OPEN PRAXIS

Critiquing Sustainable Openness in Technology-Based Education from the Perspective of Cost-Effectiveness and Accessibility

INNOVATIVE PRACTICE ARTICLE

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ABSTRACT

The over-exaggeration of technology's role in education has dominated the landscape of research, often resulting in the negligence of other important issues. This article critiques openness in technology-based education from the perspective of sustainability, put more specifically, cost-effectiveness and accessibility, both of which have direct impact on sustainable openness. It first reviews the purpose of using technology in education advocated in strategy documents, namely using technology to break the iron triangle of access, cost, and quality, hence increasing openness in high-quality education. It contends that technology-based education cannot be sustainably open without both cost-effectiveness and accessibility. Nevertheless, sustainable openness is an under-researched theme according to the findings from a review of 3,059 primary studies conducted in this article. The article then goes on to rethink sustainable openness in the digital age, arguing that technology-based education should be cost-effective to educational institutions and students alike and cater for socio-economic diversity and disparity, among other things, to ensure sustainable openness to all. It concludes by calling for a critical approach to researching technology-based education with the aim of achieving high quality, cost-effectiveness, and accessibility at the same time and opening up education to all.

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INTRODUCTION

In the past century, generation after generation of educational technology researchers and practitioners has felt it incumbent upon them to improve education by integrating technology into classrooms. Cuban (1986) drew our attention to this persistent pursuit some forty years ago which has picked up momentum ever since as more and more advanced technologies have emerged with new promising affordances for high-quality education. The belief in the role of technology in enhancing teaching and learning has even been translated into national policies (Munro, 2018; Xiao, 2019). It is the norm for countries, both developed and developing, to have "a detailed 'educational ICT strategy' based around the broad aim of guiding educational institutions to use digital technology in their teaching and learning" (Selwyn, 2011, p. 25) and the assumption is rarely challenged that digital technologies should be integrated into daily teaching practice (Borokhovski et al., 2022). Therefore, demonstrating positive impacts of "new" technologies on education seems to have been an overwhelmingly prevalent goal of educational research despite repeated failures to deliver these promises in practice (Bulfin, Henderson & Johnson, 2013; Prinsloo, 2018; Reeves & Lin, 2020).

The role of technology in education goes beyond enhancing quality. Technology in education often connotes positive meanings such as innovation (Marshall, 2010), modernization (Munro, 2018), progress and transformation (Selwyn, 2011), leading to the dominance of technological inevitabilism (Zuboff, 2019) in both the discourse and mindset of the educational (technology) community and society at large. Technology in education is even framed as the "only option" for fixing educational problems (Gilbertson et al., 2023) whose legitimacy was further consolidated by the COVID-19 pandemic (D. Clark, 2023). Inequitable access to (quality) education is a long-existing education problem to which technology seems to be universally embraced as an effective solution, if not the only option.

In summary, the use of technology in education appears to be indispensable to educational institutions in the twenty-first century or the so-called digital age. The more cutting-edge the technology is that an educational institution uses in teaching and learning, the more likely it is to accomplish its mission by enhancing its educational quality and providing more educational opportunities for more people. This seems to be a consensus among educational stakeholders. Against this backdrop, many educational institutions and in fact countries are determined to be ahead in the technology race, "to be leaders of change and be highly competitive in their domain" (Benavides et al., 2020) while some may jump on the bandwagon simply for fear of missing out and being tagged with a derogatory label.

The purpose of this reflection is to critique sustainable openness in technology-based education, an issue which is of theoretical and pragmatic relevance, not only pedagogically but also societally, on the macro (national and/or global), meso (institutional), and micro (individual learners) levels (Zawacki-Richter, 2009; Zawacki-Richter & Anderson, 2014) in that it is sure to shape the evolution of the educational ecosystem. In this article, an educational innovation is defined as sustainably open if it enables equity in access to education with cost-effectiveness for stakeholders at all levels, i. e. macro, meso, and micro levels, so that it continues to be feasible long after the initial attempt rather than just serves as a one-off, short-lived intervention.

The rest of this critique first makes a case for openness in education and reviews the purpose of technology in education from the policy perspective, arguing that there is no sustainable openness to speak of without cost-effectiveness and accessibility. It then presents results in relation to the sustainability of technology-based education as a research theme from literature reviews. The sustainable openness issue is critiqued in the wider socio-economic context before implications for future research are discussed.

WHY OPENNESS IN EDUCATION?

According to Bozkurt and Stracke (2023), "openness in education strives to shape education into its ideal form by advocating a range of values and principles that would lead to equity and social justice in education by positioning human-centred approaches at the core of its practices" (p.32). This view aligns with the conceptualization of education as a human right in that it "shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms" (United Nations, 1948, p.11). Therefore, openness,

or equity in access is essential to ensuring that everyone has the right to quality education. In this, technology is often assigned an important role in reducing and even eradicating "learning poverty", especially in less or under-developed regions and countries (World Bank, 2020) and in relation to people with disabilities (Rice, 2010). However, to what extent technology can deliver the goal of equitable education depends, in a sense, on how cost-effective technology-based education is. On the other hand, unless it is cost-effective and accessible, it is hardly sustainable. Therefore, this critique is intended to find out how well sustainable openness in technology-based education has been explored in previous research.

Selwyn (2011) raises a series of thought-provoking, inspiring questions in his critique of the relationship between technology and education, including

> Why do we really need technology in education? Are digital technologies essential to supporting effective forms of education in the twenty-first century? What do digital technologies allow to happen in education that could not otherwise happen? (p.38) ... Do digital technologies really offer a better way of organizing and providing educational opportunities? (p.147).

There is too much talking but too little thinking about these key issues, as Selwyn (2011) aptly observes (also see Xiao, 2023). At the heart of these questions lies the sustainable openness in technology-based education. Given the pervasiveness of technology in education and the increasing cost incurred as a result, it is high time to examine whether and how well, if any, sustainable openness in technology-based education has been adequately considered in the literature. This inquiry is imperative, especially against the backdrop of global austerity, even if technology can increase learning gains as popularly assumed.

WHAT IS TECHNOLOGY IN EDUCATION FOR?

Low-cost public provision of education is essential to increasing openness in education. A typical example is the traditional open and distance education model whereby technology is successfully used to provide high-quality education to people who cannot go to university otherwise, increasing access at low cost without undermining quality (Daniel et al., 2009). Low cost, high quality, and wider access are echoed in many technology-based education documents as benefits for introduction of technology into education. For example, in addition to ensuring an equitable education for people with disabilities, UNESCO Institute for Information Technologies in Education identifies six key reasons for integrating Information and Communications Technology (ICT) into education, namely the social rationale (preparing students to survive in society), the vocational rationale (preparing students for future jobs), the pedagogical rationale (enhancing teaching and learning), the catalytic rationale (driving educational change), the cost- effectiveness rationale (reducing costs of education), and the information technology industry rationale (promoting IT industry) (Butcher, 2014; also see Rice, 2010). The essence of the first four rationales is provision of high-quality education and cost-effectiveness is also highlighted as an independent rationale although only a special subgroup of the disadvantaged cohort is targeted at in terms of access (but not as an independent rationale). The World Bank (2018) lists seven possibilities that technology may offer for education which, likewise, embody the pursuit of low cost, high quality, and wider access. These three factors are reiterated in a later document in which the World Bank states that it

> supports the appropriate, cost-effective use of EdTech at all levels of education and supports countries in expanding access and improving quality, both inside and out of the classroom – so that education reaches all students (World Bank, 2020, p. 6).

Breaking the iron triangle of access, cost, and quality is also a frequent theme of national or institutional technology-based education strategies. For example, Munro's (2018) analysis of 13 digital teaching and learning strategies formulated by government departments and non-departmental public bodies in the United Kingdom (UK) between 2003 and 2013 shows that facilitation of global provision, cost saving, enhancement of quality, and more choices for learners are among the leitmotivs running through these documents. It is the same case with national strategies in China (Xiao & Zhang, 2022) and many other countries (Marín et al., 2022). At a meso level, enhancing quality and improving access are top drivers for technology

in education according to surveys of UK higher education institutions (HEI) in 2003, 2004, 2008, and 2010, although reducing costs remains one of the lowest ranked drivers in all the four surveys (Browne et al., 2010). In the case of Chinese HEIs, it is the access dimension that is relatively understated in their development plans (Xiao, 2019).

Russell's (1999) No Significant Difference Phenomenon is often drowned by the hype surrounding the learning gains brought by technology in education or mainly cited to justify distance education. If we look at Russell's study from a different angle, we may also use it to challenge the effectiveness and necessity of technology-based education: If there is no significant difference, why bother using technology? There are other studies which set out to verify this effectiveness by reviewing relevant primary studies. For example, R. Clark (1983) reviews meta-analyses and other studies of the impact of media on learning, reaching the conclusion that "there are no learning benefits to be gained from employing any specific medium to deliver instruction" (p. 445). It may be that neither the "significant difference" nor "no significant difference" conclusion is completely objective due to the possible disparity in the criteria adopted for the review. Perhaps, this is why

> for every large-scale study or "meta-study"... that concludes that technology use can be associated with improvements in learning performance, there are many others that find no difference, or even a negative relationship (Selwyn, 2011, p. 85).

Therefore, we may justifiably claim that the influence of technology on learning is at best mixed. For example, a rigorous review of the Adaptive Learning Market Acceleration Program (ALMAP) initiated by the Bill & Melinda Gates Foundation shows that adaptive courseware has mixed effects on student outcomes (Yarnall et al., 2016).

If there is no significant difference in quality between technology-based education and non-technology-based education, the cheaper option will increase access. Even if technology-based education can bring greater learning gains, it cannot increase access unless it is more cost-effective than non-technology-based education. Nevertheless, if technology-based education is not as effective as non-technology-based education or even produces adverse effects on learning, it should not be advocated at all even if it is more cost-effective and accessible. In a word, there is no point in using technology for the sake of technology; quality, cost, and access are key to sustainable openness in technology-based education. Therefore, it is of relevance to explore how well the factors of cost-effectiveness and accessibility are integrated into research on technology-based education.

TO WHAT EXTENT IS SUSTAINABILITY A THEME FOR PREVIOUS RESEARCH?

In 2022, the Commonwealth of Learning published a book entitled "*Technology Application in Teaching and Learning: Second-Order Review of Meta-Analyses*" which "summarises how the use of technology affects learning (achievement outcomes) in three different educational settings: in-class, online and blended learning" (Borokhovski et al., 2022, p.1). The selection of sample for this second-order review was made by strictly following well-designed criteria in hopes of ensuring comprehensiveness and representativeness. Altogether, 113 meta-analyses published from 2000 onwards were included in Borokhovski et al. (2022). To find out to what extent sustainability, or put more specifically, cost and access, is a topic for previous research, I set out to look for the answer from the primary studies covered by these meta-analyses. With five meta-analyses failing to provide a list of sample and another two not appearing on the reference list, hence unable to be retrieved, there were 106 meta-analyses left as sources of my sample.

These 106 meta-analyses include 4,652 primary studies but with 1,045 duplicates. I searched for the remaining 3,607 studies one by one. When the collection was done, I read the abstract of each work to identify the purpose(s) of the study, judging whether cost-effectiveness and/or accessibility were considered in the study. If the abstract was not information-rich enough, I read the full text to find the answer. In this process, 321 abstracts were found to lack the information needed but their full texts were unavailable and another 227 publications turned out to be irrelevant. Some of these irrelevant studies were not about learning gains or technology-based education, some were about conceptual research, theory/model/framework-building, and software/tool development, and some were summaries or reviews of

previous studies while others were published in languages other than English. In the end, 3,059 primary studies constitute my sample (see Figure 1). Published between 1969 and 2022, these works span over five decades whose authors were affiliated to institutions in 70 countries, including developed, developing, and under-developed countries across six continents: Africa, Asia, Australia/Oceania, Europe, North America, and South America.

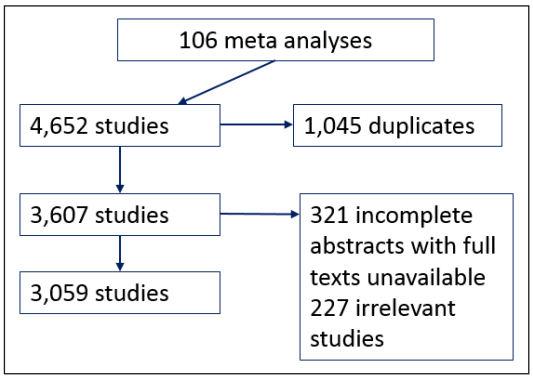

Figure 1 Sample Selection.

Slightly over 1% (n = 32) of the studies took cost-effectiveness into consideration in the research designs and slightly over 7% (n = 224) aimed at widening access/increasing equity with nine of them intended to achieve both cost-effectiveness and accessibility. For example, McNally et al. (2016) reported "on the use of digital technology to improve outcomes for disadvantaged children" in the UK (p. 4). For both the ICT and non-ICT treatments, "the impact for children eligible for free school meals and children with below average pre-test outcomes was larger than for all pupils" while the costs over three years were £25.56 and £25.47 per pupil for the ICT and non-ICT treatments respectively (McNally et al., 2016, p. 4). This suggests that there was hardly any difference in cost between the two treatments and that the ICT treatment led to greater learning gains. However, it is not known whether the technology needed was accessible to the disadvantaged pupils if their parents had to pay the cost. The nine "cost-effectiveness cum accessibility" studies were conducted in the contexts of both less developed countries (Abrami et al., 2014; O'Donovan et al., 2016; Worth et al., 2018) and developed countries (Jewett, 1998; McNally et al., 2016; Muta et al., 1997; Nicolson et al., 2000; Rouse & Krueger, 2004). It is worth noting that the technology-based model is not always found to be the more cost-effective one. For example, McClendon and McArdle (2002) came to the conclusion that the lecture model of instruction was the most cost-effective. As for the "access" studies, their subjects of study were mainly low academic achievers or students with learning difficulties (for example, Burns et al., 2012), urban students from low socio-economic backgrounds (for example, Comaskey et al., 2009), rural students (for example, McBride & Lewis, 1993), students with disabilities (for example, Bailey et al., 2016), students from indigenous (for example, Wolgemuth et al., 2011) or migrant families (for example, Troia, 2004), and distance students (for example, Hammond, 1997).

It is noteworthy that the issue of cost is examined only from the perspective of educational providers. None of the studies investigated the costs which students (and their families) had to bear when technology-based education was implemented. So even if a technology-based intervention was found to be cost-effective for educational providers as compared to the traditional non-technology delivery, it might not contribute to openness in the true sense.

This dearth of research into the cost and access issues of technology in education is also echoed by other systemic literature reviews. Cost, access, and equity do not appear as research themes in the concept map of five decades of educational technology research published in the *British Journal of Educational Technology* (*BJET*) (Bond et al., 2019) and of 40 years' publications of *Computer & Education* (*C&E*) (Zawacki-Richter & Latchem, 2018). This scarcity is also confirmed by other systemic reviews of publications in educational technology journals, including the *Australasian Journal of Educational Technology* (2013–2017) (Bond & Buntins, 2018), the *International Journal of Educational Technology in Higher Education* (2004–2017) (Marín et al., 2018), the *Turkish Journal of Online Education Technologies* (2012–2018) (Erdem Aydin et al., 2019), as well as *Educational Technology Research & Development*, *Educational Technology & Society*, *Journal of Computer Assisted Learning*, *BJET* and *C&E* (2000–2009) (Hsu et al., 2012).

Given the above findings, we may come to the conclusion that cost and access have not been as deeply researched as they should be. In other words, sustainable openness in technology-based education merits greater research interest and attention.

RETHINKING OPENNESS IN (TECHNOLOGY-BASED) EDUCATION IN THE DIGITAL AGE

Assuming that technology in education can increase learning gains, there are many meaningful research questions which can only be answered by taking cost and access into account. For example, can it reduce costs both for educational institutions and students? Is technology-based education more accessible than non-technology-based education? Is high-tech-based education more equitable than low-tech-based education?

There is little doubt that the high cost of technology in education remains a challenge not only for governments and educational institutions but also for students, especially when it comes to cutting-edge technologies such as Augmented Reality (Echeverría et al., 2012), explainability artificial intelligence (Antoniadi et al., 2021), and ChatGPT (Vanian & Leswing, 2023), not to mention various possible harms as a result of the production, consumption, disposal, and use of high-tech (Selwyn, 2023). Even if governments or educational institutions can bear the cost of technology, it is still a problem whether students and their families can afford technology-based education. For example, online learning is not a feasible option for many Indian students for various reasons, including low access to devices, poor connectivity, and unaffordable mobile data. In one survey involving nearly 1,400 underprivileged households, only 24% of children in urban areas and 8% of children in rural areas were able to study online regularly (Bakhla et al., 2021). In another large-scale survey, about 60% of public school students could not study online, with the situation much more exacerbated for children with disabilities, over 90% of whom were found unable to attend online classes (Azim Premji Foundation, 2020). Huge discrepancies in terms of access to technology and connectivity also exist in South Africa (Murris et al., 2022). The World Bank (2018) talks up the affordances of technology for enhancing educational quality and expanding access, especially "in fragile and conflict contexts or remote areas where teacher support is scarce" (p. 2) but at the same time also acknowledges that "rampant inequality in access to technology infrastructure, which includes both devices (radios, TVs, computers, laptops, tablets, and phones) and connectivity to the Internet" is a major barrier (World Bank, 2020, p. 10). No country, no matter how developed it is, has been able to free itself from this predicament.

Unless technology-based education is affordable for educational institutions and students alike, it is more likely to advantage the haves rather than those have-nots who need help most. Technology in education is not necessarily conducive to access to education; its access affordances are predicated on its affordability, among other things. Unfortunately, R. Clark's (1994) argument has fallen on deaf ears that "in a design science or an instructional technology, we must always choose the less expensive way to achieve a learning goal" (p. 22). And it must also be reiterated that the way chosen should be less expensive not only for educational institutions but also for individual students and their families because "parents have a prior right to choose the kind of education that shall be given to their children" (United Nations, 1948, p. 11), a right which, unfortunately, is simply ignored in most cases. Otherwise, "giving them books, hiring more teachers or building more schools – or even paying families to send their kids to school" may be "educationally better" than giving kids computers, as Naughton (2005) argued sensibly when commenting on the One Laptop Per Child project. This argument is somewhat echoed by Mervyn et al. (2014) who reported on the impact of two government mobile-technology initiatives in the UK which aimed to increase socially excluded citizens' access to governmental services, finding that provision of mobile access alone might worsen the exclusion rather than increase equity if other factors related to these citizens were not taken into account.

When Daniel et al. (2009) advocated taking advantage of technology to break the iron triangle of access, cost, and quality in higher education, what they had in mind was the dedicated model of open and distance learning which targets at part-time learners who find this model of technology-based education more economical than accessing full-time residential education in terms of opportunity cost. In other words, it is more cost-effective or affordable for these students. On the other hand, technology enables these educational institutions to achieve economies of scale through large enrolment and cost-effective large-scale delivery, which

in turn ensures the provision of funding needed for high-quality course production. Over half a century's practice has demonstrated its sustainable openness. Nevertheless, this model may not work for other educational institutions whose students study full time and may find technology-based education less desirable in terms of cost, including opportunity cost. Should this be the case, there is hardly any sustainable openness to speak of.

We are now living in a digital age. Nevertheless, this does not mean that only high-tech has a role to play in ensuring that everyone has the right to high-quality education. It is not a "the newer, the costlier, the better" logic. Whether technology in education can enhance quality, reduce cost, and expand access depends on for what, to whom, how, and which technology is actually used; technology is neither the best nor the only silver bullet when it comes to providing high-quality education for all. Given the diversity of and disparity in the socio-economic conditions of educational institutions and students in different countries, in different areas of a country or even within an area, there is no one-size-fits-all approach to openness in education. Sustainable openness is a relative concept: what is a sustainable equitable education provision in one place or to one cohort may prove to be otherwise in another or to another. All roads lead to Rome. An ideal spectrum of openness in education should be in the form of a continuum from high-tech to low-tech to no-tech, with many choices to cater for socio-economic diversity and disparity, among other things, as can be seen from measures taken by governments and educational institutions around the world to provide education during the COVID-19 pandemic (Bozkurt et al., 2020).

The digital age should not rule out non-digital or non-high-tech solutions to educational problems. Sustainable openness in (technology-based) education can only be guaranteed through the orchestration of a continuum of options from high-tech to low-tech to no-tech rather than any single mode. Sustainable openness in this sense should be aimed for in all efforts to realize Education for All.

CONCLUDING REMARKS: TOWARDS A PRACTICAL RESEARCH AGENDA

The iteration of the hype-hope-disappointment cycle "is perhaps the biggest lesson to be learnt from the twentieth century" (Selwyn, 2011, p. 59). Unfortunately, the zeal for technology in education shows no sign of waning due to many and various reasons. In this, a research agenda of practical relevance may be needed to cool down this obsession (Wang & Reeves, 2003; Xiao, 2023).

First and foremost, we need to be cautious of naturalizing the "mainstream" discourses concerning technology-based education (De Freitas & Oliver, 2005) which, as pointed out above, are predominantly associated with positive connotations such as openness, innovation, modernization, progress, and transformation. These discourses only represent the value propositions of particular stakeholders concerned and "the portrayal of technology as a wholly beneficial enterprise obscures other issues and inequalities" (D. Clark, 2023). The design of any research should be out of realistic necessity with a focus on meaningful issues instead of simply following suit. For example, what exactly is the problem that requires solving? Is there any evidence that this problem really exists? In what ways is the use of technology essential to solving this problem? Is there any alternative to achieving the same or even better effect than the use of (a particular) technology? Is the proposed technology-based intervention the most cost-effective and accessible option not only for educational institutions but also for individual students (and their families)? In a word, all research should be of practical relevance with the aim of solving a real problem rather than using technology for technology's sake – solving an imagined problem.

Secondly, all stakeholders, especially those whom technology-based education is supposed to serve in the first place, are entitled to have their say in what counts as accessible high-quality education. Put specifically, we need to conduct more research focusing on the sustainable openness issue, especially by involving the "disadvantaged" portion of the student population as subjects of study. Flipping classroom is a typical case in point. It would be absurd to practice this pedagogical approach among students who live in ghetto conditions getting by only with bare necessities. What do the disadvantaged students really need? What barriers do they face to accessing the same education as their peers? Is the use of technology the only option to fix their problem? If yes, can they afford the technology used? Which technology can solve

this problem most effectively in terms of cost and learning gains? Such questions should be borne in mind and proactively taken into account when designing a study. This is particularly important if we intend to design for scale (World Bank, 2020).

Thirdly, sustainable openness in technology-based education is also related to students' social and cultural factors (Kuhn et al., 2023). Simply providing access to technology may not be able to enable sustainable openness because technology itself, technological applications, and education are all culturally loaded (Xiao, 2023). A particular technology-based intervention may work for the disadvantaged in one country but not in another (Murris et al., 2022). For example, technology-enhanced autonomous learning may prove to be effective in an individualist culture but less so in a collectivist culture. It is the same case with computer-supported collaborative learning. The pedagogy needs refining when these interventions are administered in different cultural contexts. What is the students' typical learning culture? How is the role of a student defined? How is the role of a teacher defined? How is the student-student or student-teacher relationship defined? Is there any norm in relation to the students' culture, religion, and even gender that may affect their attitude to technology in education? We need to treat these issues proactively in the study design.

For technology-based education to be sustainably open, technology should not be merely the icing on the cake, adding to the cost of education and as a result making education even more unaffordable for those who can hardly afford education in the first place. The use of technology in education should be justified by its contribution to access to high-quality education for all at affordable costs for both institutions and students. Therefore, the overarching aim of research is to find the best-value-for-money model of technology-based education, in other words, enabling high quality, cost-effectiveness, and accessibility at the same time to materialize openness in education in a sustainable manner.

COMPETING INTERESTS

The author has no competing interests to declare.

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