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Disruptive Technologies: Implications for Third-level Accounting Education

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Disruptive technologies are associated with rapid change in the accountancy profession and the expected skillsets of accountants. This paper explores four such technologies: big data and analytics (BDA), robotic process automation (RPA), artificial intelligence (AI) and blockchain. This literature review investigates whether it is important to include these technologies in third-level accounting curricula, and how such technologies are or could be taught. It finds strong support for including BDA and less strong (but increasing) support for including other technologies. It suggests how to include these technologies in accounting curricula, but also flags the need for further research into these technologies and related educational practice.

1. Introduction

This special issue of *Accounting, Finance and Governance Review* considers the challenges to accounting, finance, and governance education in a rapidly changing world. This paper focuses on technology as a major driver of that rapid change, with developments of disruptive technologies described as fundamentally shifting the required skillsets of current and future accountants (ACCA, 2020b) and even the nature of accounting itself (Dai & Vasarhelyi, 2017). Accountancy firms, particularly the largest firms, have made significant investment in these technologies and have been vocal in advocating the benefits of these changes (Cooper et al., 2019). Professional accountancy accrediting bodies have responded by changing their curricula to include disruptive technologies (e.g. ACCA, 2021; Chartered Accountants Ireland, 2019; CIMA, 2021). Business school accrediting bodies' standards highlight the importance of engaging future accountants with such technologies and equipping them for future changes (Association to Advance Collegiate Schools of Business (AACSB), 2022).

In contrast, third-level institutions have been criticised as slow to respond to these changes and failing to develop students' skills (Dzuranin et al., 2018; Griffin & Wright, 2015; Hasan, 2022). Some, including Qasim et al. (2022), have argued that if this is not remedied, accountancy firms will increasingly prefer IT graduates to accounting graduates – posing an existential threat to third-level institutions and accounting educators. Recent research in the US highlighted that 31% of new accounting hires were from disciplines other than accounting, an 11% increase on previous research (Tysiac & Drew, 2018). Moreover, there has been sparse and patchy engagement with what this means for accounting education in third-level institutions (Apostolou et al., 2022) and literature reviews to date have concentrated on one technology only (e.g.

Hasan, 2022; Liu et al., 2021). Qasim and Kharbat (2020) argued that this poor response leads to two main problems: (1) graduates who lack expected technology knowledge; and (2) slower adoption of these technologies in the profession. Calls for change meet institutions and accounting educators that already face multiple demands around employability and the development of a toolkit of transferable skills (Healy & Murphy, 2019).

This paper aims to answer the practical questions facing accounting educators when considering whether and how to include such technologies in their curricula. It focuses on four technologies – BDA, RPA, AI, and blockchain – chosen among multiple possibilities as having most (potential) impact on accounting processes and accountants' skills.¹ It deliberately reviews these technologies together as they are at varying stages of development and integration into accounting practice and education, to identify emerging or common themes. The specific research questions are whether these technologies should be included in third-level accounting curricula, and how these are or could be taught.

These questions are answered using a semi-systematic literature review. Following the guidance of Snyder (2019), this approach was chosen for two reasons. Firstly, papers in this field are drawn from multiple disciplines (accounting, including various sub-disciplines, education and information systems) that conceptualise technologies differently and use varying terminology. Secondly, the research questions are broad and focused on mapping the field to create an agenda for further research.

The review began with database searches (specifically, Business Source Premier and ABI/Inform). For each of the technologies, the search combined various known names for the technology² plus 'accounting' plus 'education', in both keyword and abstract searches. Searches were initially performed in late 2021 for papers within the last 10 years, albeit that most papers were within the last five years. Given the pace of change in this area, searches were rerun at the last date of revision (March 2023) and some additional papers were added. There were no restrictions in the search on journals or types of papers, but only papers in English were reviewed. Initial search results were refined by reviewing abstracts – for example, many papers did not address education other than to vaguely call for change. In specific areas where many papers were found (BDA) these were analysed by themes developed from the literature (see Section 3). Additional papers or professional publications found in wider reading were also included to broaden coverage.

This paper contributes to accounting education in three ways. Firstly, it acts as an introduction to these technologies for accounting educators who have not engaged with these to date (Kotb et al., 2019). Secondly, it is the first literature review to bring together multiple disruptive technologies, answering

¹ For example, cloud computing was excluded, as it relates primarily to storage, and XBRL, as it relates primarily to external reporting.

² Various known terms were searched, for example, BDA, analytics, data analytics.

practical questions for educators and encouraging engagement. Finally, it acts as a call for practical application and research in this important and under-researched area.

This paper continues as follows. Section 2 provides a definition of each technology from the current literature, with suggested uses in accountancy and relevant skills required. Section 3 reviews the literature to identify whether each technology should be included in third-level accounting curricula and how these are or could be taught. Section 4 is a discussion of key themes, with a focus on how third-level accounting educators interested in including these technologies might proceed. Section 5 presents conclusions and suggestions for further research.

2. Disruptive Technologies

This paper focuses on four disruptive technologies: BDA, RPA, AI, and blockchain. This section presents a working definition of each of these, together with examples of how these technologies are being or could be implemented in accounting contexts, and the implications for accountant skillsets.

2.1 Big Data and Analytics

BDA has come to the fore in recent years because of an explosion of data available to organisations – often referred to as ‘big data’. Big data is described by characteristics known as the four ‘v’s: volume, velocity, variety, and veracity (Laney, 2001; but see also J. Zhang et al., 2015). This data differs from the data traditionally available to accountants, not just in quantity, but also in speed of creation and in the variety of formats, including images, text, video, and audio. This drives the need for innovative forms of data storage, processing, and analysis: going beyond familiar accountants’ tools (such as Microsoft Excel). BDA is defined as “the process of using structured and unstructured data through the applications of various analytic techniques such as statistical and quantitative analysis and explanatory and predictive models to provide useful information to decision makers” (Schneider et al., 2015, p. 720). Typically, there are four categories of analytics. Descriptive and diagnostic analytics help analyse past performance of a company, with Appelbaum et al. (2017) suggesting a role in summarising past events and transactions into a set of financial statements. Predictive and prescriptive analytics can provide predictions of future performance and recommendations to support decision making (Appelbaum et al., 2017).

BDA has been associated with significant changes in accounting practices in areas such as management accounting (Möller et al., 2020; Nielsen, 2015) and audit (Schmidt et al., 2020). With the increase in breadth of data and the tools available, BDA tools can provide much faster, real time (or near real time) insights compared with human analysis (Schneider et al., 2015), allowing accountants to better consider risk and uncertainty in their decision-making (Nielsen, 2015). This moves the accountant from the role of analyst to interpreter or communicator. BDA can detect operational inefficiencies

within organisations (Dai & Vasarhelyi, 2017), such as the identification of bottlenecks in the production process, and improve performance evaluation, including identifying and tracking key performance measures in management control systems (Warren et al., 2015).

BDA tools include Microsoft Excel, analytical tools built into accounting software, and standalone BDA systems such as Microsoft Power BI, Tableau and Alteryx. All such systems incorporate advanced statistical or machine learning techniques to gain insights from data, and have varying levels of visualisation capabilities (ACCA, 2020b). As such, ACCA (2020b) highlighted the need for ‘hard’ or technical skills associated with these applications, but also data literacy, finance, and accounting knowledge to interpret and use the results. Related ‘softer’ skills include problem-solving, critical thinking – often essential in determining the right question to ask – visualisation, and storytelling for effective communication.

2.2 Robotic Process Automation

RPA is “an umbrella term for tools that operate on the user interface of other computer systems in the way a human would do” (van der Aalst et al., 2018, p. 269). Sometimes referred to as ‘bots’ (Cooper et al., 2019), RPA uses software programs that follow structured commands to perform if-then-else statements on structured data. Processes that suit this type of automation are therefore generally highly structured, repetitive, simple, and routine (Cooper et al., 2019; van der Aalst et al., 2018).

Many opportunities to use RPA exist within the accounting function. Cooper et al. (2019) gave examples including bank reconciliations (also McCann, 2018), expense processing, inventory tracking, timesheet administration, and supplier and purchase order validations. McCann (2018) suggested increasing automation of core finance functions including financial closing and consolidation, cash-flow statement preparation, and tax reporting. Cooper et al. (2019) cited significant uptake of RPA in tax compliance work. Moffitt et al. (2018) expanded in detail on the successful implementation of RPA for routine audit processes. These authors proposed similar benefits across these examples, including that RPA can more accurately and efficiently complete process tasks, as the potential for human error in completion is removed (Cooper et al., 2019). RPA is seen “as a stepping stone to more sophisticated automation” (Cooper et al., 2019, p. 16), with RPA vendors adding AI to traditional rules-based bots (McCann, 2018) – this is discussed further below.

RPA can be set up in-house using coding languages, or with hosted solutions offered by dedicated RPA vendors, such as AutomationEdge, Blue Prism, and UiPath (Cooper et al., 2019; Gotthardt et al., 2020; van der Aalst et al., 2018) or general vendors – e.g. Microsoft Power Automate. Kokina et al. (2021) saw accountants as having potentially five roles in RPA, from an ‘identifier’ who identifies the potential for RPA to be used, to an ‘analyser’ who provides insights from the RPA. For each, Kokina et al. (2021) set out appropriate skills and attributes. ‘Hard’ or technical skills included a high degree of RPA literacy,

understanding of business, process, and control structures, understanding of data structures, data analysis and visualisation tools, and, for some roles, knowledge of coding languages. ‘Softer’ skills included creative thinking, communication, and collaboration skills alongside process improvement or strategic mindsets.

2.3 Artificial Intelligence

AI has been defined as: “the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages” (Petkov, 2020, p. 100). This includes a range of linked technologies, including data mining, machine learning (ML), speech and image recognition, and semantic analysis (Gotthardt et al., 2020). ML is often discussed synonymously with AI (Cho et al., 2020), and ML is described as a computer *automatically* learning patterns and trends from a data set (i.e. instead of being explicitly programmed by humans).

Many authors have cited the potential for AI to assist in common accounting tasks. Petkov (2020) suggests training AI to analyse (structured and unstructured) data to prepare accounting estimates, identify transactions from bank statements, and make relevant journal entries on demand. There are suggestions (Cho et al., 2020) and some limited empirical evidence (Ding et al., 2020) that ML can improve the accuracy of accounting estimates, not least by potentially reducing some forms of bias in decision-making, including confirmation and availability bias (ICAEW, 2018a). AI may also assist in forecasting – ICAEW (2018a) notes ML’s advantage in detecting patterns and trends in exceptionally large data sets that might not otherwise be possible. Moreover, as ML adapts to new data over time, forecasting will improve with experience (Cho et al., 2020). Cho et al. (2020) also see uses in control processes, including predicting accounting fraud (see also ICAEW, 2018a) and stock-taking, the latter utilising a visual recognition system to assess condition for stock valuation purposes.

AI systems can be developed in-house using coding languages such as Python and R (ICAEW, 2018a) or tailored by external providers including Google Cloud, Microsoft Azure, IBM Watson, and AWS Sagemaker (ACCA, 2020a). As a further alternative, some providers offer AI tools integrated within ERP solutions (e.g. SAP S/4 HANA). Going forward, ICAEW (2018a) expects ML to be integrated into accounting software – so that many accountants will be benefitting from ML without realising it.

Studies suggest that these impacts on the accounting function and accountants are not yet widespread; in a survey of 700 global finance executives in 2019, only 11% had implemented AI in their finance function (Oracle, 2019). Bakarich and O’Brien (2021) indicated limited implementation of or training in AI by accountants in practice, but a very widescale expectation that this will change over the next five years. Specific requisite skills are not clear,

but as for RPA, it is likely that accountants will potentially play multiple roles in AI implementation, with varying hard and soft skills required (Kokina et al., 2021).

2.4 Blockchain

Blockchain can be defined as “a database – a storage infrastructure for data – that’s secured by both encryption and by being decentralised” (Marr, 2020, p. 1). It enables transactions between parties in a network (peer to peer) without the need for an authoritative body or intermediary. Participants in the network work together to create and approve transactions in an open and transparent manner. Dai and Vasarhelyi (2017) explained the potential shift to blockchain as akin to moving from a double-entry to a triple-entry system. As this third entry is on an open platform (the blockchain), where all parties must agree to the entries, and entries are protected with cryptography to prevent manipulation, it instantly provides assurance over the transactions and therefore verifies the entries in the double-entry system. This is often cited as a key characteristic of blockchain: Fullana and Ruiz (2021) discussed blockchain as being immutable and transparent.

Blockchain providers include Microsoft (Azure), SAP (Leonardo), and Deloitte (Rubix Core): Inghirami (2019). Dai and Vasarhelyi (2017), Inghirami (2019), and others suggested that blockchain will have a whole-business role in verifying transactions and aggregating these into financial statements.

Literature to date has tended to be conceptual rather than empirical, but has often suggested that blockchain will fundamentally alter the recording, control, and audit of accounting transactions (Coyne & McMickle, 2017; Schmitz & Leoni, 2019). Fullana and Ruiz (2021) expected that organisations will start to implement blockchain for certain elements of their business first, and that it will have to exist alongside legacy and ERP systems. As an example, Tysiac (2020) identified the use of blockchain in ERP systems for discrete tasks such as procurement and supplier management. In contrast, Tan and Low (2019) suggested whole-business implementation is unlikely because the technology is not yet sophisticated enough to deal with estimates and judgements – limiting the potential for applications as described by Inghirami (2019) and others.

The relative lack of examples and uncertainty about future uses have also resulted in less discussion than for other technologies of what impact it will have on accounting professionals’ expected skillsets. ICAEW (2018b) addressed this by flagging the continuing importance of key professional skills such as (accounting) technical knowledge, scepticism, and regulatory compliance. Accountants will also need to be mindful of issues around the valuation, recording, and auditing of crypto assets such as currencies that are held on a blockchain (Nicolau, 2021).

The technologies discussed in this section are seen as key enabling tools for the transformation of the accounting function. Taken together, the impact of these disruptive technologies is likely to necessitate additions to the traditional

accountants' skillset (ACCA, 2020b; Kokina et al., 2021). The next section explores whether and how such knowledge and skills should be developed in third-level accounting education.

3. Disruptive Technologies in the Third-level Accounting Curriculum

This paper seeks to identify whether the disruptive technologies discussed in Section 2 should be included in third-level accounting curricula, and how these are or could be taught. This section reviews existing literature to address those questions for each technology in turn, before turning to studies that have considered multiple disruptive technologies together.

3.1 Big Data and Analytics

Relatively more has been written on BDA in accounting education than other technologies discussed in this paper, including special issues in accounting education journals (e.g. "Big data" in the *Journal of Accounting Education*, editors' commentary: Janvrin & Watson, 2017) and literature reviews (e.g. Liu et al., 2021). Reflecting the broad focus of this paper, the intention is not to provide a systematic review of BDA, but to identify key themes that may be of interest to educators seeking to introduce or further integrate BDA or other disruptive technologies into their curriculum.

A range of studies that discuss the increasing importance of BDA for accountants (including auditors) have argued that accounting curricula must change to provide new accountants with the necessary skills (Griffin & Wright, 2015). As an example, Yoon et al. (2015) argued that the accounting curriculum should reflect changing audit methods and means of securing audit evidence by including content on advanced BDA. Professional bodies increasingly expect BDA to be integrated throughout the curriculum (Janvrin and Watson (2017) cited US professional bodies; see also ACCA, 2020b). However, a number of studies have also raised concerns about the availability of qualified faculty members and lack of space in accounting curricula (Andiola et al., 2020; Dzuranin et al., 2018; Losi et al., 2022).

For many third-level institutions, teaching BDA is essential for compliance with business school accrediting bodies' standards. As an example, the AACSB's Standard A7 and subsequent pronouncement (AACSB, 2014) stated that data analytics or business analytics should be a key component of accounting curricula. There is evidence of the impact of these standards, particularly in US institutions, on accounting curricula: Andiola et al. (2020) found that heads of accounting departments in AACSB accredited schools saw a significant impact, with 94% at some level of compliance with the standard. Andiola et al. (2020) commented that this is likely to influence other institutions and indeed expectations of professional bodies and firms. Moore and Felo's (2021) review of 185 US third-level accounting programme websites found that 92% of those with both accounting and business school accreditations had a standalone BDA module versus 78% of those with only business school accreditation and 30% of those with no accreditation. Interestingly for this paper, they found no courses that focused on or

integrated blockchain or AI and commented: “while BDA has gained attention at the college level, other disruptive technologies have received little or no coverage in accounting curricula” (p. 108).

Considering how BDA can or should be taught, a first theme from the reviewed papers is whether BDA should be taught in standalone modules or embedded across the curriculum. While Coyne et al. (2016) suggested building BDA into existing (standalone) Accountancy Information Systems (AIS) courses, a greater number of studies have advocated embedding BDA across various existing accounting courses as students progress through the curriculum (e.g. Losi et al., 2022; Qasim et al., 2022; Qasim & Kharbat, 2020). Sledgianowski et al. (2017) strongly advocate such integration. Their paper took Lawson et al.’s (2014) competency integration for accounting education framework as its basis, focusing on the foundational technological competency. They then reviewed available BDA instructional resources (e.g. case studies, software, data sets) against the core accounting competencies (e.g. financial accounting), providing examples of resources that would enable competency integration, and highlighting gaps. They encouraged accounting educators to create a “fluid plan ... that can be adjusted as competency emphasis shifts to accommodate topical priorities ... or a department’s changing missions, resources, or faculty competencies” (p. 91). Dzuranin et al.’s (2018) survey of US academics found that they preferred a hybrid approach – a standalone BDA module plus integration into other accounting courses – albeit that there were considerable variations in practice. They indicated that flexible approaches might be preferred by educators facing full curricula, accreditation demands, and resourcing issues. Andiola et al. (2020) supported Dzuranin et al.’s (2018) analysis, finding that 81% of their respondents integrated technology into a few courses (with 42% offering a specific BDA course), while only 3% focused planned changes on one course (commonly AIS or similar). Most recently, Losi et al. (2022) found that BDA is primarily taught on AIS, audit and some standalone courses and called for more integration into earlier financial and management accounting courses.

A second theme highlights the importance of practical case studies and hands-on engagement with technologies. Dzuranin et al.’s (2018) survey identified that educators found hands-on projects and case studies most appropriate for delivering BDA content, versus lectures, vignettes, or readings. Qasim et al. (2022) also advocated a focus on practical case studies from various sources, and hands-on engagement with relevant technologies combined with real-world data sets. Case studies are often linked to core competencies (as advocated by Sledgianowski et al. (2017)). As examples, McKinney et al. (2017) had students make product line profitability decisions, Fay and Negangard (2017) used analytics for journal entry testing in an audit-based case, and Laplante and Vernon (2021) used Excel and Tableau in a case focused on tax compliance and risk assessment.

In terms of the software that might be used, Janvrin and Watson (2017) argued that instructors should actively seek to have students use different software packages to analyse cases, both to contrast available software and because “learning how to learn new software is an important skill for today’s worker” (p. 5). They provided a summary of free-to-use software, based on a more detailed comparison in Janvrin et al. (2014). In terms of software used, Andiola et al. (2020) found that Excel is the most taught technology (at 93% of respondents), followed by analytics technologies (86%) – much higher than, for example, the teaching of coding or query languages (32%). Raschke and Charron (2021) criticised an overemphasis in published teaching cases on the use of Excel at the expense of other tools and a related neglect of earlier stages in the analytics cycle including extraction and data preparation. Multiple papers have provided a teaching note on how they have used various technologies; for example Shoenfeldt and Birt (2020) developed students’ technical skills in using Microsoft Excel, Xero (accounting software), and Tableau in working towards a computer-based assignment. In their paper, they provided student feedback and reflection on their experience, useful for other educators considering similar changes.

Furthermore, a number of authors flag the usefulness of engagement with professional firms to facilitate practical teaching (Janvrin & Watson, 2017; Qasim et al., 2022). Qasim et al. (2022) highlighted available resources from professional bodies and accountancy firms, which they saw as particularly useful given a lack of information on BDA in textbooks³ (also Coyne et al., 2016). Riley et al. (2021) conducted an experimental study on the effect of an interactive professional learning experience (IPLE) on BDA, which included guest lectures, collaboration on a project, and final presentation to employees of a professional firm. Students’ perceptions of perceived learning, satisfaction, and career benefits were significantly improved by participating in the IPLE.

A final theme relates to the development of ‘soft’ or non-technical skills for analysis. Dzurainin et al. (2018) posed the question “What analytics skills and tools should be taught?” on a third-level accounting curriculum, and respondents prioritised developing students’ “analytics mindset” (p. 38) or data-driven critical thinking skills over any specific tools or technologies. The second most important topic was developing students’ ability to communicate outcomes and their process of analysis. McKinney et al. (2017) provided a discussion and teaching note on how to develop accounting students’ scepticism when faced with BDA. They developed a series of seven topics of questions in a framework (e.g. “understand the difficulties of effective analysis ... consider other data sources”: p. 65), to be addressed across a semester, including a specific example related to product line profitability. This approach is technology independent and, they argued, can “better prepare students for

³ Blix et al.’s (2021) study of auditing textbooks found that many provided insufficient information on BDA. If replicated in other subject area texts (e.g. management accounting), this might hinder efforts to integrate BDA into accounting modules across the curriculum.

long-term career demands and reduce emphasis on first job skills” (p. 64). The perceived importance of developing both hard and soft skills might also explain the preferences for hands-on and case study methods of teaching BDA, as discussed above. By way of example, Shawver and Shawver (2020) explicitly embed ‘hard’ skills in terms of BDA and visualisation alongside the ‘soft’ skills of teamwork, collaboration, and communication through a case assignment.

The BDA literature to date has also flagged challenges that have been faced in including BDA in the curriculum. Appelbaum et al. (2017) also noted specific concerns about students’ motivation and staff training to integrate BDA, while Losi et al. (2022) highlighted challenges faced by accounting educators in gaining and maintaining relevant skills, not least because these technologies were evolving quickly. Andiola et al. (2020) countered that faculty resistance was of little or no challenge, but full curricula and availability of resources remained issues.

3.2 Robotic Process Automation

Relatively less has been written about RPA than BDA in third-level accounting curricula. Cooper et al.’s (2019) study of accountants working in ‘Big 4’ accountancy firms found a particular need for understanding of RPA among junior staff, given that it is their work that is most commonly impacted by the technology. Accordingly, their contributors argued that graduates should have experience of technologies including RPA and BDA. Vincent et al. (2020) commented on current shortages of staff to implement RPA and suggested this as an opportunity: “current students will benefit from learning this new technology to be competitive and efficient in their career in the short- and long-term” (p. 76). Harrast and Wood (2023) supported teaching RPA in a university setting specifically citing pronouncements from accrediting bodies on increased digital knowledge and technology skills, but also acknowledging the challenge of prioritising technologies like RPA over other desirable skills.

As was the case in early publications on BDA, existing research on RPA tends to present resources or teaching approaches as a guide for other educators. As examples, Vincent et al. (2020) summarised available teaching resources on RPA (noting limited engagement with this topic in AIS textbooks) and a proposed undergraduate course in RPA, with learning objectives including understanding of RPA, its benefits and challenges, implementation of RPA tools (including UiPath), RPA project management and governance (i.e. combining some of the ‘hard’ and ‘soft’ skills discussed in relation to BDA above). Others have similarly risen to this challenge by publishing step-by-step exercises that would allow students hands-on experience with RPA tools such as UiPath (Keys & Zhang, 2020). Cooper et al. (2019) found disagreement among respondents as to whether including RPA on curricula necessitated coding skills, or whether the RPA tools now available meant that bots could be easily programmed without such knowledge. They flagged the importance of the ‘soft’ skills of critical thinking and communication, and how the combination of these with accounting technical knowledge allows accountants to complete value-added activities, having been

freed from more mundane tasks. As such, the teaching of cases may again be important and, as for BDA, some large firms are identified as providing resources in this space. For example, case material, data sets, working bots, teaching materials and solutions are available through the EY Academic Resource Center (ARC) (EY, 2022). As in BDA, RPA publications to date have highlighted the importance of practical application and of using relevant software and resources from professional firms.

3.3 Artificial Intelligence

When compared with BDA, AI generates less discussion in accounting education. Zhang et al. (2020) questioned whether third-level education exists to provide a liberal education or a professional training, aligning the teaching of AI and associated technologies with professional training. They argued that third-level institutions should focus instead on equipping students for value-added tasks including financial management and data-driven decision making, while developing ethical and emotional intelligence. Hasan (2022) conducted a literature review of AI in accounting and auditing and argued that accounting educators should reconceptualise curricula and meet the needs of AI-driven markets and industries. However, he went on to limit expectations by explicitly stating the need for development of specific BDA and IT skills, but merely suggested that “AI technology concepts have to be incorporated in the business education” (p. 460). Moreover, he saw this as facilitating work between accountants and AI practitioners – so quite differently from BDA and RPA as previously discussed, AI is outside the remit of accountants. This explains why teaching AI might be limited to a conceptual, rather than practical, understanding. Taken together, there appears to be limited appetite to include AI in third-level accounting curricula beyond a conceptual understanding.

Again, there has been limited discussion of how this can be taught at third level. Zhang et al. (2020) flagged the importance of teaching cases in this area, encouraging students to use accounting and technology knowledge to solve practical issues that draw on financial management, corporate governance, and ethical aspects. They argued that this will be relevant for future technological change as well as current technologies. Beyond this, Hasan (2022) advocated the use of projects with industry leaders to present students with the problems faced by real-life organisations and for them to attempt to solve them. In an unusual example of hands-on use of AI technology, Polimeni and Burke (2021) noted the particular importance of cases to allow students to evaluate the usefulness and challenges of AI in specific contexts, alongside the use of simple AI tools (CountThings). As previously, the cases they flagged come from professional firms. Taken together, there has been more focus on conceptual teaching of AI than BDA and RPA, and the continuing importance of cases and professional firm resources is notable.

3.4 Blockchain

Perhaps reflecting its largely conceptual discussion so far in the wider literature, there has been limited discussion of the potential impact of blockchain on the third-level accounting curriculum, including whether and how it should be taught. Studies and reports from professional bodies exploring the next steps for blockchain have often flagged a potential impact on education but have been vague on what this might entail (e.g. ICAEW, 2018b). Zhang et al.'s (2020) comments on AI were replicated in respect of blockchain: rather than teach current technology, the focus of third-level education should be on developing students' broader skillsets to deal with ongoing technological change. However, Stratopolous (2020, p. 64) argued that "accounting students (i.e. future accountants) need to understand blockchain in order to evaluate its impact on the profession (e.g. audit, tax, consulting), as well as the impact on the business of their clients (e.g. auditees, investors)". He further suggested that accounting students "do not want to become programmers, cryptographers, or database experts" (p. 64) and suggested giving accounting students a fundamental understanding of blockchain and tasks that encourage them to consider relevant applications across financial accounting, tax, and audit. Indeed, Stratopolous supported this approach with an array of resources and teaching notes (see Stratopoulos, 2020). Lee et al. (2022) further developed this conceptual understanding with an experiential learning exercise linked to Bitcoin that demonstrates various mechanisms of blockchain technology, explaining the nature and importance of each stage. They found that this approach has a strongly positive impact on students' understanding of blockchain concepts.

Others have taught hands-on technical skills in implementing blockchain. Stern and Reinstein (2021) developed an online blockchain course for postgraduate students. They advocated building up, through key blockchain concepts including key technologies and their impact on accounting, towards a group assignment to code and test a smart contract. They provided a wide variety of information on their approach, including learning outcomes, cases, and student feedback. Interestingly, they noted an unsuccessful attempt to run the same course for an undergraduate cohort. Kaden et al. (2021) explicitly rejected conceptual teaching of blockchain and instead taught students to code blockchain using R (coding language). Again, they provided a range of resources to support others in similar teaching. Taken together, these early studies indicated a lack of consensus on whether and how to teach blockchain, and a divergence between postgraduate and undergraduate teaching.

3.5 Studies Considering Multiple Disruptive Technologies

Some authors have discussed the implications for accounting curricula of multiple technologies together. Most commonly, those who have advocated the inclusion of multiple disruptive technologies have suggested that these are included across the accounting curriculum at various levels. For example, Qasim and Kharbat (2020) called for "radical changes in the accounting curriculum to reach a balance between existing accounting knowledge and

information technology skills relevant to the profession” (p. 107). They suggested a foundational course in ‘business technologies’ before then integrating these technologies into existing accounting courses – for example, introducing BDA in an early financial accounting course, developing to applications of blockchain and XBRL in intermediate/later financial accounting courses (see also Qasim et al., 2022). Kotb et al. (2019) also advocated the inclusion of technologies in a variety of courses and levels, arguing that this reflects the impact of these disruptive technologies on the profession and should have a positive impact on the employability of graduates. Polimeni and Burke (2021) presented an interesting insight into how they implemented such a wide-ranging change, including managing this through internal committees and supporting staff with resources. Mirroring previous suggestions relating to BDA, Qasim and Kharbat (2020) suggested that the success or otherwise of including disruptive technologies in third-level accounting curricula will derive from the resistance or acceptance of both students and faculty. The next section summarises and synthesises key points from this review with a focus on informing accounting educators.

4. Discussion

This review set out to explore whether these disruptive technologies should be included in third-level accounting curricula and, if so, how they might be taught. On the first question, in respect of BDA, the overwhelming impression from this review is that BDA is now an essential component of third-level accounting curricula – multiple studies have argued for this (e.g. Janvrin & Watson, 2017) and there is considerable evidence of such teaching, especially in US institutions (Moore & Felo, 2021). Some dissent (note Zhang et al.’s (2020) comments on the purpose of third-level education) and issues remain (Andiola et al., 2020) but the importance of teaching BDA is clear. For other technologies, the answer is less certain. The nature of this review is that it highlights papers advocating for the importance of these technologies (e.g. Harrast & Wood, 2023), but the small numbers of such papers and the lack of empirical evidence on teaching mean that the importance of including RPA, AI and blockchain in third-level accounting curricula is undecided, albeit increasing with more recent papers.

Taking the existing research on all these technologies together, it is possible to consider the factors that might impact on the importance of including technologies such as RPA, AI, and blockchain in third-level accounting curricula going forward. Firstly, the requirements of business school accrediting bodies have been seen as driving the inclusion of BDA in accounting curricula (Andiola et al., 2020; Moore & Felo, 2021). This influence is likely to continue, and the most recent AACSB standard (AACSB, 2022) is broader, emphasising existing *and emerging* technology – depending on how this is interpreted, this may mean that it will become more important to teach some of the technologies discussed here.

Secondly, the relative accessibility of technologies may be a factor in whether such technologies can be included in curricula. The most taught technologies per Andiola et al. (2020) are Excel and specific analytics tools. The familiar (Excel), user-friendly (analytics tools such as Tableau), and low-cost (both) nature of these technologies creates a low barrier to implementation for both faculty and students and has allowed BDA to be relatively easily included. This can be contrasted with coding languages – Stratopolous (2020) saw faculty and students as averse to these, and this may have hindered inclusion of RPA, AI, and blockchain to date. However, as discussed in Section 2, the technology for RPA and AI is developing such that it is increasingly possible to engage with bots and ML without knowledge of coding (Keys & Zhang, 2020; Polimeni & Burke, 2021). The ease of use of these technologies may lower the barriers to teaching them in third-level education and may increase expectations that students will have exposure to these.

Thirdly, the challenge of integrating technologies into already full curricula may be a further factor (Healy & Murphy, 2019). Advocates for BDA often highlight the potential of including it within existing courses, and it is relatively easy to make a link to BDA in financial accounting, management accounting, or tax courses (see examples above). This may be less true, or require more thinking, in respect of technologies such as RPA, AI, and blockchain. This indicates that a standalone module, such as Qasim and Kharbat's (2020) business technologies module, or an AIS module (Coyne et al., 2016) might be more appropriate for these technologies and this could be a barrier to inclusion. A standalone module also poses further questions as to when to offer such a course and whether it should be optional or compulsory. There are notable gaps in the existing literature on student outcomes and attitudes relating to different types and timings of interventions that might inform that discussion.

Beyond these macro-level factors, the literature has also indicated a range of factors that might impact on a given institution or accounting department's inclusion of such technologies. These have included faculty skill and interest (Kotb et al., 2019), space in the curriculum (Harrast & Wood, 2023), and local employer support (both in attitude, e.g. Cooper et al. (2019) and ability to offer resources, e.g. Janvrin and Watson (2017)).

In summary, while the importance of teaching these technologies beyond BDA is undecided now, this may change quickly. Educators who want to include these, and have the space and resources to do so, will be able to justify their decision to include them, and could contribute to the field by sharing their practice.

In response to the second research question as to how such technologies can or should be taught, some themes are repeated across multiple technologies. Firstly, where possible, hands-on engagement with technologies is preferred (Qasim & Kharbat, 2020). This is especially true in BDA (Dzuranin et al., 2018) and RPA (Vincent et al., 2020), and to a lesser extent at this time for AI (Polimeni & Burke, 2021) and blockchain (Kaden et al., 2021). This echoes

Janvrin and Watson's (2017) suggestion that actively exposing students to multiple technologies improves their skills in learning new technology (an enduring skill). As noted already, hands-on engagement typically becomes easier as technology develops, and we might expect to see more teaching of RPA and AI as related tools become easier to use. Cohort skills may change also: Apostolou et al. (2022) noted that future cohorts may be more comfortable with technology. Presently, more conceptual approaches are advocated by some authors for AI and blockchain, ensuring students have some knowledge of the technology and its potential impact (e.g. ICAEW, 2018b; Stratopoulos, 2020; Y. Zhang et al., 2020). This approach might offer some flexibility for institutions keen to include these technologies but facing issues in resourcing hands-on engagement (Andiola et al., 2020).

Secondly, the development of broader skills alongside the ability to use technology is a recurring theme. Technical accounting skills remain high priority, for example ACCA (2020b) have highlighted the importance of core finance and accounting skills to interpret the outputs of BDA. Kokina et al. (2021) flagged the importance of understanding business processes and controls to identify uses for RPA/AI and successfully implement these. BDA studies particularly emphasise the need to integrate the ability to use technology with softer skills, including professional scepticism (ICAEW, 2018b; McKinney et al., 2017), communication (Shawver & Shawver, 2020), and critical thinking (Dzuranin et al., 2018). This is likely to have significant read-across for other technologies and is mentioned, although less developed, in the literature on RPA (Cooper et al., 2019), AI, and blockchain (Y. Zhang et al., 2020). Accordingly, some of the approaches used in BDA would be instructive for embedding these skills with other technologies, for example the widespread use of cases (multiple authors), assessment designed to reward technical knowledge, skills development (Shawver & Shawver, 2020) and even technology-independent frameworks (McKinney et al., 2017). The development of such skills would also be in line with calls to equip students for emerging and future technologies (AACSB, 2022; ACCA, 2020b).

Finally, the involvement of professional firms in teaching these technologies was a recurring theme across BDA (Qasim et al., 2022), RPA (EY, 2022), AI (Polimeni & Burke, 2021), and to a lesser extent blockchain (Stratopoulos, 2020). Resources provided included teaching materials, case studies, data sets, and software. Involving professional firms in teaching and assessment had a positive impact on student engagement and attainment (Riley et al., 2021). This also supports faculty skills development and plugs skills gaps (Kotb et al., 2019), assists students in developing professional skills and identity (McKinney et al., 2017), and keeps teaching relevant as technologies develop (ACCA, 2020b).

In summary, educators seeking to implement any of these technologies will find guidance in the prior literature, including read-across between technologies. An important caveat to all these suggestions is that these technologies are still developing and there is a lack of research both on the

impact of these on accountant skillsets and on how these skills can be developed, including in third-level education. The next section presents a call for further research alongside conclusions from this paper.

5. Conclusions

Many of the studies cited here begin with a clear statement that accounting education is lagging behind professional training and professional practice, both in research and in practice. However, this review shows how accounting educators might begin to address that lag and includes practical suggestions for how to do so.

By looking at the selected technologies together, this review makes the following contributions. Firstly, it introduces these technologies to accounting educators who might not have engaged with these technologies to date – responding to the call for more engagement by authors including Kotb et al. (2019) and Polimeni and Burke (2021). Secondly, it provides answers to practical questions facing educators, including whether such technologies should be included in curricula and how these are or might be taught. This paper has highlighted that BDA has become an essential component of third-level accounting curricula, while support for the inclusion of RPA, AI, and blockchain is gaining momentum. By looking at these technologies together, this paper highlights a number of factors that will impact on whether (or how soon) such technologies could become essential. Furthermore, by considering these technologies together, this paper has identified a series of recurring themes as to how these technologies can be successfully taught that may be useful to educators. These include the importance of hands-on experience where possible (and conceptual teaching when not possible), teaching technologies in conjunction with technical accounting skills and soft skills, and engagement with professional bodies and firms in delivery.

Limitations of this paper include that the varying terms used, and the involvement of various discipline areas, have mitigated against a systematic literature review (Hasan, 2022; Snyder, 2019). The emerging nature of RPA, AI, and particularly blockchain has meant a relatively small number of papers, and many of these papers are either conceptual or based solely on the authors' own experience, with most calling for further empirical work. Conversely, the considerable number of papers in BDA meant that only some that best encapsulated the themes could be referenced here, given the broad research questions of this paper. Finally, available accounting education research in this area is primarily American in source, which may limit the read-across to other areas including the UK and Ireland.

This review points to several opportunities for further research. Firstly, there is a need for more research on the impact of these technologies on accounting work, by accounting discipline (e.g. in management accounting) and on accountant skillsets. This could help clarify gaps, which third-level accounting curricula could attempt to address. For the less researched technologies (RPA, AI, and blockchain), there is a need to explore whether third-level accounting education is the correct place for such learning, and a mapping exercise of

current practice (e.g. replicating Moore and Felo (2021) in the UK and Ireland) could be a useful prompt. More publications of all kinds – teaching notes, empirical papers, and literature reviews – are needed to build our knowledge of how these technologies can be taught effectively. This paper has suggested that themes emerging from the BDA literature will also be seen in teaching other technologies, and it will be useful to explore whether that assumption will hold. Across all technologies there is scope for evaluation of teaching approaches as the field matures, including whether learning outcomes are met, and what approaches work best in particular contexts or with particular cohorts. Exploring student attitudes to these technologies and responses to various approaches could help to shape future practice. Research could also usefully explore employer perceptions of workplace readiness, recruitment practices, and perhaps even experience of engagement in teaching these technologies (as flagged by multiple authors). This is a very fertile area for future research, with real potential to impact on accounting educators' practices in this challenging field.



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