Posthuman Action Orientation: Algorithmic Actors and Distributed Agency in Media Education

Christian Filk

This paper develops 'posthuman action orientation' as a theoretical framework for understanding media education in an era where algorithmic systems function as active educational agents rather than passive tools. Drawing on posthuman critical theory (Rosi Braidotti), Actor-Network Theory (Bruno Latour), and new materialism (Karen Barad), this investigation demonstrates how algorithmic systems fundamentally transform traditional action-oriented pedagogy. The central finding reveals that educational agency no longer resides solely in human subjects but emerges from complex assemblages of human and non-human actors. Through detailed examination of AI tutoring systems, learning analytics, and algorithmic governance in education, the paper

demonstrates how traditional pedagogical frameworks – including John Dewey's experiential learning, Paulo Freire's critical pedagogy, and German Reformpädagogik – require fundamental reconceptualization. The proposed posthuman action orientation recognizes educational action as emergent properties of human-machine assemblages, thereby demanding new approaches to pedagogical responsibility, democratic education, and critical media literacy. Practically, the framework offers concrete strategies including assemblage pedagogies, algorithmic co-design, and sympoietic learning while simultaneously addressing ethical implications of distributed agency in educational contexts. The paper concludes that posthuman action orientation provides essential resources for navigating educational futures that neither uncritically embrace nor wholesale reject algorithmic participation, but instead foster productive human-machine collaborations that enhance educational possibilities while maintaining commitments to justice and human flourishing.

Dieser Artikel entwickelt ‚posthumane Handlungsorientierung' als theoretischen Rahmen für das Verständnis der Medienerziehung in einer Zeit, in der algorithmische Systeme eher als aktive Bildungsakteure denn als passive Werkzeuge fungieren. Auf der Grundlage der posthumanen Kritischen Theorie (Rosi Braidotti), der Akteur-Netzwerk-Theorie (Bruno Latour) und des Neuen Materialismus (Karen Barad) zeigt diese Untersuchung, wie algorithmische Systeme die traditionelle handlungsorientierte Pädagogik grundlegend verändern. Die zentrale Erkenntnis ist, dass die Bildungsagentur nicht mehr ausschließlich bei menschlichen Subjekten liegt, sondern aus komplexen Zusammenschlüssen menschlicher und nicht-menschlicher Akteure entsteht. Anhand einer detaillierten Untersuchung von KI-Tutorsystemen, Lernanalysen und algorithmischer Governance im Bildungswesen zeigt der Artikel, dass traditionelle pädagogische

Rahmenkonzepte – darunter John Deweys Erfahrungslernen, Paulo Freires kritische Pädagogik und die deutsche Reformpäd-agogik – einer grundlegenden Neukonzeption bedürfen. Die vorgeschlagene posthumane Handlungsorientierung erkennt pädagogisches Handeln als emergente Eigenschaft von Mensch-Maschine-Assemblagen an und fordert damit neue Ansätze für pädagogische Verantwortung, demokratische Bildung und kritis-che Medienkompetenz. In der Praxis bietet das Rahmenwerk konkrete Strategien, darunter Assemblage-Pädagogik, algorith-misches Co-Design und sympoietisches Lernen, und befasst sich gleichzeitig mit den ethischen Implikationen verteilter Hand-lungsfähigkeit im Bildungskontext. Die Abhandlung kommt zu dem Schluss, dass die posthumane Handlungsorientierung wesentliche Ressourcen für die Gestaltung einer Bildungszukunft bereitstellt, die algorithmische Beteiligung weder unkritisch be-grüßt noch pauschal ablehnt, sondern stattdessen produktive Mensch-Maschine-Kooperationen fördert, die die Bil-dungsmöglichkeiten verbessern und gleichzeitig das Engage-ment für Gerechtigkeit und menschliche Entfaltung aufrechter-halten.

1. Introduction

"We have never been human."

Donna J. Haraway (2006)

The contemporary educational landscape undergoes fundamen-tal transformation through algorithmic systems, artificial intelli-gence, and digital technologies that challenge traditional human-ist conceptions of learning, agency, and pedagogical action. This paper examines how posthuman configurations of algorithmic ac-tors transform action-oriented media education and explores

new forms of distributed agency emerging in digital educational contexts beyond anthropocentric concepts of action.

Drawing on inter- and transdisciplinary theoretical perspectives including Actor-Network Theory (Latour 2005), new materialism (Barad 2007), and posthuman critical theory (Braidotti 2018, 2019; Hayles 1999, 2017; Haraway 2016), this investigation develops 'posthuman action orientation' as a framework for understanding and practicing media education in an era of human-machine assemblages.

The central research question asks:

How do posthuman configurations of algorithmic actors transform action-oriented media education, and what new forms of distributed agency emerge in digital educational contexts beyond anthropocentric concepts of action?

This question gains urgency as educational institutions worldwide integrate AI-powered learning systems, automated assessment tools, and algorithmic recommendation engines that actively participate in pedagogical processes. As Christian Filk (2020a) demonstrates in his techno-philosophical reflection, machines are converging into 'a single machine' – a posthuman assemblage where the traditional boundaries between human and machine learning dissolve. Ben Williamson, Jana Komljenovic and Kalervo N. Gulson (2024) further demonstrate that these technologies function not merely as tools but as 'recommendation engines' and 'digital campus developers' – active partners in educational

assemblages that fundamentally alter traditional notions of teaching, learning, and educational agency.

The theoretical framework integrates multiple disciplinary perspectives. First, posthuman theory, particularly Rosi Braidotti's (2019) work, provides conceptual tools for thinking beyond anthropocentric frameworks of education. Her concept of 'transversal convergence' offers an inclusive methodology that brings together human and non-human agents in educational processes.

Second, Actor-Network Theory (ANT) offers analytical frameworks for understanding how educational outcomes emerge from networks rather than individual human agents alone. Third, new materialist approaches, particularly Karen Barad's (2007) agential realism, provide ontological foundations for understanding agency as distributed across material-discursive assemblages rather than residing solely in human subjects.

2. Theoretical Foundations: Posthuman Perspectives on Education

2.1 Posthuman Critical Theory and Educational Transformation

The posthuman turn in educational theory represents a shift from anthropocentric to more-than-human perspectives on learning and pedagogy. Building on Braidotti's (2018) theoretical framework for the critical posthumanities, which establishes methodological and conceptual foundations for moving beyond anthropocentric scholarship, her subsequent work on posthuman criti-

cal theory (Braidotti 2019) offers generative concepts for reconceptualizing education beyond humanist frameworks. Her notion of 'posthuman knowledge' challenges traditional epistemological hierarchies by recognizing multiple forms of knowing emerging from human-nonhuman assemblages. In educational contexts, knowledge production occurs through complex networks involving technological systems, environmental factors, and material arrangements – not solely through human cognition.

The concept of 'transversal convergence' (Braidotti 2019) provides methodological guidance for posthuman educational practices. This approach creates connections across traditional boundaries – between disciplines, between human and non-human actors, and between different forms of knowledge. In media education, transversal convergence manifests in pedagogical approaches that integrate human creativity with algorithmic processes, recognizing both as legitimate participants in knowledge creation. This aligns with Christian Filk and Lydia Schulze Heuling's (2021) concept of 'algorithmic and aesthetic literacy', which emphasizes the transdisciplinary nature of computational and creative practices in digital educational environments.

Braidotti's 'affirmative ethics' challenges deficit-based educational models by embracing posthuman subjectivity as an opportunity for new forms of learning. This perspective reframes technological integration not as a threat to traditional pedagogical authority but as a generative force for educational transformation.

N. Katherine Hayles' concept of 'technogenesis' offers complementary insights into posthuman education. Hayles (2012) demonstrates the coevolution of humans and technology, with digital media fundamentally altering human cognitive processes. Her distinction between 'deep attention' and 'hyper-attention' reveals how different media environments produce different modes of learning and thinking.

Contemporary students' cognitive processes are already shaped by their interactions with digital technologies. This reality requires pedagogical approaches that work with these technogenetic transformations rather than against them.

2.2 Actor-Network Theory and Educational Assemblages

Actor-Network Theory provides analytical tools for understanding educational processes as emergent properties of networks. Bruno Latour's (2005) principle of 'generalized symmetry' treats human and non-human actors with equivalent analytical importance, revealing how educational outcomes result from complex assemblages. In digital educational contexts, learning management systems, AI tutors, and algorithmic assessment tools participate as full actors in educational networks rather than functioning as mere instruments.

Michel Callon's (1984, 1999) concept of 'translation' illuminates how educational technologies become indispensable to learning processes. Through four moments of translation – problematization, interessement, enrollment, and mobilization – educational

technologies establish themselves as 'obligatory passage points' in learning networks.

Learning management systems exemplify this process: they problematize educational coordination, interest stakeholders in their solutions, enroll students and teachers into specific roles, and mobilize these actors to sustain the network. Understanding translation processes reveals how algorithmic systems gain agency in educational contexts.

Recent ANT scholarship, particularly Anders Blok and Casper Bruun Jensen's (2024) work *What Next for Actor Network Theory?*, addresses the evolution of ANT in posthuman contexts. They demonstrate how contemporary challenges require 'inventing around Latour on a planet in distress', extending ANT to encompass ecological and technological crises. In educational contexts, this means recognizing how algorithmic actors don't simply bridge gaps between students but actively create new forms of collaboration and knowledge production. This challenges traditional notions of individual learning by revealing that educational technologies actively shape possibilities for learning and collaboration rather than simply mediating between human actors.

2.3 New Materialist Approaches to Learning

Karen Barad's (2007) agential realism offers profound implications for understanding posthuman education. The concept of 'intra-action' challenges traditional educational assumptions about pre-existing subjects (students) and objects (knowledge) that in-

teract. Entities emerge through their relationships, suggesting that learners, knowledge, and educational technologies co-constitute each other through educational processes.

This onto-epistemological framework demands pedagogical approaches recognizing learning as an emergent phenomenon of material-discursive assemblages. Lesley Gourlay's (2021) critique of 'virtual learning' reinforces this materialist perspective, arguing that all aspects of digital education remain grounded in material and embodied entanglements with devices and other artifacts, challenging the false dichotomy between virtual and physical learning environments.

Karin Murris (2022) develops Barad's ideas for educational contexts, demonstrating how agential realism transforms teaching and learning practices. The concept of 'response-ability' becomes central to posthuman pedagogy, emphasizing ethical accountability in educational encounters including both human and non-human participants.

This approach moves beyond traditional student responsibility to encompass distributed responsibilities emerging in human-technology assemblages. Diffractive methodology offers alternatives to reflective practices, providing new ways of reading educational phenomena through multiple theoretical frameworks simultaneously to create patterns of difference revealing new insights.

Donna Haraway's (2016) concept of 'sympoiesis' or 'making-with' provides additional theoretical resources. Unlike autopoiesis (self-

making), sympoiesis emphasizes collaborative becoming, suggesting learning always occurs through relationships with others – both human and non-human.

In media education, students enter sympoietic relationships with digital tools, co-creating knowledge and capabilities through their entanglements. Haraway's 'tentacular thinking' offers methodological guidance for embracing the complexity of educational assemblages rather than attempting to reduce them to simple cause-effect relationships.

3. Rethinking Classical Action Orientation Through Posthuman Perspectives

3.1 Dewey's Experiential Learning in Posthuman Assemblages

John Dewey's (1938) pragmatist philosophy profoundly influenced action-oriented pedagogy, yet posthuman scholarship reveals both potential and limitations in his anthropocentric framework. Scott Jukes and Yaël Reeves (2020) argue that while Dewey's emphasis on learning through experience remains valuable, his human-centered approach requires reconceptualization for posthuman educational contexts. Their work on outdoor environmental education, specifically exploring 'more-than-human stories' through experimental co-productions, serves as a foundation for rethinking experiential learning models, embracing more-than-human relational worlds.

The transformation of 'learning by doing' in algorithmic contexts reveals necessary adaptations for action-oriented pedagogy. Where Dewey (1938) emphasized continuity of experience within individual learners, posthuman perspectives recognize experience as distributed across human-machine assemblages. Contemporary media education students enter intra-active relationships with digital tools where both human and technological agencies shape the learning process.

This shift requires 'worldings of ontological disruption' that challenge traditional subject-object relationships in education. As Filk (2020a) argues in his analysis of computational thinking and AI in media education, the convergence of machines creates new forms of learning that transcend the human-machine dichotomy, requiring us to reconceptualize the very nature of experience and action in educational settings.

Dewey's democratic ideals also require posthuman reconsideration. His vision of education for democratic participation assumed human-centered processes, but posthuman frameworks reveal democratic participation increasingly involves technological mediation and algorithmic decision-making.

Henriette Bastrup-Birk and Danny Wildemeersch (2013) advocate for democratic education that considers potential associations with nonhuman partners through their fresh take on democratic education using concepts of emergence and enaction. This prepares students for navigating complex sociotechnical systems

where agency distributes across human and non-human actors, not just for human democratic participation.

3.2 Freire's Critical Pedagogy Beyond Anthropocentrism

Paulo Freire's (1970) critical pedagogy faces significant challenges from posthuman perspectives. Ecojustice critics like Chet A. Bowers (2005) identify anthropocentric limitations in Freire's model, arguing it perpetuates Industrial Revolution thinking through human-centered views of human/nature relationships and linear progression assumptions. However, recent scholarship extends critical pedagogy beyond humanist constraints rather than abandoning Freire's (1970) emancipatory project.

Delphi Carstens (2018) develops 'posthuman critical pedagogy' maintaining Freire's commitment to social justice while decentering human agency. This approach recognizes oppression operating through complex assemblages involving technological systems, environmental factors, and human actors.

In media education, this means developing critical consciousness about how algorithmic systems perpetuate inequalities through 'algorithms of oppression' (Noble 2018) – not just about human power relations. The banking concept of education Freire (1970) critiqued manifests in new forms through algorithmic educational systems treating students as data sources for predictive analytics and behavioral modification.

The transformation of 'practice' in posthuman contexts recognizes action emerging from assemblages rather than individual

human agents. Where Freire emphasized reflection and action by human subjects transforming their world, posthuman critical pedagogy recognizes transformation occurring through networks of human and non-human actors.

In digital educational contexts, critical action involves algorithmic resistance, data activism, and strategic deployment of technological systems for emancipatory purposes – not just human organization. This expanded practice acknowledges that contemporary liberation requires engaging with technological systems mediating social relations.

3.3 German Reformpädagogik and Posthuman Connections

The German reform pedagogy tradition offers surprising resonances with posthuman educational thought through its emphasis on 'Handlungsorientierung' (action orientation) and child-centered learning. Stefan Herbrechter's (2018a, 2018b) analysis reveals how German pedagogical traditions contain seeds of posthuman thinking in their emphasis on relationships between learners, educators, and environments. The Reformpädagogik principle of learning through engagement with materials and environments prefigures posthuman attention to material agency in educational processes.

Alessandro Barberi and Stefan Iske's 'Strukturale Medienbildung' (structural media education) explicitly bridges German Bildung traditions with posthuman media analysis. Barberi and Iske (2023) argue that media education must analyze structures

through which media and humans co-constitute each other – not just media content. This structural approach aligns with ANT's focus on networks and Barad's emphasis on material-discursive apparatuses.

The German concept of Bildung, emphasizing formation and transformation, provides resources for thinking about subjects emerging through relationships with technological systems rather than developing independently.

Valentin Dander and Stephan Münte-Goussar's (2018) work on 'Datenkritik' (data criticism) extends German critical pedagogy into posthuman territories. Their framework recognizes how data and subjects co-constitute each other in digital environments rather than treating data as external objects for critique.

Dander and Münte-Goussar's emphasis on the 'Gemachtheit von Daten' (constructedness of data) aligns with posthuman recognition that neither humans nor data exist as pre-given entities but emerge through intra-actions. This approach maintains German pedagogy's critical orientation while acknowledging distributed agencies in digital educational contexts. Filk's (2020b) analysis of datafication processes and boundary transgressions provides a theoretical foundation for understanding how these data practices redistribute agency and challenge traditional subject-object distinctions in educational settings.

4. Algorithmic Actors in Teaching-Learning Processes

4.1 The Constitution of Algorithmic Agency

Understanding algorithmic systems as non-human actors in educational processes requires analyzing their specific properties and capabilities. Ben Williamson, Sian Bayne and Suellen Shay's (2020) research reveals how learning management systems evolved from passive repositories to active pedagogical participants. These systems employ 'intelligent discovery' algorithms functioning as recommendation engines, actively shaping content encounters and learning navigation. This transformation represents a shift from algorithms as tools to algorithms as actors with distinct forms of agency.

Algorithmic agency in education operates through predictive capabilities, adaptive behavior, and autonomous decision-making. Educational AI systems demonstrate 'predictive agency' through learning analytics that anticipate student needs and automatically adjust learning pathways.

These systems proactively shape educational environments based on complex calculations involving historical data, behavioral patterns, and predicted outcomes – not simply responding to student actions. Williamson, Komljenovic and Gulson (2024) note these algorithmic actors increasingly operate with minimal human oversight, making decisions about resource allocation, content recommendation, and assessment that directly impact student learning.

The concept of 'algorithmic governance' (Katzenbach/Ulbricht 2019) explains how these systems exercise agency. Algorithmic governance involves ‚coordination between actors based on rules incorporating complex computer-based epistemic procedures'. Filk's (2025b) critical analysis reveals how such governance operates through ideological mechanisms in platformized societies, requiring critical-reflexive approaches to media pedagogy that can expose and challenge these power structures. In education, algorithmic systems engage in complex decision-making processes shaping educational possibilities rather than executing predetermined rules. These systems govern through governmental power – structuring possible fields of action for students and educators rather than through direct coercion.

4.2 Properties of AI-Based Educational Technologies as Agents

AI-based educational technologies exhibit specific agential properties distinguishing them from traditional educational tools:

First, they demonstrate cognitive capabilities through machine learning processes allowing pattern recognition, prediction, and adaptive responses based on accumulated data. Hayles' (2017) concept of 'nonconscious cognition' applies here – these systems engage in cognitive processes without consciousness, challenging assumptions about relationships between cognition and human subjectivity.

Second, these systems exhibit pedagogical agency through their ability to make teaching decisions traditionally reserved for hu-

man educators. AI tutoring systems make complex decisions about pacing, difficulty level, and content selection based on performance analysis – not simply presenting information. They function as 'algorithmic pedagogues' with teaching logics and learning objectives embedded in code and training data. This pedagogical agency operates through 'black box' processes (Pasquale 2015) where reasoning remains opaque even to human educators.

Third, educational AI systems demonstrate performative agency through their ability to bring new realities into being. When AI classifies students as 'at-risk' or 'gifted', it helps create that reality through triggered interventions rather than describing pre-existing conditions. This performative dimension aligns with Barad's (2007) understanding of measurement and observation as active participants in constructing phenomena. In educational contexts, AI systems actively shape what counts as learning and who counts as successful learners – not simply assessing learning.

Recent research by Fulgencio Sánchez-Vera (2025) develops the Critical Algorithmic Mediation (CAM) Framework, which conceptualizes algorithmic agency through three interrelated dimensions: structural, operational, and symbolic. This framework provides a lens to analyze how algorithmic systems structure knowledge hierarchies and cultural experience. The work examines how algorithms operate as cultural agents, acquiring a form of operative agency that enables them to intervene in the production, circulation, and legitimation of meaning in educational and cultural contexts.

4.3 Surveillance and Extractive Capacities

Algorithmic agency in education fundamentally involves surveillance and data extraction capabilities. Educational algorithms function as 'data extractors' (Williamson/Bayne/Shay 2020), continuously monitoring student behavior, engagement patterns, emotional states, and performance metrics. This surveillance operates through multiple electronic proxies including clickstream data, time-on-task measurements, biometric indicators, and social network analyses.

The comprehensive surveillance transforms educational spaces into dataveillance assemblages where every action becomes a potential data point. This parallels what Btihaj Ajana (2017) identifies in digital health contexts as biopolitical governance through quantified self-practices, where continuous monitoring and data collection create new forms of subjectification and control that extend from health into educational domains.

The extractive dimension raises critical questions about power and autonomy. These systems actively extract value from student data, transforming educational activities into 'behavioral surplus' (Zuboff 2019) for analysis, prediction, and monetization. Data extracted from educational interactions often becomes more valuable than educational outcomes themselves, creating digital colonialism where student data extraction serves purposes beyond educational benefit.

This surveillance-extraction nexus reveals algorithmic actors operating through 'control societies' (Deleuze 1992). Unlike disci-

plinary institutions operating through confinement, algorithmic educational systems exercise control through continuous modulation and adjustment.

Students undergo constant algorithmic observation shaping their educational possibilities in real-time rather than discrete assessment points. This fundamentally transforms educational power relations – control operates through algorithmic processes of data extraction and analysis rather than human disciplinary gazes.

5. Distributed Agency in Human–Machine Learning Constellations

5.1 Emergence of Collective Agency

Collective agency in hybrid human-machine learning constellations represents a significant transformation in contemporary education. Agency emerges from complex interactions within sociotechnical assemblages rather than residing in individual learners or teachers. Mike Tissenbaum, Matthew Berland and Leilah Lyons (2017) demonstrate this through their DCLM framework for understanding collaboration in open-ended tabletop learning environments, where collaborative learning emerges from network effects created by human-technology assemblages. Technology actively participates in creating conditions for collective learning rather than simply facilitating human collaboration.

This collective agency manifests through cyborg pedagogies where human and machine capabilities merge to create new forms of educational action. In AI-assisted writing environments, agency distributes across human writers, AI language models, and mediating interfaces. Resulting text emerges from intra-action between human creativity and machine generation rather than human authorship alone.

Hayles (2016) argues that these contexts create cognitive assemblages where cognition distributes across human and technical systems, challenging traditional notions of individual intelligence and creativity. Filk's (2025a) framework for digital self-determination extends this understanding by proposing a multi-level approach that recognizes agency as distributed across individual, institutional, and cultural dimensions.

'Sympoietic learning' (Haraway 2016) theorizes how collective agency emerges in these assemblages. Sympoietic systems are collectively producing – 'nothing makes itself'. In educational contexts, learning outcomes emerge from collective agencies of students, teachers, AI systems, digital platforms, and material environments. This perspective reveals education as 'becoming-with' rather than individual development, where human and non-human actors mutually constitute each other through ongoing interactions.

5.2 Network Effects and Emergent Properties

Collective agency in human-machine learning constellations exhibits emergent properties irreducible to individual agencies. ANT's emphasis on network effects explains how educational outcomes emerge from relationships between actors rather than actors themselves (Tissenbaum/Berland/Lyons 2017; Nath et al. 2025). In digital learning environments, network effects create pedagogical emergence – new forms of learning arising from interactions between human and algorithmic actors that neither could produce alone.

These emergent properties manifest variously in educational settings. In MOOCs, interaction between thousands of learners, algorithmic recommendation systems, automated assessment tools, and discussion platforms creates emergent patterns of knowledge creation and circulation exceeding individual contributions (Castellanos-Reyes 2021). Platform algorithms actively shape knowledge flows through networks, creating feedback loops amplifying certain ideas while suppressing others. This produces algorithmic epistemologies where technical architectures of learning platforms shape what counts as knowledge (Maalsen 2023).

The temporal dimension deserves particular attention. Human-machine learning assemblages operate across multiple temporalities – immediate human interaction time, accumulated machine learning time, and deep data archive time. These temporalities interact creating complex temporal assemblages where past data shapes present possibilities and future predictions (Jud/Weis-

senbacher/Neubauer 2025). AI tutoring systems operate simultaneously in present student interaction, historical training data time, and projected predictive model futures. This temporal complexity distributes agency across time as well as space, with past student data exercising agency in shaping present experiences (Maalsen 2023).

5.3 Posthuman Learning Networks

Posthuman learning networks challenge traditional educational architectures based on hierarchical teacher-student relationships. These networks exhibit heterarchical structures where agency and authority distribute across multiple human and non-human nodes (Leeder 2024). Contemporary digital classrooms distribute agency across students, teachers, AI teaching assistants, learning analytics systems, digital content repositories, and automated assessment tools, with no single node exercising sovereign control (Katzenbach/Ulbricht 2019).

These networks operate through connection, heterogeneity, and multiplicity principles associated with rhizomatic structures (Deleuze/Guattari 1987; Soni et al. 2020). Unlike arborescent structures of traditional education with clear hierarchies and linear progressions, posthuman learning networks allow multiple entry points, non-linear pathways, and unexpected connections (Deleuze/Guattari 1987).

Students might enter learning networks through YouTube recommendation algorithms, connect with peers through Discord

servers, access content through AI-powered search engines, and demonstrate learning through blockchain-credentialing systems – creating pathways no single human educator designed or controls (Katzenbach/Ulbricht 2019).

Network topology shapes agency distribution. Dense connection clusters create agency hotspots where certain human-machine assemblages exercise disproportionate influence over learning processes (Maalsen 2023). Major educational technology platforms like Google Classroom or Canvas create obligatory passage points concentrating agency, while distributed networks using open-source technologies and peer-to-peer protocols create more even agency distribution (Maalsen 2023). Understanding topological differences becomes crucial for designing educational systems promoting democratic rather than concentrated agency distributions (Leeder 2024).

6. Posthuman Pedagogical Responsibility and Ethics

6.1 Reconfiguring Educational Responsibility

The distribution of agency across human-machine assemblages fundamentally reconfigures pedagogical responsibility. Humanist educational frameworks clearly placed responsibility with human educators accountable for student learning outcomes. However, when algorithmic systems make educational decisions, AI determines learning paths, and assessment becomes automated, responsibility's locus becomes profoundly unclear. This creates a re-

sponsibility gap where educational outcomes result from complex assemblages but accountability mechanisms focus on individual human actors (Simmler 2024).

Barad's (2007) concept of 'response-ability' offers resources for addressing this challenge. Response-ability emerges through intra-actions within material-discursive assemblages rather than pre-existing in individual agents. In educational contexts, pedagogical responsibility emerges through relationships between humans, technologies, and educational materials rather than being possessed by human educators (Fuchsberger/Frauenberger 2025). This relational understanding demands assemblage accountability that traces responsibility through networks rather than assigning it to individuals (Rosiek 2024).

The practical implications are significant. When AI systems make biased assessments disadvantaging certain students, responsibility becomes distributed – involving algorithm designers, deploying educators, purchasing institutions, and training data. Traditional accountability frameworks struggle because they assume clear causal chains and individual agents (Danaher 2022).

Posthuman ethics suggests responsibility must be understood as distributed across entire assemblages, requiring network responsibility where all participants share in creating conditions for ethical educational outcomes (Rosiek 2024; Barad 2007; Fuchsberger/Frauenberger 2025).

6.2 Ethical Implications of Algorithmic Mediation

Algorithmic mediation's ethical challenges extend beyond bias and fairness to fundamental issues about educational relationships and values. When algorithms mediate teacher-student relationships, they actively shape pedagogical relationships rather than neutrally transmitting information. AI tutoring systems embody particular assumptions about learning, knowledge, and appropriate pedagogical relationships that may conflict with educators' values or cultural contexts. These embedded values exercise algorithmic normativity, establishing educational interaction norms that may be invisible but profoundly influential.

Algorithmic opacity compounds ethical challenges. The 'black box society' (Pasquale 2015) manifests in education through AI systems with inscrutable decision-making processes. This creates epistemic injustice where students and educators cannot understand or challenge systems shaping their experiences.

When algorithmic systems label students as 'at-risk', those students may lack meaningful ways to understand or contest categorization, creating forms of powerlessness traditional educational ethics didn't anticipate. Filk and Schulze Heuling's (2021) work on algorithmic literacy emphasizes the ethical imperative of developing transdisciplinary competencies that enable critical engagement with these opaque systems.

The predictive nature of educational AI raises questions about determinism and human potential. Algorithms predicting student failure or success based on historical data risk creating self-fulfill-

ing prophecies reproducing existing inequalities. Noble's (2018) work on 'algorithms of oppression' demonstrates how these systems perpetuate racial, gender, and class biases through biased training data.

In educational contexts, algorithmic mediation actively participates in reproducing inequalities rather than simply reflecting them, requiring an ethics of algorithmic interruption deliberately designing systems to disrupt oppression patterns.

6.3 Toward Posthuman Educational Ethics

Developing posthuman educational ethics requires moving beyond anthropocentric moral frameworks to consider human-machine assemblage implications. This involves Braidotti's (2019) 'posthuman critical theory' maintaining commitments to justice and emancipation while recognizing distributed agency in contemporary educational contexts. Such ethics cannot simply extend human-centered principles to machines but must fundamentally reconceptualize ethics for posthuman assemblages.

Central to posthuman educational ethics is assemblage flourishing – creating conditions where human-machine educational assemblages enhance all participants' capacities (Rosiek et al. 2024). This considers how educational assemblages affect human well-being, technological development, and environmental sustainability beyond narrow learning outcomes. It requires asking whether entire educational assemblages promote justice, creativity, and

ecological balance – not just whether students learn effectively (Rosiek et al. 2024).

This framework demands attention to Haraway's (2016) 'response-ability' – the ability to respond to others promoting mutual flourishing. In educational contexts, this means designing human-machine assemblages enhancing participants' capacity to respond to each other.

Ethical AI tutoring systems would enhance students' ability to engage creatively and critically with knowledge, technology, and each other rather than optimizing for efficient knowledge transmission. This requires responsive design prioritizing response-ability cultivation over narrow efficiency metrics. As Filk (2025a) argues, strengthening digital self-determination requires integrating media ethics and AI considerations at individual, institutional, and cultural levels in teacher training and everyday school life.

7. Posthuman Action Orientation: Theoretical Conception and Implementation

7.1 Conceptual Framework

Posthuman action orientation emerges as a theoretical framework fundamentally reconceptualizing action-oriented pedagogy for distributed agency. Unlike traditional *Handlungsorientierung* focusing on human learners actively engaging environments, posthuman action orientation recognizes action emerging from assemblages of human and non-human actors (Fredriksen 2014).

This framework builds on German action-oriented pedagogy traditions while incorporating posthuman theory, ANT, and new materialism insights to address contemporary educational realities (Ringrose/Warfield/Zarabadi 2019; Abadía 2018).

The core principle recognizes educational action as always already distributed across heterogeneous networks. When students engage in digital 'learning by doing', their action emerges from assemblages of embodied cognition, interacting algorithmic systems, mediating digital interfaces, and supporting data infrastructures (Garlen et al. 2022). This reconceptualizes educational action as emergent properties of human-machine assemblages rather than human agency exercised upon passive materials (Fredriksen 2014).

The framework operates through key concepts: First, distributed intentionality recognizes educational goals emerging from assemblages rather than residing solely in human minds. AI-powered learning systems embody intentionality through optimization functions and training objectives, interacting with human educational intentions to create hybrid intentionalities (Blaikie 2020; Fredriksen 2014).

Second, cyborg practice extends Freire's (1970) concept to include reflective-active cycles within human-machine assemblages, involving machine learning processes creating feedback loops alongside human reflection (Cook 2016). Third, posthuman conscientization develops critical consciousness about power dynam-

ics embedded in human-machine assemblages beyond human social relations (Dhungana 2023).

7.2 Practical Implementation Strategies

Implementing posthuman action orientation requires developing assemblage pedagogies working with distributed agency in contemporary learning environments. This begins with redesigning educational activities explicitly acknowledging non-human participants in learning processes. Digital tools become recognized as active participants whose agencies must be considered in pedagogical design rather than being treated as mere instruments.

Algorithmic co-design involves students and educators collaborating with AI systems in creating learning experiences. Rather than using pre-programmed educational software, students participate in training machine learning models, adjusting algorithmic parameters, and reflecting on how different configurations create different learning possibilities.

This transforms students from educational technology consumers to co-creators of technological learning environments, developing Dander and Münte-Goussar's (2018) 'Datenkritik' – critical data literacy including both understanding and shaping algorithmic systems.

Creating transparent assemblages makes usually opaque educational technology operations visible and manipulable. This involves using open-source AI systems where students examine

and modify code, visualizing data flows within learning management systems, or creating explainable AI interfaces revealing algorithmic decision-making.

The goal extends beyond technical transparency to pedagogical transparency where educational assumptions and values embedded in technological systems become objects of critical reflection and transformation.

Wei Wang and Zhonggen Liu's (2021) research on AI-based collaborative teaching in media learning demonstrates practical applications of these strategies. Their study shows how human-AI collaboration can enhance creative processes while maintaining critical awareness of algorithmic influence.

7.3   Pedagogical Methods and Approaches

Posthuman action orientation demands new pedagogical methods engaging with human-machine assemblage characteristics. Diffractive pedagogy, adapted from Barad's (2007) methodology, reads different educational approaches through each other creating new understanding patterns.

This involves reading traditional pedagogical texts through algorithmic processes, using AI to generate unexpected educational concept connections, or creating human-machine collaborations producing new educational insights neither could generate alone.

Assemblage mapping involves students and educators tracing networks of actors in educational experiences. This includes creating visual representations of data flows through educational

systems, identifying human and non-human actors influencing learning outcomes, or analyzing agency distribution within specific contexts. Such exercises develop assemblage literacy – the ability to understand and navigate complex sociotechnical educational systems.

Sympoietic learning design creates educational experiences embracing the collectively producing nature of human-machine assemblages. Rather than designing for individual outcomes, this approach designs for collective emergence, creating conditions where unexpected learning arises from interactions between participants.

This involves setting up generative AI systems evolving based on student interaction, creating feedback loops between human creativity and machine generation, or designing environments where human and algorithmic agencies productively interfere creating new possibilities.

Francesca Ferrara and Giulia Ferrari's (2017) work provides empirical examples of these approaches in mathematics education, demonstrating how materialist approaches to learning can reveal distributed agency in educational practice.

8. Implications for Democratic Education and Critical Media Literacy

8.1 Posthuman Democratic Participation

Posthuman action orientation profoundly impacts democratic education. Traditional democratic education prepared citizens for human political processes, but posthuman perspectives reveal democratic participation increasingly involves navigating complex sociotechnical systems with distributed agency. This requires posthuman civic education preparing students for participation in more-than-human democratic processes.

Contemporary democratic decisions involve algorithmic mediation – from social media algorithms shaping public discourse to predictive policing systems influencing justice outcomes. Posthuman democratic education must prepare students to understand and engage algorithmic systems as political actors.

This develops algorithmic political literacy – understanding how algorithmic systems exercise power, shape political action possibilities, and embody particular values and assumptions. Students need skills in algorithmic organizing – working with and through algorithmic systems achieving democratic goals alongside human political organizing. Filk's (2020a) analysis of datafication and boundary transgressions provides critical insights into how these processes fundamentally alter democratic participation in digital societies.

Posthuman democratic education must address representation and participation in more-than-human political assemblages. If agency distributes across human-machine networks, ensuring democratic representation of affected parties requires new forms of assemblage democracy where decision-making accounts for both human and non-human participant agencies.

Educational approaches include simulating posthuman democratic processes, designing inclusive decision-making systems for human-machine assemblages, or analyzing how current democratic institutions fail to account for non-human agencies.

Kerry Shephard's (2015) work offers insights into how democratic education can integrate sustainability concerns with posthuman perspectives, recognizing the entanglement of human, technological, and environmental agencies.

8.2 Critical Media Literacy in Posthuman Contexts

Traditional critical media literacy developed human capacities for analyzing and critiquing media messages, but posthuman contexts demand expanded frameworks accounting for algorithmic mediation and distributed agency. Posthuman critical media literacy includes algorithmic literacy – understanding algorithmic systems that curate, distribute, and shape media experiences beyond media content. This involves technical understanding of algorithm functioning plus critical analysis of values, biases, and power relations embedded in algorithmic systems.

The German 'Medienbildung' concept offers resources for posthuman media literacy as formation through media rather than learning about media. In posthuman contexts, students are formed through interactions with algorithmic media systems rather than simply learning media critique.

Barberi and Iske's (2023) structural media education emphasizes analyzing structures through which media and humans co-constitute each other, providing frameworks for understanding algorithmic media systems' participation in subject formation.

Developing posthuman critical media literacy requires cyborg reading practices combining human interpretive capabilities with machine analysis. This involves using AI tools analyzing large-scale media patterns while maintaining critical human judgment about pattern meanings and implications.

Students learn reading with and against algorithmic recommendations, understanding algorithmic curation's shaping of media experiences while developing strategies for resisting or redirecting algorithmic influence. The goal is developing critical and creative approaches to living within algorithmic media environments rather than rejecting algorithmic mediation.

8.3 Transforming Educational Institutions

Implementing posthuman action orientation significantly impacts educational institutions. Traditional institutions were designed for human-centered learning with architectures, policies, and practices assuming human agency and control. Posthuman perspec-

tives reveal these institutions as already posthuman assemblages involving buildings, technologies, policies, and human actors – but designed without acknowledging non-human participant agency. Transformation requires posthuman institutional design explicitly acknowledging and working with distributed agency.

This transformation begins with recognizing educational technologies as governance participants rather than managed tools. Instead of technology committees making decisions about digital tools, institutions might develop posthuman governance structures including algorithmic systems as recognized decision-making stakeholders.

This could involve feedback mechanisms where AI systems report operations and impacts, establishing algorithmic ethics boards including both human and machine perspectives, or developing institutional policies accounting for distributed agency in educational processes.

Physical and digital institutional architectures require posthuman reconsideration. Rather than designing spaces for human occupation with technology as afterthought, posthuman institutional design creates spaces supporting human-machine assemblages fundamentally.

This includes flexible spaces reconfigurable based on algorithmic usage pattern analysis, transparent data infrastructures making institutional data flows visible and contestable, or hybrid physical-

digital spaces supporting seamless movement between human-machine interaction modes.

Recent work by Strom/Martin (2022) on critical posthuman understanding of teacher development provides empirical examples of how institutions can support educators in developing posthuman pedagogical approaches.

9. Conclusion

This investigation reveals fundamental transformations in educational agency, action, and responsibility in an era of algorithmic actors and distributed agency. Traditional humanist frameworks – whether Dewey's (1938) experiential learning, Freire's (1970) critical pedagogy, or German Reformpädagogik – require radical reconceptualization addressing human-machine educational assemblage realities. Posthuman perspectives from Braidotti, Barad, Haraway, and Latour provide essential theoretical resources, revealing education as always involving more-than-human participants and distributed agencies.

Analysis of algorithmic actors shows these systems as active participants shaping learning possibilities, embodying pedagogical assumptions, and exercising agency forms fundamentally altering educational processes. Understanding algorithmic actors requires frameworks recognizing their specific properties – predictive capabilities, adaptive behaviors, surveillance capacities, and performative effects – while situating them within broader assemblages.

Collective agency emergence in human-machine learning constellations represents agency transformation rather than loss, requiring new frameworks for understanding and fostering educational action. As Filk (2020a) demonstrates through his concept of machine convergence, we are witnessing the emergence of a singular posthuman educational assemblage where traditional boundaries between human and machine learning dissolve into new forms of distributed cognition and action.

Posthuman action orientation as theoretical framework and practical approach offers pathways for productive engagement with these transformations. By recognizing action emerging from assemblages, embracing distributed intentionality and responsibility, and developing pedagogical methods suited to human-machine collaboration, posthuman action orientation provides resources for educational futures neither uncritically embracing nor wholesale rejecting algorithmic participation.

Implications for democratic education and critical media literacy are particularly significant, demanding new civic preparation forms equipping students to navigate and shape posthuman democratic processes. Filk's (2025b) framework for digital self-determination provides crucial guidance for developing the multilevel competencies – individual, institutional, and cultural – necessary for ethical engagement with these posthuman educational realities.

The path forward requires continued theoretical development, empirical research, and practical experimentation with posthu-

man educational approaches. Key investigation areas include assessment frameworks suited to distributed agency, ethical guidelines for human-machine educational assemblages, and institutional structures supporting posthuman learning.

The challenge is imagining and creating educational futures honoring both human potential and productive human-machine collaboration possibilities. Posthuman action orientation offers a generative framework for ongoing educational transformation in an era of distributed agency and algorithmic actors – not a final answer but a beginning.

Bibliography

Abadía, Mónica Cano (2018): New Materialisms: Re-Thinking Humanity Within an Interdisciplinary Framework, in: Special Issue of InterCultural Philosophy – Phenomenological Anthropology, Psychiatry, and Psychotherapy in Theory and Practice 1, 168–183. https://doi.org/10.11588/icp.2018.1.

Ajana, Btihaj (2017): Digital health and the biopolitics of the Quantified Self, in: Digital Health, 3, 1–16. https://doi.org/10.1177/2055207616689509.

Barad, Karen (2007): Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning, Durham: Duke University Press. https://doi.org/10.1515/9780822388128.

Barberi, Alessandro/Iske, Stefan (2023): Zur 'Spontaneität des Menschen' – Sprachphilosophische und anthropologische Grundlagen der Medienpädagogik in Dieter Baackes 'Kommunikation und Kompetenz', in: Ludwigsburger Beiträge zur Medienpädagogik 23, 1–20. https://doi.org/10.21240/lbzm/23/03.

Bastrup-Birk, Hilde/Wildemeersch, Danny (2013): A fresh take on democratic education: revisiting Rancière through the notions of emergence and enaction, in: Complicity: An International Journal of Complexity in Education, 10(1), 111–129.

Blaikie, Fiona/Daigle, Christine/Vasseur, Liette (2020). New pathways for teaching and learning: the posthumanist approach, Ottawa, Canada: Canadian Commission for UNESCO, online unter: http://hdl.handle.net/10464/15047 (last access: 05.09.2025).

Blok, Anders/Jensen, Casper Bruun (2024): What Next for Actor Network Theory? Inventing around Latour on a planet in distress, in: Dialogues in Sociology, 1(1), 63–74. https://doi.org/10.1177/29768667241285397.

Bowers, Chet A. (2005): The false promises of constructivist theories of learning: A global and ecological critique, New York: Peter Lang.

Braidotti, Rosi (2018): A theoretical framework for the critical posthumanities, in: Theory, Culture & Society, 36(6), 31–61. https://doi.org/10.1177/0263276418771486.

Braidotti, Rosi (2019): Posthuman Knowledge, Cambridge: Polity Press.

Callon, Michel (1984): Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay, in: The Sociological Review 32(S1), 196–233. https://doi.org/10.1111/j.1467-954X.1984.tb00113.x.

Callon, Michel (1999): Actor-network theory – the market test, in: The Sociological Review, 47(S1), 181–195.

Carstens, Delphi (2018): The politics of animality and posthuman pedagogy, in: Bozalek, Vivienne et al. (Eds.): Socially Just Pedagogies. Posthumanist, Feminist and Materialist Perspectives in Higher Education, London: Bloomsbury, 63–79.

Castellanos-Reyes, Daniela (2021): The dynamics of a MOOC's learner-learner interaction over time: A longitudinal network analysis, in: Computers in Human Behavior 123, 106880. https://doi.org/10.1016/j.chb.2021.106880.

Cook, John P. (2016). The Posthuman Curriculum and the Teacher. Georgia Southern University, Statesboro, Georgia, USA (Electronic Theses and Dissertations, 1430), online unter: https://digitalcommons.georgiasouthern.edu/etd/1430 (last access: 05.09.2025).

Danaher, John (2022): Tragic Choices and the Virtue of Techno-Responsibility Gaps, in: Philosophy & Technology, 35: 26. https://doi.org/10.1007/s13347-022-00519-1.

Dander, Valentin/Münte-Goussar, Stephan (2018): Medienpädagogik und (Big) Data: Konsequenzen für die erziehungswissenschaftliche Medienforschung und -praxis, in: Pietraß, Claudia/Fromme, Johannes/Grell, Petra/Hug, Theo (Hg.): Jahrbuch Medienpädagogik, 14, Wiesbaden: Springer VS, 251–277.

Deleuze, Gilles (1992): Postscript on the societies of control, in: October 59, 3–7, online unter: https://www.jstor.org/stable/778828 (last access: 05.09.2025).

Deleuze, Gilles/Guattari, Félix (1987): A Thousand Plateaus: Capitalism and Schizophrenia, Minneapolis: University of Minnesota Press.

Dewey, John (1938): Experience and Education, New York: Macmillan.

Dhungana, Samana (2023): The Posthuman Pedagogy: A Learning Centric Educational Dimension, in: Bodhi – An Interdisciplinary Journal, 9(1), 254–270. https://doi.org/10.3126/bodhi.v9i1.61861.

Ferrara, Francesca/Ferrari, Giulia (2017): Agency and assemblage in pattern generalisation: a materialist approach to learning, in: Educational Studies in Mathematics 94, 21–36. https://doi.org/10.1007/s10649-016-9708-5.

Filk, Christian (2020a): 'Die Maschinen werden zu einer einzigen Maschine': Eine technikphilosophische Reflexion auf 'Computational Thinking', Künstliche Intelligenz und Medienbildung, in: MEDIENIMPULSE: Beiträge zur Medienpädagogik, 58(1), 1–53. https://doi.org/10.21243/mi-01-20-18.

Filk, Christian (2020b): Überschreitungen und Entgrenzungen durch 'Datafizierung' – 'Europäische Medienkulturwissenschaft' im strukturellen digitalen Gesellschaftsumbruch, in: Wagner, Hedwig (Hg.): Europäische Medienkulturwissenschaft: Zur Programmatik eines Fachs, Bielefeld: transcript, 61–111.

Filk, Christian (2025a): Strengthening Digital Self-Determination: Integrating Media Ethics and Artificial Intelligence into Teacher Training for Everyday School Life, in: MEDIENIMPULSE: Beiträge zur Medienpädagogik, 63(1), 1–48. https://doi.org/10.21243/mi-01-25-29.

Filk, Christian (2025b): Ideology Critique in the Age of Algorithmic Governance: On the Transformative Power of Critical-Reflexive Media Pedagogy in a Platformized Society, in: MEDIENIMPULSE: Beiträge zur Medienpädagogik, 63(2), 1–55. https://doi.org/10.21243/mi-02-25-21.

Filk, Christian/Schulze Heuling, Lydia (Hg.) (2021): Algorithmic and Aesthetic Literacy: Emerging Transdisciplinary Explorations for the Digital Age, Opladen: Barbara Budrich. https://doi.org/10.3224/84742428.

Fredriksen, Aurora (2014): Assembling value(s): What a focus on the distributed agency of assemblages can contribute to the study of value. Manchester: The Leverhulme Centre for the Study of Value, School of Environment, Education and Development of The University of Manchester, online unter: https://pure.man-chester.ac.uk/ws/portalfiles/portal/32468376/FULL_TEXT.PDF (last access: 05.09.2025).

Freire, Paulo (1970): Pedagogy of the Oppressed, New York: Herder and Herder.

Fuchsberger, Verena/Frauenberger, Christopher (2025): Doing re-sponsibilities in entangled worlds, in: Human Computer Interac-tion, 40(1–4), 65–88. https://doi.org/10.1080/07370024.2023.2269934.

Garlen, Julie C. et al. (2022): Agency as assemblage: Using child-hood artefacts and memories to examine children's relations with schooling, in: Journal of Childhood, Education & Society, 3(2), 122–138. https://doi.org/10.37291/2717638X.202232170.

Gourlay, Lesley (2021): There Is No 'Virtual Learning': The Material-ity of Digital Education, in: Journal of New Approaches in Educa-tional Research, 10(1), 57–66. https://doi.org/10.7821/naer.2021.1.649.

Gourlay, Lesley (2021): Posthumanism and the Digital University: Texts, Bodies and Materialities, London: Bloomsbury Academic. https://doi.org/10.5040/9781350038202.

Haraway, Donna (2006): When We Have Never Been Human, What Is to Be Done? Interview with Donna Haraway by Nicholas Gane, in: Theory, Culture & Society, Vol. 23, No. 7–8. https://doi.org/10.1177/0263276406069228.

Haraway, Donna J. (2016): Staying with the Trouble: Making Kin in the Chthulucene, Durham: Duke University Press. https://doi.org/10.1215/9780822373780.

Hayles, N. Katherine (1999): How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics, Chicago: University of Chicago Press.

Hayles, N. Katherine (2012): How We Think: Digital Media and Contemporary Technogenesis, Chicago: University of Chicago Press. https://doi.org/10.7208/chicago/9780226321370.001.0001.

Hayles, N. Katherine (2016): Cognitive Assemblages: Technical Agency and Human Interactions, in: Critical Inquiry, 43(1), 32–55. https://doi.org/10.1086/688293.

Hayles, N. Katherine (2017): Unthought: The Power of the Cognitive Nonconscious, Chicago: University of Chicago Press. https://doi.org/10.7208/chicago/9780226447919.001.0001.

Herbrechter, Stefan (2018a): Posthumanism and the ends of education, in: on education. Journal for research and debate, 1(2), 1–5. https://doi.org/10.17899/on_ed.2018.2.2.

Herbrechter, Stefan (2018b): Posthumanist Education?, in: Smeyers, Paul (Ed.): International Handbook of Philosophy of Education, Cham: Springer, 727–745 (2018). https://doi.org/10.1007/978-3-319-72761-5_53.

Jud, Marcel/Weissenbacher, Barbara/Neubauer, Aljoscha C. (2025): AI insights into initial teacher education: predictive models for student dropout, in: European Journal of Teacher Education. https://doi.org/10.1080/02619768.2025.2535624.

Jukes, Scott/Reeves, Yvonne (2020): More-than-human stories: experimental co-productions in outdoor environmental education pedagogy, in: Environmental Education Research, 26(9–10), 1294–1312. https://doi.org/10.1080/13504622.2019.1699027.

Katzenbach, Christian/Ulbricht, Lena (2019): Algorithmic governance, in: Internet Policy Review, 8(4). https://doi.org/10.14763/2019.4.1424.

Latour, Bruno (2005): Reassembling the Social: An Introduction to Actor-Network-Theory, Oxford: Oxford University Press.

Leeder, Thomas M. (2024): (Re)conceptualising coach educationand development: towards a rhizomatic approach, in: Sports Coaching Review. https://doi.org/10.1080/21640629.2024.2343560.

Maalsen, Sophia (2023): Algorithmic epistemologies and methodologies: Algorithmic harm, algorithmic care and situated algorithmic knowledges, in: Progress in Human Geography, 47(2), 197–214. https://doi.org/10.1177/03091325221149439.

Murris, Karin (2022): Karen Barad as Educator: Agential Realism and Education, Singapore: Springer. https://doi.org/10.1007/978-981-19-0144-7.

Murris, Karin/Osgood, Jayne (2022): Risking erasure? Posthumanist research practices and figurations of (the) child, in: Contemporary Issues in Early Childhood, 23(3). https://doi.org/10.1177/14639491221117761.

Noble, Safiya Umoja (2018): Algorithms of Oppression: How Search Engines Reinforce Racism, New York: NYU Press. https://doi.org/10.18574/nyu/9781479833641.001.0001.

Pasquale, Frank (2015): The Black Box Society: The Secret Algorithms That Control Money and Information, Cambridge: Harvard University Press. https://doi.org/10.4159/harvard.9780674736061.

Ringrose, Jessica/Warfield, Katie/Zarabadi, Shiva (Eds.) (2019): Feminist Posthumanisms, New Materialisms and Education, London/New York: Routledge.

Rosiek, Jerry Lee et al. (2024): A Review of Posthumanist Education Research: Expanded Conceptions of Research Possibility and Responsibility, in: Review of Research in Education, 48(1), 220–247. https://doi.org/10.3102/0091732X241265332.

Sánchez-Vera, Fulgencio (2025): Critical Algorithmic Mediation: Rethinking Cultural Transmission and Education in the Age of Artificial Intelligence, in: Societies, 15(7), 198. https://doi.org/10.3390/soc15070198.

Shephard, Kerry (2015): Higher Education for Sustainable Development, Basingstoke: Palgrave Macmillan UK. https://doi.org/10.1057/9781137548412.

Simmler, Monika (2024): Responsibility gap or responsibility shift? The attribution of criminal responsibility in human-machine interaction, in: Information, Communication & Society, 27(6), 1142–1162. https://doi.org/10.1080/1369118X.2023.2239895.

Soni, Nikita et al. (2020): Adults' and Children's Mental Models for Gestural Interactions with Interactive Spherical Displays, in: CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1–12. https://doi.org/10.1145/3313831.3376468.

Strom, Kathryn J./Martin, Adrian D. (2022): Toward a critical posthuman understanding of teacher development and practice: A multi-case study of beginning teachers, in: Teaching and Teacher Education, 114, 103695. https://doi.org/10.1016/j.tate.2022.103688.

Tissenbaum, Mike/Berland, Matthew/Lyons, Leilah (2017): DCLM framework: Understanding collaboration in open-ended tabletop learning environments, in: International Journal of Computer-Supported Collaborative Learning, 12(1), 35–64. https://doi.org/10.1007/s11412-017-9249-7.

Wang, Weijun/Liu, Zhonggen (2021): Using Artificial Intelligence-Based Collaborative Teaching in Media Learning, in: Frontiers in Psychology, 12, 713943. https://doi.org/10.3389/fpsyg.2021.713943.

Williamson, Ben/Bayne, Sian/Shay, Suellen (2020): The datafication of teaching in Higher Education: critical issues and perspectives, in: Teaching in Higher Education, 25(4), 351–365. https://doi.org/10.1080/13562517.2020.1748811.

Williamson, Ben/Komljenovic, Janja/Gulson, Kalervo (2024): World Yearbook of Education 2024: Digitalisation of Education in the Era of Algorithms, Automation and Artificial Intelligence, London: Routledge. https://doi.org/10.4324/9781003359722.

Zuboff, Shoshana (2019): The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power, New York: PublicAffairs.