

Technology enhanced learning: rethinking the term, the concept and its theoretical background

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Abstract

This theoretical paper is concerned with problematising the rethinking of theoretical backgrounds associated with one of the commonly-used educational technology terms (fields) – technology enhanced learning – in the wider context of scholarship. Examples will show that the term itself is now used beyond its apparent, stated scope, that it is used in a number of varied ways, and that this is in itself problematic. The ways in which the term is used will be identified, and from these a strategic categorisation to rethink the use of the single term in areas of scholarship (particularly research and teaching) will be proposed, offering terms specifically encompassing the realms in which technologies are being used. From this categorisation, it will be shown that each specific category is based on different conceptions related to or arising from practice. Consequently, ways that theoretical backgrounds should be considered will be explored in each case. Whilst existing theoretical backgrounds enable conceptual underpinnings in some of those cases, in other cases it will be shown that there are currently no fully-developed theories or limited theoretical frameworks available. The paper will conclude by identifying key research areas needed if we are to develop and take pertinent aspects of scholarship further forward.

Keywords

Theoretical backgrounds; technology enhanced learning; theories and TEL; problematising TEL

Structured practitioner notes

What is known already about this topic is:

- There is often lack of or inappropriate use of theoretical underpinnings in research studies on educational technologies.
- Educational technology terms are not clearly defined.
- Reasons for using theoretical underpinnings in scholarly areas of research are varied.

What this paper adds:

- The lack of use of theoretical underpinnings in scholarly practice in educational technology (technology enhanced learning) environments is problematised.
- A need is argued for precise uses of terms, through a strategic categorisation of current uses.
- An overview of existing levels of models, frameworks and theories to underpin the separate areas of technology enhanced learning research studies provides for a future research agenda.

Implications for practice and/or policy:

- Theories to strengthen understandings of how to effectively develop scholarly aspects of integration and application for practice and policy need to be developed in key areas.

- There is an arguable need to differentiate and distinguish between research findings that relate to education, learning or teaching, and the management of education, learning or teaching.
- Ways in which research into educational technologies can support education, learning and teaching and how each of these is managed need to be separately considered, but research designs need to accommodate integration and application of outcomes for practice and policy.

The wider context

This paper is fundamentally concerned with ways that digital technologies have influenced, are influencing and could be influencing conceptions of academic scholarly practice, particularly related to the field of technology enhanced learning (TEL). Academic practice (scholarship) is not conceived similarly by all academics. Differences in academic conceptions of scholarly practices were highlighted in the seminal report of Boyer (1990), who was concerned not only with differences exhibited across a wide population, but also in ways that social changes were affecting or driving these differences, leading to consequent shifts in balances and links between them. From his analysis of this shifting situation, he identified four key areas of scholarship – discovery (concerned with research), integration (concerned with interdisciplinary connections), application (concerned with using knowledge to apply to particular concerns, problems or situations), and teaching (concerned with ways of informing others). Boyer argued that academics should “strengthen research, integration, application, and teaching” (p.78), while Haigh (2010), in a later report, continuing to call for strengthening these elements of scholarship, also highlighted the need for learning to be explicitly included within the scholarship of teaching. He argued importantly for context to be a key concern, for individuals to be involved in “systematic inquiry into, and critical reflection on, aspects of their own teaching and their students’ learning” (p.12). Similarly concerned with such individual academic inquiry and reflection on teaching and learning, Greenhow and Gleason (2014) explored from a contemporary perspective how digital technologies (social media, specifically) had influenced and were affecting teaching and learning contexts, not only at the level of the individual academic but also at the level of subject specialisms. Indeed, these authors highlighted how digital technologies had expanded scholarly possibilities, such as enabling academics to access data about student performance in ways that were not previously feasible. Garnett and Ecclesfield (2011) further explored this line of argument, that digital technologies were affecting the boundaries of the key areas of scholarship. They stressed that the focal areas of discovery, integration, application and teaching (DIAT) that Boyer (1990) highlighted, should not be regarded as linear, as effects of digital technologies had been a major factor in determining a shift from linearity to non-linearity. They discussed cross-linkages between the four DIAT areas, particularly in the ways that integration and application might be supported within digital environments, highlighting influences of digital technologies as enabling scholarly practice that is not as age-, time- or place-bound. From their contemporary analysis of the digital context, they proposed a fifth scholarship area – of co-creating - where outcomes are not determined in linear fashion, but where increased cooperation and collaboration are involved in a wider ‘Open Scholarship’. From conceptions of scholarship discussed by the authors above, the evolution that emerges indicates that scholarship of discovery (research) is shifting. The role of research in practice is itself developing, in ways that are not linear, or not even necessarily expected, but embodying both discovery to inform at a personal level and at a wider level (within or beyond departments or institutions).

A number of authors have focused specifically on concerns and shifts with scholarship arising from the emerging digital technology landscape. Wickens (2006) highlighted how TEL had been a driver in terms of the scholarship of teaching and learning (SoTL), illuminated by distinctive practices, for example, the strong delineation of recording uses from communication and collaboration uses, even though TEL provides facilities for both. She argued that teaching and research had become more integrated, to the extent that “teaching and research are indivisible” (p.30). In the context of TEL, Haynes (2016) proposed a discrete scholarship of TEL (SoTEL), although this paper is not concerned either with arguing for this proposition, or for the proposition of TEL being an environment through which SoTL can be developed and supported. Concerning the relationship of research and teaching, certainly the importance of integrating these areas of scholarship was supported by Frielick (2016), who argued that the self-reflective process on one’s own teaching would be vital to the shaping of

future teaching and learning. Weller (2011) also pointed to examples of greater integration of research and teaching, defining digital scholarship as an exploration of how digital resources can be used. If this is the case, then it is fundamentally important to know how this might be done – to gain ideas of possible approaches that would be of potential value. Weller suggests a “networked research cycle” (p.56). If, as he suggests, there are important “changes in granularity” (p.63) happening, alongside a “pedagogy of abundance” (p.91), then the range of opportunities, of uses and of applications, is continuously increasing. Hence, having possible strategic starting points will become increasingly necessary as abundance increases further.

Methodology and approach

The focus in this paper is concerned with strategic starting points, with the Boyer (1990) DT areas of scholarship, how they might be considered from an underpinning theoretical perspective in a TEL environment, and implications these have for the Boyer IA areas of scholarship (see Figure 1).

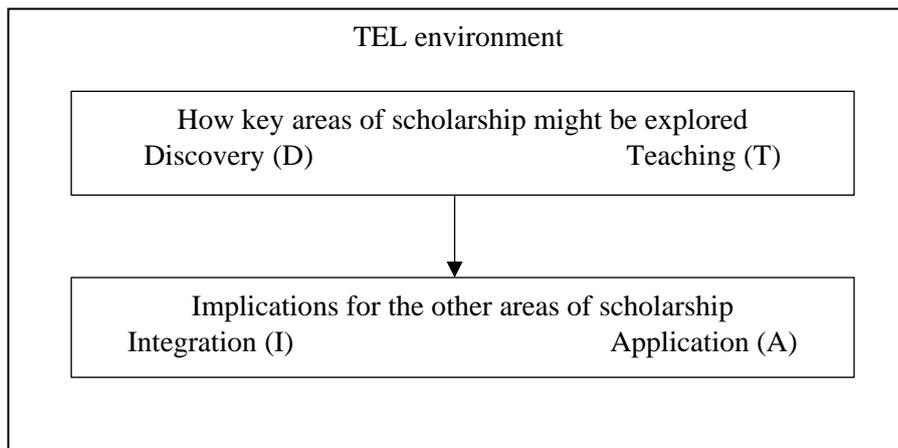


Figure 1. The focus of this paper through the Boyer (1990) areas of scholarship

However, the argument in this paper does not advocate a linear approach as might be suggested by the diagram; rather, the diagram indicates the structure of the contents of this paper. From a practice perspective, a cyclical or networked approach across these areas can be readily argued. The methodology and approach is theoretical, concerned with a strategic review of key works, and a strategic analysis of significant articles and selected documentary sources in the field.

Introduction to concepts and complexity

Considering scholarly perspectives in relation to the areas of DT, previous academic literature has called for more theoretically-concerned approaches to the field of research in teaching and learning with educational (digital) technologies. For example, Bennett and Oliver (2011) stated that learning technology research had at that time been concerned more with the practical uses of technologies and design problems in creating technologies, and had largely ignored theory or had applied it uncritically. This lack of theory, the authors suggested, was due to the fact that research was often driven by market needs and by policy (what might be considered a strong but particular focus on IA), meaning that funding was directed to equipment rather than pedagogy, consequently resulting in theory and empirical work being viewed as separate entities (moving towards a more linear DIAT approach, perhaps). Selwyn (2012) stressed also the need for greater concern with theoretical foundations, asserting that: “The academic study of educational technology is clearly strengthened by a broad and rigorous engagement with theory. However, there are many theoretical approaches and traditions that currently are under-utilised in the educational technology literature, yet might support the building of better questions, highlight otherwise neglected issues and to act both as a point of reference and a point of correction” (p.217). Different ways that theory could be deployed in research studies had been discussed earlier; Oliver (2002) raised the need to consider how theory might be used beyond the research design stages, stating that: “Approaches vary considerably — from theory as tool, to theory as principle; from theory building, to theory using” (p.2). The researcher was alerted here to the need

to be in a position, therefore, of understanding these different opportunities and approaches, relating them to any contemporary research study (how theory might be involved in the linking of implications between DT and IA).

Concerns for appropriately adopting theoretical engagement with research studies have been paralleled by a continuity of development and deployment of technological resources. So, whilst technological advances continue to provide opportunities for teaching and learning, the absence of consistently considered and applied theoretical underpinnings to research in educational technologies has been recognised to persist. Bartolomé, Castañeda and Adell (2018) asked in their paper: “do we understand educational technology as an issue independent of the pedagogical assumptions that underpin educational action?” (n.p.), and stated that reported studies they reviewed showed: “a lack of an explicit pedagogical perspective in the experiences analysed, especially those with greater impact” (n.p.). The concern for appropriate theoretical underpinnings has also been raised with regard to businesses who develop educational technology products. Veletsianos and Moe (2017) stated in their recommendations that it is necessary to: “take steps to inform and educate the entrepreneurs seeking to create edtech about the essentials of teaching and learning: theory, pedagogy and emergent trends in the research” (n.p.). Concerns for appropriate adoption of theoretical underpinnings are, therefore, multifaceted; they are consequently complex, and appropriate practice and decisions are context-dependent.

Starting to unpick the complexity: rethinking the term ‘technology enhanced learning’

In this paper, I focus on a field of educational technology that enables us to consider the many potential ambiguities that appear when exploring any field of educational technology; I focus on TEL. Considering the term and what it might encompass, as Kirkwood and Price (2014) stated: “it is rare to find explicit statements about what TEL actually means. Most frequently, TEL is considered synonymous with equipment and infrastructure” (p.7). If we are to adopt appropriate theoretical underpinnings in this field (TEL), we certainly need to consider and understand the breadth, width and scope of the concept we are exploring. In this respect, from a more literal perspective, TEL might initially be perceived to focus on learning, and how technologies might enhance learning (that is, a part of the environment in which scholarly practice takes place).

From an historic perspective, Duval, Sharples and Sutherland (2017) stated that in their view the origins of TEL lay in Sidney’s experimental development of an ‘adaptive teaching machine’ in the 1930s, followed in the 1950s by Skinner’s development of such machines concerned with ‘programmed learning’. They went on to state that the field of TEL subsequently focused on a number of key elements: “learning through technology; design of learning materials; individualized learning; enhancing rather than replacing human teaching” (p.2). It is clear to see, even in their introductory framing of the field, that there is already a wide expansion of scope beyond what might be regarded and assumed as the TEL term’s stated focus – learning. From the authors’ text, the expansion focuses on a number of different areas: the development of ‘teaching machines’ can be argued to concern ‘teaching’ as much as, if not more than, ‘learning’; the design of learning materials is concerned with the management of teaching; and enhancing teaching is focused predominantly on teaching. Such expansion can certainly be explained from a developmental perspective. The ongoing development of educational technologies has meant that uses of a single technology by a learner or teacher are now much rarer; it is often the case that learners and teachers have a wide range of technologies at their disposal. This ‘ecology of technologies’ has been a focus of research (although not named in this way). For example, Luckin (2010) has explored ecologies from a learner-centred perspective, while Davies (2017) has adopted an ecosystem and change perspective. The ecology of technologies that are now accessible (see, for example, Passey, 2018) means that the focus of use can be much wider than just learning per se. But, given this, the implications of this widening environment in which scholarship is taking place need to be carefully considered.

This form of expansion of the term and what it encompasses is demonstrated well beyond the research literature. In a policy context, for example, Wetton and Scott (2014), in a strategic university policy

document, state that one intention for TEL is to: “Refresh ‘Clickers’ personal response system technology”. It can be argued that this intention fundamentally concerns educational provision rather than being directly concerned with learning. Similarly, in a practitioner context, a document to support teachers in using technologies in higher education (Gordon, 2014), for example, was titled “Flexible Pedagogies: technology-enhanced learning.” The report states that: “It focuses on how e-learning, also known as technology-enhanced-learning, may support flexible pedagogies, and so encompasses a range of topics where technology can enable new choices for learners. Flexible learning focuses on giving students choice in the pace, place and mode of their learning” (p.3). The expansion illustrated in these two cases can clearly lead to assumptions made about the width and scope of the outcomes of research in these situations (and by implication, its approaches). Confusions and assumptions that could arise from accepting this expansion are that TEL encompasses teaching as well as learning, and that learning benefits are associated with pace, place and mode of learning, without measuring learning in any way (as the features identified are concerned with its management, rather than learning per se). Further assumptions that might arise from taking an expanded scope are demonstrated by the content of a report from Price et al. (2005), who identified outcomes of TEL from a benefits perspective. They listed six examples of benefits: “Learners are able to access high-quality teaching and learning at any time, at any place; Information previously available only through a professor or instructor is accessible on demand through computers and the internet; Well-designed multimedia learning materials can be more effective than traditional classroom methods because students can learn more easily and more quickly through illustrations, animations, different structuring of materials and increased control of and interaction with learning materials; New technologies can be designed to develop and facilitate higher order learning skills, such as problem-solving, decision-making and critical thinking; Interaction with teachers can be structured and managed through on-line communications to provide greater access and flexibility for both students and teachers; and Computer-mediated communication can facilitate team teaching, use of guest faculty from other institutions, and multicultural and international classes” (pp.8-9). Considering what each of these listed benefits details, from a perspective that TEL focuses on learning, these six show that it might be assumed that areas of focus for TEL also include: education or resource provision; teaching approaches and practices; the ways learners manage their learning; and how teachers manage their teaching.

Within the TEL literature and research field, illustrated by the examples provided above, it becomes clear that the concept of TEL can cover much more than concerns focused on learning and the role that technology might play in enhancing learning; there are at least six different sub-concepts or areas of focus identifiable from the examples above. These are concerned with how TEL is used in and can influence: education; the management of education; teaching; the management of teaching; learning; and the management of learning. These six areas of focus are concerned not only with different practices, but they are also concerned with different underlying principles.

Education can be considered as a process, or as a system, that supports and enables teaching and learning. In the case of TEL, this area of focus and the potential influences from TEL might cover the ways that technologies are built into an organisation or institution, or into a system to support processes of teaching and learning, such as uses of online feedback from students about their courses, or online assessment results from teachers about student results, with both being able to be viewed so that overall successes and weaknesses can be considered. In these cases, TEL is supporting educational provision and organisation; and TEL is being used to enable communication, and access to data. Many studies already explore this area of focus; the model of evaluation of TEL proposed by Quentin-Baxter, Kelly, Probert, MacMahon and Ferrel (2008), for example, clearly includes elements related to this area of focus: “influence on retention... modifications to learning spaces... effect on a social justice agenda... influence on policy” (p.787).

The management of education, on the other hand, concerns how the organisation of teaching and learning is handled. For example, the management of blended or hybrid courses or programmes would be included in this category. In this case, TEL would be viewed from the perspective of influence, enhancement or improvement of a course or programme, or whether it might enable a wider audience

to participate. This area of focus has also been explored in many studies. Byrne, Donaldson, Manda-Taylor, Brugha, Matthews, MacDonald, Mwapasa, Petersen and Walsh (2016), for example, evaluated a technology enhanced learning programme, and concluded that: “Remote collaboration and engagement are paramount in the design of a blended learning programme and support was needed for selecting the most appropriate technical tools” (n.p.).

Teaching is concerned with more individual practice, with forms of instruction and interaction, with how teachers implement and handle learning activities with and to support their learners. In this case, TEL might be deployed to enable more questioning through the use of clicker devices, or to create and use presentations that are more visual or diagrammatic. Many studies highlight elements of this area of focus. Young and Nichols (2017), for example, claimed that: “diversification of communication within teaching and learning practice gives students more choice and opportunity to interact with both their peers and teaching staff” (n.p.).

The management of teaching, however, is concerned with how the teacher handles the process of teaching. This might involve using TEL to offer a greater focus on group work or collaboration, or on the handling of homework through a virtual learning environment. This area is often explored in studies, but the distinction between teaching and the management of teaching is not always clearly made. Uskoković (2018), for example, discusses the development of flipped classrooms, stating that: “in the flip model, they [students] are introduced to the content beforehand and the comprehension of the content is set to occur during the class through a variety of individual or group learning activities” (n.p.). This statement highlights the management of teaching, rather than detailing processes and practices of teaching.

The area of focus of learning is concerned with the learner, and how they engage with learning, how they cognitively process ideas, concepts and knowledge, and how they externalise their learning. The features explored in this area of focus revolve around learner engagement, cognitive and metacognitive processing, and externalisation of learning. In this area, TEL might influence or enable engagement through alternative forms of text, audio or video, or to enable a focus on analysis rather than description, or to support writing as a form of externalisation. Some studies have focused on this area very specifically. Pöysä-Tarhonen, Care, Awwal and Häkkinen (2018), for example, identified how: “pairs of students can build a shared understanding and acquire collaborative problem-solving (CPS) practices during an online assessment of CPS skills” (n.p.).

By contrast, the management of learning is concerned with how the learner accesses and handles their learning. For example, a learner might use a laptop with internet connectivity to access a range of details online rather than visiting a library, or might choose to do an online quiz in order to find out how much they might know about a particular subject topic. Here, the area of focus is on the management of the learning rather than on a measurement of the learning arising. This area of focus has often been explored through studies in this field. Kennedy and Dunn (2018), for example, concluded from their study on student responses to uses of technology enhanced learning, that: “VLE [virtual learning environment] content and TEL more generally appear to be valued by students for its ability to provide quick and efficient access to resources/course-wide content, maximize time spent learning (rather than searching), allowing learners to go at their own pace and its capacity for making learning more engaging and fun” (p.87). The benefits identified are not here measures of learning; they are measures of how the learning is managed.

Naming TEL terms and concepts: considering theoretical backgrounds for areas of ‘TEL’ research

Many articles and texts in this field (including those cited above) take a wide and non-delineated view of TEL. In terms of working within a TEL environment, from a practice perspective, this can be argued to be entirely appropriate. But, if the focus is on the DT elements of scholarship, then this means that there can be no clear distinction made between the different concerns and, consequently, the appropriate selection of underpinning theories or frameworks that would support the studying of these six separate elements. As explained subsequently, a delineation is fundamentally important from

the perspective of theoretical underpinnings. From the six ways in which TEL can be considered, proposed terms to cover these different areas of focus are:

- Technology Enhanced Education (TEE)
- Technology Enhanced Management of Education (TEME)
- Technology Enhanced Teaching (TET)
- Technology Enhanced Management of Teaching (TEMT)
- Technology Enhanced Learning (TEL)
- Technology Enhanced Management of Learning (TEML)

The importance for separating these aspects of concern and study focus becomes clear when theoretical underpinnings are considered in each case. Before exploring this point further, however, it is important to recognise that there are distinctions between different forms of underpinnings, based on choices of models, conceptual frameworks, theoretical frameworks, or theories (Grant and Osanloo, 2014). Indeed, originating authors of these forms of underpinnings often state which form they are proposing or using. It is clearly important that researchers using these background underpinnings respect these originating forms, for good reasons. For example, Technological, Pedagogical and Content Knowledge (TPACK or TPCK) (Mishra and Koehler, 2006) was stated by these authors to be a framework. In this particular case, as indeed in many other cases, the authors outline a model from this framework, which holds for that given case or stated population, arising from their context-specific research study. In this and many other cases, a model is concerned with summarising findings in a visual way. It might then be used as a model for exploring practice or further research, but it should be recognised that its specific context and summarisation of factors or features might not be exhaustive. A framework, on the other hand, tends to be more flexible and descriptive, as it usually identifies factors or criteria that have influence on a particular field (whereas a model might not do this in such a detailed way). Such a framework can be used as a means to underpin a research study, and may be used as a starting point, since it can offer a thematic view for creating research instruments or methods. A theoretical framework, however, arises from outcomes beyond a single study, based on one or more theories, which might be social constructivism, constructionism, behaviourism, social learning, discovery learning, experiential learning, etc. A conceptual framework, by contrast, is different, in that it selects concepts that are used to frame or provide background for a research study. It does not need to be based on a theory, although it certainly might take theory or theoretical elements into consideration as a part of the background concept(s). At a wider level, a theory considers a broader and deeper concern or context. It suggests the detail of what might be more general, beyond one or a number of contexts. However, it is important to recognise that theories are there to be questioned, that they arise often from specific contexts, and that they can be questioned sometimes as to whether they are detailing practice rather than providing fundamental theory (and networked learning has been discussed in this way as a case in point). The level of generalisation of a theory is important to consider when exploring a research study's context. Piaget's theory of learning development, for example (Piaget, 1952), was based on observation of three of his children and a number of his colleagues' children in his later work. It was, therefore, completely Western-specific, socially-specific and time-context-specific.

When considering what might underpin research in TEL (the specific focus of the discovery element of scholarship), therefore, there are at least two important dimensions to consider: the choice of any underpinning model, framework or theory; and the focus of the research study delineated by the six areas of focus identified above. Taking the latter dimension as the starting point from which to consider a research study, once a delineation has been identified for that study, it is possible to consider which theories, theoretical or conceptual frameworks or models might specifically relate in that case. Any specific study needs to identify underpinnings that are relevant to the research context. Any underpinning model, framework or theory should match the research inquiry, and the research questions. Some examples are given here to exemplify how the delineation of specific research inquiries of TEL can critically affect the choices that are possible.

For education (TEE), concerned with educational provision with technology within a system or institution, possible theories, theoretical or conceptual frameworks or models might cover the

introduction, implementation or integration of technology, or indeed values associated with that provision. In terms of exploring implementation at an institutional level, Hooper and Rieber (1995) developed an implementation step-wise model that might be considered, while Rogers (1995) developed a theory of diffusion of innovations which might be applicable in situations where the focus is more on an organic integration rather than a planned implementation approach. On the other hand, at a systems level, contextual factors affecting implementation and associated values might be explored using an underpinning model such as that provided by Corbett and Rossman (1989). What is clear in the TEE area of focus, is that a range of models, frameworks and theories exist, they may well be concerned with implementation or change, but many arise from a Western- and context-specific focus, so their applicability needs to be considered carefully.

For the management of education (TEME), concerned with ways that educational provision with technologies is managed, possible theories, theoretical or conceptual frameworks or models might relate to the development of blended or hybrid learning, or the development of virtual learning environment facilities. For example, Huang, Ma and Zhang (2008) offer ideas for developing a design theory of a blended learning curriculum, with a model for practice that might underpin some studies, while Graham, Henrie and Gibbons (2014) consider features for the development of models and theories applicable to blended learning provision. If the management is more focused on a networked learning (communicative) approach, then an underpinning framework such as that of Ostashewski and Reid (2010) might be appropriate. The literature offering underpinnings for TEME is concerned with the management of change as much as with the management of implementation, but also considers the role of the technology in that management.

For teaching (TET), concerned with pedagogical approaches used, possible theories, theoretical or conceptual frameworks or models might include the forms of pedagogy that can be adopted and used, or the balance of these forms. For some studies, where the focus is on the relationship of technology to subject content and pedagogy, the TPACK framework from Mishra and Koehler (2006) might be appropriate. In studies where the concern might be more on the balance of forms of activity developed, the concepts of Dewey (1974) might be more appropriate, while in situations where the concern is with the perceptions of how readily the technology might be used, then the Technology Acceptance Model (TAM) of Davis (1989) might provide a useful underpinning. What is clear from the literature is the profound absence of specific theories of teaching; concepts of practice, frameworks and models exist, but references to theories are usually based on an application of learning theory to teaching, rather than providing underpinnings from a teaching theory perspective per se. Based on the earlier work of Boyer (1990), and from many studies that have supported and illuminated that work, the revised scholarly framework proposed by Garnett and Ecclesfield (2011) certainly offers a theoretical framework of value when considering TET.

For the management of teaching (TEMT), concerned with ways that technologies are used to manage teaching approaches, possible theories, theoretical or conceptual frameworks or models might be concerned with how online environments or social media can be used to support interactions, or how online environments can enhance communications asynchronously and outside classrooms. For example, Kearsley and Shneiderman's (1998) engagement theory might be a way for some studies to consider the ways in which the management of teaching supports an engagement with learning, while Laurillard's (2002) conversational framework might be a way for other studies to consider managing teaching to support learning with constructivist theory underpinnings (involving roles of communication, networking and collaboration). In the literature, the distinction between teaching and its management is not always clear; yet it is clear that the two are distinct, that there are different concerns associated with each, and that conceptual and theoretical underpinnings need to be separated so that research outcomes can be strongly and effectively underpinned. At the same time, it is clear that the development of management of teaching theories is an open research area.

For learning (TEL), concerned with ways that technologies support cognition and metacognition, possible theories, theoretical or conceptual frameworks or models might offer details of the ways that learning is developed or how its measurement or identification can be approached. This area of focus

is, by comparison to other areas, well supported with models, frameworks and theories. Whilst many researchers have fallen back on theories that were not specifically developed in a technological context (for example, Bandura, 1997; Kolb, 1984; Piaget, 1952; Vygotsky, 1978), others have used underpinnings from authors that have considered the technological context (such as Pask, 1976). Even so, in a TEL environment, the choice of a theory, framework or model can be crucial to the identification of the learning that is of interest. If the inquiry focuses on metacognitive outcomes of learning, then Presseisen (2001) might provide an appropriate framework. On the other hand, if the inquiry explores social and emotional competencies, then a variety of possible frameworks and models are identified in Berg, Osher, Same, Nolan, Benson and Jacobs (2017).

By contrast, for the management of learning (TEML), concerned with ways that technologies are used to manage learning approaches, possible theories, theoretical or conceptual frameworks or models might detail and illuminate how learners use Internet access, or use writing or presentation software, to access information or frame their ideas. In this area of focus, there are theories emerging, and there are certainly models and frameworks that can be considered for underpinning research studies in this field. For example, Siemens (2005) offers a theory of connectivism which, it can be argued, discusses in a contemporary context the management of learning rather than learning per se. For whilst some would argue that connectivism is more concerned with the connections that individuals make through networks, others would argue that the theory is concerned as much with the ways that knowledge in different parts of a network can be identified and accessed (hence, its potential application to a focus on TEML). As Weller (2011) states: “Connectivism ... is still relatively new and, while it set out some clear principles and draws on other theories, it is not yet fully formed as a pedagogic theory” (p.94). While some research into the management of learning can focus on wide technology or learning contexts, such as ways VLEs manage learning for different learner groups, and can use connectivism as an underpinning theoretical base, other studies can explore more specific contexts. For example, for a study focusing on accessing information from the Internet, underpinning frameworks from the guest-edited issue of Brett (1992) could be considered.

Implications and conclusions

There are a number of related problems that are preventing us from moving forward with appropriately developed scholarly discovery research practice in studying the field of TEL that is underpinned by reasoned and strong theoretical perspectives. These problems can be summarised as:

- The field of TEL has expanded well beyond an area focusing on learning per se. It now encompasses areas (ecologies of technologies) that take theoretical underpinning needs beyond the concerns of learning.
- Any specific context being researched needs to be delineated carefully, so that areas where technology enhancement might arise can be more clearly understood and defined. As a consequence of delineation, application of theoretical underpinnings can be more pertinently appropriated.
- In scholarly research studies, the wide areas that are now included within TEL means that confusion between an area of focus on learning per se, and on its management, can easily arise. In many cases, research findings relate to the management of learning rather than to learning. Granberg (2000), for example, in an article on how technology enhances teaching and learning reports that: “This [having lecture notes accessible online] not only replaced the textbook, it allowed students to spend more time focused on the lecture and less time copying formulas from the board” (n.p.). This statement clearly indicates enhancements with the management of teaching and learning, rather than with teaching and learning.
- The areas of research focus that are now included within the field of TEL are in some respects supported by recognised theories, while in other areas models or frameworks predominate, with few theories developed to match the focus under investigation.
- The choice of underpinning models, frameworks or theories should always take into account their originating contexts, to ensure that they are applicable, or indeed, whether they should be questioned as an integral part of the research study itself.

By using delineated areas of focus for the scholarly concerns of discovery in TEL, pertinent choices of theoretical underpinnings are aided. However, there are implications arising from this more specific categorisation, concerned with directions for future research. These can be summarised as follows:

- Technology Enhanced Education (TEE) – there are theories of education that can underpin research, but theories of education in a technological environment, and beyond Western contexts, need to be explored and developed more.
- Technology Enhanced Management of Education (TEME) – there are implementation and change models and frameworks that can underpin research, but developing theories of the management of education in shifting technological contexts will need a continuing focus, as educational intentions and uses continue to accommodate and explore shifting contexts.
- Technology Enhanced Teaching (TET) – while there are models and frameworks of practice that can be used to underpin research, the absence of theories in this area of focus severely limits our abilities to examine this field in a strong and reasoned way. This highlights a clear need for future research activity.
- Technology Enhanced Management of Teaching (TEMT) – models and frameworks exist that can underpin this area of focus, but a wider range of theories accommodating the continuing technological context shifts would be of value in supporting stronger research backgrounds.
- Technology Enhanced Learning (TEL) – research in this area of focus can be underpinned by a range of theories, but these need to be considered carefully in terms of temporal, social and cultural contexts. The development of theories within contemporary social and cultural contexts would add to our abilities to undertake more strongly reasoned research.
- Technology Enhanced Management of Learning (TEML) – some theories are being developed in this field, but further development would support research more strongly. There is an argument that theories and theoretical concepts should be reviewed and examined regularly, perhaps every five years, as major technological changes happen with that form of regularity (Passey, 1999).

In terms of the scholarly concerns of discovery, with research being based on appropriate background theories and theoretical underpinnings, it seems hardly surprising that confusion about their selection, uses and values exists; terms (in this case TEL) encompass greater scope and width than they indicate ‘on the can’, and such assumed increases in scope and width may well be diverting attention away from the critical needs of research in this field. As research study contexts move more towards ecologies of technologies, the selection of research focus, what theoretical principles underpin that focus (or focuses), and implications for methodological approaches, all need to be carefully considered. Clarification is vitally important if we are to understand what we need in this field; delineating research inquiry in the field into discrete areas of focus means that we have the chance to recognise where fundamental and strong support from underpinnings can arise, but importantly, where we can identify current strengths and weaknesses in existing theoretical backgrounds. From these, we can not only select appropriately, but develop appropriately, ensuring that we both use and can plan for the theories and concepts on which to base our future research endeavours.

Having said this, taking the entirety of scholarly endeavour into account, Boyer’s (1990) original areas of focus – DIAT – are still appropriate, when we consider the fundamental need for discovery of technological support for education, teaching and learning. Whilst it is important that scholars retain a focus across the areas of DIAT, the increasing complexity associated with the areas of DT discussed in this paper, driven by the ongoing development and opportunities that TEL affords, means that the scholarly areas of IA will also become increasingly important. Scholars will need to be able to integrate and apply, not only within their own practice, but also for the practice of others, as communication, networking and collaboration become more possible and will lead to a continuous emergence of innovative uses. This paper has offered an analysis that provides an initial way to consider this complexity, so that the nature and relationship of integration and application of discovery into education, the management of education, teaching, the management of teaching, learning, and the management of learning, can be further discussed and considered.

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Statements on open data, ethics and conflict of interest

As this paper is a theoretical paper, the data are restricted to the studies and literature referenced throughout. Ethical approval was not required for this form of study. There is no conflict of interest that arises from the contents of this paper.

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