Lyn Yates · Peter Woelert
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Knowledge at the Crossroads?

Physics and History in the Changing World of Schools and Universities

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Preface

This book originated in a research project that set out to use a study of history and physics in Australia today to examine two important sets of questions. The first set of questions is about knowledge and the content and structure of the curriculum of schools and universities. What value do traditional studies such as history and physics have in the changing world and knowledge fields of the twenty-first century? How have fields like history and physics changed? What do those who work in these fields see as important in their teaching and research activities? The second set of questions is about the changing policy environment and the management of schools and universities today. How are changes of governance affecting the knowledge work of schools and universities?

The project itself was built on an earlier research project that had studied changing thinking about the school curriculum around Australia over the past half century. This had found considerable upheaval among curriculum leaders and policy-makers about what should ground curriculum today, how it should be structured, what should be emphasised. Should this be learning, or standards, or skills, or capabilities? Where does knowledge come from? Which school subjects should have priority? How to avoid an over-crowded curriculum?

From the other end the project was built on our experiences of working in the research environment of Australian universities, including in a senior management role. Here other questions were apparent. What is specific to different fields of knowledge, and how are they impacted by priorities of funding bodies and university management? What impact do the curriculum reforms taking place in undergraduate teaching have on research agendas and research quality? How are universities and academics dealing with a knowledge explosion, demands for impact, preferences for collaboration or interdisciplinarity and ever greater scrutiny of research productivity?

Both the school curriculum questions, and the knowledge production and university management questions have been the subject of a lot of attention in the academic literature as well as on the ground. In this book, we use interviews with over 100 teachers and academics working in two important disciplinary fields to take a fresh look at what is happening now, and to take up the academic literature

and arguments about knowledge and about what matters going forward. The design of the study lets us keep in view what is similar and different about these forms of knowledge drawn from the humanities/social sciences on the one hand, and the sciences on the other. And it lets us see and think about the role of formal education institutions, across the trajectory from secondary school to the undergraduate years to research training and research.

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We wish to thank the many teachers and academics across the country who generously gave their time for interviews and feedback on the work in progress. In the course of the project, we valued the research assistance given by Dr. Huong Nguyen, especially in the preparation and searching of transcripts using Nvivo. Additional research assistance support was provided by Kerrie Delves and Elizabeth King. In the writing stage, we thank Glenn Savage, David Goodman, Maurice Toscano and Julie McLeod who read and gave advice on some particular chapters.

The project benefited by a two-day colloquium on *The Structuring of Knowledge Across School and Higher Education* held at the University of Melbourne in July 2013 focused on the work in progress. We warmly appreciate the contributions made at this event by Prof. Michael Young (Institute of Education, University College London), Prof. Lesley Farrell (University of Melbourne); Prof. Joe Muller (University of Capetown) and Prof. Terri Seddon (Australian Catholic University) and their ongoing interest in and discussion of the research and ideas discussed in this book. Lyn Yates further benefited by funded periods of discussion with researchers at University of Capetown (courtesy of an A.W. Mellon fellowship) and at the University of Oslo with the HEIK (Higher Education) and the curriculum (CLEG) research groups, and she thanks the Dean, Prof. Berit Karseth and Prof. Peter Maasen (leader of the HEIK group) for arranging and facilitating these visits. In the later stages of the project, our discussions were enriched by a series of discussions in Melbourne with a large cohort of

researchers from the University of Oslo working on related but different projects in higher education, led by Prof. Peter Maassen and Prof. Monika Nerland.

The authors want to acknowledge support from families and friends over the course of the project, in particular as we collectively produced two new babies during this time. In this context, Kate would like to thank her family for supporting her work at this time, particularly her partner Jon and parents Liz and Liam. Vic would also like to thank her partner James, parents Malcolm and Judy and parents-in-law Peter and Rhonda for their continued support.

Finally throughout the project we have had the good fortune to be situated among colleagues who consistently stimulate and challenge the work that we do and whose company we much value—thank you to all on level 7 of MGSE (Education Policy, Equity and Identity domain and the Social Transformations and Education research hub).

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Contents

Acronyms

ACARA	Australian Curriculum Assessment and Reporting Authority
AHA	Australian Historical Association
AIP	Australian Institute of Physics
ALTC	Australian Learning and Teaching Council
ARC	Australian Research Council
ATAR	Australian Tertiary Admission Rank
AUQA	Australian Universities Quality Agency
CAE	Colleges of Advanced Education
CERN	Conseil Européen pour la Recherche Nucléaire (European Organisation for Nuclear Research)
CTEC	Commonwealth Tertiary Education Commission
ERA	Excellence in Research for Australia (Australia's national research assessment program)
FOR	Field of Research (discipline-based classification system used by Australian Bureau of Statistics and Australian Research Council)
Go8	Group of Eight (Australia's elite research-intensive universities)
HASS	Humanities and Social Sciences
HERDC	Higher Education Research Data Collection
HSC	Higher School Certificate
KPI	Key Performance Indicators
MOOC	Massive Open Online Course
NAPLAN	National Assessment Program—Literacy and Numeracy
NPM	New Public Management
NSW	New South Wales (largest Australian state)
OECD	Organisation for Economic Cooperation and Development
Ph.D.	Doctor of Philosophy
PISA	Programme for International Student Assessment
SKA	Square Kilometre Array (large-scale physics research project)
STEM	Science, Technology, Engineering and Mathematics

TAFE	Technical and Further Education
TEQSA	Tertiary Education Quality Standards Agency
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNS	Unified National System
VCE	Victorian Certificate of Education

Part I
Introduction

Chapter 1
Researching the Changing World of Education

A Google search today brings up 2.3 billion links for the question 'what is education for?' The purposes, content and structure of schools and universities are very much in question. The rise of new and vastly different technologies and technological capacity; the reality of global communication, mobility, flows of population, global benchmarking and competition for students and jobs; the breakthroughs and 'knowledge explosion' in traditional fields, and the rise of new talk about 21st century skills and new forms of research collaborations to tackle 'wicked problems', are all widely evident. Harvard and many other universities now send their students to gain experience in different parts of the world. Across countries of the European Union, or in Australia or in countries of Asia, many previously tradition-bound universities make radical reforms to the undergraduate curriculum structure. And in school curriculum, most countries have introduced major reviews and reforms, not just once but repeatedly, over the past two decades. The curriculum literature itself is rife with major debates: 'reinventing the curriculum', 'bringing knowledge back in', '21st century skills and competencies'. The literature on universities also evidences major rifts, debates, dilemmas: should university teaching as we know it be replaced by online forms of learning? What is the purpose of undergraduate education? What forms of specialisation are needed? To what extent should research problems be built from 'national priorities' and collaborations with industry, rather than from within a more self-contained academic discourse?

In both universities and schools these changes and debates flag important questions about knowledge in the context of education, and about the governance, management and steering of education. These are the focus of this book and the research project on which it is based. In the sociological research literature education policy studies and curriculum studies have usually been considered as separate arenas of theory and practice (Rizvi and Lingard 2010). In what follows, we try to keep both kinds of study in focus. The curriculum inquiry question this project takes up is 'how should we think about knowledge today?' (Bok 2006;

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Karseth 2008; Tuomi-Gröhn and Engeström 2003; Yates and Young 2010; Young 2008). The education policy and strategy question the project takes up is: 'is the emphasis on learning outcomes and on auditing and managing education achievements in schooling and higher education distorting and undermining knowledge-building?' (Baert and Shipman 2005; Lamont 2009; Minelli et al. 2006; Power 1997, 2003; Shore 2008).

In 2011, the authors of this book set out to take a fresh look at these questions by embarking on a substantial research project with a relatively tight focus, one that we hoped would give some interesting close-up and bottom-up empirical evidence about changes in the work and work contexts of teachers and researchers, but that would also provide a springboard for returning to some of these big questions about knowledge and the role of formal education both in schools and universities. Our interest was in knowledge, knowledge building, and the changing institutional, policy and management contexts of those who are the knowledge workers. And our decision was to focus in this project not on the new entities—the various 21st century skills projects that are infiltrating the work of schools and the OECD, the interdisciplinary research institutes tackling grand challenges that dominate university website pages—but on two disciplinary fields that had long been considered core enabling foundations of education in both school and university, namely physics and history. Here we might hope to see something about what is changing in the contexts and forms of knowledge of the past, and to revisit through this lens the debates about foundations and what matters today.

The interviews, institutional settings and policy context we draw on in this book are located in Australia. In later chapters we discuss some of the specificities of this context, and we draw attention to particular concerns and emphases that are distinctive in this country (for example the particular form in which history has been drawn into public debates about Australian identity; and the extent and particular form in which centralised, quantified and high stakes measures are important in research funding and assessment). But the broad themes we pursue here have a strong international presence, and in the final chapters we touch again on these so-called global trends as well as the national specificities that are part of these.

In relation to knowledge in the 21st century (the literature of which is discussed in more detail in Chaps. 2 and 3 of this book), a core question which we focus on in this book is the extent to which older forms of disciplinary organisation and teaching need to be protected, reframed or overturned in the face of the knowledge explosion, new technologies, new global communications and relationships. In recent times, for example, much curriculum policy foregrounds the concern with what kind of world we are now in, and the capabilities required for that world (e.g. Dawkins 2009; Reid 2009). But another prominent debate (by Young 2008, Muller 2000 and others, drawing on earlier work by Bernstein 1996), argues that this outcomes-based focus has led to some fundamental weakening of the foundations of education, that it fails to take seriously the distinct role of formal education (as compared with broader socialisation), and undervalues the importance and specificity of disciplines such as chemistry, physics, history and the like. These forms

of disciplinary knowledge, it is argued, were socially created, but developed over time in a way that gives a particular kind of more objective and powerful knowledge, different from common-sense knowledge, and not simply aligned with social interests of the elite. A public version of this thinking is somewhat evident in the critical public and media campaigns in Australia that rejected the 'essential learnings' curricula in some states, and that paved the way for the National Curriculum Board (later the Australian Curriculum and Assessment Authority [ACARA]) which, initially at least, seemed to exemplify a new disciplinarity in its orientations to the role of schooling.

In higher education, institutions and governments are struggling with two parallel and overlapping concerns. One concerns the extent to which the content of the learning should be derived from what matters in the world now (big problems, 'grand challenges', workplace competencies and the like) or, conversely, whether moves in this direction tend to hollow out the learning. A second concern is with the implications of the rapidly changing forms that disciplines themselves are taking, the creative cross-fertilisation between fields that is creating new knowledge; and the prominence of big collaborative teams in leading research projects today. Approaching knowledge change through this lens generally recognises that there are both practical and conceptual questions about at what point interdisciplinarity is most usefully developed, and what kinds of 'foundations' are relevant to maintaining the sharpness and creativity of the future research.

So there are issues about how knowledge today is changing and also issues about what kind of education and training over time is needed. This ambivalence about what is to be nurtured is evident in national higher education policies themselves, with many programs explicitly encouraging innovative and cross-disciplinary work and non disciplinary-based 'graduate attributes'; while Australia's national research assessment program ERA (Excellence in Research for Australia) and indeed government funding of different elements of universities, assumes the continuing foundational nature of disciplinary units of more traditional types. And in schools it is evident in the swing between concerns with 'the basics' and 'standards' on the one hand and on the fears about a quite different world in the 20th century and the need to put more of the focus on flexibility, working in teams and the like.

Disciplines such as physics and history themselves are not static, and by approaching questions about change through those working in these fields, we thought we might capture something interesting about knowledge work. The historians and physicists and history and science teachers we interview have been formed by and continue to be involved in their own disciplinary intellectual fields in the form of networks and journals and associations, the intellectual disciplinary history of their field, the boundaries and identifications associated with these fields. But these knowledge workers are also employed in present day schools and universities, and the changing environments, agendas and horizontal associations these entail. We wanted to see how physicists and historians (and science and history teachers) see their agendas and practices as teachers and researchers today—how much they are part of and advocates for a disciplinary orientation, and how

much in their work of 'knowledge building' they are engaged with and enthusiastic about new forms of association that are cross-discipline rather than within-discipline. Through our interviews we aimed to see what purposes they are oriented to in their teaching and research activities, and how they see their own work in the context of the education life-cycle, and the context of other developments that are important today. This would let us return to some of the questions about new forms of knowledge and collaboration that are much discussed today. It would also allow us to keep in sight a comparative focus on science and on humanities or social science as forms of knowledge.

In relation to policy and management issues (discussed further in relation to literature and the Australian context in Chaps. 4 and 5 of this book), the backdrop to this study is the new kinds of belief about processes required to optimise quality in education, and the effects of permeation of education systems globally by what has been called New Public Management or an 'audit' culture (Baert and Shipman 2005; Karseth 2006, 2008; Marginson 2007; Power 1997; Rizvi and Lingard 2010). As Karseth and Sivesind (2010, 109) note in relation to school curriculum, 'organisations like OECD advocate a new political technology where formalised curriculum-making is ignored or even contested in favour of assessment and accountability systems.' An 'audit' culture is one where institutions are publicly scrutinised in terms of process and quantified results; and New Public Management is an approach which sees ongoing measurement and benchmarking as the means by which progress and quality will be driven (these concepts are discussed further in Chap. 4). In Australian schooling policies, the widespread appeal to PISA data, the prominence given to public assessment and reporting via NAPLAN (the National Assessment Program—Literacy and Numeracy), the increasing amount of data of all kinds that are being collected about schools by governments are part of this mind-set (exemplified in Dawkins 2009). In the case of universities, output measures such as course completion times and national research assessments are all part of this culture.

In relation to the interests of this project in what is happening to knowledge in education, the accounting culture has produced strong interventions into the work of schools and universities and a policy context very different to that of the mid-20th century. These institutions now have a particular concern with 'learning outcomes' rather than the content of the education experience; and learning outcomes are normally expressed in ways that have an instrumental thrust, and that need to be expressed as numbers. Moreover this data-collection is ongoing, and is tied to funding mechanisms, and to performance assessments for teachers and lecturers, so it potentially acquires some new primacy in how they direct their own work with students and in what they begin to attend to in building new knowledge (Baert and Shipman 2005; Hodkinson 2008; Karseth 2006; Marginson 2007; Minelli et al. 2006; Shore 2008; Rizvi and Lingard 2010).

The three year research project was funded by the Australian Research Council, and was named *Knowledge Building in Schooling and Higher Education: policy strategies and effects*. In the course of this project we carried out lengthy interviews with 115 people working in different kinds of institutions and roles across

three Australian states. Interviewees were selected to encompass much of the diversity that might be seen among physics and history teachers and researchers in Australia: some working in academic and elite environments (both school and university) and some in more comprehensive or disadvantaged settings; some who were highly successful, leading their national bodies, consulted on government reviews, heading their departments, and others who were just entering the field, having a casual foothold, or having had mixed experiences of building their career in that field. (A further discussion of the methodology of the project is included in the appendix along with our interview protocols.)

In semi-structured and open-ended interviews we sought to capture new empirical data and insights on a number of issues. Our primary focus was an interest in 'disciplines'—and change. Here we were interested in what both the overarching policy documents and the interviewees are expressing about their conceptions of knowledge. What forms of disciplinarity, cross-disciplinarity and capabilities orientations are evident in Australian policy documents in relation to secondary schooling, to undergraduate university education, and to postgraduate education? How do teachers, lecturers and supervisors working in history and in physics think about knowledge and what they are attempting to achieve in their practice in particular areas? What, if anything, is changing about this?

A second focus was the effects of the current forms of policy and management of schools and universities in Australia, in so far as this impacts on the knowledge work of these institutions. Here we ask, how are the assessment and auditing or accountability demands and practices shaping what is now being enacted as curriculum in schools and in higher education?

And a third interest was in the education and research training spectrum: what do we see that is similar and different in terms of purposes and concerns as we look across senior secondary school through undergraduate and research training, and across more and less elite/advantaged settings. How do those we interview think about this spectrum and education development across the education life-cycle?

Disciplines are social entities in their origins and interests, and in their professional associations, journals, communications and the identities of those who work in them; but disciplines are also ways of delineating, focusing on and building knowledge over time, of developing understandings of the world and ways of further researching it that extend beyond the individuals or social entities that make up the field. One of the key recent debates in relation to school curriculum and undergraduate curriculum is whether student learning runs the risk of becoming more superficial, less powerful, if it abandons some strong attention to induction into these forms of inquiry that have built over time, in favour of a flatter or outward problem-focused perspective that treats the world as composed only of problems in the everyday world, and information and techniques for dealing with these. In practical terms the questions here pose themselves for schools in terms of what kind of relative emphasis should be given to 'subjects' compared with 'competencies' or 'capabilities'—what should be driving practices, and timetabling, what should be the focus of assessment? In universities a related practical

issue is 'what are the gains and losses of moving to an organisational structure that de-emphasises disciplinary departments?' or of developing course offerings that mainly work backwards from what university leaders think the student market will choose? In the research environment, questions about disciplinarity and new forms of knowledge translate into questions about 'how can research performance be assessed?' (i.e. What role does a 'disciplinary' community have in this? Is such a community important or merely a historical artefact that is now needing serious change? Should meta-assessments and benchmarking replace judgements within the field?).

The contemporary rhetoric of university policy and management (at least in Australia) often suggests that 'disciplines' are static and backward looking, and that innovation is necessarily cross-disciplinary or interdisciplinary. But disciplines themselves are not static: their boundaries and techniques change, new disciplines or discipline-like fields emerge. And cross-disciplinary and inter-disciplinary work by definition is built on disciplinarity (though other possibilities exist).

So in our interviews we asked participants (with minor variations for school and university, see the appendix for further details) to talk about their perspective on some relevant questions: What do they see as characterising their discipline? What has changed in their perspective on the discipline since they first studied it? Do they do interdisciplinary or cross-curriculum work? What is their experience of these? Do they describe themselves (identify) as a historian or as a physicist? How do they see their discipline or subject relative to current concerns about relevance and capability and employability? What kinds of projects do they work on? What do they value in their knowledge work?

Our approach here is one particular way of entering the debates about the value of disciplinary structuring of curriculum compared with a de-emphasis on that. And it is also a way of revisiting and rethinking the past literature about disciplines and disciplinary communities with specific regard to current times. We chose history and physics because these are such emblematic subjects of the sciences and humanities disciplines, and there has been a lot of previous writing by educationists and sociologists of knowledge about the different knowledge forms that these fields represent (e.g. Becher and Trowler 2001; Maton 2009; Muller 2009). Science disciplines such as physics are often seen as archetypally 'vertical' or 'hierarchical' in their learning needs. Certain things need to be learnt and mastered first before other types of knowledge work within the field can be done. Paradigm consensus and testing and refinement of existing theory are important. Disciplines like history have been seen as having a different kind of form, where refinement and expertise is built in a different kind of way. Normative issues and social change and the questions and movements this generates are part of their formulations; the importance of evidence and ways of testing or respecting evidence may have broad agreement, but some ongoing presence of paradigm differences and contested interpretive accounts are normal within the discipline.

So, how far do these characterisations still hold in relation to recently reworked school and undergraduate curriculum? How are physics and history each impacted

on by new policy forms that require some degree of common template? The current 'Australian Curriculum' (the first national curriculum for Australian schooling) required each year level in all subjects to be set out in terms of a number of common formulations, for example to identify what will be further developed at that level compared with the earlier one, or to reflect certain capabilities and 'cross curriculum priorities'. How does this vertical development and cross-curriculum template impact on what is taught as history and how teachers orient to history teaching? How do the cross-curriculum competencies and priorities influence what teachers are required to do and think about and convey as science, as physics? And at university, if historical knowledge and physics knowledge have different structural forms, how do the new management templates for judging research quality and research achievements affect the work of those who work in those fields?

In designing our study around interviews, we wanted to keep in view both the discipline (an abstract conception that includes the knowledge and inquiry processes, the journals and other publications, the conferences, activities and history of the field) and the person in the discipline (the person engaged in reproducing or rebuilding the discipline through their teaching and research), a person whose working life and agendas is not only framed by their disciplinary associations but by their working environment as teachers and academics. One of the things that is characteristic of recent university management (national and local) is a greater interest in steering and managing and making judgements about quality from outside the disciplinary community. But this does not mean that peer judgement has disappeared or is not also important. So how do historians and physicists understand these different aspects of their working environment, the criteria by which their work will be judged, the aspirations they have for their work? How do they think about what matters in their work today? And how are teachers of particular subjects in schools (science, history) impacted in the knowledge work itself by the broader settings in which they now work?

In Australia, the national curriculum body ACARA has a brief that covers curriculum, assessment and reporting. The national testing and data-base approach to displaying the value of what schools do is highlighted in the form of a publicly promoted *My School* website that aims to show the comparative performance of each school. The data here encompasses the national numeracy and literacy testing, and the final year 12 results and student destinations—but it is not built on testing what is being achieved in history and physics. So how are these subjects impacted by student subject choices and the individual and school gaming that are part of the NAPLAN comparisons, and the high stakes final school certificate in Australia?

Undertaking a study whose empirical focus ranges across secondary school, undergraduate teaching, research training and research itself is somewhat unusual. In doing this we become more aware than is often the case of how some common developments and concerns (about knowledge, the changing world, a market philosophy, approaches to management) are entering these different phases of the education spectrum, and are able to think about some of the effects and scale of the kinds of changes in train. At the same time our focus across the different stages

of the education spectrum allows us to think again about the purposes and specificities of each stage: for example the cultural significance of what is required in the compulsory stages of schooling. Similarly, looking at undergraduate education in the context both of schooling and of research agendas shows some of its distinctive tensions. Today this phase is both a phase of mass education, preparing students for a range of future jobs and also, for future researchers, the beginnings of the foundational work for the research and innovation activities which have become more important to contemporary universities than they once were.

So in this book we aim to bring together new empirical accounts of what is happening in Australian schools and universities today, and to revisit and hold in comparative view two major disciplines of knowledge: physics and history. The study arises from some conceptual questioning about knowledge work and about the directions of education institutions. It engages with and aims to contribute to the contemporary literature on curriculum, sociology of knowledge, disciplines, and the policy and management of schools and universities.

The book begins in this opening section with a more detailed account of the literature we have flagged in this introduction (on knowledge, change, and institutional management), and on the Australian context in which our study is set. We then in two sections look in some detail at our research findings, first in relation to schools, then in relation to universities. In the final section of the book we return to our findings and these major questions to reflect in three chapters on schools, universities, the disciplines of physics and history and the big questions about 'knowledge building' today.

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Part II
Re-thinking and Reform of Education Today—Foundations and Debates

Chapter 2
Knowledge and Education in the 21st Century

This is a time of questioning and reform in relation to the curriculum and the broad mission of schools, universities and other education institutions, and in particular in relation to their role as knowledge transmitters and builders of new knowledge. This chapter reviews for the non-specialist reader some thinking and research that frames 'the knowledge question' for schools and universities today. We begin with a brief section on the changing context that impacts on this issue and then review a number of lines of argument that touch on the role of the disciplines and school subjects that are the focus of this book.

Knowledge itself is an ambiguous term that threads through these debates. Schools and universities are concerned with at least three different ways of taking up knowledge in their programs and purposes. One relates to the object of study that constitutes the curriculum of these institutions. Here decisions are taken, both deliberately and implicitly, about what should be known or learnt about, what matters in the world. This includes decisions about what range of studies are mandated as well as about the relative weight to be given to 'knowing how' and 'knowing that' or variants of these.

A second concern is about the particular characteristics that distinguish knowledge from 'mere' belief or 'innate skill' and the like, the sense in which knowledge is seen as a special kind of learning or cognitive claim with special power. It represents the aspiration of institutions to be making available to students something more powerful or reliable or truthful or valuable than they would otherwise have. Here education institutions have to address the structure or form associated with ways of knowing that are more powerful or incisive or reliable or conceptually astute.

A third sense in which schools and universities deal with knowledge is in how they take account of the social practices associated with knowledge in the sense just mentioned. These may include attention to how disciplines or knowledge fields operate, or to what knowledge in the workplace looks like, or recognition of

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the way in which knowledge is tied to power and capital. These too underpin and are implicitly addressed by the forms and reforms of schools and universities. And each of these lenses on knowledge has been subject to considerable debate in the late 20th and 21st century.

To some extent schools and universities are located differently in relation to knowledge, but both have been facing versions of some similar questions that this chapter reviews.

The Changing Context

A Global World Economy

Although schooling and university systems in countries like Australia have long had a history of looking to other countries (particularly the UK and the USA) for inspiration about their education institutions, from the late 20th century this began to take on a heightened and new form. Concerns about unemployment and national economic wellbeing became self-consciously framed within a picture of global competition, and within a perspective where resources, including human resources, were assessed globally and comparatively. At the same time economists began to emphasise the role of education as a central factor in economic strength (Sharma 2004). And a growing body of influential supra-national measures (via the OECD, World Bank and international university ranking systems) offered some new standardised high-profile lenses on what education systems, both schooling and higher education, were achieving.

The impact of this global comparative economic lens has been widely felt—in the rapid rise and aspirations of systems in China and other Asian and developing countries, and in new anxieties and public debates about standards and quality in the USA, Europe and most parts of the world (see for example Hopmann 2013; Yates and Grumet 2011). This positioning of knowledge as a comparative economic resource underpins on the one hand an ongoing close attention to benchmarking, testing, research metrics and the like; and on the other, an ongoing concern about what kinds of knowledge are economically potent and should be prioritised in schools and universities—for example entrepreneurial capacity, languages, and the ability to work in teams. The focus on education and knowledge as an economic competitive good has been accompanied by expectations for more extended education, where advanced countries now expect to have school completion as the norm rather than achievement of a minority, and where undergraduate education becomes a more mass pursuit than in previous times. Associated with this the role and function of both secondary schooling and undergraduate education has seen considerable reworking: in terms of their length, their function as generic education or as vocational preparation, their relationship to postgraduate education.

Technological Change

Discussions about knowledge and about education in the late 20th and early 21st century are marked by the need to engage with a rapidly changing material world and dramatically changed technological capacities (e.g. Cope and Kalantzis 2009; Sugrue 2008). Compared with a world where knowledge was primarily exchanged in paper form or in face to face meetings, the power, the speed and the forms of new technologies pose challenges to education at all levels especially in relation to what is now foundational. For example the power of computers to work with big data and the distributed form of some of that work globally (especially in physics) poses questions about the directions of influence between theory and calculation that has ramifications for the science curriculum of school, undergraduate curriculum and research training. The changes raise questions about the locality of knowledge and about the various agents of knowledge (human and non-human). In relation to the study of history, the availability of new kinds of searching capacities, new kinds of online archives, ability to search and work with visual texts and oral records and the like is also potentially transformational, in terms of what students might need to learn or be able to do.

One further major impact of the internet and new searching and communication capacities has been to raise questions about the role (or even continued existence) of traditional schools and universities compared with informal learning, new entrepreneurial commercial ventures (for example Griffin et al. 2012; see also Ball 2012; Reckhow 2013) and new entities such as MOOCs (Massive Open Online Courses) and other forms of online learning.

Social Movements, Politics, the Politics of Knowledge

The curricula of schools and universities are never simply a given or a deduction from their national and historical setting—they always represent some deliberate choices, purposes and interests, and traditionally, especially in the case of higher education, reflect some orientation to elite interests and social roles ('leadership' for example). But from the mid 20th century, the politics of what counts as knowledge has been subject to much more vigorous contesting. Social movements concerned with gender and race targeted the content and language of the curriculum as sources of discrimination. They argued, and gained considerable support for, an understanding that what was being conveyed as knowledge was in fact ideological and itself contributing to the continued marginalisation and disadvantage of women and of non-mainstream groups. The attack on the politics of knowledge in schools and universities, and its relation to power, was also evident in broader attacks, for example in the writings of Paulo Freire, Ivan Illich and others in relation to schools; and May 68 student demonstrations in relation to higher education. Later, as world politics shifted from the cold war configuration to new kinds