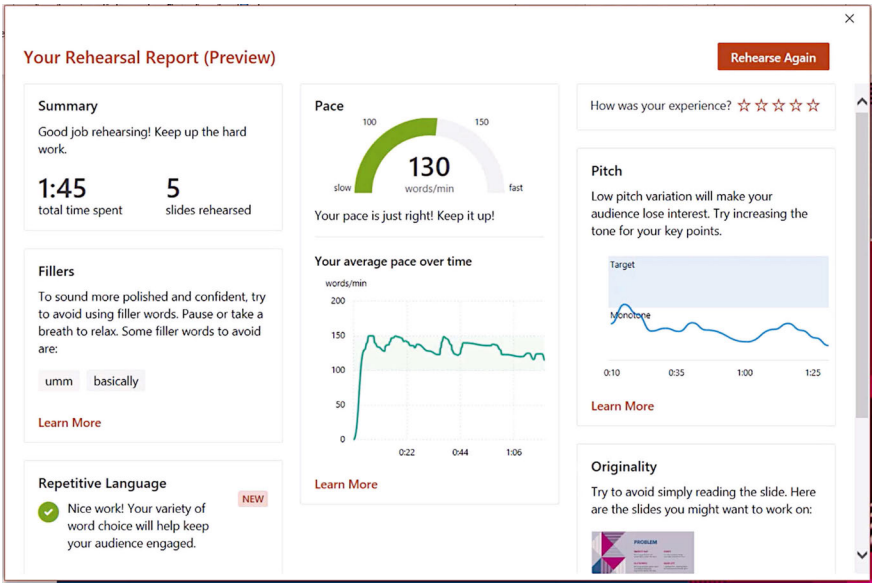
While the content-generation still has limitations, there are also useful AI tools for learners to rehearse their presentations and obtain immediate feedback about their performance. In Microsoft PowerPoint, users can activate the "Rehearse with Coach" function when practicing their presentation. When talking about the slide contents, users receive instant feedback about common shortcomings of presentations, such as the excessive use of filler words. As shown in the bottom-right corner of Figure 6, the tool suggests to the presenter that they should "try to not use too many fillers like 'umm'."

Figure 6: "Rehearse with Coach" Feedback in Microsoft PowerPoint



Moreover, the program provides a "Rehearsal Report" at the end (see Figure 7).

Figure 7: Rehearsal Report in Microsoft PowerPoint



3.5. AI Feedback on Lesson Planning and Materials Development

ChatGPT and more specialized AI tools can support (pre- and in-service) teachers in lesson planning and materials development (Amin, 2023, p. 2). They help to craft course outlines and tasks which are tailored to specific learning objectives and student needs (Amin, 2023, p. 2). For instance, to-teach.ai is a promising AI-driven application that

can help educators create customized lesson plans and task sheets for texts, images, videos and websites. With this tool, teachers can adjust various settings to create the most fitting lesson plans for their learners. Similarly, further applications such as autoclassmate.io or lessonplans.ai can assist in the creation and development of lesson plans. Even though such applications do not yet incorporate a feedback feature for drafted lesson plans, they could be combined with other tools (e.g. ChatGPT) to receive such feedback.

3.6. AI Feedback on Teaching

Especially for pre-service teachers, but also for continuous reflection and professional development, feedback on teaching performance is crucial. However, such feedback opportunities are typically severely limited to a few occasions of trial lessons, e.g. as part of teacher education or job applications. Moreover, teachers are often hesitant to invite colleagues or external persons to observe their lessons. Therefore, a less intrusive option could be granted by AI technologies. For example, with the TeachFX app (https://teachfx.com/), teachers can record a lesson, provided that all required permissions for such a recording have been obtained. The app then evaluates the session and creates a detailed report, together with feedback on instructional practices. For example, it generates word clouds of the words that the teacher and the students mostly used during the lesson, together with reflective questions, e.g. "Does this vocabulary reflect your objectives for this lesson?" (TeachFX, 2022, at https://youtu.be/QIL6mQGDTME). The aim is to improve teaching and increase student engagement and learning.

Another possibility would be the use of AI feedback in classroom simulations. For instance, Kirubarajan et al. (2022) focused on personalized and automated (preferably real-time) feedback in medical training (surgical). In other words, medical students received feedback from an AI in a simulation. However, a specific name of an AI tool was not mentioned. Through a brief web search, the simulation app Simofun (https://www.simofun.com/siminclass) was found. It utilizes virtual and augmented reality to help teachers practice classroom interactions with 3D student avatars. The app considers various aspects of classroom management and evaluates instructor performance, complemented by suggestions for further improvement. Based on the training history, trainee teachers can also obtain feedback on their progress.

With further advancements in AI technologies, it is likely that the quality and scope of feedback will be improved for the benefit of teachers and learners.

4. Discussion

This chapter has shown that AI technologies offer unprecedented possibilities for personalized feedback on a variety of skill areas. However, there are several challenges that still need to be addressed adequately. This section will therefore outline some suggestions for future research and teaching in the field of AI-enabled feedback practices.

4.1. Suggestions for Future Research

Future research on AI feedback should take a multifaceted and transdisciplinary approach to enhance existing affordances while reducing still-prevailing limitations.

Firstly, the reliability and accuracy of AI-generated responses needs to be improved continuously (Amin, 2023, p. 11; Fakher Ajabshir, 2023, p. 108). In that regard, studies should elicit practices and perceptions from a diverse range of teachers and students in different disciplines, educational institutions and sociocultural environments (cf. Gültekin Talayhan & Babayiğit, 2023, p. 91). AI feedback in heterogeneous and multilingual classrooms could be a particularly fruitful avenue (Amin, 2023, p. 11). Moreover, ethical guidelines for utilizing AI in education need to be established and enacted (Fakher Ajabshir, 2023, p. 108). In that respect, a balanced and human-centered AI approach that focuses on fostering learners' agency and critical thinking appears crucial.

An exploration into multimodal AI avenues, such as Virtual Reality (VR) and game-based learning, is another promising area for investigation. While VR holds potential in mitigating language learning anxieties, its high cost and limited accessibility necessitate critical consideration (see the review by Fakher Ajabshir, 2023, p. 106). Moreover, game-based learning might facilitate collaborative learning through social interactions among learners but it requires more research into its effectiveness (Fakher Ajabshir, 2023, p. 104). As far as feedback processes are concerned, much game-based learning or gamified language learning apps still need to move beyond mere error correction.

Additionally, it is essential to investigate students' actual learning gain (Fakher Ajabshir, 2023, p. 108) as compared to and when combined with other feedback methods. Research in this area will also help to derive recommendations for feedback practices, which will be considered next.

4.2. Suggestions for Teaching Practices and Policies

As Baker and Smith (2019, pp. 41–42) emphasize, AI is not only changing the "how" but also the "what" of assessment. Instead of putting a focus on knowledge-testing, feedback should ideally encourage learners' critical thinking and foster their problem-solving skills (Baker & Smith, 2019, p. 42).

With critical thinking having become more fundamental than ever before, teachers should engage in dialogues with their students to reflect on the affordances and limitations of AI (Kostka & Toncelli, 2023, p. 13) and to encourage its judicious usage (Rudolph et al., 2023, p. 355). Together with their students, educators should discuss and co-create guidelines for AI use in their courses (Kostka & Toncelli, 2023, p. 12; cf. the review by Moorhouse et al., 2023, p. 8). They could explore AI tools in the classroom to become aware of their limitations and possible areas of use (Spannagel, 2023, p. 1). Indeed, in Moorhouse et al.'s (2023) review of official guidelines, most of them recommended the implementation of "an assessment task that requires students to generate responses on tools such as ChatGPT and then critique their responses" (p. 7).

Provided that their use is not prohibited, students need to acknowledge their usage of specialized AI tools for assignments and cite them appropriately (MU guideline, quoted in Moorhouse et al., 2023, p. 7; Spannagel, 2023, p. 1). However, it is crucial for the stu-

dents to realize that, in the end, they will be held accountable for any errors that might have been produced by the AI tool (Spannagel, 2023, p. 1). It is therefore their responsibility to verify the correctness of the information that the AI system has provided (Foltýnek et al., 2023; Peres et al., 2023; both cited by Moya & Eaton, 2023, p. 4; Spannagel, 2023, p. 1). As Spannagel (2023) emphasized, "[t]he tool does not think *for you*, but *you think with the help of the tool*" (p. 1; original emphasis).

To make appropriate assessments, AI feedback crucially needs to be combined with human judgment, including the students themselves, their peers, their teachers and potentially further relevant persons (e.g. mentors in teacher education) (cf. Baker & Smith, 2019, p. 44). Collaborative learning projects, peer feedback and group discussions appear beneficial to this end (Amin, 2023, p. 5).

Altogether, AI literacy is an emerging key notion in the area of digital literacy (e.g. Rütti-Joy et al., 2023). As digital technologies have become an integral part of everyday life and many professional contexts, it is vital to build students' capacities "to use, understand, and critically assess various digital tools" and diverse sources of information while being acutely aware of potentially biased output and security threats (Amin, 2023, p. 5; see also Moya & Eaton, 2023, p. 4). Consequently, it is essential for teachers and students to use AI in a responsible and ethical manner (Rütti-Joy et al., 2023, p. 175; cf. Kohnke et al., 2023, p. 10). In that respect, the so-called 4Ms and 4Cs frameworks might serve as a useful orientation.

The "4 Cs" are four fundamental skills needed for 21st-century learning (Trilling & Fadel, 2009). They include critical thinking, communication, collaboration, and creativity. The first C, "critical thinking and problem solving", involves students' ability to actively filter, analyze, synthesize and question information from diverse sources to construct meaningful understandings and solutions (Partnership for 21st Century Skills, 2009; cf. Anugerahwati, 2019, p. 166). The second C, "creativity and innovation", underscores a person's capacity to generate novel ideas individually and collaboratively, be open towards new perspectives and implement as well as assess innovations for continuous improvement (Partnership for 21st Century Skills, 2009). The third C, "communication", entails the ability to effectively convey ideas and information in a concise, clear, and coherent manner (Anugerahwati, 2019, p. 166) as well as in different media and modes (and languages). It also comprises attentive listening and meaning negotiation in interpersonal interaction (Partnership for 21st Century Skills, 2009). The fourth C, "collaboration", requires proactive engagement with others and denotes the ability to utilize their distinct personalities, talents and expertise effectively and responsibly to synergistically produce better outcomes that benefit the community (Anugerahwati, 2019, p. 166; Partnership for 21st Century Skills, 2009). Collaboration can thus cultivate creativity and rests on effective communication skills (Tom, 2015, p. 24), which underscores the manifold connections between the different Cs.

The "4Ms", in turn, emphasize that changes need to occur at all organizational levels in interconnected ways (micro, meso, macro, mega). These levels span from individual behaviors and actions to broader institutional and societal contexts (as reviewed by Moya & Eaton, 2023, pp. 6–10; Schmohl et al., 2023, pp. 10–11). More precisely, the micro-level refers to the realm of the individual practitioner and involves an understanding of how individuals could contribute to learning and organizational change (Moya & Eaton,

2023, p. 6). Here, it is worth investigating teachers' and students' use of AI in concrete learning settings (Schmohl et al., 2023, p. 10). Second, the meso-level relates to support units, networks, departments or committees that seek to transform policies into actions (Moya & Eaton, 2023, p. 6). For instance, AI could become part of curricula which are then enacted at the micro-level (Schmohl et al., 2023, p. 11). Both informal and formal faculty peer coaching and mentoring could be conducive in that regard (Moya & Eaton, 2023, p. 10). Moving to the macro-level, the focus shifts to the policies and processes that are set by an organization, e.g. the official guidelines on AI usage that were released by the university (Moya & Eaton, 2023, p. 6; Schmohl et al., 2023, p. 11). Finally, the mega-level pertains to practices at larger (e.g. national or global) levels (Moya & Eaton, 2023, p. 6). For example, guidelines issued by the European Commission or the UNESCO on AI would become relevant here.

It is also clear that processes of change cannot solely be driven by top-down processes at mega- or macro-levels, but likewise need to incorporate practices and challenges found at micro- and meso-levels. Altogether, this can lead to a more holistic and inclusive approach to fostering AI literacies in educational contexts and beyond.

5. Conclusion

In conclusion, the integration of AI feedback into teaching and learning processes necessitates a balanced and thoughtful approach (cf. e.g. Fakher Ajabshir, 2023, p. 101). While AI offers numerous advantages, its implementation should be coupled with critical thinking and verification procedures to ensure pedagogical effectiveness and an ethical use. In that respect, it is crucial to "strik[e] a balance between AI assistance and […] student agency" (Darvishi et al., 2024, p. 12) as well as human interaction (Amin, 2023, p. 12), which can be achieved through the development of AI literacy (Rütti-Joy et al., 2023). AI could be incorporated into single courses and curricula in a needs-based and iterative matter through collaborative dialogue between students, teachers and other relevant stakeholders (cf. Rütti-Joy et al., 2023, p. 183).

While AI presents unprecedented possibilities for learners through automated feedback provision, it is nevertheless crucial to recognize the essential role of teachers and peers to establish social relations and exchange personalized feedback, which in turn can boost learners' confidence (Schmied, 2023, p. 6). Likewise, AI can strengthen students' self-regulated learning through customized feedback and learning recommendations. AI might also help learners develop a sense of agency as they are no longer reliant on teachers as the sole source of feedback (cf. Iftanti et al., 2023, p. 458). As with all other digital feedback methods, there is thus a widespread consensus that AI feedback needs to be used in conjunction with other digital and non-digital sources of feedback to gain a deeper understanding in a variety of skill areas and knowledge domains (see Schluer, 2022).

With these new developments, also the "Digital Feedback Map" (Schluer, 2023) is likely to grow further, even beyond the official project duration (09/2022–11/2023). For example, a video tutorial about "AI feedback on speaking and writing" via the Kansei app was added in December 2023. Moreover, a transdisciplinary project between the

humanities and the natural sciences is taking place since summer 2024 (Schluer & Meier, 2024), which is likely to produce additional inspirations for future research and teaching practice in the ever-growing field of digital feedback.

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