Patterns of Adoption and Learning: Students' Relationships with Generative AIs

Bente Meyer, Ulla Højmark Jensen and Sara Paasch Knudsen
Department of Culture and Learning, Aalborg University, Copenhagen, Denmark

bentem@ikl.aau.dk
Ullahj@ikl.aau.dk
spk@ikl.aau.dk

Abstract: Generative AIs have become part of increasingly intimate relationships between humans and technologies, and have created both serious concerns and heightened pedagogical interest in higher education. However, though interest in generative Ais and their contribution to education is spreading, little is still known about how they are used by students in their everyday lives and how this affects education. In this paper we investigate how GAIs such as ChatGPT enter students' lives and become part of their learning. The paper draws on observations and interviews with students in a Master Program where students partnered with ChatGPT to investigate concepts and philosophical aspects of technology. The aim of the study was to understand how ChatGPT could support students' collaborative group work as part of problem-based learning practices. As our study involved investigations of students' everyday uses of generative AIs as well as their learning we were able to make connections between students' learning strategies and their emerging experiences with GAI technologies. In the paper we investigate these relationships focusing on how GAIs are enrolled and participate in students' lives and in collaborative learning contexts where uses and understandings of GAI technologies are negotiated in group sessions. Our data suggest that some students enter education with extensive experiences with generative AIs and others commence their engagement after meeting these technologies through education. What characterizes these patterns of adoption - and what are their effects on learning? Theoretically, we draw on sociomaterial approaches to understand GAIs as material agents in students' lives and in education building on the concepts of *patterns of relations* and *distributed agency*. These concepts emphasize the collaborative relationship of humans and GAI technologies, underlining both the specifics of GAIs as 'human-like' agents and the blurring of agencies and authorship involved in e.g. AI-generated writing.

Keywords: GAIs in higher education, Students' perspectives, Sociomateriality

1. Introduction

In this paper we investigate ways in which Generative AIs (GAIs) become part of and act as material agents in students' everyday lives, emergent work practices and academic activities. Our research contributes with empirical knowledge to studies in the high-paced development and dissemination of GAIs currently affecting higher education. This is a development that has initially created serious concerns for academia, however, the discourse of concern is increasingly paired with empirical research in the learning potentials of GAI. Drawing on interview data from a Master Program in *ICT Learning and Organizational Change* our research therefore contributes to this emergent field of research by investigating the specifics of how GAIs enter, form and affect higher education in the context of relationships between students and GAIs. In addition to this we argue that GAIs should be made controversial, ie critically addressed in terms of their stability and unity in and outside of education.

In the paper we ask *What characterizes students' relationships with GAIs - and what are their effects on learning*? In investigating this question we attach specific significance to how GAIs are involved in both students' private lives, work and education, providing a complex qualitative perspective on practices of use.

2. Data and Methodology

Our paper builds on data from a course in *Concepts and philosophical aspects of technology* (5 ECTS) at a Danish university in Copenhagen. The course was part of a Master Program (MSc) in *ICT, learning and Organizational Change* that builds on problem-based learning practices (Savin-Baden 2014). Problem-based learning is a broad concept that in our case is defined by a focus on problem-solving and collaborative group work (Ryberg et al 2018). For the course students were asked to work with ChatGPT in different ways during group work in class in order to reflect on eg ethical perspectives and uses of GAI in education, understanding concepts of technology relevant for the course, and assessing frameworks for responsible innovation (see Figure 1). Students were in each case asked to reflect on feedback given by ChatGPT to specific prompts formulated either by the teacher or through their own prompting strategies, and to upload reflections to Moodle. Prior to teaching, the students were asked to create a profile at https://chatgpt.com/ and recommended to check university regulations for using GAI. Groups were organized at the outset, each comprising 3-4 students and totaling 56 students. Group work was followed up by mandatory written work focusing on further uses of ChatGPT for exploring learning

and technology adoption. 4 students did not give consent, which meant that 52 students participated in the research.

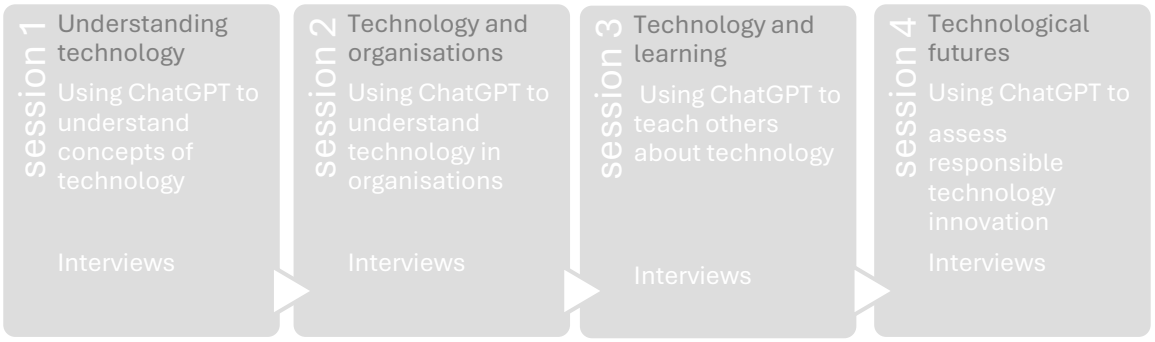

Figure 1: The 5 ECTS course Concepts and philosophical aspects of technology

The purpose of our study was to understand how ChatGPT can support students' group work and reflections on the role of technology in society and in learning. Data collections were organized as observations of group work and subsequent group interviews with students in 11 groups during a 25-minute break purposely placed near the end of the 4-hour session (Davies 1999, Halkier 2020), totaling approx 4,5 hours of interviews. Data collection and teaching was done in a team of 5 colleagues, all of which were known to the students from other modules as either teachers or supervisors[1]. One person had from the outset had the role of teacher and the others acted as interviewers and observers, usually two or three at a time. Meetings were held before, during and after the course in order to discuss common themes and frameworks for the research.

Our observations and interviews were supported by audio recordings and notes and focused primarily on students' prior experiences with GAI and the social dynamics of students' group work with ChatGPT. For both observations and interviews we had a special interest in investigating practices of inquiry, dialogue and collaboration in group work where students were asked to use ChatGPT as part of their collaborative work (Hetherington & Wegerif 2020, Miettinen 2000). We also focused on ways in which students spoke about GAI, ie ways in which the technology was anthromorphized (made human) or given specific roles in the group (Placani 2024, Mollick & Mollick 2023). This was based on the expectation that the participation of ChatGPT in problem-based group work would affect ways of interacting and engaging with knowledge, as well as possibly group dynamics and roles. For the interviews we asked students about their group work, but also their everyday uses of generative AI, ie for work and private purposes. This gave us insights into students' adoption practices and their prior knowledge about GAIs as a possible framework for using ChatGPT for learning.

In this paper we focus primarily on the interviews, as group interviews gave us significant insights into students' patterns of adoption of GAI not only in education but in their everyday lives, contributing to a holistic understanding of what characterizes students' relationships with GAIs and how this affects learning.

3. Adoption and Learning - Sociomaterial Perspectives

In the paper we focus on adoption and learning through sociomaterial perspectives that can help us capture the ways in which GAIs participate in the social dynamics of interaction and learning (Bearman & Ajjawi 2023, Godwin-Jones 2024, Johri 2022, Ou et al 2022, Suchman 2023, Sørensen 2009). Drawing on sociomaterial approaches we first of all understand relationships between students and GAIs in a posthuman perspective, ie we view GAIs and humans as collaboratively involved in producing knowledge through interaction. As described above, GAIs are often associated with human-like agency, blurring the boundaries between humans and technologies as agents in education and learning. Secondly, we use sociomaterial perspectives to focus on the materiality of learning, ie on ways in which GAIs and other materials in learning participate in forming adoption and learning activities. Sørensen (2009) describes sociomaterial relationships as patterns of relations which are particular arrangements of social and material components that make up spaces of learning. As a concept, patterns of relations point to the idea that connections are dynamic and that relationships are more than their

[1]Participating researchers were in addition to authors of this paper, research assistants Clara Laimer, and Jane Retz Jespersen

parts. GAI adoption can thus be seen as a pattern of relationships between humans and computational artefacts in a particular moment of time (Bearman & Ajjawi 2023). These are relations that often affect ecosystems of learning, ie ways in which knowledge is produced and distributed in higher education (Godwin-Jones 2024).

With regard to the materiality of learning a number of publications point to the fact that GAIs as material agents alter the way we think about education and knowledge. Peters et al (2023) for instance underline that GAIs can be understood as amplifiers of the human but also as new forms of intelligence that challenge human-centered learning. Johri (2022) similarly argues for an understanding of AI as fundamentally shifting the role of humans in learning practices, as these technologies "… can enact attributes that have largely been associated with a human and with social norms more broadly" (2022, 3). Finally, Suchman (2023) argues that the thinginess and stability of AI as a phenomenon needs to be made controversial, ie critically addressed. Thus she calls for "a keener focus on the locations, politics, material-semiotic specificity, and effects…of AI as a singular and controversial object" (2023, 4).

In addition to these theoretical insights, we build on existing research in GAI in higher education. These are studies that to a large extent focus on individual learning opportunities e.g. potentials for personalized learning, brainstorming, immediate feedback, and prompt literacies as well as ways in which GAIs challenge academic integrity, writing and assessment practices (Stöhr et al 2024, Hwuang et al 2023, Williamson et al 2023, Coeckelberg & Gunkel 2023).This research is still emerging and empirical studies, specifically with a qualitative approach, are still limited (Bruun et al 2024).

4. Analysis

Based on our data and a sociomaterial perspective we can describe different patterns of relations involved in generating GAI adoption. These are patterns in which GAIs are seen as agentic, ie we focus on what humans and AIs do together and how this contributes to forming knowledge and learning (for instance in higher education). This is an approach that differs from seeing GAIs as generalized computational artifacts with specific affordances.

For purposes of analysis and organization of our material we propose two ways of approaching patterns involving students' relationships with GAIs. These are patterns related to students' private lives and work and patterns related to education and learning. We propose that these patterns are both significantly different and interconnected as students' responses to using ChatGPT in group work is affected by relationships formed by engagements outside of the university. Thus, students' adoption of GAI is a complex pattern of relations involving ways in which GAIs enter students' lives and become part of their learning. Following our sociomaterial perspective we have chosen not to include direct student quotations, but to identify significant patterns of relations that emerge from the interviews. Our analytic approach therefore involves identifying the locations, specific uses, and effects of GAIs in education by following patterns in the interviews, ie patterns of relations between humans and computational artefacts (GAIs) in a particular moment of time. These are sociotechnical ensembles (Bearman & Ajjawi 2023) that emerge analytically from our data and involve humans and technologies, but which are also formed by eg time and efficiency restrictions as significant local phenomena.

As our study is qualitative we are focusing on specific uses of GAI and not on statistics, e.g. how many students use GAI or how often. However, we wish to underline that in our study all participating students except two had some prior experience with GAI, either from their BA-studies or through work experience. As a rule, students at our university have part time work alongside their studies to support themselves, and some students have had full time work between finishing their BA studies and enrolling in MA education, e.g. as teachers. As our data were collected in the autumn of 2024, ie within a short period of time from the launch of ChatGPT in November 2022, some students, who went directly from their BA into the master program had used GAI in their BA and others had only used it for private and work purposes. Patterns of adoption therefore involved multiple and heterogeneous relationships between humans and GAIs.

4.1 GAIs as Agents in Students' Lives and Work

Looking at patterns of relations in our data, we can point to ways in which students engaged in relationships with GAIs outside the university. First of all, students entered into relationships with GAIs that were emerging from specific needs, strategies, events or necessities in their everyday lives, including work. Some of these relationships emerged from needs and strategies where students would previously use a search engine or an app, and where they now used GAI, e.g. to plan sightseeing, routes and budgets for holidays, find recipes, plan birthdays and dates and count calories in their food. Other uses of GAI were connected to organizing activities or generating texts and tables they would previously had found elsewhere or worked out on their own. Students thus for instance talked about using GAI for creating bed-time stories for their children, organizing training

events for e.g. football and for creating speeches and finding gifts for private events such as birthdays. Several students had used ChatGPT to write job applications or improve their cvs. These were patterns of relations in which other media (search engines, apps, books) were regularly replaced or displaced by GAIs, as students discovered the value of synthesizing, organizing or generating new material with these technologies. Though students also spoke of the necessity of using e.g. Google or Wikipedia for checking and finding information, searching for and booking tickets, hotels and more, their patterns of use showed significant shifts in the ecosystem of technology usage, pointing to multiple patterns of relations in which students experimented with ways in which they could use GAIs in meaningful ways in their private lives. GAI in this way both centralized usage that had previously been associated with other technologies and simultaneously contributed to proliferating uses, e.g. for searching, organizing and generating material.

For work, students had experiences with GAI that were similar to the patterns of relations in their private lives. Thus students told us that GAIs were to a large degree integrated in their part-time jobs or had been used in prior employment, e.g. as a teacher. Students for instance told us that they had used ChatGPT or other GAIs to create content for social media, write emails or product descriptions, and create figures or images. These were generative uses where students could quickly produce text or visualisations to save time or to enhance content. Some students had also used GAIs for translations and for summarizing text, ie for organizing purposes or for simplifying or disseminating text or information at work. A student who used to be a teacher had used GAI to create scenarios for teaching German to children, another had used it for communication with parents. The general impression from the interviews was that using GAI for work was both acceptable and widespread in the companies where students have part-time jobs (or had had full-time jobs), making it necessary for them to acquaint themselves with these technologies and their uses. GAIs used by students for work were often ChatGPT, but also other platforms such as Claude and Co-pilot, and in some cases companies had created their own GAI platforms that the students used in order to comply with data regulations. One student told us that her company had initially banned the use of GAI for work, but had changed their strategy to allowing use within rules formulated by management. This tells us that companies associate uses of GAI with competitive or efficiency advantages, affecting work and thereby students' patterns of use.

4.2 GAIs in Education

In our data we see patterns of relations with GAIs in students' lives and work that are significant for their understanding of these technologies and that affect education in specific ways. Significant patterns of relations are the ways in which GAIs are enrolled into work and life practices in heterogeneous ways and without notable restrictions. In education and learning we see some of the same tendencies but also with significant differences. First of all, a number of students experience that the understanding and uses of GAI in the specific course (ie *Concepts and philosophical aspects of technology*) is significantly different from their everyday and work uses. Thus in class they were generally asked to use only ChatGPT and not other platforms and they were also sometimes required to use standardized prompt strategies defined by the teacher rather than their own strategies. For some students this contradicted their experience with GAI as a fluid and heterogeneous phenomenon, ie as a technology that has multiple and situated uses (e.g. Suchman 2023). For other students, using GAI at university and in the specific course, turned out to give them a safe learning space in which to experience with ChatGPT together with others and monitored by the teacher. This was the case for a group of two students for whom the course provided their first experience with using GAI. Initially, these students had been apprehensive of using ChatGPT due to negative media coverage and other social critiques of the technologies. In class, they therefore benefited significantly from being in a context where the teacher and other students contributed to framing uses of the technology and helped them in their reflections on how it could be used in meaningful ways.

For students who already had experience with ChatGPT and other GAIs from work or private uses, using ChatGPT in the course in many ways enhanced their uses, for instance by giving them additional knowledge and opportunities for reflection. Students for instance spoke about using ChatGPT more for learning without being stuck in the idea that using GAI is cheating. They also spoke about the fact that using it more in many cases made them more critical of specific uses. This underlines the significance of teaching as an experimental and reflective space for learning about GAI, in which students can reflect freely and critically on their experiences with the technology.

Secondly, interviews with students uncovered ways of using GAI for homework and project work, i.e. reading, writing, revising and organizing material, that emerged as highly strategic both in terms of learning and in terms of study techniques and time management. Thus, a number of students told us that they regularly used ChatGPT

for summarizing academic texts, translating difficult English texts into Danish (i.e. their first language), explaining concepts and theories, coding interviews and revising their language in project reports to make it sound more academic. These were strategies that some students had brought with them from their BA, where a number of students had initially encountered ChatGPT. For others, usage at work had initiated their experience with GAI, which had quickly spread into adoption in their studies. For reading academic texts, this to a large extent meant, according to students, that they would on a regular basis choose to prompt ChatGPT to summarize texts rather than read them. This choice was fueled both by some students' difficulties with reading English or academic texts in general, but also with time concerns, i.e. freeing up time for other activities such as analysis (e.g. of cases or their own data). Several students mentioned that they felt that prompting GAI to summarize texts gave them a better overview of theories and concepts than reading, as the time-consuming process of working through a text did not necessarily help them understand or learn. Several students also said that producing AI-generated summaries was better than not reading the texts at all, which had apparently been a strategy for some students when texts were perceived as challenging. For writing, some students would use ChatGPT to revise initial drafts, enhance their academic writing and to check orthography. Finally, for time management and study techniques students would as mentioned also save and organize summaries and explanations generated by AI for project writing, or use GAI to organize and analyze their data.

All in all these results highlight that many students have embraced uses of ChatGPT that are highly strategic and competent, though not always clearly in accordance with current rules and expectations laid down by the university. University regulations thus allow students to enhance their academic writing with GAI when they are drafting and brainstorming, but as a rule not when they are writing up the text for submission and assessment. Uses of GAI for written assignments should therefore, according to the regulations, be accounted for in submitted written work. Similarly, students are expected to read academic texts that are part of the module, however, whether they actually do so is generally their own responsibility and can possibly only be assessed through written and oral exams. We are not suggesting that students did not comply with the rules laid down by the university, only that students' practices of writing and reading were to some extent transforming and challenging ways in which we as teachers generally think about homework, research and academic writing. Significantly, in some cases we were met with claims from students that they did not use or hardly used ChatGPT for their studies, which may be the case or may signify a reluctance to disclose uses to us, their teachers. This is a methodological challenge in our investigation, as our role as teachers and supervisors (in other modules) may have affected what students communicated to us in the interviews. In any case, our results highlight that GAI has apparently in no time at all significantly changed students' literacy practices. Our results also show that reasons students give for these changes are to a large extent based on time and efficiency arguments as well as a perceived lack of academic competence in e.g. reading and writing as well as understanding texts and concepts in English. Time and perceived academic level and competence are therefore significant aspects of students' patterns of adoption that will be discussed below.

4.3 Patterns of Adoption and Learning: Summary of Results

In our interviews with students we were often told, as mentioned above, that saving time was the outcome of and the reason for using GAI for learning. In addition to this, efficiency and enhancement were significant aspects of students' GAI use, ie doing things in smarter ways, and also to some extent in better ways, specifically with regard to performing academically. With regard to time, students seemed to attach value to saving time, not only to use more time on other activities, but to increase efficiency and understanding. GAI in this sense is associated with what Sharma (2013) calls speed culture, i.e. the feeling that technology contributes to handling accelerating time in society (see also Rosa 2013). For students, the accelerated pace of reading and writing with GAI seems to have a largely positive impact on their learning, giving them a feeling of control of and access to knowledge that was perceived to be both slower and more challenging before GAI. One student even felt that she had missed out compared to fellow students who had had more extensive experience with using ChatGPT than her, i.e. she felt that they had an unfair advantage. However, distributing aspects of their reading and writing activities to ChatGPT also came with challenges, specifically challenges of cognition, engagement and pace, as students told us that using ChatGPT threatened to make them lazy, less creative and less prone to thinking independently. Relationships with GAIs in this way created new forms of agency in which students felt that they both gained and lost agentic capability.

Time, on the other hand, also figured as a restriction for students' potential to engage critically in GAI usage, according to the interviews. Thus, a number of students mentioned that time limits involved in their group work with GAI in class pushed them toward using ChatGPT in less critical ways. Lack of time for instance meant that they copied feedback from ChatGPT directly into Moodle or built their answers directly on GAI feedback, rather

than exploring it. Time was therefore a significant part of the students' patterns of adoption that in various ways affected how GAI was taken up and engaged with.

5. Discussions and Conclusions

This paper has focused on students' adoption of GAIs in education, related to patterns of relations with GAI in their work and private lives. First of all, our data show that students become involved with GAIs in multiple ways and that practices at work and at home become significant points of contact that initiate relationships and collaboration between students and GAIs. These are relationships that continuously change the field of agency for students as GAIs become involved in and form how they seek knowledge, how they plan and organize private events and activities and how content and performance at work is enacted. Both at home and at work, relationships between students and GAIs seem to be constituted by emergent strategies and needs and uses are largely unregulated, ie GAI technologies seem to flow into students' lives and in many cases contribute to enhancing and accelerating their everyday activities, projects and work practices.

For education, patterns of relations between students and GAI are to some extent understood by students as being more restrictive, however, education also, according to the interviews, acts as a space for reflection and collaboration in which GAIs are not only used but also made controversial (Suchman 2023). This is specifically true for the course described in this paper, as students' uses of ChatGPT in their former (BA) education seems to have been largely experimental and unregulated. This is probably due to the fact that GAI at the time that students did their BA was a relatively new phenomenon. Teacher colleges and universities had therefore generally not yet had time to set standards for GAI use.

In terms of reflection and learning, our data underline that ChatGPT in no time at all has transformed ways in which students read, prepare, research and write projects. Shifts in the ecology of learning affected by GAI have thus contributed to changing practices of working academically with texts and data, ie reading, writing, editing etc. have become distributed practices where students collaborate with GAI to enhance their academic performance and knowledge. This calls for increased attention to ways in which teachers can address these changes, as our data also show that teaching is a significant (safe) space for investigating GAI. Based on our analysis, we therefore propose the following implications for educators:

Collaboration and dialogue: In our interviews students often mentioned the challenges of working with GAI on their own, where they had to some extent been forced to trust feedback given by chatbots. Relationships between students, teacher(s) and reflective activities in class can therefore create a significant (safe) space for investigating GAI as a phenomenon in society and in learning.

Time: time is a significant aspect of students' patterns of adoption as investigated in this paper. Accelerated time contributes to forming students' relationships with GAI in education, illustrated by distributed literacy practices (eg summarizing and editing text). In some cases these practices generated a form of academic 'persona' and voice for students which for some had seemed almost unobtainable before GAI. The creation of academic standards, practices and identities with GAI could therefore be a significant focus for teaching. Significantly, students also formulate a need for using more time in class in order to deepen and critically investigate GAI feedback and practical uses.

Heterogeneity: making GAI controversial implies challenging and demystifying e.g. ChatGPT as a single and stable technology. The heterogeneity of uses and relationships in practice can be enhanced by collaborative learning and by investigating GAI as a situated phenomenon. In this context teaching could build on students' patterns of adoption outside the university.

Ethics declaration: An Ethics declaration as well as students' declaration of consent was obtained in accordance with GDPR regulations

AI declaration: AI tools were not used in the creation of this paper

References

Bearman, M., & Ajjawi, R. (2023). "Learning to work with the black box: Pedagogy for a world with artificial intelligence". *British Journal of Educational Technology*, Vol 54, No 4, pp. 1160–1173

Bruun, M.H., Krause-Jensen, J. og Hasse, C. (2024) Store sprogmodeller og AI-chatbots på videregående uddannelser (Large Language Models and AI-chatbots in Higher Education). *Pædagogisk Indblik* 26. DPU, Aarhus Universitet. Copenhagen

Coeckelbergh, M., & Gunkel, D. J. (2023). "ChatGPT: deconstructing the debate and moving it forward". AI & SOCIETY, Vol 39, No 5, pp. 1-11.

Davies, C.A. (1999) *Reflexive ethnography. A guide to researching selves and others*. Routledge, London & New York

Godwin-Jones, R. (2024) "Distributed agency in second language learning and teaching through generative AI". *Language Learning & Technology*. Vol 28, No 2, pp 5-31

Halkier, B. (2020) Fokusgrupper (Focus groups). In: Brinkmann, S. & Tanggaard, L. (eds) *Kvalitative metoder. En grundbog*. Hans Reitzels Forlag, Copenhagen

Hetherington, L., & Wegerif, R. (2020). Developing a material-dialogic approach to pedagogy to guide science teacher education. In *Teaching STEM Education through Dialogue and Transformative Learning* pp 26-42. Routledge.

Hwang, Y., Lee, J. H., & Shin, D. (2023). "What is prompt literacy? An exploratory study of language learners' development of new literacy skill using generative AI". *arXiv preprint arXiv:2311.05373*.

Johri, A. (2022). "Augmented sociomateriality: implications of artificial intelligence for the field of learning technology". *Research in Learning Technology*, vol *30*.

Miettinen, R. (2000) "The concept of experiential learning and John Dewey's theory of reflective thought and action. International". *Journal of Lifelong Education*, Vol 19, No 1., pp 54-72

Mollick, E., & Mollick, L. (2023). "Assigning AI: Seven approaches for students, with prompts". *arXiv preprint arXiv:2306.10052*.

Ou, A. W., Stöhr, C. & Malmström, H. (2024). "Academic communication with AI-powered language tools in higher education: From a post-humanist perspective". *System*, Vol 121, pp 1-14

Peters, M.A., Jackson, L., Papastephanou, M., et al. (2023): "AI and the future of humanity: ChatGPT-4, philosophy and education – Critical responses" *Educational Philosophy and Theory* Vol 56, No 9, pp 828-862

Placani, A. (2024). "Anthropomorphism in AI: Hype and fallacy". *AI and Ethics*, Vol 56, No, pp 828-862.

Rosa, H. (2013). *Social acceleration: A new theory of modernity*. Columbia University Press.

Ryberg, T., Davidsen, J., & Hodgson, V. (2018). "Understanding nomadic collaborative learning groups". *British Journal of Educational Technology*, Vol 49, No 2, pp 235-247.

Savin-Baden, M. (2014). "Using problem-based learning: New constellations for the 21st century". *The Journal on Excellence in College Teaching*, Vol 25, No 3 & 4, pp 197-219.

Sharma, S. (2013) "Critical time". *Communication and Critical/Cultural Studies* Vol 10, No 2-3, pp 312-318

Stöhr, C., Ou, A. W., & Malmström, H. (2024). "Perceptions and usage of AI chatbots among students in higher education across genders, academic levels and fields of study". *Computers and Education: Artificial Intelligence*, Vol *7*, 100259.

Suchman, L. (2023). "The uncontroversial 'thingness' of AI". *Big Data & Society*, Vol 10, No 2.

Sørensen, E. (2009). *The materiality of learning: Technology and knowledge in educational practice*. Cambridge University Press

Williamson, B., Macgilchrist, F. & Potter, J. (2023) "Re-examining AI, automation and datafication in education". *Learning, Media and Technology*, Vol 48, No 1, pp 1-5