Chapter 1: Conceptualizing e-Learning[1]

Bill Cope and Mary Kalantzis

On Learning Environments

This book explores a phenomenon we call "e-learning ecologies". We use this metaphor because a learning environment is in some senses like an ecosystem, consisting of the complex interaction of human, textual, discursive and spatial dynamics. These take a coherent, systemic form. Traditional classrooms, with their linear arrangement of seating and desks, their lecturing teachers, their textbooks, their student workbooks, their classroom discussions are also learning systems. Moving from one of these classrooms to another, the modes of interaction are familiar and predictable because they are so systematically patterned. After a while, they seem "normal". However, these are strange human artifacts that were not put together into this configuration until the nineteenth century. They quickly became universal and compulsory sites of socialization of mass-institutionalized education. In terms of the long arc of human history, it was not until our the time of about our great, great grandparents that we first encountered these modern educational systems. But will these institutional forms survive long into the twenty-first century? Is it time for them to be reformed? And if change is to come, what will be the role of new technologies of knowledge representation and communication in bringing about change?

This book explores transformations in the patterns of pedagogy that accompany e-learning, or the use of computing devices to mediate or supplement the relationships between learners and teachers, to present and assess learnable content, to provide spaces where students do their work, and to mediate peer-to-peer interactions.

Our thesis is this: e-learning ecologies may play a key part in the largest shift in the systems of modern education since their rise to dominance in the nineteenth century. Everything may change—configurations of space, learner-to-teacher and learner-to-learner relationships, the textual forms of knowledge to which learners are exposed, the kinds of knowledge artifacts that students create, and they way their outcomes of their learning are measured. Or, we may introduce a whole lot of technology into schools, and nothing changes in institutional or epistemic senses. Technology is pedagogically neutral.

So our questions of e-learning ecologies becomes these: how can they be different? And, why should they be different?

About this Book

This book is a collaborative work, written by the members of the "new learning" research group coordinated by Bill Cope and Mary Kalantzis, including colleagues, postdocs and graduate students at the University of Illinois, some of whom have authored the chapters in this book. The work of the group has been in part conceptual, to create an analytical

[1] Forthcoming in Bill Cope and Mary Kalantzis (eds), *e-Learning Ecologies,* Routledge NY, 2016

framework with which to differentiate those aspects of educational technology that reproduce old pedagogical relations from those that are genuinely innovative and generative of new kinds of learning. However, our work has been in equal measure practical. We have been working in schools, from elementary to college and university, experimenting with the practicalities of new learning ecologies. A focal point of this work for our team has been the a research and development program that has resulted in the creation of the *Scholar* platform, supported by a series of research grants from the Institute of Educational Sciences in the US Department of Education and the Bill and Melinda Gates Foundation.[2] Research papers arising from this work are to be found here: http://newlearningonline.com/scholar/references

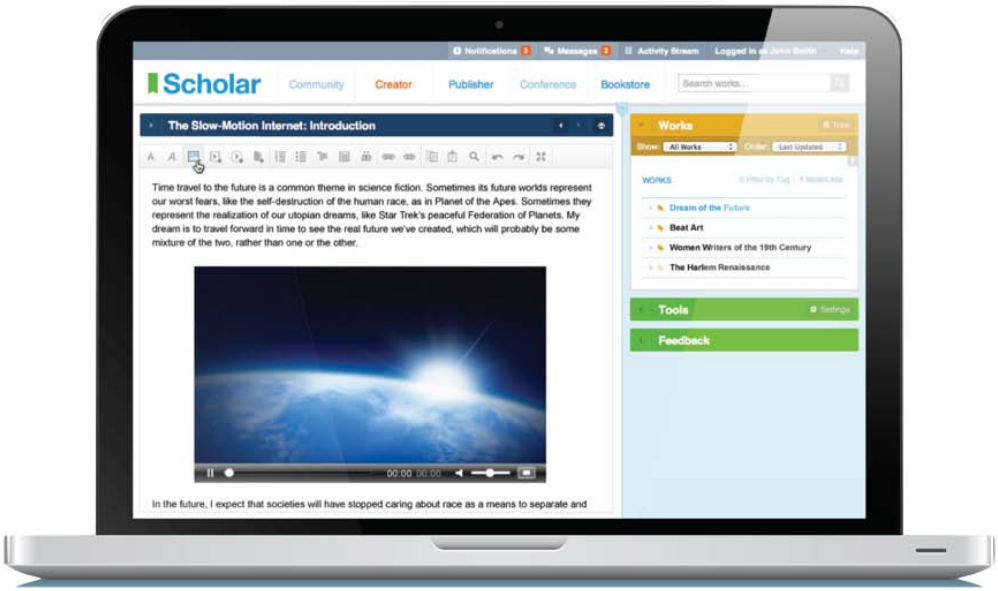

Fig. 1.1: The Scholar Platform

The theoretical framework for this book—seven affordances for transformative e-learning ecologies—covers the same territory as the "e-Learning Ecologies" MOOC offered through Coursera. The companion website to this book, http://elearningecologies.com has the video mini-lectures that accompany this course. The book also reflects key themes developed for our Learning Design and Leadership masters and doctoral programs at the University of Illinois. At our http://elearningecologies.com website you will also find a rich (and always growing) directory of e-learning case studies created by our graduate students.

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[2] US Department of Education, Institute of Education Sciences: 'The Assess-as-You-Go Writing Assistant: a student work environment that brings together formative and summative assessment' (R305A090394); 'Assessing Complex Performance: A Postdoctoral Training Program Researching Students' Writing and Assessment in Digital Workspaces' (R305B110008); 'u-Learn.net: An Anywhere/Anytime Formative Assessment and Learning Feedback Environment' (ED-IES-10-C-0018); 'The Learning Element: A Lesson Planning and Curriculum Documentation Tool for Teachers' (ED-IES-lO-C-0021); and 'InfoWriter: A Student Feedback and Formative Assessment Environment for Writing Information and Explanatory Texts' (ED-IES-13-C-0039). Bill and Melinda Gates Foundation: 'Scholar Literacy Courseware'. Scholar is located at http://CGScholar.com

Forces of Educational Change

e-Learning environments fall into two categories: new institutional sites of learning, and the traditional sites of learning that are being transformed by educational technologies. Striking new institutional forms include the rise purely online learning and "virtual schools" (Molnar, Rice, Huerta, Shafer, Barbour, Miron, Gulosino, and Horvitz 2014), the phenomenon of MOOCs or Massively Open Online Courses (Knox 2014; Waldrop 2013) and "open education" (DeBoer, Ho, Stump, and Breslow 2014; Peters and Britez 2008). Traditional sites of learning are also undergoing transformation, including blended and ubiquitous learning (Cope and Kalantzis 2009b; Cope and Kalantzis 2013), extending the range of classical classroom interactions beyond the physical classroom and class times, and by one-to-one schools where every student has a device that they can take home.

In both new and traditional sites of learning, a range of new educational technologies is emerging. To a large degree, the same platforms are used in both new and traditional contexts. Following are some of the key educational technologies to emerge since the introduction of computer-mediated and online learning:

1. *Learning Management Systems.* Older systems include the commercial offering Blackboard and the open source offering, Moodle. More recent commercial systems include D2L and Canvas. MOOC platforms, principally Coursera and edX, follow essentially the same pattern. Learning management systems align with the historical genre of the syllabus, laying out content to be covered and activities to be undertaken is a sequence, often ordered by time targets and deadlines. They may include readings, pre-recorded videos, discussion areas, tasks and assessments. A new feature of these systems is the possibility of learning analytics to track learner engagement, including, not only traditional assessments and teacher gradebooks, but analyses based on incidental "data exhaust" including keystroke patterns, edit histories, clickstream and navigation paths, social interaction patterns (Cope and Kalantzis 2016)

2. *e-Textbooks.* Replacing print textbooks, e-textbooks may include multimedia content and quizzes.

3. *The "Flipped Classroom".* Low cost, easily accessible video recording and web upload of teacher lectures (Bishop and Verleger 2013).

4. *Intelligent Tutors, Games and Simulations.* These guide a learner through a body of knowledge, serving content, requesting responses, making hints, offering feedback on these responses, and designing stepwise progression through a domain depending on the nature of these responses (Aleven, Beal, and Graesser 2013; Chaudhri, Gunning, Lane, and Roschelle 2013; VanLehn 2006). Underlying intelligent tutors, games and simulations are cognitive models that lay out the elements of a target domain, anticipating a range of learning paths (Conrad,

Clarke-Midura, and Klopfer 2014). Intelligent tutors work best in problem domains where highly structured progressions are possible, such as algebra or chemistry (Koedinger, Brunskill, Baker, and McLaughlin 2013). They are less applicable in areas where progression cannot readily be assembled into a linear sequence of knowledge components (Graesser, VanLehn, Rosé, Jordan, and Harter 2001).

5. *Discussion Boards.* These substitute for the oral discussions of the traditional classroom, supporting various forms of conversational interaction. Patterns of peer interaction can be mapped—who is participating, with whom, to what extent (Speck, Gualtieri, Naik, Nguyen, Cheung, Alexander, and Fenske 2014; Wise, Zhao, and Hausknecht 2013). Natural language processing methods can be used to parse the content of interactions (Xu, Murray, Woolf, and Smith 2013).

6. *Web workspaces and e-Portfolios.* Contemporary student workspaces differ from traditional pen-and-paper student activity in a number of key respects, including expansion of the media of knowledge representation, the ease of collaborative work, and the possibility of sharing completed work in e-portfolios. These spaces also support logistically complex, highly structured interactions such as peer review. Using a single, cloud-located source, it is possible to manage what is otherwise a difficult-to-administer processes of anonymization, randomization, and simultaneous review by multiple reviewers (Abrams 2013; Cope and Kalantzis 2013; Kline, Letofsky, and Woodard 2013; Lammers, Magnifico, and Curwood 2014; McCarthey, Magnifico, Woodard, and Kline 2014).

7. *Adaptive, Personalized and Differentiated Instruction.* Such systems monitor differential learning progress from student to student, and adapt the path and pace of learning to the speed at which the learner is progressing. This represents a break from the logics of "one-size-fits-all", "everyone-on-the-same-page" of traditional classrooms, continuously calibrating learning to individual needs (Conati and Kardan 2013; Koedinger, Brunskill, Baker, and McLaughlin 2013; Shute and Zapata-Rivera 2012; Walkington 2013; Wolf 2010; Woolf 2010).

8. *Machine Assessments.* Two principal kinds of machine assessment have emerged with the use of computing in education: computer adaptive testing and natural language processing (Cope, Kalantzis, McCarthey, Vojak, and Kline 2011; Vojak, Kline, Cope, McCarthey, and Kalantzis 2011). Computer adaptive testing extends longstanding item response theory, where correct student response to test items varies according to what the student knows or understands (a latent cognitive trait), and the relative difficulty of the item. Computer adaptive tests serve students progressively harder or easier questions depending on whether they answer correctly or incorrectly. Such tests provide more accurately calibrated scores for students across a broader range of capacities, reach an accurate score faster, and are harder to game because no two students end up taking quite the same test (Chang 2015). One variant of these assessments, computer diagnostic testing, allows for the coding of topic areas within a test, and disaggregation of

> scores within the subdomains addressed by the test (Chang 2012). In another major form of machine assessment, natural language processing technologies are today able to grade short answer and essay-length supply-response assessments with reliability equivalent to human graders (Burstein and Chodorow 2003; Chung and Baker 2003; Cotos and Pendar 2007; Shermis 2014; Warschauer and Grimes 2008). Natural language processing offers two types of tools for writing assessment, often used in concert with each other: statistical corpus comparison and analytical text parsing (Cope et al. 2011). In the case of the corpus comparison, the computer is 'trained' by being given a corpus of human-graded texts; the machine compares new texts and grade them based on statistical similarity with the human-graded texts. In the case of text parsing, computers are programmed to search for language features such as markers of textual cohesion, the range and complexity of vocabulary, and latent semantics based on word clustering and frequencies (Crossley, Laura, Allen, Snow, and McNamara 2015; Landauer, McNamara, Dennis, and Kintsch 2007; McNamara, Graesser, McCarthy, and Cai 2014).

None of these technologies is particularly new. Indeed, in a sense, the future of education represented by these shifts in educational media has been a long time coming. As early as 1959, researchers at the University of Illinois were developing the world's first e-Learning System, PLATO (Programmed Logic for Automatic Teaching Operations), connected to the ILLIAC mainframe computer, also developed at the University. Prompted in part by the requirements of an e-learning system, this work spawned pioneering developments including the plasma screen for a visual interface, a messaging system, synthesized sound, and the first computer games. Half a century later, we are still to realize full potentials of these developments on education.

Fig. 1.2: The ILLIAC mainframe computer, c.1959

Fig. 1.3: A PLATO workstation, c. 1980

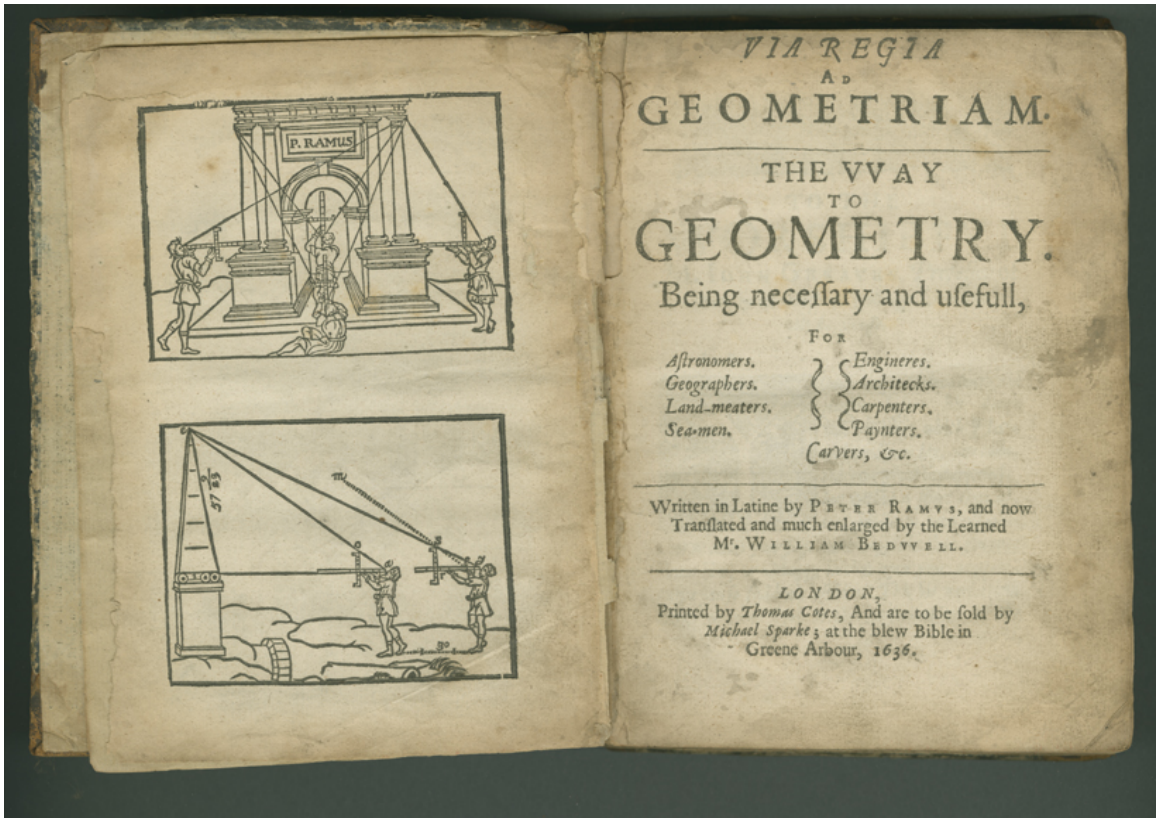
Paradigms of Learning

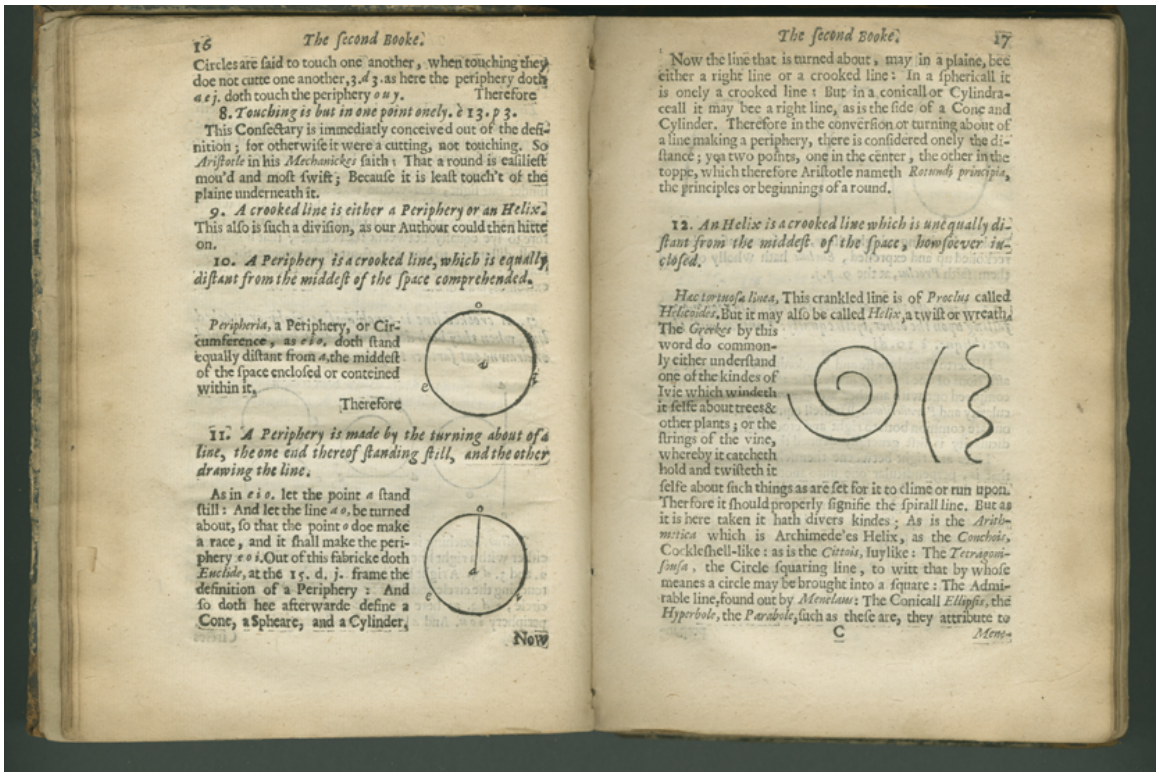
We opened this chapter with the provocative proposition that everything might change in education with the application of educational technologies. But also, in a pedagogical sense nothing might change. Technologies are pedagogically neutral.

To make this case, we need to delineate the main pedagogical alternatives. We have done this in the past a number of times in historical narratives that distinguish threefold didactic/authentic/transformative pedagogies (Kalantzis and Cope 2012), fourfold didactic/authentic/functional/critical pedagogies (Kalantzis, Cope, Chan, and Dalley-Trim 2016), or more simply, a twofold distinction of didactic/reflexive pedagogies (Cope and Kalantzis 2015a; Kalantzis and Cope 2016 [Forthcoming]). For our analysis now, we are going to stay with the simpler twofold didactic/reflexive distinction.

The discursive forms of didactic pedagogy are older than mass-institutionalized education, but on the scale of human history, not very old. Our reference point for the modern might be Plato's Academy of Athens, where learning was primarily dialogical ("Socratic dialogue"), rhetorical, and argumentative. The Western universities that arise

in the late middle ages represent a newly didactic mode of learning, originating as they do from a monastic tradition, where in the words of one of the founders of this tradition, "It belongeth to the master to speak and to teach; it becometh the disciple to be silent and to listen." (St Benedict c.530 [1949]). Then, after the rise of the printing press, teacher lectures are supplemented by a novel textual artifact, the textbook. This lays out, in a synoptic, systematically ordered, definite and seemingly inarguable way, knowledge that students are to acquire, with the aim of optimizing efficient acquisition and retention by learners (Ong 1958). These modern discursive and pedagogical forms become universal by the end of the nineteenth century.





16 The second Booke.

Circles are ſaid to touch one another, when touching they doe not cutte one another, 3. d 3. as here the periphery doth a e j. doth touch the periphery o u y. Therefore

8. *Touching is but in one point onely.* è 13. p 3.

This Conſectary is immediatly conceived out of the definition; for otherwiſe it were a cutting, not touching. So *Ariſtotle* in his *Mechanickes* ſaith: That a round is eaſilieſt mou'd and moſt ſwift; Becauſe it is leaſt touch't of the plaine underneath it.

9. *A crooked line is either a Periphery or an Helix.*

This alſo is ſuch a diviſion, as our Authour could then hitte on.

10. *A Periphery is a crooked line, which is equally diſtant from the middeſt of the ſpace comprehended.*

Peripheria, a Periphery, or Circumference, as *e i o*, doth ſtand equally diſtant from *a*, the middeſt of the ſpace enclоſed or conteined within it.

Therefore

11. *A Periphery is made by the turning about of a line, the one end thereof ſtanding ſtill, and the other drawing the line.*

As in *e i o*. let the point *a* ſtand ſtill: And let the line *a o*, be turned about, ſo that the point *o* doe make a race, and it ſhall make the periphery *e o i*. Out of this fabricke doth *Euclide*, at the 15. d. j. frame the definition of a Periphery: And ſo doth hee afterwarde define a Cone, a Spheare, and a Cylinder.

Now

The ſecond Booke. 17

Now the line that is turned about, may in a plaine, bee either a right line or a crooked line: In a ſpherickall it is onely a crooked line: But in a conicall or Cylindraceall it may bee a right line, as is the ſide of a Cone and Cylinder. Therefore in the converſion or turning about of a line making a periphery, there is conſidered onely the diſtance; yea two points, one in the center, the other in the toppe, which therefore Ariſtotle nameth *Rotundi principia*, the principles or beginnings of a round.

12. *An Helix is a crooked line which is unequally diſtant from the middeſt of the ſpace, howſoever incloſed.*

Hæc tortuoſa linea, This crankled line is of *Proclus* called *Helicoides*. But it may alſo be called *Helix*, a twiſt or wreath. The *Greekes* by this word do commonly either underſtand one of the kindes of Ivie which windeth it ſelfe about trees & other plants; or the ſtrings of the vine, whereby it catcheth hold and twiſteth it ſelfe about ſuch things as are ſet for it to clime or run upon. Therfore it ſhould properly ſignifie the ſpirall line. But as it is here taken it hath divers kindes; As is the *Arithmetica* which is Archimede'es Helix, as the *Conchoide*, Cockleſhell-like: as is the *Cittois*, Ivylike: The *Tetragoniſmus*, the Circle ſquaring line, to witt that by whoſe meanes a circle may be brought into a ſquare: The Admirable line, found out by *Menelaus*: The Conicall *Ellipſis*, the *Hyperbole*, the *Parabole*, ſuch as theſe are, they attribute to

C Mene-

Fig. 1.4: Early modern textbook: Petrus Ramus, "The Way of Geometry" (1569; English Translation, 1636)

As early as the eighteenth century, Jean-Jacques Rousseau railed against didactic pedagogy.

> Teach your scholar to observe the phenomena of nature; you will soon rouse his curiosity, but if you would have it grow, do not be in too great a hurry to satisfy this curiosity. Put the problems before him and let him solve them himself. Let him know nothing because you have told him, but because he has learnt it for himself. If ever you substitute authority for reason he will cease to reason, he will be a mere plaything of other people's thoughts (Rousseau 1762 [1914]).

By the beginning twentieth century, educational thinkers and practitioners from John Dewey to Maria Montessori and Rabindranath Tagore, were to offer systematic critiques and practical alternatives to didactic pedagogy. We call these "reflexive" in the sense that they represent in certain senses a revival of the dialogical, where the agency of the learner is at play in a dialectic between teacher and learner, the to-be-learned and the learning.

In a twenty-first century version of this debate, Kirschner, Sweller and Clark argue in favor of something they term "guided instruction". The object of their critique is a series of ostensible evils that they label "constructivist, discovery, problem-based, experiential, and inquiry-based teaching". They put the case for "direct instructional guidance, ... defined as providing information that fully explains the concepts and procedures that students are required to learn." These "procedures of the discipline" are "based on the facts, laws, principles and theories that make up a discipline's content". To what pedagogical end? "Long-term memory is now viewed as the central, dominant structure

of human cognition. ... We are skillful in an area because our long-term memory contains huge amounts of information concerning the area. ... The architecture of long-term memory provides us with the ultimate justification for instruction. The aim of all instruction is to alter long-term memory." This is where, according to these authors, fundamental problems arise with the various approaches that they seek to criticize. "Minimal guidance places a huge burden on working memory. ... Cognitive load theory suggests that the free exploration of a highly complex environment may generate a heavy working memory load that is detrimental to learning" (Kirschner, Sweller, and Clark 2006: 76-80).

Here are key features of what we call didactic pedagogy:

1. For there to be "direct instructional guidance", the *balance of control of a learning environment must be with the instructor,* along the lines of Fig. 1.5—hence the synoptic, monological artifacts of the lecture and the textbook.

2. There is a *focus on cognition,* and mostly at times, one particular aspect of cognition, *long term memory*—measurable per the artifact and ritual of closed-book, summative examination.

3. The focus is on the *individual learner* because long term memory is singularly individual.

4. There is an emphasis on a narrow range epistemic processes by means of which a learner can *demonstrate that they can replicate disciplinary knowledge*—which in this pedagogical mode is limited to remembering facts, appropriately applying definitions, and correctly deducing answers by the application received theorems, and faithful application of the "procedures of the discipline". This is pedagogy of mimesis or knowledge replication.

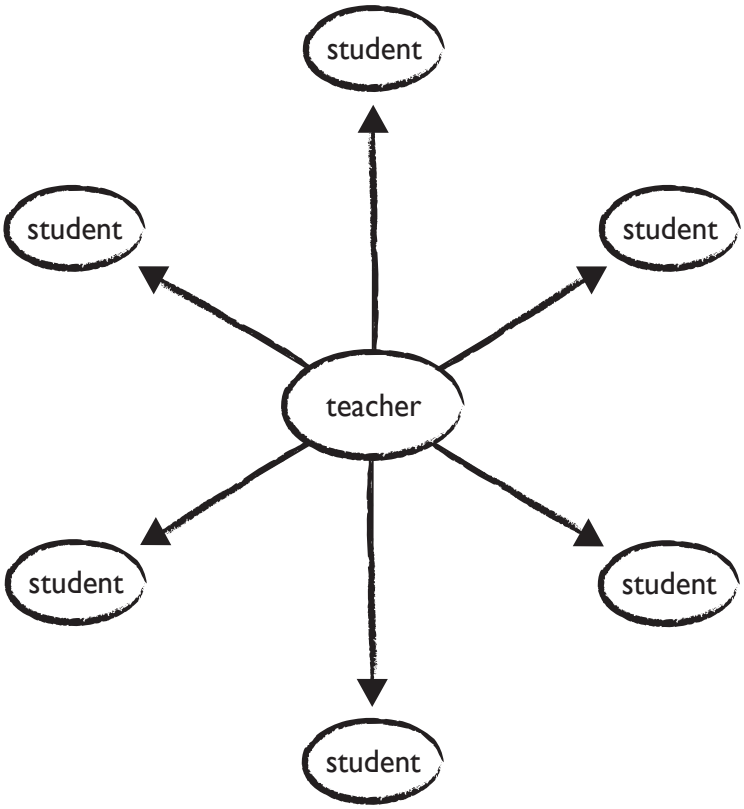


Fig. 1.5: Role Configurations in Didactic Pedagogy

Soon after the publication Kirschner et al. article, there came a rebuttal by Hmelo-Silver, Duncan and Chinn. They argue that pedagogical processes such as problem-based learning and inquiry learning "provide students with opportunities to engage in the scientific practices of questioning, investigation, and argumentation as well as learning content in a relevant and motivating context." This entails "not only learning content but also learning 'softer skills' such as epistemic practices, self-directed learning, and collaboration that are not measured on achievement tests but are important for being lifelong learners and citizens in a knowledge society." This is not to say that learning is without structure. This structure takes the form of "scaffolding [that] makes the learning more tractable for students by changing complex and difficult tasks in ways that make these tasks accessible, manageable, and within student's zone of proximal development (Vygotsky 1962 [1978])." Such pedagogy constitutes a kind of "cognitive apprenticeship, whereby students become increasingly accomplished problem-solvers given structure and guidance from mentors who scaffold students through coaching, task structuring, and hints, without explicitly giving students the final answers" (Hmelo-Silver, Duncan, and Chinn 2007: 100, 105).

Here now, is our gloss on what we call reflexive pedagogy:

1. There is a shift in the balance of agency between an instructor and a learner, where *the learner has considerable scope and responsibility for epistemic action*, albeit within the frame of reference of an activity sequence that has been

scaffolded by the instructor. Knowledge activity is dialogical, with backwards and forwards movement between instructor and students, and students and students—see Fig. 1.6. The sources of knowledge are not monological (the artificially singular, synoptic voice of the lecturer or textbook writer). Rather, they are multiple—the great variety of authentic and problematically varied knowledge sources now immediately accessible in the universal library that is the internet, and beyond that, the lived experience of learners.

2. The focus is on *the artifacts and knowledge representations constructed by the learner and the processes of their construction*. In an age where knowledge is always accessible via personal digital devices, long term memory is not so important. Long term memory will develop, but that will be an incidental and inessential consequence of deep engagement in a discipline. There is no longer a need to emphasize long term memory in pedagogy. For, if a fact cannot for the moment be remembered, it always possible to look it up in an instant. If a procedure cannot be remembered, there is an app that will execute that procedure—a calculation, series of directions, a data mashup. The objectives of learning are different in an age where we have these ubiquitous devices, these cognitive prostheses. The measurable object of learning now shifts from long term memory to knowledge processes and their documentation in the form of epistemic artifacts or knowledge representations—the report, the worked solution, the recorded activity, the model, the design. This, in other words, involves a shift in emphasis from cognition to epistemic artifacts, a phenomenon that we have elsewhere called "ergative pedagogy" (Cope and Kalantzis 2015a).

3. The focus is on *the social sources of knowledge*. Knowledge is not a matter of what I know as an individual. It is my capacity to navigate the wide epistemic world at my fingertips; it is my ability to discern critically what is salient and what is not; it is commitment to acknowledge the social provenance of my knowledge by means such as citations and links; it is my ability to work with others to create collaborative knowledge where the sum of the knowable is greater than the individual contributions of colleagues in-the-knowing; it is my capacity for synthesis; and it is my ability to extend creatively socially acquired knowledge.

4. By now, we will have brought to education *a wider range of epistemic processes*. In a reflexive pedagogy, we don't need to abandon evidence in the form of facts, conceptual clarity with finely calibrated definitions, or deductions grounded in theorems—all things Kirschner et al. rightly value. However, these always sit within a wider epistemic frame of reference, where evidence is contextualized by argument to justify the supportability of a claim, where non-trivial claims are always provisional and open to rebuttal, and where in our disciplinary practice knowledge is dynamic and evolving.

In these four senses, the pedagogy we are describing here is reflexive, by way of contrast with didactic pedagogy, which is essentially mimetic.

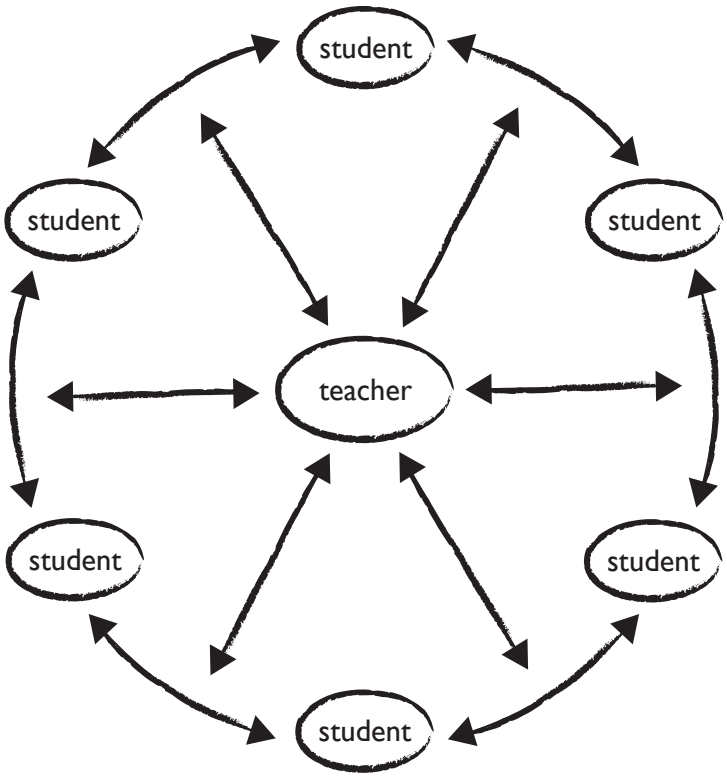


Fig. 1.6: Role Configurations in Reflexive Pedagogy

The debate between Kirschner et al. and Hmelo Silver et al. has been rehearsed time and time again over the course of the history of modern education, and doubtless it will be rehearsed many times again. Our purpose here has been to use this debate as a symptomatic starting point, as a reference point upon which to ground our analysis of e-learning ecologies.

It's Not the Technology That Makes a Difference ... It's the Pedagogy

Here are some relatively recent educational technologies, and the ways in which, on our four measures, in some fundamental respects they reinstantiate didactic pedagogies. Perhaps even at times, they resuscitate them in their moment of imminent decline:

- *The Learning Management System* reinforces a didactic role for the instructor, reviving a role like that of the textbook as they lay out course content, section by section, delivering content such as video lectures or quasi-textbook reading materials. As the course unfolds week by week, tests of memory may provide a retrospective view of what has been learned. The focus is still individual learning, and the replication of disciplinary knowledge. Learning management systems need not be used this way—they can be used in other ways, and increasingly are.

However, this is commonly the default mode of delivery.

- *The Flipped Classroom* transfers to a recording the monological, synoptic lecture form. In this sense, the relationship of teacher to student is exactly what St Benedict had prescribed. Of course, there are differences. The idea behind the flipped classroom is not to waste valuable in-person time, and to leave space there of interaction. The learner also has a modicum of control not possible in a live lecture—to play the recoding when it suits them, to run the lecture at double speed when the pace of spoken language is slower than the speed of thought, or to go back over bits that were not fully understood on the first hearing. However, these differences are minor compared to the effect of preserving the lecture medium.

- *The e-Textbook* may add a little to the print textbook, such as moving images or adaptive multiple choice tests at the end of each chapter, but the basic textual form is the same as it was at the time of its invention in the century after emergence of the printing press. Just as textbooks have for centuries, the e-textbook summarizes knowledge, lays it out in a systematic order, and speaks in the singular, authoritative, teacherly voice of the author.

- *Intelligent Tutors and Games* march students through domains which require the correct application of procedures—classically and most effectively mathematics, or the mechanics of language, or empirical science. To the extent that they adaptive and personalized, and to the extent that they operate on small cycles of behaviorist response (stimulus-response-sanction/reward), their focus is on individualized cognition. This individualization is heightened when students can work at their own pace, separate from peers. Here the relationship of learning to learnable content is one computer/lone mind.

- *Computer Adaptive Tests* are extensions of longstanding item-response theory. Items need to be just hard enough to be able to differentiate those students who understand what is being delivered (the concept of "theta," or understanding) and those who don't. But they work on the basis of a simple epistemology: that facts can only be right and wrong; that deductions can only have one correct answer; that concepts can only have one congruent meaning. In an item, there can only be one correct answer. The other alternatives are "distractors", designed to be plausible but wrong. There is no way of knowing whether the learner's plausible but wrong response is based on thinking that is in a certain sense insightful, or whether their correct answer was based on false premises or instinct without adequate underlying reasoning. The computational mechanisms of today's psychometrics may be more advanced, but the epistemological premises remain unchanged.

These are just some of the media by means of which didactic pedagogies may be brought back to life. The technology has changed, but not in any fundamental way, the pedagogy. To say it again, technology is pedagogically neutral. But it has affordances ...

e-Learning Affordances: Towards a Theory

What is potentially new and transformative about e-learning ecologies? We have two "nothing" answers to this question. The first "nothing" we've just addressed—educational technologies can be used as a medium for didactic pedagogy. And for some domains, and in some instances this may not be a bad thing, for instance where repetition and memory is still important—to learn a new language, or to get better at mathematics.

Our second "nothing" answer is that educational technologies at their best can do little more than to realize long held aspirations for education, traceable from Rousseau to Dewey, Montessori, Tagore and many others. If they make a difference, it is just to make these aspirations more practicable, or more achievable in practice.

However, we also want to offer an "everything" answer. Educational technologies could support the most fundamental change in ecologies of learning since the invention of the modern school and its mass-institutionalization in the nineteenth century. A pedagogical paradigm change is possible—a change from didactic to reflexive pedagogy.

To make a promise of "everything" is not to make a prediction, because who knows? We could easily slip back into a world where didactic pedagogy rules again. To try for "everything" is to set an agenda. It is to make a promise to ourselves as educators. Reflexive pedagogy, enabled by an emerging wave of educational technologies, can create e-learning ecologies will be more engaging for learners, more effective, more resource efficient, and more equitable in the face of learner diversity.

So what, is potentially new and transformative about these e-learning ecologies? In the rest of this chapter and the remaining chapters of this book, we will explore seven "new learning" affordances opened up by new media: ubiquitous learning, active knowledge production, multimodal knowledge representations, recursive feedback, collaborative intelligence, metacognitive reflection and differentiated learning (Fig. 1.6). The book offers a theoretical overview of the dimensions of new and emerging learning environments, a review of the research evidence of their effectiveness, and a wide variety of examples of learning technologies and technology implementations that demonstrate these affordances in action.

Fig. 1.7: e-Learning Affordances

	Didactic Pedagogy	*Reflexive Pedagogy*
Spatio-Temporal Dimension	Confined by the four walls of the classroom and cells of the timetable	Ubiquitous Learning: anywhere, anytime, anyhow
Epistemic Dimension	The learner as knowledge consumer, passive knowledge acquisition, memorization	Active Knowledge Making: the learner-as-knowledge producer and discerning knowledge discoverer/navigator
Discursive Dimension	Academic literacies: traditional textbooks, student assignments and tests	Multimodal Meaning: new media texts, multimodal knowledge representations
Evaluative Dimension	Emphasis on summative assessments and retrospective judgments that serve managerial purposes but are not immediately actionable	Recursive Feedback: formative assessment, prospective and constructive feedback, learning analytics
Social Dimension	The isolated learner, with a focus on individual cognition and memory	Collaborative Intelligence: peer-to-peer learning, sourcing social memory and using available knowledge tools appropriately

Cognitive Dimension	Focus on facts to be remembered, theories to be correctly applied	Metacognition: thinking about thinking, critical self-reflection on knowledge processes and disciplinary practices
Comparative Dimension	Homogenizing, one-size-fits-all curriculum, standardized teaching and assessment	Differentiated Learning: flexible, self-expressive and adaptive learning, addressing each student according to their interests, self-identity and needs

Affordance #1: Ubiquitous Learning

The classroom of mass-institutionalized education is a communications medium. There is nothing of the knowable world outside of the classroom that cannot be brought into the classroom via media: volcanoes, or algebra, or dentistry, or poetry, or geometry, or spelling, or geology. The reference is exophoric, to things outside of the classroom. The outside is brought in via media—primarily in the era of didactic pedagogy, teacher lecture and textbook. These are classical one-to-many media, in their general form not unlike the mass media of pre-digital newspapers, radio and television. For younger learners, one-to-twenty or thirty or seems to work. Much of the time, the teacher speaks and the students listen. Each student has a limited opportunity to speak in classroom discussion. This is simply a matter of logistical necessity, given the affordances of the media. For college students, a lecture may be one-to-hundreds, with even less opportunity if any for dialogue.

As a communications system, this classical modern classroom requires two kinds of confinement. One is spatial, or what is hearable within the four walls of the classroom. The other is temporal, framed by the cells of the timetable, determined by the necessity to listen together, and to be on the same page of the textbook at the same time.

Just as media in the wider society have changed, so the media of classrooms are changing. Where the mass media were one-to-many, the social media are many-to-many. Where the mass media configured audiences, viewer and readers as relatively passive recipients, the social media configure "users" simultaneously as readers and writers, viewers and image makers, media creators and media consumers. Where the mass media assumed an audience which was fundamentally the same (because their message had to be mass produced and mass distributed), the social media express and reflect a panoply of identities and interests depending on a user-selected pattern of friends, or likes, or followings. Quietly underlying these transformations are some fundamental technological changes which might variously be named "ubiquitous computing" (Cope and Kalantzis 2009b), "web 2.0" (O'Reilly 2005), "cloud computing" (Erl, Puttini, and Mahmood 2013), and "semantic publishing" (Cope, Kalantzis, and Magee 2011). But the technologies do not produce the change; they only offer affordances, for the same technologies could with equal force be used for control, command, and social homogenization, and sometimes are. To the extent that there is change, it is fundamentally social, in our everyday communicative relationships (Kalantzis and Cope 2015).

So what might happen in education that parallels these changes in the wider world of our communications media? To provide an example from the microdynamics of

pedagogy, we will examine the subtle but profound changes in classroom discussion that occur when it moves from oral, in-class discussion, to online discussion.

In her pathbreaking book, *Classroom Discourse,* Courtney Cazden characterizes the classical pattern of classroom discussion as Initiate-Respond-Evaluate (I-R-E) (Cazden 2001). Teacher Initiates: "What's the furthest planet from the sun in the Solar System?" Students shoot up their hands, and one responds, a proxy for all the others: "Pluto." Teacher Evaluates: "Yes, that's correct!" (Or an alternative ending: "No, that's wrong, does someone else know the answer?")

Fig. 1.8: "Hands Up!" Classical Classroom Discourse

To compare this to the dialogue that occurs in discussion boards, they're the same in this respect—a class discussion space which enacts the classic discursive Initiate-Respond-Evaluate pattern. And they are utterly different. And they are better in the following ways. We will use examples from the "Community" space in *Scholar,* illustrated in Fig. 1.9 (Kalantzis, Cope, Chan, and Dalley-Trim 2016):

- *Everyone responds*. In classical I-R-E, one person is proxy, answering for all. Instead, in *Scholar* everyone can respond. In fact, there may be an expectation that everyone must respond. The result: a silent classroom that in classical classroom discourse would have been chaotically noisy as everyone speaks at once, or where the class would have to wait an interminably long time for more or all to give their response. Student A: "I can be sitting next to someone, and we are not even looking face to face but I can know everything that they are saying, and to be able to have everyone do it at once instead of just having one person talk, it's really cool, it's total collaboration."

- *Lowered barriers to response*. Here's a rough rule of thumb—in classical I-R-E, it's usually the wrong person who responds with the proxy answer—the student who has the confidence to shoot up their hand first or early, or the person who the teacher can rely upon to have the anticipated answer. In *Scholar,* the initiation happens in an 'update', and the response in a 'comment' on that update. Students

often tell us that simply having a few extra moments to look over their response before they press the "submit comment", button reduces their anxiety to participate. Student B: "In other classes teacher talks and you get to raise your hand occasionally. I like *Scholar* because you have a better chance of being heard in the classroom. There can be those kids that dominate the conversation, so I think it's cool that we all get to hear what each other really has to say."

- When everyone responds, *differences become visible*. In the classical I-R-E scenario, it is not practicable to get answers from everyone. The expectation is that there is one answer because the person answering for the rest of the class must act as proxy for the others. This becomes an exercise in guessing the answer that the teacher expects. In asking the question, they must have had something particular in mind. If only one person is going to answer, it must mean there is only one answer. But is Pluto really a planet? Perhaps not, but if it is, might there be other small planets? The definition of planet is not so simple. Most things are interesting enough for there to be more than one answer, or differently nuanced answers, or different examples that students might give to illustrate a point based on personal interest and experience. Student C: "I think I learn more because I am hearing more perspectives, more opinions, rather than have one student dominate the conversation, hearing from everyone." In the *Scholar* Update <=> Comment dialogue, the univocal response of the proxy in classical I-R-E, becomes polyvalent. Distinctive identities and voice come through. Students soon start discussing these differences, addressing each other @. Student D: "You could see all the different views from all the different people, it's interesting because a lot of people have different views." If classical I-R-E erases the differences, now they become visible and valued as a resource for intellectual dialogue. This phenomenon we have elsewhere termed "productive diversity" (Kalantzis and Cope 2016 [Forthcoming]). Student E: "Sometimes someone will make a comment and it could be something you had never thought about, and once you read it, it changes your view." Also, anxieties to participate and voice one's own view are reduced as others' responses start to come through. Student F: "I get to hear everyone else's opinions and based of theirs, you can create your post."

- *This is highly engaging*. Classical I-R-E is boring—listening to the teacher ask a question and another student give an answer. The cognitive load is suboptimal. Reading lots of answers is much more engaging. Instead of one answer, there may be as many as there are members of the community, and more. In the era of Facebook and Twitter feeds, the cognitive load when everyone answers in the discussion thread is about right. And there is a social stickiness in the visibility of the discussion—you stay engaged because others will be reading and responding to your updates and comments.

- *The read/write mix and the participation mix is right*. Heritage classrooms had students listening more than speaking, reading more than writing. Like the participatory social media, e-learning environments such as *Scholar* offer a balance of read/write, and an expectation of active participation that resonates

with the spirit of our times. Also, the text of the discussion is deceptively different from oral language. Linguist Michael Halliday contrasts the grammars of orality and writing—speaking is linear, redundant, and strings of clauses; writing is in sentences, concise and carefully composed in a non-linear, backwards-and-forwards process (Halliday 1987 [2002]). Student G: "When you are writing stuff down, instead of speaking where you get jumbled up in your words, you get a chance to lay everything out and see it in front of you, so you can have it all planned out." Looking back over a comment and editing it before submitting, moves part way from the grammar of speaking to the grammar of writing—and towards "academic literacy". Student H: "People think about what they say before they say it; it's more concise and more thoughtful conversation, you get a better view of what they want to say than a kind of in-moment answer."

- *We can break out of the four walls of the classroom and the cells of the timetable*. In an environment like *Scholar,* there is no difference between in-person, synchronous classroom discussion and at-a-distance, asynchronous discussion. And there are useful intermediate permutations—"Finish the discussion tonight," or "Not at school today? No problem, participate anyway."

- *Anyone can be an initiator*. It's not only the teacher who can make updates in *Scholar,* to start a classroom discussion. If the teacher choses to open this setting in the Community area, students can make updates too—and this can include any number of media objects, including image, sound, video and dataset.

- *A new transparency, learning analytics and assessment*. Whereas discussions in the traditional classroom were ephemeral, online discussions are for-the-record. In the new I-R-E where everyone responds, every response can be seen, and the responses can be parsed using learning analytics (frequency of engagement, extent of engagement, language level, discussion network visualizations, and a myriad of other measures). If you are not participating, it will be visible to others and your teachers. It will show up in your results. Teacher A: "The kids like to be able to talk to each other, but the are thinking more than they would in a regular Facebook kind of setting, they realize that the teacher can see this as well. There's a certain helpful guardedness before they post, and thoughtfulness before they post it, which is a good skill for us to teach kids in the technology age."

Such are the renewed dynamics of classroom discourse in the era of social media.

Notifications 2 | Messages | Library | Logged in as William Cope | Help | Cart

Scholar | Community | Creator | Publisher | Analytics | Bookstore | Search Peers and Communities...

Mr Tate's Grade 8 Writing

WorkHard DreamBig BeHumble

Writing is its own reward (Henry Miller).

Views : 279

COMMUNITY ADMINS (6)

- William Cope
- Rita van Haren
- Richard Tate
- Duncan Ferguson
- Patriann Smith
- Wei Liu

View All

MEMBERS (7)

- Adam Rusch
- Yingbo Chan
- Soraya Garcia-Sanchez
- Antony Schultz
- Felisha Richards
- Shelby Kozak
- Hester Rodriguez

View All

INTERESTS (1)

Grade 8 English Language Arts

View All

Mr Tate's Grade 8 Writing's Updates

Ordinary People Who Lead Extraordinary Lives

Watch Ordinary People Doing Extraordinary Things. Have you ever thought about what makes an ordinary person extraordinary? Think about all the people who started off as normal people like you and made a difference in people's lives. It could be a famous person in history, science, education, medicine, politics, etc. It could also be a friend, parent, grandparent, teacher, coach, leader, etc.

Rosa Parks

Comment: Name one or two qualities of ordinary people who have led extraordinary lives. Provide an example of a person who demonstrates the quality, either from the video or from your own knowledge and experiences. Then comment on other students' comments, building on their ideas by suggesting other qualities and other people.

Posted 9 months ago | By Rita van Haren

Brave - – Rosa Parks refused to give up her seat in the colored section of the bus to a white passenger, after the white section was filled. She was brave as she knew she would probably be arrested.

Hester Rodriguez | Posted 9 months ago

Determined! Dale Beatty lost both his legs in the Iraq War but he still build houses for other veterans who were disabled.

Antony Schultz | Posted 9 months ago

POSITIVE and INSPIRATIONAL like Nelson Mandela. After 25 years in jail, he then became president of South Africa. He didn't bear any grudges and worked hard to bring peace to his country.

Yingbo Chan | Posted 9 months ago

Recent Activity

You added the interest Grade 8 English Language Arts to the community Mr Tate's Grade 8 Writing.

You created the update 2. Thyroid Hormone Synthesis and Secretion.

Rita van Haren created the update 1. Prior Knowledge.

You created the update 1. Thyroid Overview - TED Ed.

Rita van Haren created the update 3. What do you Think this Story is about?.

You created the update 1. What is your Passion?.

Soraya Garcia-Sanchez joined the community.

View All

SHARES (2)

- Book Club
- Transition Words

View All

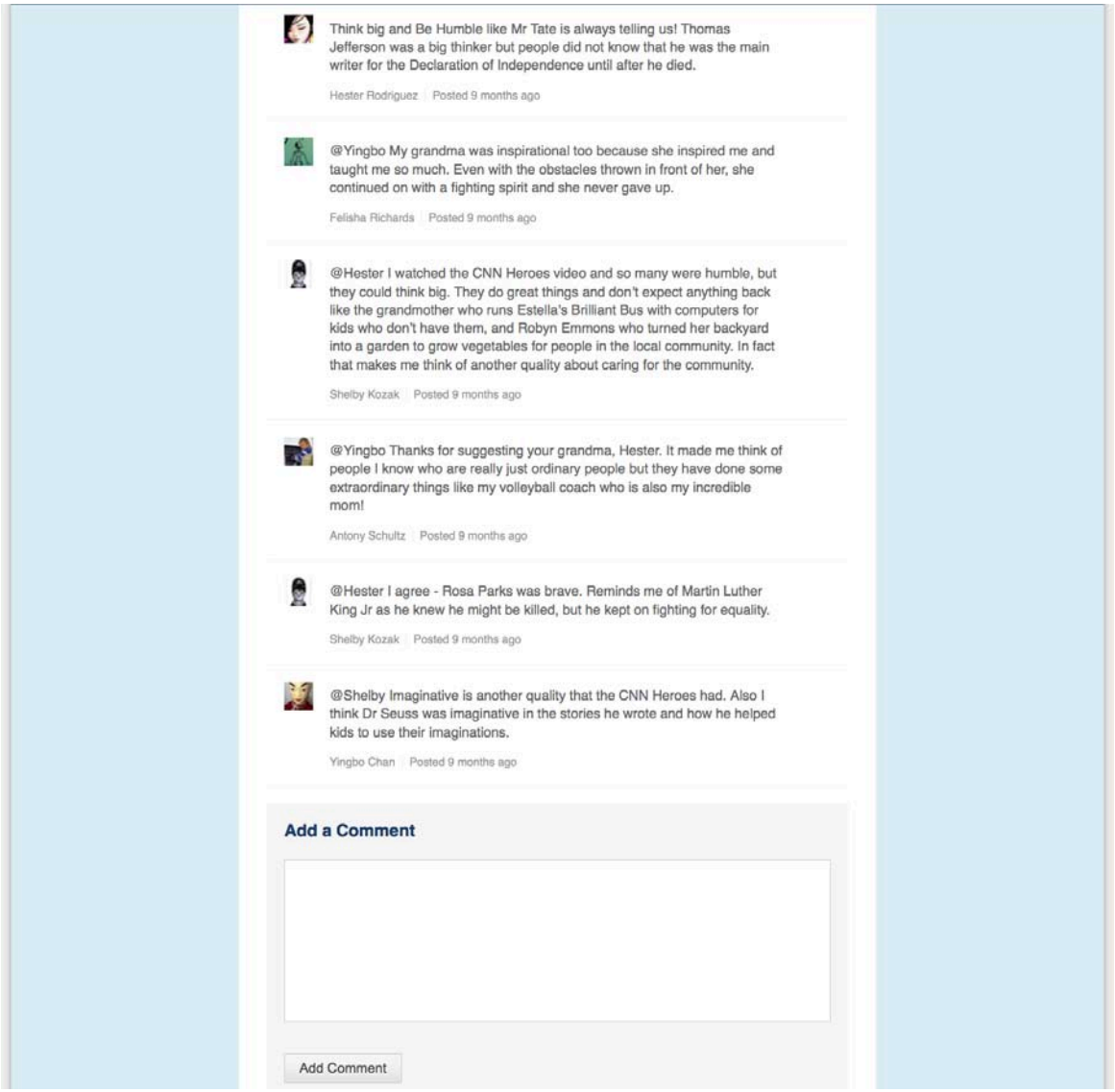


Fig. 1.9: Discussion in Scholar's "Community" Space

In these ways, classroom discussion in social media spaces is deceptively the same and totally different from traditional classrooms. In this medium, there is no difference between the dynamics of in-class and out-of-class discussion. Ubiquitous learning means that we have transcended the old pedagogical separations of space (the walls of the classroom) and time (the cells of the timetable). Not that classrooms go away, just that a certain kind of convergence occurs, where there are no pedagogical differences between in-person and at-a-distance learning. The platforms can be the same. The learner-teacher and learner-learner dynamics can be the same. Gone too is teacher surveillance requiring that students be in the teacher's direct and embodied line of sight, in the fashion of Bentham's panoptical prison (Foucault 1979). Student work and activity in the cloud is always accessible, and always recorded for the purposes of learning analytics and behavior management. A new transparency plus insistence on responsible digital citizenship, is accompanied on the flip side of new forms of digital surveillance. In the case of cyberbullying and other forms of antisocial behavior, new duties of care must be

exercised by teachers. Finally, there is a question of scale. For children, traditional classrooms had in an optimal scale of twenty or thirty students. In the era of ubiquitous learning, scale is variable—from a teacher working one-to-one with a student while others work autonomously, small groups working together based on activity scaffolds created by teachers, or larger numbers of students across multiple grade levels working in open online spaces. Ubiquitous learning makes possible all of these profound changes in the institutional forms and pedagogical modes of education.

Affordance #2: Active Knowledge Making

e-Textbooks can reproduce the relationships of knowledge and learning that accompanied the invention of the print textbook in the sixteenth century. Characteristically, the learner is placed in a relatively passive relation to knowledge, which has been simplified, summarized, and ordered for them in the monological voice of the textbook writer. In the end, there is a test to see what the student has retained in long term memory. Students are configured as knowledge consumers more than they are knowledge producers. The moral of their learning is that they should comply with epistemic authority.

How could things be different in e-learning ecologies? The key is a pedagogical process we call "active knowledge making". We want to allow learners more scope for agency in their learning. Here we want to suggest a recalibration of the balance agency. It's not that students completely lacked agency in the didactic classroom—listening attentively involves a certain level of agency. Reading the textbook and making some sense of it involves agency, a phenomenon that Barthes and Eco have called "the role of the reader" (Barthes 1964 [1977]; Eco 1981). On the other hand, learning activities without scaffolds can lack focus, to the point of becoming chaotic (Kalantzis and Cope 1993). So the agency of learners needs to be within a framework of optimally generative constraint. The art of effective pedagogy is to calibrate just the right balance of open-ness and structure.

As part of our *Scholar* research and development project, we have designed and trialed as an alternative to the e-textbook, an artifact that we call a "learning module". The learning module is a hybrid of syllabus, lesson plan, and textbook. It is all of these things and none of them.

To describe the design, a learning module has a two column format: a 'for the member' side where the teacher speaks directly to the student, and a 'for the admin' side where the teacher speaks the professional discourse of education, articulating learning aims, curriculum standards and teaching tips (see Fig. 1.11). The learning module offers three modes of interaction with and between students:

1. *Updates* that can be pushed into the student's activity stream, including a wide range of multimedia formats. Each update prompts comments from students and class discussion. If the teacher selects the "unrestricted" setting, students can also be asked to make updates that initiate discussions.

2. *Projects,* including a prompt and a rubric for peer, self and/or teacher review.

3. *Surveys*, including knowledge surveys that anticipate right and wrong answers, and information surveys that do not have right or wrong answers (such as an opinion survey).

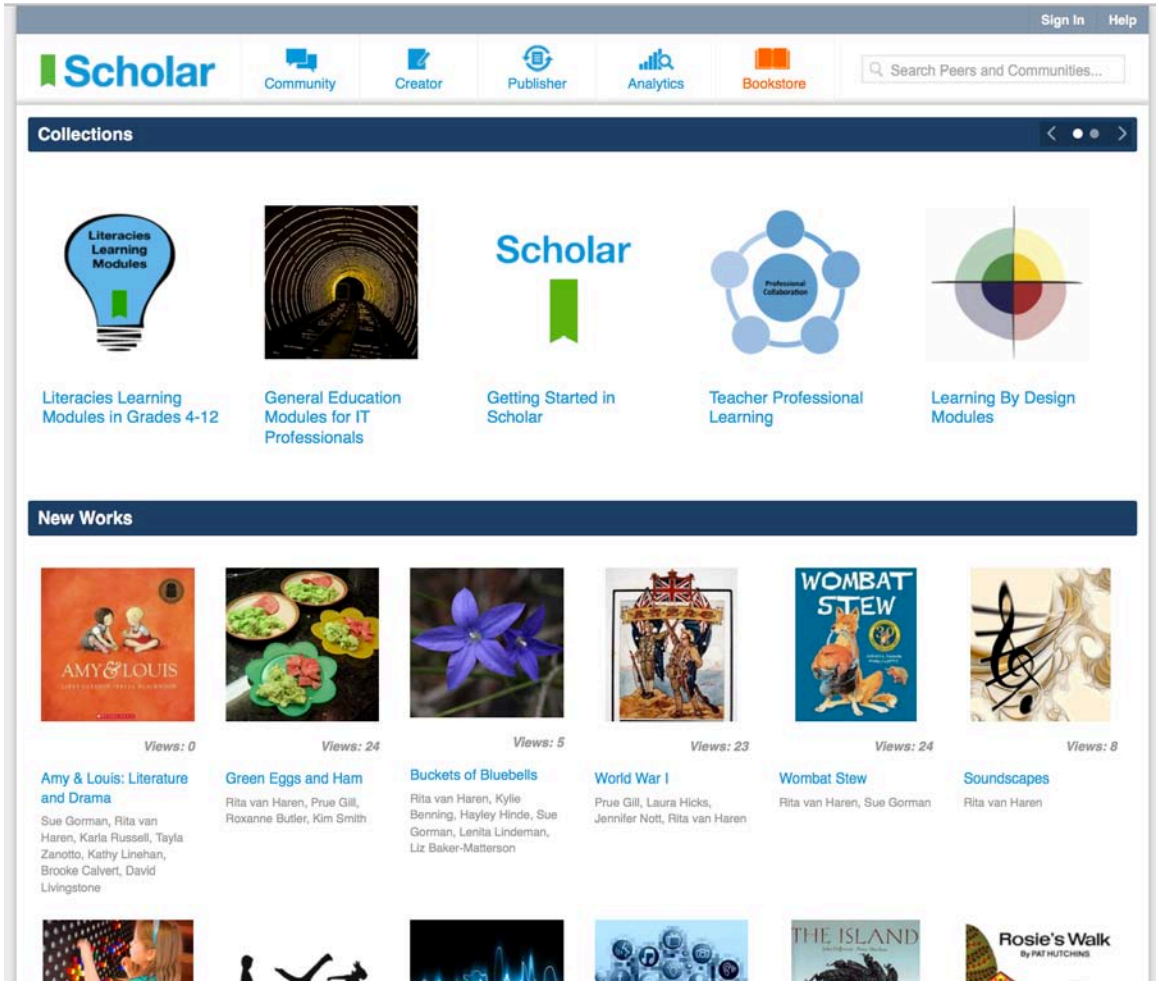


Fig. 1.10: Learning Modules in the "Bookstore" area of Scholar

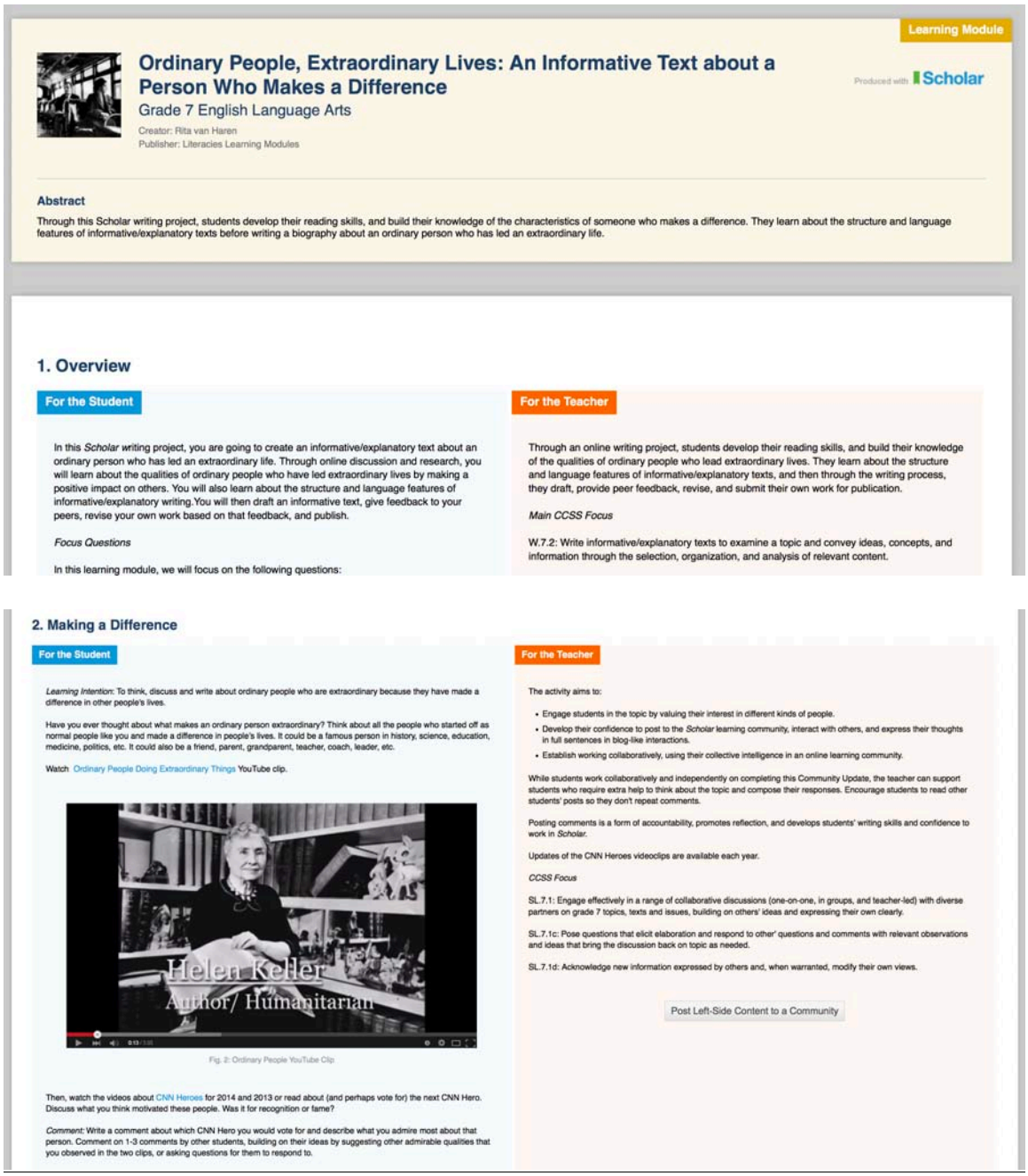


Fig. 1.11: The two-column format of the Learning Module

Here are the differences: whereas a textbook summarizes the world, transmitting content to learners in the single voice of the textbook writer, the learning module curates the world—web links to textual content, videos and other embedded media. It is multimodal. And it uses a variety of sources, requiring students to critically evaluate sources, not just to memorize content that has been delivered to them to consume. It suggests that learners may also find and curate content. Whereas a syllabus outlines content and topics to be covered, a learning module prompts dialogue—an update prompts class discussion; a project sets in train a peer reviewed work; a survey elicits a student response. It is a medium to facilitate active and collaborative learning, rather than

individualized content acquisition. And whereas a lesson plan is the teacher's private activity outline, the Learning Module can be shared with the class, and optionally published to the web, for other teachers to use within a school or beyond, so building a school-based pedagogical knowledge bank. For professional collaboration and learning, a learning module can be jointly written and peer reviewed before publication.

The underlying shift in textual architecture from a textbook to a learning module reflects a shift in the assumed role of the learner, a recalibration of the balance of learner and teacher agency. From the content transmission model of the textbook, the learning module sets up a series of reflexive, dialogical relationships with and between learners—the comments they make on an update, the peer- and self-reviews, the responses to surveys. This is a move from telling to dialogue, in which every learner must participate. The learning module also places responsibility up learners to be knowledge producers: when they make an update to initiate a discussion: when they create a "work" for peer review; and when these works are published and shared in a class knowledge bank. In a sense, instead of reading the textbook, the students have been placed by the learning module in a position where there are now in effect writing the textbook. This represents a change in direction of knowledge flows, from hierarchical, top-down knowledge flows to lateral knowledge flows and distributed model of learners as co-creators or designers of new knowledge. This aligns with the logic of contemporary, participatory media (Haythornthwaite 2009) and the skills and sensibilities for a 'knowledge society' and 'knowledge economy' (Peters, Marginson, and Murphy 2008).

However, the process is highly scaffolded, in the design of open-ended updates, the nature of the requests that students receive to create updates, the project prompts and review rubrics, and the survey instruments. This changes in a quite fundamental way the nature of the teaching profession, from a talking profession (someone else has written the textbook), to a profession where the central medium of interaction with learners is a documented, web-deliverable, interactive learning design.

Affordance #3: Multimodal Meaning

Student I: "With kids in our age group, technology is everything, it gets us to do something better than a student writing on paper and pencil."

Contemporary digital media are multimodal—where text, image, sound are all manufactured of the same raw material: binary encoding. In the era of analogue information and communication technologies (letterpress print, lithography, photography, sound recording, cinema, radio, telephone), media for the production, reproduction and distribution of knowledge and culture were relatively separate. In the digital era, they are now made of the same stuff and distributed through the shared infrastructure of the internet. With this transition, we have seen the rise of new, multimodal genres where text, image, sound and data are inseparable: the social media feed, the website, the app, the infographic, the data visualization. Elsewhere, we have called this phenomenon "Multiliteracies" (Cope and Kalantzis 2009a). As it happens, the web still tends to separate the media into spaces that have a specialist focus on audio, video or text. But this need not be the case, and often it is not the case.

Our response in *Scholar* has been to offer expanded tools for knowledge representation and communication through the multimodal editor, "Creator" (see Fig. 1.12). Here, creators can write their text, and insert audio, video, image or any other data type—a manipulable dataset, a 3D animation, or a mathematical formula, for instance. They can also embed inline external media—a YouTube video, SoundCloud audio, or code in Github for instance.

Creator is a "semantic editor" (Cope, Kalantzis, and Magee 2011), so the creator is always prompted to be explicit about their meaning. When "emphasis" is added to a word or a phrase, this text is italicized. When "block quote" is selected, it is indented, and this tells us for the purposes of analytics, that the creator did not write the selected text. The "structure" tool is for creating sections and headings, and so doing tells us clearly what the creator intends in terms of their architecture of their text. It also prompts the creator to think explicitly about the structure of their text. Having a semantic editor means that the creator's work is more readily analyzable, and also allows for flexible rendering to a web portfolio or a PDF. Rendering to different formats varies based on the medium, but always based on the creator's "semantic markup".

This is a fundamental difference between technologies such as the word processor and desktop publishing software which are based on the typography of the printed page invented in the fifteenth century—fonts, and point sizes, and, and type weights, variable spacing in a million possible combinations, the differences between which don't mean a great deal. There is no directly entered typography in Creator; nor are there in contemporary social media spaces such as Facebook or Twitter. This is how they are able to render effectively to very different devices. Now we have also educational reasons to move to a semantic editor—to prompt students to think explicitly about the form of their text, and to make that text more readily analyzable by peers, teachers and natural language processing technologies.

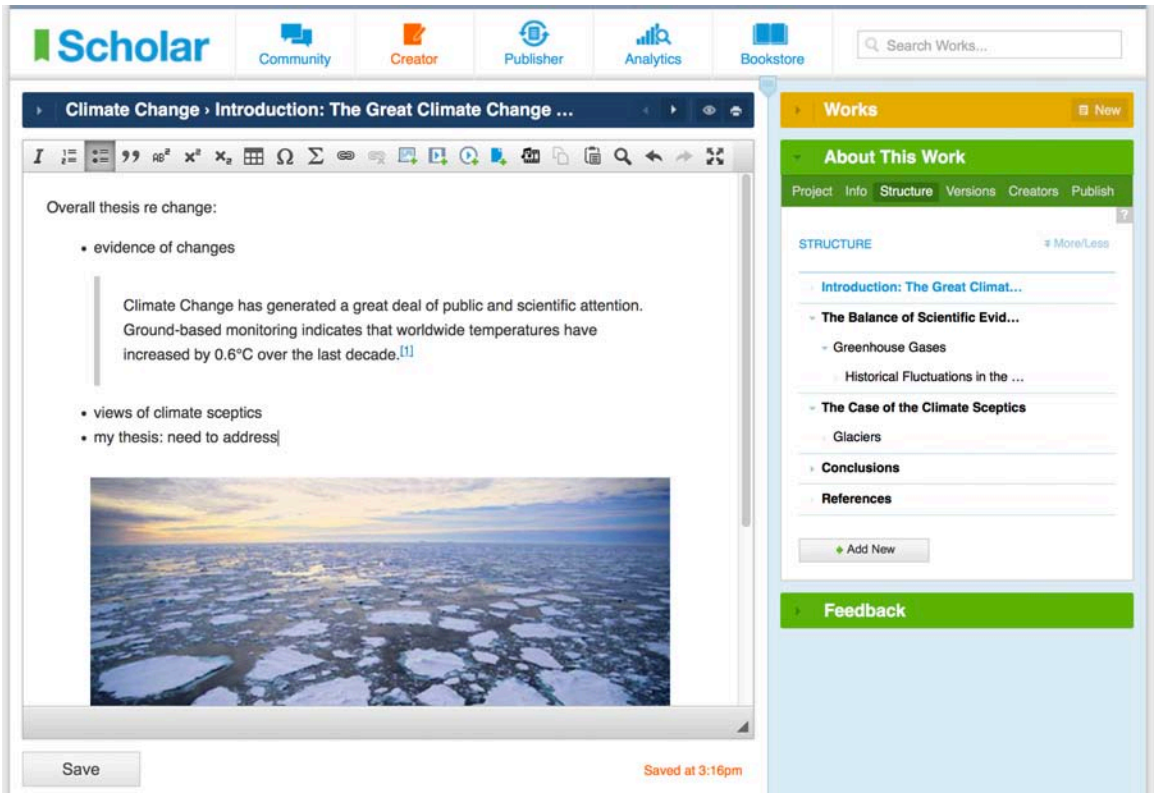


Fig. 1.12: Beginning to draft work in the multimodal editor (left); planning and navigating its structure (right).

Affordance #4: Recursive Feedback

What evidence do we have that a student has learned? In didactic pedagogy, the classical answer is to be found in the result of a test. At the end of a period of learning, there is a test, typically "closed book", to see what the student has retained in long term memory. The focus is essentially cognitive, to draw inferences about an individual's mind. Classical testing logic runs along these lines: cognition developed in learning => observation in a test => interpretation of the test results as evidence of cognition (Pellegrino et al., 2001). Cognition itself is inaccessible, so we construct instruments with which we can develop an interpretative argument based on indirect evidence. The process is linear: learn => test. The test is "summative", or retrospective and judgmental. The result is an individualized, "mentalist" (Dixon-Román & Gergen, 2013) construct. Such tests are peculiar artifacts and processes, quite different from the other artifacts and processes of learning, inside and outside of school. They are external to the learning process. There is a sharp distinction between times of learning and the time of the test. They are also "standardized," to ensure that all learners are being tested for the same things. Their frame of reference is "normative", to compare students with each other on the assumption that some will prove themselves smarter and others dumber. A "normal" distribution guarantees inequality. In order for the few to be smart, most have to be at least mediocre and some dumb. Comparative inequality among learners is statistically guaranteed (Fig. 1.13).

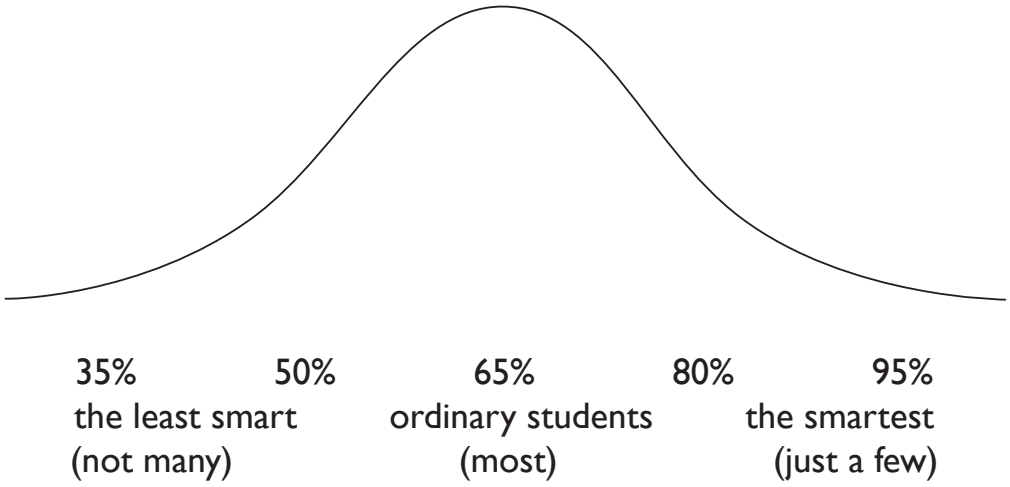


Fig. 1.13: Norm-referenced assessment in standardized tests

Educational technologies can be used to deliver classical tests with no change in their underlying pedagogical and social presuppositions. In fact, they can intensify the process by mechanizing select response assessments (computer supported psychometrics) and supply response assessments (natural language processing). The "standardization" of inequality persists, albeit with ever more obscure algorithmic bases. Mechanization means that educational systems can offer more tests, so teaching comes to be dominated by test prep, and the peculiar logic of the test.

But what could be different? How could educational technologies support other ways of measuring evidence of learning? If tests are linear, how could we create assessment processes that are more reflexive and recursive? In answering this question, we might learn from digital media. Not only are these intrinsically dialogical (captured in the difference between Web 2.0 and its predecessors), but the underlying data systems are recursive. Take for instance, the mechanisms that underlie "web reputation systems" (Farmer and Glass 2010)—the recursive reviewing processes that drive e-Bay, Amazon, or YouTube, with their incessant rating, commenting, commenting on comments, and ranking upvoting comments are useful. They are also dialogical. The "stickiness" of social media is in the feedback that comes with quick responses in the form of likes and retweets, then the response to response. Mass media (for instance, newspapers and television) were transmissive rather than dialogical, linear rather than recursive. So was didactic pedagogy. What is going to happen with schooling if we fail to address the disjunction of the traditional didactic discourses of school and the recursive 'stickiness' that keeps us engaged with the social media? In these media, not only have we now become active media creators, but we always have a responsive audience. We are always adapting based on friends' or followers' responses. If we don't change our pedagogical ways, students will become (even more) disaffected with school.

Students of today will not want to wait until the end of the course or the unit of work to be told "B-", which is simply to say something like, "you're a bad person, try harder next time." They want and need continuous feedback. Not to be merely retrospective and judgmental, they require feedback that is prospective, constructive and constitutive of their learning. This may be a machine response in a game or an intelligent tutor, a peer

comment against the criterion of a rubric, a select response question where the answer can immediately be checked, a reply in a discussion board, or a review of a work in a e-portfolio. This builds upon and older tradition and literature on "formative assessment", or assessment for learning—though all agree that formative assessment has been badly neglected given the longstanding and ongoing domination of our education systems by summative assessments (Armour-Thomas and Gordon 2013; Gorin 2013; Kaestle 2013; Ryan and Shepard 2008). The formative/summative distinction was first named by Michael Scriven in 1967 to describe educational evaluation, then applied by Benjamin Bloom and colleagues to assessment of learning (Airasian, Bloom, and Carroll 1971; Bloom 1968). The subsequent literature on formative assessment has consistently argued for its effectiveness (Baker 2007; Bass and Glaser 2004; Black and Wiliam 1998; OECD Centre for Educational Research and Innovation 2005; Shepard 2008; Wiliam 2011).

Moreover, instead of norm-referenced assessment, we might return to some other old but neglected notions. With rich, on-the-fly feedback from multiple sources and perspectives (machine, peers, teacher, self-reflection), it may be more possible for all students to achieve "mastery" (Bloom 1968). There is no reason why, against the measure of criterion-referenced assessment (Fig. 1.14), all students in a class should not achieve criterion—particularly with non-standardized instruction (i.e. "differentiated learning"—see affordance #7), with a lot of formative feedback or interim assessment designed to bring all students up to criterion (Fig. 1.15). In this context, moreover, it is not so relevant whether students meet criterion at a different pace, as long is they do. The measure then is self-referenced, or progress assessment. Could we create a no-failure educational paradigm where you can keep taking feedback until you are as good as you are supposed to be? Perhaps this is for the first time possible where the teacher's grade and the test are the principal forms of feedback. Instead of the "B-" on the test at the end of the term in the course of that term a student may receive tens of thousands of small, incremental pieces of feedback that were responsive to their needs.

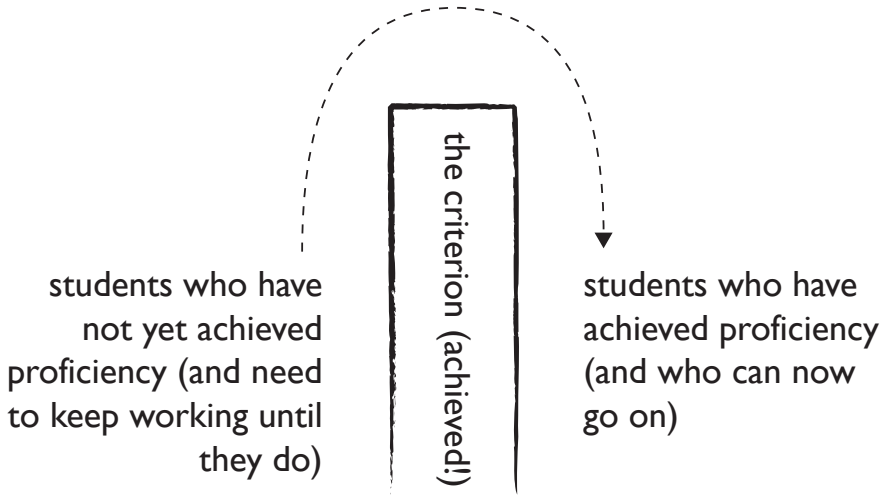


Fig. 1.14: Criterion-referenced assessment

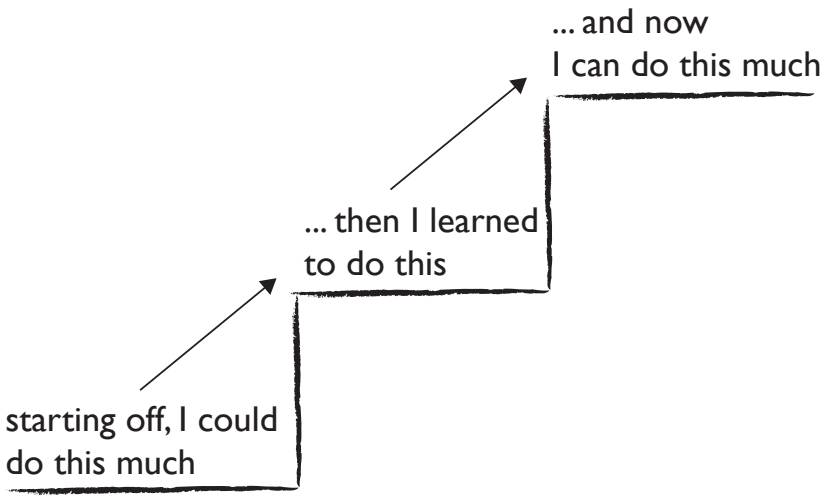


Fig. 1.15: Self-referenced, or progress assessment

In *Scholar,* over the course of a single project (a piece of writing, documentation of a science experiment, a worked mathematical example), students may receive many hundreds or even thousands of pieces of feedback in a process that is carefully designed by the teacher or the creator of the learning module: a comment from a peer against a criterion in a peer review rubric, a coded annotation, machine feedback from the natural language processor, an answer to a question a survey, a comment in a class discussion (Fig. 1.16). It's not just the teacher who is offering feedback and at the end. The sources are multiple—in fact there are many more items of peer and teacher feedback than a teacher alone could realistically offer. In the context of Web 2.0, this phenomenon is called "crowdsourcing" (Surowiecki 2004)—in this case crowdsourcing assessment. We have shown that average peer review ratings across multiple raters in *Scholar* align with expert ratings (Cope, Kalantzis, Abd-El-Khalick, and Bagley 2013).

Feedback is embedded, constructively contributing to the creation of a work during its draft phases (Fig. 1.17). This involves a reframing of learning outcomes as described in standards, from retrospective and judgmental to prospective and constructive, suggesting to reviewers the kinds of feedback that might be most helpful in the revision of the work (Fig. 1.18). Teacher B: "I think the peer review piece is one of the most important parts of *Scholar*. The students are able to look at a piece of writing and give constructive feedback. Instead of just saying 'good job,' they have rubric inside of Scholar. I think they really take it seriously because they know that the other student has really put some hard work into their peer review. You can see they are learning from each other. You're learning that we are a team, helping everyone to become a better writer."

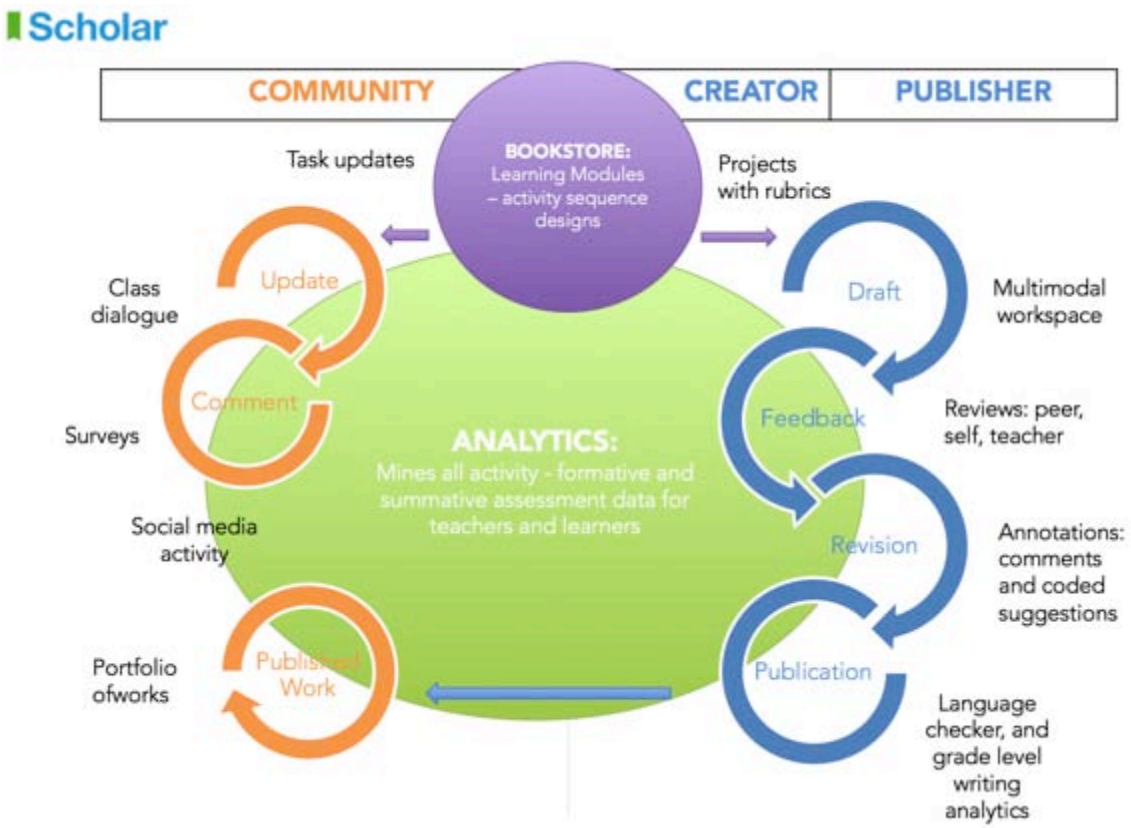


Fig. 1.16: The Scholar learning and recursive feedback ecology

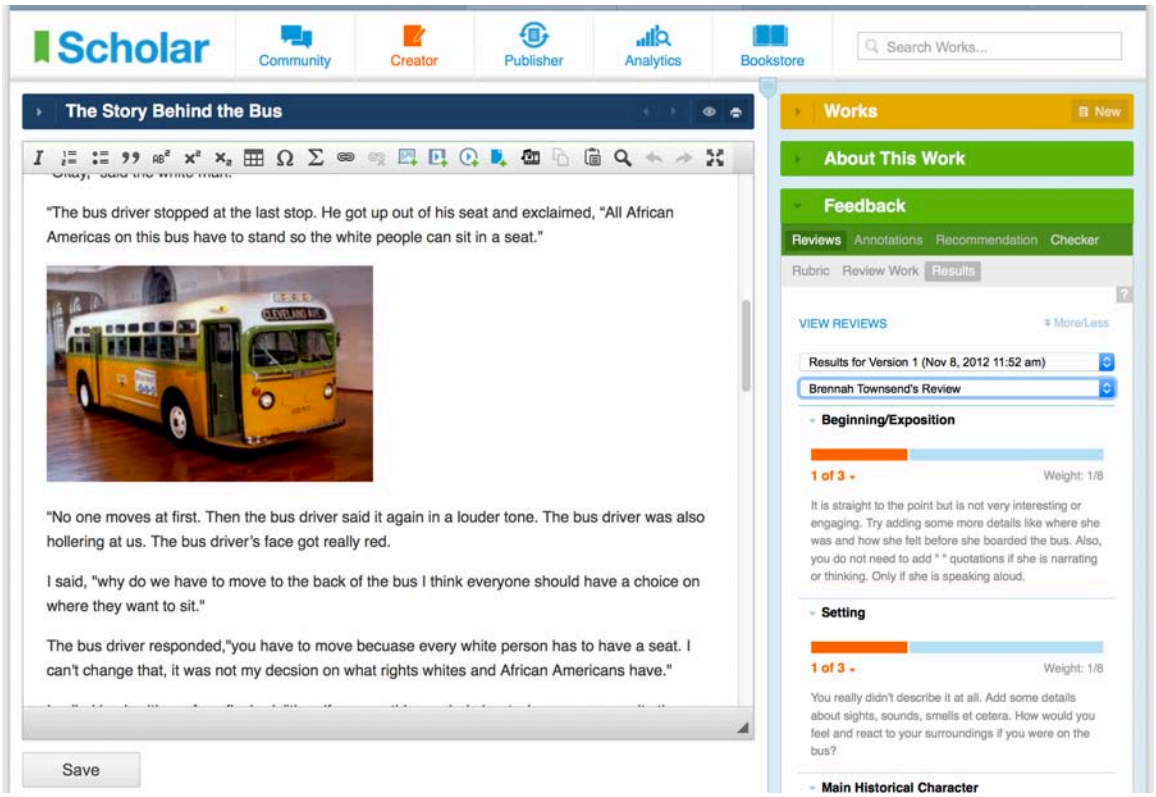


Fig. 1.17: Peer review in "Creator"

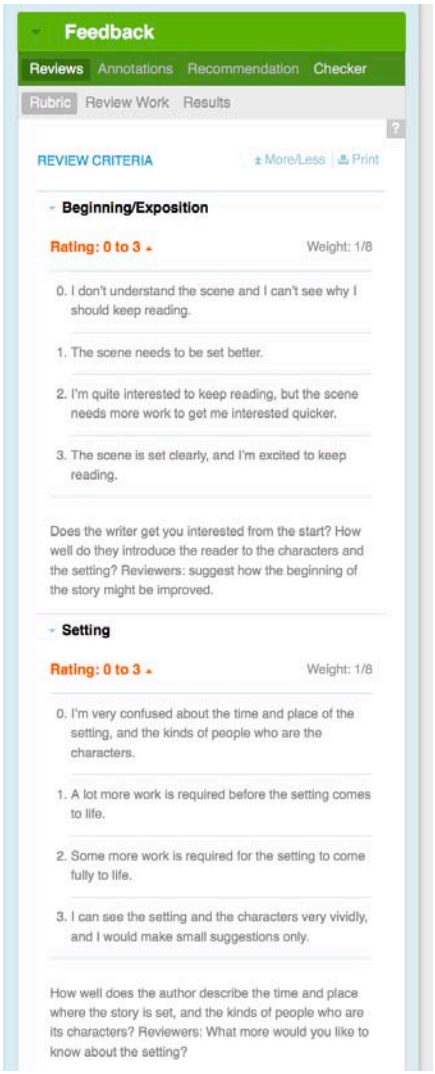
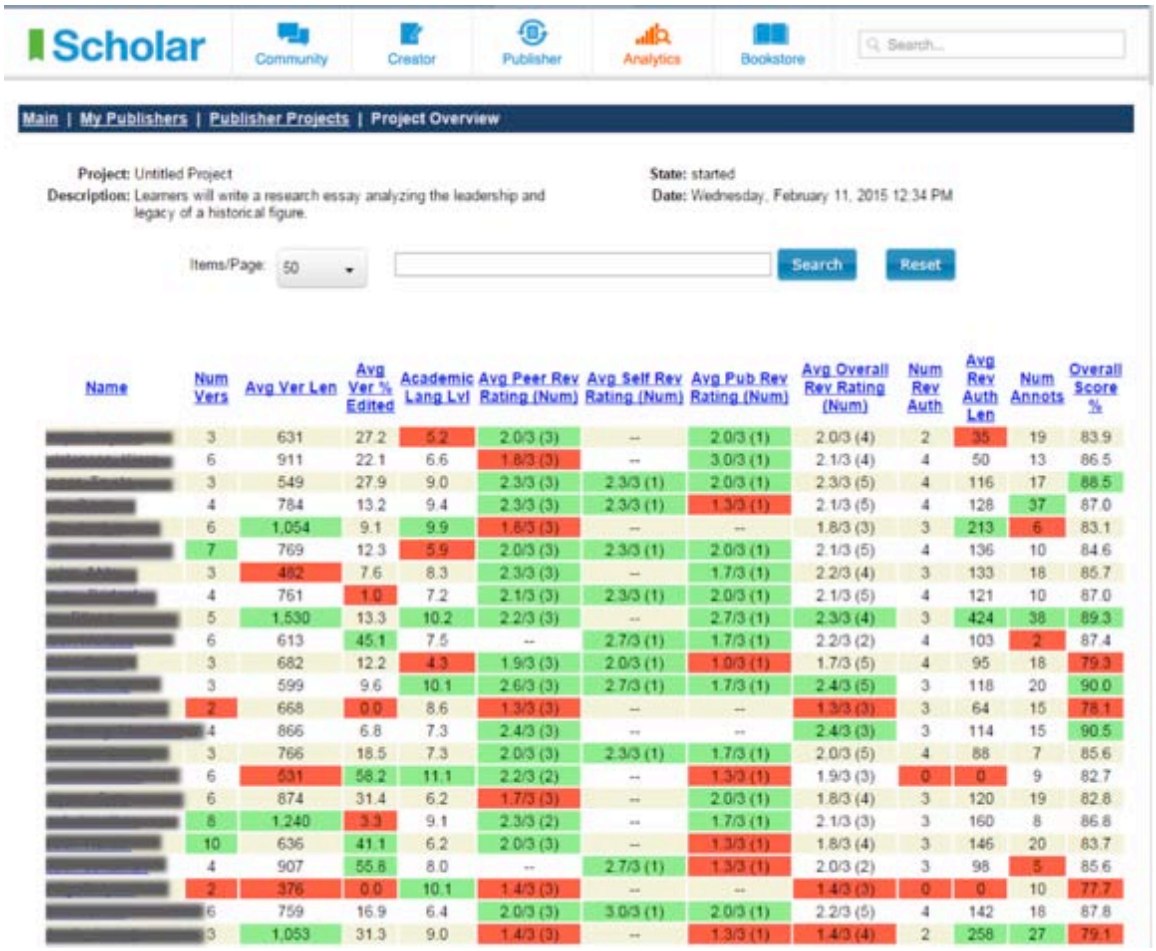


Fig. 1.18: Rubric with a prospective/constructive orientation

The result is an enormous amount of data, in different forms and from multiple sources. Fig. 1.18 is a snapshot of *Scholar* Analytics area in an open plan learning environment where approximately 100 students are writing and offering peer feedback on each other's projects. We have data showing version development, peer/self/teacher assessments, reviews written, annotations made—hundreds of thousands of words, generated over a week of work. It is possible for the teacher to drill down to see every detail including every piece of feedback and every change the student makes. They can do this at any time during the learning process, not just at the end when papers are turned in. Red warning signs might alert the teacher to a student in need of attention. Teacher C: "Analytics is allowing us to have insights that we never had, when with one teacher and a bunch of papers, it was just too overwhelming."



Name	Num Vers	Avg Ver Len	Avg Ver % Edited	Academic Lang Lvl	Avg Peer Rev Rating (Num)	Avg Self Rev Rating (Num)	Avg Pub Rev Rating (Num)	Avg Overall Rev Rating (Num)	Num Rev Auth	Avg Rev Auth Len	Num Annots	Overall Score %
[redacted]	3	631	27.2	5.2	2.0/3 (3)	--	2.0/3 (1)	2.0/3 (4)	2	35	19	83.9
[redacted]	6	911	22.1	6.6	1.8/3 (3)	--	3.0/3 (1)	2.1/3 (4)	4	50	13	86.5
[redacted]	3	549	27.9	9.0	2.3/3 (3)	2.3/3 (1)	2.0/3 (1)	2.3/3 (5)	4	116	17	88.5
[redacted]	4	784	13.2	9.4	2.3/3 (3)	2.3/3 (1)	1.3/3 (1)	2.1/3 (5)	4	128	37	87.0
[redacted]	6	1,054	9.1	9.9	1.8/3 (3)	--	--	1.8/3 (3)	3	213	6	83.1
[redacted]	7	769	12.3	5.9	2.0/3 (3)	2.3/3 (1)	2.0/3 (1)	2.1/3 (5)	4	136	10	84.6
[redacted]	3	482	7.6	8.3	2.3/3 (3)	--	1.7/3 (1)	2.2/3 (4)	3	133	18	85.7
[redacted]	4	761	1.0	7.2	2.1/3 (3)	2.3/3 (1)	2.0/3 (1)	2.1/3 (5)	4	121	10	87.0
[redacted]	5	1,530	13.3	10.2	2.2/3 (3)	--	2.7/3 (1)	2.3/3 (4)	3	424	38	89.3
[redacted]	6	613	45.1	7.5	--	2.7/3 (1)	1.7/3 (1)	2.2/3 (2)	4	103	2	87.4
[redacted]	3	682	12.2	4.3	1.9/3 (3)	2.0/3 (1)	1.0/3 (1)	1.7/3 (5)	4	95	18	79.3
[redacted]	3	599	9.6	10.1	2.6/3 (3)	2.7/3 (1)	1.7/3 (1)	2.4/3 (5)	3	118	20	90.0
[redacted]	2	668	0.0	8.6	1.3/3 (3)	--	--	1.3/3 (3)	3	64	15	78.1
[redacted]	4	866	6.8	7.3	2.4/3 (3)	--	--	2.4/3 (3)	3	114	15	90.5
[redacted]	3	766	18.5	7.3	2.0/3 (3)	2.3/3 (1)	1.7/3 (1)	2.0/3 (5)	4	88	7	85.6
[redacted]	6	531	58.2	11.1	2.2/3 (2)	--	1.3/3 (1)	1.9/3 (3)	0	0	9	82.7
[redacted]	6	874	31.4	6.2	1.7/3 (3)	--	2.0/3 (1)	1.8/3 (4)	3	120	19	82.8
[redacted]	8	1,240	3.3	9.1	2.3/3 (2)	--	1.7/3 (1)	2.1/3 (3)	3	160	8	86.8
[redacted]	10	636	41.1	6.2	2.0/3 (3)	--	1.3/3 (1)	1.8/3 (4)	3	146	20	83.7
[redacted]	4	907	55.8	8.0	--	2.7/3 (1)	1.3/3 (1)	2.0/3 (2)	3	98	5	85.6
[redacted]	2	376	0.0	10.1	1.4/3 (3)	--	--	1.4/3 (3)	0	0	10	77.7
[redacted]	6	759	16.9	6.4	2.0/3 (3)	3.0/3 (1)	2.0/3 (1)	2.2/3 (5)	4	142	18	87.8
[redacted]	3	1,053	31.3	9.0	1.4/3 (3)	--	1.3/3 (1)	1.4/3 (4)	2	258	27	79.1

Fig. 1.18: Scholar's Analytics dashboard

The larger context for these educational technologies has been public discussion of the issue of "big data," in society (Mayer-Schönberger and Cukier 2013; Podesta, Pritzker, Moniz, Holdern, and Zients 2014), and in education (Cope and Kalantzis 2015b; Cope and Kalantzis 2016; DiCerbo and Behrens 2014; Piety 2013). We would like to make a series of propositions towards an agenda for the future of assessment:

1. Assessment can increasingly be *embedded in instruction*, allowing us to realize long-held ambitions to offer richer formative assessment.

2. We may now have so much *interim learning or progress data,* why do we even need these strange artifacts, summative assessments? With the help of data mashups and visualizations, the datapoints need only be those located within the learning process. The test is dead; long live assessment!

3. Now that we can assess everything, and there is no learning without reflexive, recursive, machine feedback, peer and teacher feedback, and structured self-reflection, do we even need a distinction between instruction and assessment? There should be no instruction without embedded recursive feedback, and no feedback that does not directly and incrementally contribute to learning. Reflexive

pedagogy *ends the assessment/instruction distinction*.

4. The focus of what is assessable now shifts from individual cognition, to the *artifacts of knowledge representation and their social provenance*. It's not what you can remember, but the knowledge artifact you can create, recognizing its sources in collective memory via links and citations, and tracing the collaborative construction process via the feedback offered by peers and teachers, and the revisions made in response.

5. The focus of what is assessable moves from the repetition of facts and the correct application of theorems to what we call *complex epistemic performance*, or the kinds of analytical thinking that characterize disciplinary practices—being scientist, or a writer, or to apply mathematics to a problem.

Affordance #5: Collaborative Intelligence

Over the course of this analysis, we have been moving away from a focus individual cognition, to a notion of collaborative intelligence. Jim Gee calls this notion the "social mind" (Gee 1992 [2013]). Carl Bereiter calls it "distributed cognition" (Bereiter 2002). Perhaps the notion of the individual mind was ever only and at least in part an ideological illusion created by didactic pedagogy and its assessment systems. In e-learning ecologies, it becomes more necessary to recognize the social sources of intelligence. We can also actively nurture the social mind in these environments—hence a renewed focus on collaborative intelligence. There are two fundamental aspects of this new recognition of the sociability of knowledge: a shift away from knowledge memorization towards a culture of knowledge sourcing; and developing skills and strategies for knowledge collaboration and social learning.

Today, we have remarkable, world-connected cognitive prostheses at our fingertips, carrying them in our bags or keeping in our pockets. There is no fact that cannot be looked up, no calculation that cannot be made using computational and data access tools in the myriad of "apps". Memory may come as an ancillary part of learning and knowledge work, but it need no longer be the central pedagogical concern that it once was. If in everyday life, we have ubiquitous access to these cognitive prosthesis, assessments and pedagogies that deny us these lack "validity", to apply a key term from assessment theory. So, replacing the fiction that memory is my personal knowledge, learners must increasingly acknowledge the social sources of their learning, via citations and links, distinguishing clearly their own thoughts from the social knowledge upon which those thoughts are built. This is mnemonic work rather than memory work.

The other key aspect of collaborative intelligence is to structure learning systematically around peer collaborations. In Fig. 1.19, we see one example from *Scholar*—a snapshot of critical clinical case analysis by a medical student, with one of three peers' reviews. This tracks the process of offering a "second opinion," an essential part of the collaborative culture of medicine. In traditional classroom architecture and teacher-coordinated pen and paper processes, systematic processes of collaboration are logistically difficult to achieve. However, in e-learning ecologies it is possible to manage

this complexity—random distribution of review requests to a pre-determined number of peers, anonymizing creators and reviewers, automatically versioning from draft to revision to publication, and providing data mashups that analyze progress. By the time a project has been finished, your work is as good as the collaborations you have had with your peers. Each learner has been thinking, but the social provenance of their thinking can be traced in the peer and machine feedback to which they responded in their redraft, and their self-reflections on the impact of peer feedback on their revisions. This also shifts the focus of motivation in learning, from the grade at the end (an institutional reward, an extrinsic motivation), to the responsibilities to give feedback and an interest receive feedback. This tracks the "stickiness" of digital media—there is a strong motivational force now in the logic of collaboration and task achievement (intrinsic motivation) (Magnifico, Olmanson, and Cope 2013).

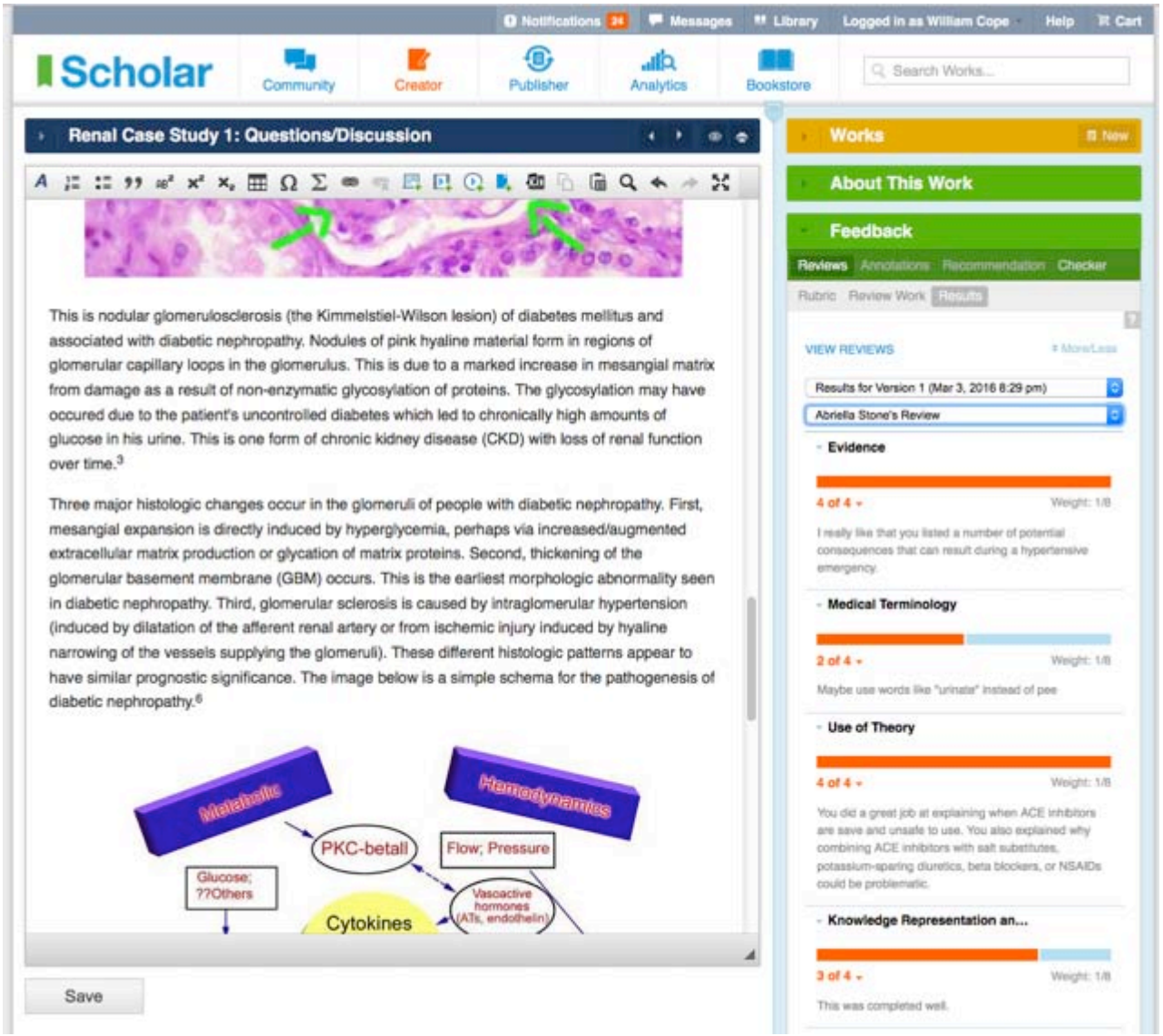


Fig. 1.19: Critical clinical thinking peer review

Affordance #6: Metacognition

Metacognition is second order thinking. It is thinking about thinking. Research shows that metacognitive awareness improves learner performance (Bransford, Brown, and Cocking 2000). Metacognition can have several meanings. In one is psychological: "self-regulation", or to undertake an educational endeavor with self-conscious intent, to focus and to achieve goals (Schunk and Zimmerman 1994). A broader definition includes thinking that exemplifies disciplinary practice—to think like a historian, writer or physicist. This requires explicit thinking about the methods of the discipline, for instance how claims are supported by evidence in history, or how persuasion works in writing, or to explain mathematical thinking. It also involves theoretical work where the learner not only immerses themselves in content, the facts of a topic, but us able to relate these facts to overall explanatory frameworks, applying facts to frameworks and testing frameworks against facts.

Here we are in *Scholar* again. These students are working on the physics of drag on a cricket ball.

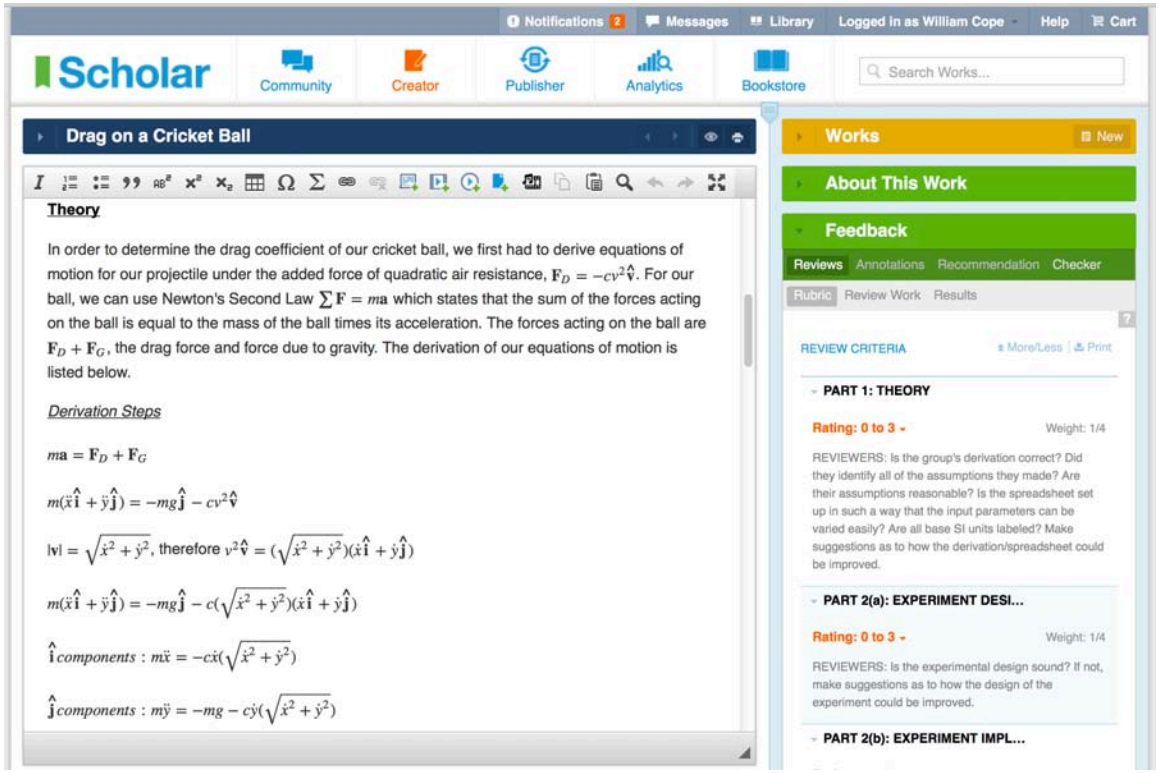


Fig. 1.20: Cognition on the left; rubric prompting metacognition on the right

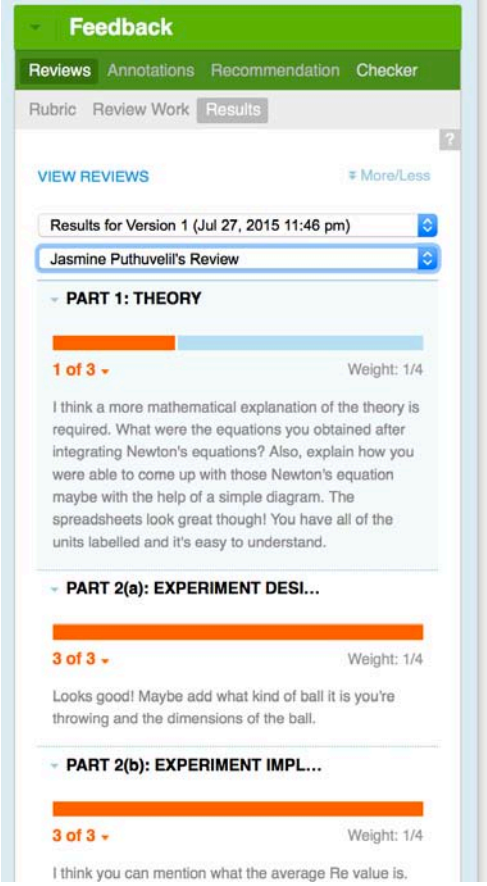


Fig. 1.21: Peer review

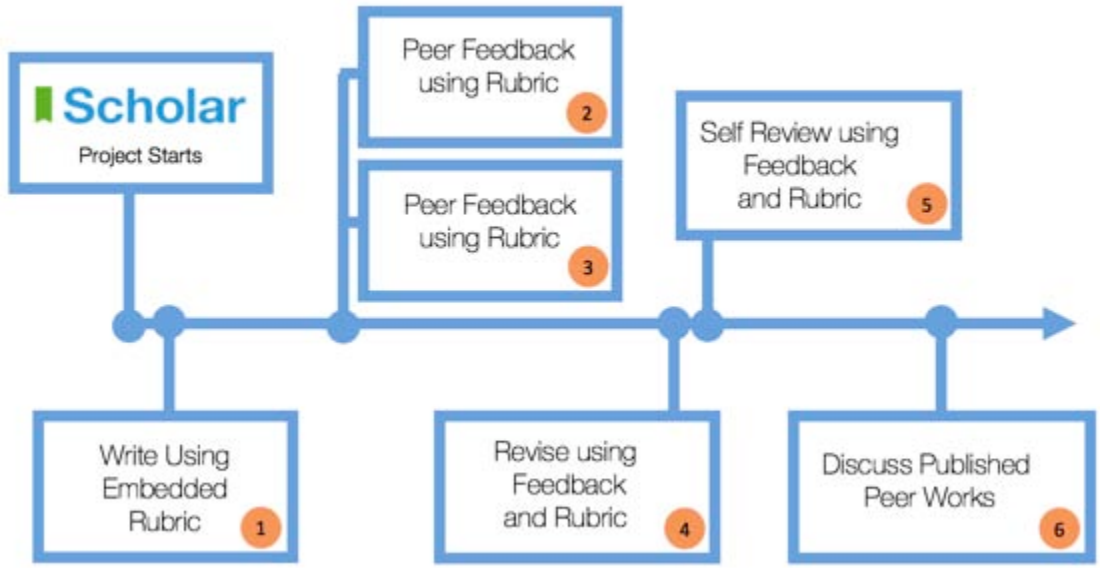


Fig. 1.22: The knowledge process, a play between cognition and metacognition

Scholar's Creator space has a temporal structure, consisting of a number of phases (Fig. 1.22). It also has a spatial structure, designed to support metacognition. The student (or students, in the case of jointly created works) does their work in the multimodal editor on the left. Aspects of metacognition are juxtaposed on the right: a rubric, peer reviews, coded annotations, a natural language processor, dialogue with contributors. In every phase there is a dialectic between cognition on the left and metacognition on the right:

1. While the student creates their work on the left, they see the rubric on right, created by the teacher or learning module designer, specifying disciplinary expectations at a high level of generality.

2. They read their peers' works and review them on the right—the number of reviews having been determined by the teacher/admin, anonymous or named as determined by settings. They may also annotate these works.

3. Feedback is returned, viewable on the right, and the juxtaposed text on the left is revised based on feedback from multiple perspectives, and against the same rubric that they have already used intensively in phases 1 and 2.

4. In a self-review on the right, criterion by criterion and against the same rubric, students reflect on the influence of peer feedback on their work, and the changes they have made from version to version, viewable on the left.

5. Finally, the revised work is published to an e-portfolio by the teacher/admin, where further dialogue around the work may occur. The teacher/admin may also review the work at this stage, and request revisions before publication. Teacher D: "We see a process of metacognition—I have created a rubric, students are giving feedback to each other, and now we're talking about whether that feedback is worthwhile."

In every phase of this process, there is a play between the left and right sides of the screen as follows:

Cognition: Left Side of the Scholar Screen	*Metacognition: Right Side of the Scholar Screen*
Learning Activity: a focus on representation of specific content knowledge	Self-regulation of Learning: project objectives, phase outline; ongoing dialogue around processes
Disciplinary Practice: thinking about a specific topic, its facts and arguments	Disciplinary Thinking: a focus on the general conditions of insightful work in this discipline; epistemological reflection
Empirical Work: outlining specific content, applying disciplinary reasoning to that content	Theoretical Work: thinking based on the general theoretical precepts of the discipline;

	a play/dialogue between the particular (thinking about specific details of knowledge), and the general (thinking about conceptual concepts and frameworks that tie this knowledge together).
Individual Intelligence: the activity of representing knowledge (including contribution to jointly created works)	Collaborative Intelligence: structured feedback; productive diversity in learning from varied perspectives
Learning: the knowledge representation made by the student	Assessment: formative assessments by peers, teachers and self; retrospective data analytics

Affordance #7: Differentiated Learning

Traditional educational media were grounded in an architecture of sameness: the whole class listening to the teacher lecture in real time, all the students on the same page of the textbook, and tests that were standardized. New educational media facilitate the management of the complexities of differentiated instruction, where students can be working on different things at the same time. Variants of this notion include adaptive learning where the environment is responsive to micro-steps made by each student in the learning process, and personalized learning (Conati and Kardan 2013; Koedinger, Brunskill, Baker, and McLaughlin 2013; McNamara and Graesser 2012; Wolf 2010).

To broaden the notion of differentiated learning, we have developed principles for what we call a pedagogy of productive diversity (Kalantzis and Cope 2016 [in press]):

1. *The Differentiation Principle:* Architectures of pedagogical sameness are no longer logistically necessary, as perhaps they were in the era of didactic pedagogy. It is not necessary that learner do the same tasks at the same time and in the same way. It is not necessary that they work through and complete a task at the same pace. With today's dashboards, on-the-fly learning analytics, alternative navigation paths, recalibrating systems, and adaptive learning mechanisms, new educational media make the organizational intricacies of productive diversity ever more manageable. In fact, managing learner differences becomes easier than one-size-fits-all teaching because there is not the dissonance of bored or disaffected students for whom the pace of learning may be wrong.

2. *The Design Principle:* In reflexive pedagogy, learners are positioned as designers of their own knowledge. Students are scaffolded by their teachers and digital learning environments to encounters with available knowledge resources in the world, in all their multivocal and multimodal diversity. They remake that world according to the disciplinary scaffolds that are the studies of science, or art, or language. They are positioned as disciplinary practitioners—as scientists, as art critics or artists, as critical readers or writers. Now knowledge producers more

than knowledge consumers, every artifact of their knowledge (re)making is uniquely voiced—a notion that we have called "design" (Kalantzis, Cope, Chan, and Dalley-Trim 2016). Learning is no longer a matter of replicating received knowledge from memory. The evidence of learner activity is to be found in designed knowledge artifacts—for instance, students' projects, worked examples, online discussions, models, or the navigation paths they have taken though games, simulations or intelligent tutors. As active designers, the world of knowledge is redesigned by learners, revoiced according to the tenor of each learner's interest, identity, and experience.

3. *The Collaboration Principle:* One unfortunate consequence of personalization with educational technologies can be to individualize the experience of learning, reducing the learning relationship to a lone student with their computer. However, in technology-mediated learning environments designed on social media principles, complex structured social interactions can also be managed. And as soon as the social comes into play, differences become visible may be deployed as a productive resource. Different perspectives prompt deeper discussion. Providing structured peer feedback exposes learners to different perspectives and ways of thinking. Sharing work-in-progress and finished work highlights different points of focus and different angles on knowledge. In these ways, learner diversity can be harnessed as a resource for learning.

4. *The Comparability Principle:* Under the principle of comparability, where assessment rubrics are pitched at a high level of generality, students can be doing different things but of comparable cognitive or practical difficulty. Learners no longer have to be the same to be equal.

Towards Reflexive Pedagogy

In the pages of this book that follow, we will examine these seven pedagogical possibilities in greater detail.

From didactic Pedagogy:	*To Reflexive Pedagogy:*
1. Learning that is institutionally confined in time and space	1. Ubiquitous learning—anytime, any place
2. Transmission pedagogy	2. Active knowledge making, where learners are knowledge producers
3. Traditional academic literacies	3. Multimodal meaning and knowledge representations
4. Standardized, summative assessment	4. Recursive feedback
5. Individual memory	5. Collaborative intelligence

6. Single-level content focus	6. Metacognition, double level thinking
7. One-size-fit-all curriculum	7. Differentiated learning

Educational technologies, as we have argued, can reproduce didactic pedagogies, even to give them an aura of newness that affords them a new life. Meanwhile, the principles of reflexive pedagogy are by no means new. Many of these things we have aspired to do in education for a long time. But now, with educational technologies, they become feasible. The result, we contend, will be learning that is more engaging, more effective, more resource efficient, and more equitable in the face of learner diversity. If anything has decisively changed with the emergence of new educational media, it is to offer a new economy of effort that makes long-held pedagogical ambitions more practicable. Because now we can, we should.

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