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Disability, Data, and Design: Toward a Critical Framework for Evaluating AI in Inclusive Education

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Abstract- ***In today's digital landscape, artificial intelligence (AI) is significantly influencing higher education by driving adaptive learning platforms, automated assessment, predictive analytics, and generative AI tools.From adaptive learning systems to predictive analytics and automated assessment, AI is transforming higher education in today's digital era. The developments bring up some significant issues relating to the impact these will have on disabled learners. Though the issues of equity and inclusion are common to both fields, AI in Education (AIED) and critical disability studies have developed separately for the most part. This paper presents a critical evaluative approach to evaluate the impacts of AI systems in education on reinforcing, challenging or changing ableist structures. The framework centres on four aspects: (1) the range of assumptions of a normed nondisabled learner that may be found in system design and training data; (2) whose ability can be facilitated by AI adaptations; (3) the politics of disclosure, personalisation and surveillance; and (4) whose knowledge and perspectives inform system development. It summarizes existing research on both sides, proposes theoretical links, and illustrates its applicability in three educational AI scenarios, providing a basis for empirical and critical research.***

Keywords: Artificial Intelligence in Education, Critical Disability Studies, Ableism, Capability Approach

I. INTRODUCTION: THE MISSING CONVERSATION

A. An Urgent Convergence

Big language models have gained public release in late 2022, ushering in an unprecedented surge in the adoption of AI in higher education. A new generation of adaptive learning platforms has emerged to customize the content that is delivered and learn more about how to deliver it; predictive analytics systems have been deployed to identify the 'at-risk' students; systems of automated feedback, that respond to students' online writing as it happens have been introduced; and AI tutors have been piloted to adapt their explanations to apparent levels of understanding, at rates that exceed both the rate of pedagogical change and governance frameworks (Crompton & Burke, 2023; Selwyn, 2022; Williamson, 2017). This expansion is not even. AI systems are not just tools to make education more efficient, but social artefacts that embody attitudes towards learning, learners, the nature and interpretation of deviations, and educational success (Benjamin, 2019; Noble, 2018; Williamson, 2017). These assumptions have actual repercussions for the learning, thinking, and bodily movements of all learners, and especially for those whose learning, thinking, and autism don't align with the normative baseline on which these systems rests.

There are many disabled learners at university in the UK and elsewhere in the OECD region, and disabled learners are an increasing part of the university population. However, the prevailing narrative in AIED focuses on accessibility issues (some incorporate it as a factor) and works as an interface design/format adjustment rather than as a structural and political challenge of who counts as normal, as a structural challenge of who is included in educational systems, and as a political challenge about whose minds and bodies define what is normal. (Crompton and Burke, 2023; Zawacki-Richter et al., 2019) In this context, 'accessibility' can be summed up as if the system is accessible to disabled persons. It doesn't question whether the basic 'macfhinery' of the system, the set of assumptions it puts forward about a child (content of its model of a learner), the idea of progress, or its conception of deviation, is itself disabling?

B. The Mutual Isolation of Two Fields

Finally, critical disability studies has as a point of contact, a number of digital technologies, including

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surveillance technologies in welfare systems (Eubanks, 2018), algorithmic discrimination in the job market and in the justice system (Whittaker et al., 2019), the politics of assistive technology (Hamraie & Fritsch, 2019), and the so-called 'New Jim Code' (Ruha Benjamin, 2019) — digital systems that reproduce historical patterns of oppression that appear as neutral automation. But this key tradition has not yet made use of the analytical tools directly to examine the effects of AI on education as disabled students are being transformed by the adaptive platforms, knowledge-tracing math and science algorithms, and predictive dashboards in their schools.

This mutual isolation means that the outcome is a significant orderinstitutional and epistemic threat. AIED is growing rapidly without a critical disability presence; the systems being designed may reinforce ablestcentral learning, normal and deviant notions; it is hard to audit, question and overturn a system when it is built into systems and infrastructure. A cadre of young students are exposed to critical disability studies as a potent analytical category not currently used to the areas of critical need.

C. The Paper's Contribution

This paper fills this gap and then some by introducing a Critical Disability Framework forAI in Education (CDF-AIED). The framework is not intended to be a taxonomy or checklist for compliance. It is presented here as an analytical and political framework: Placing it together with the dimensions and questions could guide research, inform designs and guide policy making without having a specific disciplinary language for this intersection. The paper needs to be set in the context of the concept of postdigital (Fawns, 2019; Jandrić et al, 2019; Knox, 2019), where the weaving of the human and the digital are the domain of the analytical, and theoretical intervention is seen as a necessary – indeed appropriate and legitimate – form of scholarly engagement.

A note on positionality is warranted Written by a disabled practitioner-researcher, thendis paper looks at how the field of computing education, and critical disability studies, are understood and practiced in the context of disability. The Design Power and Epistemic Justice of the framework is explicit, and directly related to the production of knowledge about AI and disability. .But, the perspective of this paper is also a contribution to the epistemic politics that it theorises (Hamraie & Fritsch, 2019).

The paper will proceed as follows: Section 4 reviews the status quo in the field(s) and presents a synthesis of the four • theoretical traditions that give birth to the " intellectual foundation" of the framework. The synthesis methodology, called conceptual synthesis, is described in section 5. The four framework dimensions will be set out in Sections 6. Section 7 demonstrates use of the AIED in 3 scenarios, and discusses implications beyond these. Section VII acknowledges limitations and identifies directions fourfor future research.

II. THE LITERATURE REVIEW OF RESEARCH AND THEORY

A. What AIED Says (and does not say) about Disability

The ten-year history of AI research and its use in higher education has yielded a considerable amount of work, particularly in a recent PRISMA systematic review by Crompton and Burke (2023) of 138 papers (2016-2022); and an earlier review of 146 papers (2007-2018) by Zawacki-Richter et al. (2019). In combination these reviews paint a picture of an overwhelmingly concentrated field of work which can be summarised with four application areas: intelligent tutoring systems and adaptive learning platforms, learning analytics and predictive modelling, automated feedback and assessment, and in recent times, the integration of AI tools and conversational agents into learning. The technology achievements are impressive: There was a consistent positive effect on student learning in the use of the step-based intelligent tutoring system, according to a meta-analysis by du Boulay (2016), and Holmes et al. (2019) offer a comprehensive classification of AIED applications showing it has pedagogical value.

In all these reviews, what comes across is the attitude toward disability. Except where they are present at all, disabled learners are normally represented as a set

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in accessibility research – a stream of work that covers issues such as using a screen reader, captioning or adapting to the flexibility of format – or as a variable in research on special educational needs in K-12 settings. The most significant missing ingredient in the mainstream of AIED is the structural question, which has to do with the model of the learner that underlies the system, and how does that model construct 'normal' and 'abnormal' learning?

The closest to a structural account of this kind is articulations of the Universal Design for Learning (UDL) principles in the framework of AIED. Holmes et al. (2019) state that although adaptive learning systems can, in theory, operationalize UDL by offering multiple means of representation, engagement, and expression, it will be difficult to do so in practice. The relationship between UDL principles and AIED design, however, is superficial, thus under-theorized—UDL is used as a design goal, but the epistemologies that lie behind the AI systems that claim to provide UDL are not investigated. A system that: adapts the format of content without questions who having what format is the human default would be the implementing UDL version without altering the structural implications.

The Figure 1 displays the distribution of the disability framings in the thematic synthesis of six selected AIED review sources. This paper takes individual and medical model framings to be the dominating problem, compared to social and structural framings.

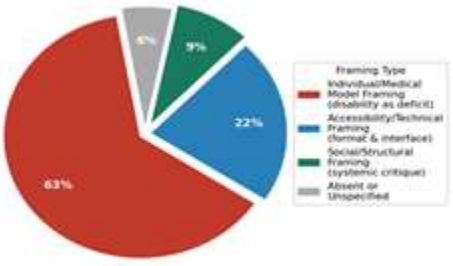

Figure 1. Framing of Disability in Selected AIED Literature (Thematic Synthesis)

Note. Thematic synthesis based on: Crompton & Burke (2023); Zawacki-Richter et al. (2019); Selwyn (2022); Williamson (2017); du Boulay (2016); Holmes et al. (2019). Categories represent dominant framings in each review source. This is an analytical synthesis, not quantitative original data.

This chapter concludes with the examination of what Critical Disability Studies does and does not say about AI.

There has been a significant engagement of Critical Disability Studies with digital and algorithmic technologies. The AI Now Institute's 2019 flagship report shows how disability discrimination is represented and reinforced in these three areas: healthcare, jobs, and criminal justice. Eubanks (2018) chronicles the systematic disadvantages that poor and disabled people face when it comes to welfare, and how this happens through an opaque algorithmic process. Building on the 'New Jim Code' devised by Benjamin (2019), racial hierarchies are reproduced in digital systems, and this has profound implications for disability where ableism and racism are long-term ‘partners in hierarchy and exclusion' as categorisation systems (Goodley, 2014). In his book (2018), Noble demonstrates how the algorithms used for search engines reflect the views of the dominant social groups and exclude other groups.

The discussion of AI by and for disabled people has tended to focus on assistive technology (Hamraie & Fritsch, 2019), welfare automation (Eubanks, 2018), and what Kafer (2013) has termed 'curative temporality' – the idea underpinning many assistive and adaptive technologies for disabled people and that it is the role of technology to ‘normalise' their lives. In the context of education, Williamson's (2017) critique of big data in education begins to draw on this critical tradition, claiming that algorithmic governance in education is a politics of normalisation. Social harms and ideological assumptions are highlighted as the focal points in AI-in-education by Selwyn (2022).

But there has been no continued analysis of the field of "educational AI" itself that can be traced back to this critical tradition. The adaptive learning platform, the knowledge tracer, the AI tutor, the predictive analytics dashboard, these are platforms that are

affecting disabled students' learning experiences on a mass scale. These decisions, such as identifying a 'learning gap', deciding that a student is 'at risk', and suggesting extra 'remediation' all have material consequences for learners with disabilities whose ability to engage in a pattern of learning might diverge systematically from the models the system is operating on which are established on a normative pattern of engagement.

C. Theoretical Resources for the Intersection

There are four theoretical principles we need and they are all required to construct the critical framework in this paper. However, they do not share the same analytical purchase and they are in productive tension with each other; taken together, they offer a multi-dimensional framework for considering AI in education from a disability justice perspective.

The Social Model of Disability argues that there is a production of disability in society not in people with impairment (Oliver, 1990). Social model thinking draws on focusing the analytical process of the person's capabilities on the surrounding context, rather than focusing on the person's limitations or deficits: What the person cannot do, rather than what the system hasn't done. Shakespeare (2014) 's more pluralist view allows for impairment-effects and keeps the social production of disability as the primary analytical framework. Thomas (2007) extends the social model with a move to 'barriers to being' — psycho-emotional aspects of disablism beyond barriers or limiting factors (BLFs) — relevant to the affective aspects of the learning environments in which AI operates.

Capability Approach proposed by Sen (1999) and Nussbaum (2011) and used in disability and education by Terzi (2005) is actually critical to assessing social arrangements by considering their actual freedoms (capabilities) offered to the individuals they cater to. The Capability Approach to AIED would turn the question from one of whether a system is effective for disabled students' learning outcomes to whether it widens the 'reality' of their educational freedoms—freedom of pathway, freedom of modality or freedom from difference management. Terzi's (2005) use of the 'dilemma of difference' in special education is particularly fruitful: she suggests that the capability framework could be used to assess systems of conditions that foster individuals' flourishing, whenever considering disability reduction as individual deficit or exposure to difference as a system that are taken to be mutually exclusive each are erroneous.

Designed by Hamraie and Fritsch (2019) and based on Kafer's (2013) crip theory, crip technoscience argues that technology is never neutral: it is embedded in design principles and principles of normalcy, in its assumed users, and in its criteria for success. The 'default user', the archetype against which adaptation works for an adaptive learning system is a political entity, not a technical specification. However, critics of technoscience offer tools which can question this construction and ask whose bodymind is made 'exceptional' by the design and 'logic' of the technoscience system.

The analytical framework to think through how patterns of exclusion get embedded in the algorithms come from Critical Algorithm Studies (e.g., Noble, 2018; Benjamin, 2019; Eubanks, 2018). Part of the key move, as Benjamin (2019) puts it, is to understand that algorithms are not 'biased' just in a statistical sense, but that bias is an integral part of the data fed into the algorithm, its design choices, the problem formulations, and the measures used to evaluate it, from the beginning. That a system of adaptive learning, which is based on data generated by what has been observed as normal engagement in schools, in the context of a neurotypical education, will not, simply, reproduce less effectively for neurodivergent learners: will actively generate patterns of interaction that map onto the disruptions that are observed and experienced by neurodivergent learners and react to them in terms of a remediation logic, not an accommodation one.

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Table 1. Four Theoretical Traditions and Their Contributions to the CDF-AIED Framework

Tradition	Key Theorists	Central Concept	Contribution to Framework	Dimensions Generated
Social Model of Disability	Oliver (1990); Shakespeare (2014); Thomas (2007)	Disability as social production; barriers to participation	Shifts from individual deficit to structural design assumptions; names the 'normal learner' as a political construction	D1: Normal Learner; D2: Adaptive Benefits
Capability Approach	Sen (1999); Nussbaum (2011); Terzi (2005)	Real freedoms; human flourishing; converting resources into capabilities	Evaluates systems by capabilities enabled, not just outcomes achieved; requires disaggregated analysis of whose freedoms expand	D2: Distribution of Adaptive Benefits
Crip Technoscience	Hamraie & Fritsch (2019); Kafer (2013)	Technology as politics of embodiment; curative temporality; the default user	Interrogates the default user; names normative assumptions in design logic; insists disabled people are experts and designers	D1: Normal Learner; D4: Design Power
Critical Algorithm Studies	Noble (2018); Benjamin (2019); Eubanks (2018); Whittaker et al. (2019)	Structural embeddedness of bias; the New Jim Code; discriminatory design	Examines data, design choices, and evaluation criteria as sites of ableist reproduction; opposes technical fix with structural critique	D1; D2; D3: Disclosure & Surveillance

Note. D1–D4 refer to the four framework dimensions presented in §6. CRPD = UN Convention on the Rights of Persons with Disabilities.

III. METHODOLOGY / RESEARCH DESIGN

A. The project was developed using the conceptual framework construction as method.

This paper is a conceptual framework paper, which is also considered a type of theoretical study in which the existing thoughts of intellect are combined to create a new concept that forms a kind of structure for analysing the knowledge gap (Jabareen, 2009). It has been found that conceptual framework construction is one of the methodologies in interdisciplinary research, especially when there is no suitable theoretical word to describe it even though it is possible to carry out empirical research. The framework that is proposed is not an empirical one, it is a theoretical framework that has been produced through the critical synthesis of the bodies of theory from four disciplines.

B. Methodological Warrant

There are three observations, which form the methodological basis for this approach. First, the divide between AIED and disability studies, foremost, it is conceptual, not that the two disciplines haven't developed a common vocabulary, or a common set of questions, or a common set of analyses. Without developing the conceptual infrastructure, no empirical work can be carried on. Second, in interdisciplinary studies, secondary uses of the conceptual framework as a tool of research have been presented as a 'critical praxis' (Jandrić et al., 2019; Williamson, 2017) in times when the speed of the technological deployment exceeds the academy's capacity to respond with an evaluative play of the mind. Third, and this is the third point, the postdigital tradition in educational research to which this paper belongs, perceives theoretical intervention as a legitimate and necessary mode under which educational research should be self-reflection (mapping, contextualisation and descriptive narration are other modes of doing research) and as a means of developing new analytical concepts and tools that are

not repeatable across different spatial or temporal contexts but that are related to the technosocial conditions of the present.

C. Synthesis Process

Four streams of literature were used as a starting point in the synthesis process: adaptive systems, learning analytics, generative AI, as well as critical disability studies (social model, crip theory, algorithmic ableism) and the Capability Approach in subject of "education. Analytical questions related to AI systems and disabled learners were generated for each tradition, assessing its capacity for this purpose. The dimensions of the framework were created where there was productive convergence and/or tension across traditions, not as an average of the traditions, but as an analytical affordance that each tradition contributes when applied to the nexus of AIED and disability. The resulting framework is proposed as heuristic, one of the parties to a dialogue about methodology, not as a taxonomy among taxonomies, a rather than a statement of last lectures.

IV. IV RESULTS / FINDINGS: THE CDF-AIED FRAMEWORK

A. The CDF-AIED Framework is a series of results/finding dimensions.

The Critical Disability Framework for AI in Education (CDF-AIED) consists of four evaluative dimensions based on various dimensions of theoretical traditions (as described in §4) and each comes with a set of guiding questions for research, design, and policy. The dimensions are analytically separate from each other but they are empirically connected: they reveal some parts of the same systems; evaluation on one dimension also raises questions which relate to the other dimensions.

B. Dimension The Teacher of the Normal Learner

Basic fundamental questions when evaluating AI systems on critical disability analysis is; What is 'normal' in this system and who said so? All the adaptive learning systems are based on a learner model. This model defines learning trajectories, the patterns of engagement that are considered evidence of understanding, variations from learning trajectory considered 'risk' or 'difficulty', and assessment of what being 'mastered' by a student means. These specifications are not “pure” specifications that the data is describing to; they are the specifications are the specifications the data was trained with and they accurately describe the learning patterns of the populations that this data came from. Whether that population consists largely of neurotypicals or not, a model of the normal learner will be a neurotypical model and deviation from that model will be systematically built up as deficiency.

This critique provides a vocabulary: social model of the disability (Oliver, 1990) which suggests that it is not the disabled learner, but the system that creates disability as deviation that is a problem. The 'default user,' however, is a political construction and naturalisation is political activity that helps naturalise the construction of the default user for this 'adaptive learning system' (Hamraie & Fritsch, 2019). No single, universal answer to whether the system ‘works' for disabled learners is possible; it is frustrating to assume that it does, when it is actually the cognitive style, nature of acquisition and form of engagement of a particular learner from a particular time that created the concept of ‘working'.

Guiding Questions for Dimension 1

- Which learning trajectories do you use for training the model of the learner that the system uses?
- Is the training set representative in terms of gender and cognitive skills?
- In what ways are 'deviations' from 'expected patterns' identified and who is doing the identifying?
- What happens algorithmically, to a learner's pattern when it does not match the algorithmic model?
- Are the learning patterns of neurodivergent students considered disruptive behaviors that need to be managed and adjusted to the norm or does the designer incorporate them as design parameters?

The Capability Approach does not allow to ignore the 'who' and the distributional question: whose capabilities are enlarged, and how much? even in cases of a true extension of the learning capabilities

of some students due to an AI system. It is perfectly possible for an adaptive learning system to enhance the averages of learning outcomes and expand the difference between average good and average poor learning outcomes. A more obvious realization of this would be that the distribution of the adaptive benefits would not be random but systematically weighted toward learners' patterns that are most similar to the training data, if the system's model of the normal learner describes a system that is neurotypical.

The Capability Approach to disability and education (Terzi 2005) is useful in this context. The evaluative question for Terzi is not whether a student has reached a certain learning outcome but whether he/she really has freedom to work on his/her learning project - freedom that includes a choice of modality, rate, pathway and expression.

Such an adaptive learning system that maximizes for one outcome (quiz scores, completion rates, time-on-task, etc.) might blow through the results of that measure, but it may shrivel the learning environment that allows for cognitively appropriate and personally satisfying avenues into the content.

Does learning outcomes gaps by disability group/s status symptomology, or by actual disability group/s status, occur?

• Is the gap between the most able/achieving learners and the least able/achieving going to widen or close? How does the system stretch — and are these the abilities that are important to disabled learners?

Is adaptation doing something at and within the bounds of normal or does it tackle structural barriers (e.g. format, pacing)?

Do the parts of the system lack effectiveness with certain disabled learners?

C. THE POLITICS OF DISCLOSURE AND SURVEILLANCE

The third dimension is related to the circumstances in which personalisation takes place and practices with regard to the data on which it depends. The present adaptive learning systems used in supporting disabled learners can be based on two approaches: explicit disclosure (the learner admits there is a disability and provides explicit feedback for particular accommodations) and implicit adaptive compromise (the system detects learning patterns from the learner's behavior and adapts to it). Both carry up unique and grave concerns.

The disclosure dependent model encapsulates both the documented issues in the disability in-education literature: that disclosure brings with it stigma (Eccles et al., 2018; Goode, 2007; Madriaga, 2007); that disclosure will bring with it bureaucratic complexity of both processes, and that disclosure may change how the learner is perceived. It also highlights a particular concern: in AI systems, the disclosure of disability isn't shared directly with a named support service worker; it might be baked into a more ongoing information about the user, across sessions, institutions and platforms.

Another concern with the implicit, as opposed to explicit, inference model is that if the system is created to infer learning difficulty based on behavioural patterns without triggering ‘disability' disclosure under equalities legislation, it can be used to generate data profiles which may be regarded as a substitute for a ‘disability' classification that, however, would not benefit from the same legal protection. A student that has not been diagnosed with ADHD but is perceived by others to have attentional challenges might receive a treatment that reflects this perceived difficulty with attention, but may not have been their actual difficulty and might not even have been their student's rule-breaker. Both variants fit Benjamin's (2019) definition of ‘discriminatory design’ because disclosure-requiring systems are discriminatory per their definition, whereas inference-based systems are limiting participants' perception of their rights and textures of potential design.

Interacting with peers and colleagues at work or on school projects:

Do the system require people to disclose their disability to provide them with personalised support?

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what information is gathered regarding learning styles, behavioral indicators or inferred thinking styles?
What is the length of time that data is stored and who is it shared with?
Are there opportunities for learners to audit, challenge or remove data profiles that are formed through inferences?
Is personalisation by disabled learners an empowering or an institutionalising experience?

C. Dimension 4: Design Power and Epistemic Justice

The last dimension has to do with who creates that system and what they know. The results of the critical algorithm studies have repeatedly illustrated the mirroring of the social positions and the claims to knowledge of algorithmic systems. Whereas, Noble (2018) and Benjamin (2019) report on the absence of marginalised groups in the development and design of search and facial recognition systems that ended up to encode bias into the systems' architecture rather than its output. Just like any products are built when developers and engineers take up design and development with a neurotypical perspective, it is difficult to avoid incorporating neurotypical presumptions into the design at every stage of an AIED system, if it's designed by neurotypical people, tested by neurotypical learners, and evaluated based on a neurotypical conceptualization of learning.

This is a conceptual (non-representational) issue as well as a representational one. Hamraie and Fritsch (2019) suggest that as a result, disabled people are 'experts and designers of everyday life', and that crip knowledge, their practical knowledge of how to navigate systems and spaces designed for them, is a unique epistemic expertise of design. When the algorithms that inform the design of learning resources for disabled students fail to acknowledge disabled students' knowledge of their learning, it is epistemic harm – the harm done to a person by a failure to acknowledge their status as a knower – that has been done to them here: they lose the benefit of the materials, and also they lose the knowledge being systematically excluded from the domain in which it is most needed.

Guiding questions for Dimension 4:
Was there a disabled person to include in the design, testing and evaluation of the system?
What type of disability stereotypes or perceived disabilities does the design team anticipate in their logic of a system?
Who determines success in the system when it comes to learning and disability?
Have disabled users the ability to contest (challenge), overrule or add to the system's model of how they learn?
• In which ways can there be accountability for disabled learners who suffer harm from the system?

Table 2. The CDF-AIED Framework — Four Dimensions, Guiding Questions, and Methodological Applications

Dimension	Core Focus	Key Guiding Questions	Theoretical Grounding	Methodological Application
D1: The Normal Learner	Training data & design assumptions about normative learning	What learning trajectories define the baseline? Whose cognitive style is the default user? How is 'deviation' algorithmically constructed?	Social Model (Oliver, 1990); Crip Technoscience (Hamraie & Fritsch, 2019)	Training data audit; design documentation review; participatory testing
D2: Distribution of Adaptive Benefits	Whose capabilities are expanded; distributive justice	Is the distribution of learning gains tracked by disability type? Does adaptation narrow or widen gaps? Are normative parameters challenged?	Capability Approach (Sen, 1999; Terzi, 2005); Social Model	Disaggregated impact analysis; capability mapping; outcome audit
D3: Disclosure &	Data practices, consent, and	Does the system require disclosure? What data is	Critical Algorithm Studies (Benjamin,	Privacy audit; learner consent

Surveillance	personalisation politics	inferred without consent? How long is disability-related data retained? Can learners audit their profiles?	2019; Whittaker et al., 2019)	review; data retention policy analysis
D4: Design Power & Epistemic Justice	Who designs; whose knowledge counts	Were disabled people involved in design and evaluation? Whose definition of 'success' is encoded? What accountability mechanisms exist for disabled learners harmed by the system?	Crip Technoscience; Critical Algorithm Studies; Fricker (2007) on epistemic injustice	Participatory design audit; team composition review; governance analysis

Note. CDF-AIED = Critical Disability Framework for AI in Education. Theoretical grounding: D1 = Oliver (1990), Shakespeare (2014), Hamraie & Fritsch (2019); D2 = Sen (1999), Nussbaum (2011), Terzi (2005); D3 = Benjamin (2019), Whittaker et al. (2019); D4 = Hamraie & Fritsch (2019), Noble (2018), Fricker (2007).

V. DISCUSSION

A. Illustrative Application to Three AIED Scenarios

To demonstrate the framework's analytical utility, I apply it briefly to three AIED scenarios. These applications are illustrative rather than evaluative: the purpose is to show that the CDF-AIED generates questions that standard AIED evaluation does not, not to provide a comprehensive assessment of any specific system.

Scenario A: Adaptive Learning Platform. Consider an adaptive learning platform that disaggregates content into modules, assesses mastery through automated quizzing, and recommends next steps based on a probabilistic model of knowledge acquisition. Applied through the CDF-AIED: D1 asks what model of knowledge acquisition underpins the system — if trained on neurotypical data, the 'knowledge gaps' it identifies for students with dyslexia or processing differences may reflect measurement artefacts rather than genuine gaps. D2 asks whether adaptive benefits are equally distributed — evidence suggests adaptive systems produce larger gains for higher-achieving students, potentially widening gaps for those most distant from the normative model. D3 asks what data about identified 'difficulties' is retained and whether this data is accessible to the student's institution beyond the tutoring context. D4 asks whether neurodivergent learners were involved in defining 'mastery' and 'gap'.

Scenario B: GenAI Tutor. Large language model-based tutoring tools are proliferating rapidly. Applied through the framework: D1 asks how the LLM's training corpus represents neurodivergent communication patterns — LLMs trained on large internet corpora may have absorbed normative assumptions about what 'good' academic communication looks like, responding less effectively to communication styles associated with autism or ADHD. D3 asks whether conversation logs are retained and whether they constitute persistent cognitive profiles. D4 asks whether disabled people were involved in defining 'helpfulness' in the RLHF (reinforcement learning from human feedback) process — if the human evaluators who trained the model's responses were predominantly neurotypical, the model's conception of a 'helpful' explanation may be systematically inaccessible to neurodivergent learners.

Scenario C: Predictive Analytics Dashboard. Systems that flag 'at-risk' students based on engagement data — log-in frequency, forum participation, submission timing — are widespread in UK HE. Applied through the framework: D1 asks what engagement patterns are treated as baseline — disabled students may have systematically different patterns due to energy management, medication schedules, or access needs, patterns the system may classify as 'disengagement' rather than as legitimate variations in studying. D2 asks whether downstream interventions triggered by 'at-risk' flags are equally effective for disabled

students — if protocols are designed for students whose 'risk' is motivational, they may actively harm disabled students by adding pressure without removing the structural barriers causing the engagement pattern. D3 asks whether students know they have been flagged, and whether they can contest the classification.

For researchers, the CDF-AIED provides an analytical vocabulary for studying AIED systems from a disability justice perspective. It names four dimensions that can be operationalised through a variety of methods: critical discourse analysis of system documentation, participatory research with disabled learners, algorithmic auditing of training data, and distributional impact analysis of learning outcomes.

For designers, the framework translates theoretical concerns into practical design questions. It asks of any AIED system: who is your default user, and is that construction defensible? Have you disaggregated your impact data by disability type? Have you involved disabled people in defining what your system is trying to do? These are questions that existing accessibility standards and WCAG compliance checklists do not ask.

For policymakers, the framework offers criteria for evaluating AI procurement decisions in education. It moves beyond accessibility compliance asking whether the system can be used by disabled people to structural adequacy: asking whether the system's core logic reproduces or challenges ableist assumptions about learning.

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B. Tensions Between Theoretical Traditions

The four theoretical traditions from which the framework is synthesised are not fully compatible, and acknowledging this is important. The social model's structural focus can sit uncomfortably with the Capability Approach's attention to individual flourishing: the former is suspicious of interventions that adapt to individuals without addressing the structural conditions that produce disability, while the latter insists that individual capabilities matter irreducibly. This tension is productive — it prevents the framework from collapsing either into pure structuralism (which would prohibit attention to individual learning needs) or into pure capability individualism (which would ignore the structural conditions that constrain capability expansion).

Similarly, crip technoscience's radical critique of normalisation sits in tension with the practical demands of designing systems that function effectively. A system that refuses to define a 'normal' learner has not solved the problem — it has avoided it. The framework's task is not to make these tensions disappear but to keep them visible as generative sites of intellectual and political work, and to insist that the resolution of these tensions should involve disabled people as central, not peripheral, participants.

VI. CONCLUSION AND IMPLICATIONS

A. Summary

This paper has proposed the Critical Disability Framework for AI in Education (CDF-AIED), constructed through the synthesis of four theoretical traditions — the social model of disability, the Capability Approach, crip technoscience, and critical algorithm studies — that have not previously been brought into sustained dialogue with one another or with the AIED research field. The framework operates across four dimensions: the construction of the normal learner in system design and training data; the distribution of adaptive benefits across disability categories; the politics of disclosure and surveillance in personalised systems; and the question of design power and epistemic justice.

B. Implications

The framework's practical import is urgent. AI systems are being deployed in educational settings at a pace that has outrun critical scrutiny, and the disabled learners most affected by their design assumptions are the least likely to be represented in the development processes that produce those assumptions. If AIED continues to develop without sustained engagement with critical disability studies — and if critical disability studies continues to attend to AI in welfare, employment, and criminal justice without turning its analytical apparatus on

educational AI — the result will be the embedding of ableist assumptions in the technological infrastructure of education at a scale and permanence that will be difficult to challenge after the fact.

This framework is a starting point, not a solution. It requires empirical testing, critical revision, and application by researchers with expertise that the present author does not fully command. It requires, above all, the engagement of disabled people whose knowledge of their own learning constitutes the most important data set that AIED has not yet collected.

VII. LIMITATIONS AND FUTURE RESEARCH

A. Limitations of a Conceptual Framework Study

This paper has three principal limitations. First, the framework is conceptual rather than empirically validated. Its four dimensions and guiding questions are proposed on the basis of theoretical reasoning, not demonstrated effectiveness. Application to specific AIED systems, and feedback from disabled learners and disability practitioners, will be necessary to assess whether the framework generates analytically productive questions or misses dimensions that practice reveals to be important.

Second, the paper's treatment of disability is inevitably partial. Disability is not a unitary category, and the framework's dimensions may have different analytical purchase for different disability types: the concerns raised by D1 (the normal learner) are particularly salient for neurodivergent learners; those raised by D3 (disclosure and surveillance) are particularly acute for learners with invisible disabilities. A more granular framework might attend to disability-specific concerns, but at the cost of the cross-disability analytical purchase the present framework seeks to provide.

Third, the paper focuses primarily on the UK higher education context and draws on a literature disproportionately from English-speaking contexts. The framework's applicability across different national legal frameworks, cultural contexts, and institutional settings requires further investigation.

B. Directions for Future Research

Three research directions follow from this framework. First, empirical testing: the CDF-AIED should be applied to existing AIED systems through mixed-methods research combining technical audit (training data composition, model architecture, evaluation criteria) with learner-centred inquiry (participatory research with disabled students about their experiences of specific AI tools). Second, co-design: the framework should be developed collaboratively with disabled learners and disability practitioners, not for them. Third, critical comparison: comparative application across the three scenarios described in §7 would generate a cumulative evidence base that could inform procurement and regulatory decisions at institutional and sector level. These directions constitute the empirical programme to which this theoretical intervention is an invitation.

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