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Using Problem-Based Learning: New Constellations for the 21st Century

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The author argues that there is still too much teaching to the test, and the consequence is growing constellations of problem-based learning (PBL). Today, what passes for PBL practice often seems more like guidelines than any kind of reasoned pedagogy. While at one level the range of variations shows the value and flexibility of PBL as an accommodating, adaptable, and culturally relevant approach to learning, there is relatively little understanding of the impact of these different constellations on student engagement and learning. Nevertheless, these diverse constellations of PBL need to be delineated and understood. The author outlines the constellations, but also suggests that there are a number of issues that have not been considered in relation to the use of PBL.

Introduction

There are growing constellations of problem-based learning (PBL) **[You need to unpack and define what this means.]** . While at one level this shows the value and flexibility of problem-based learning as an accommodating, adaptable, and culturally relevant approach to learning, there is relatively little understanding of the impact of these different constellations on student engagement and learning. Nevertheless these diverse constellations of problem-based learning need to be delineated and understood. It will then be possible to link the impact of such diversity to different forms of engagement. This article takes on such a task by drawing on recent research on improving engagement (Wimpenny & Savin-Baden, in press) and suggesting the use of ingenuous and innovative scenarios. It also introduces some questions about the relationship between problem design curriculum manifestations and student engagement.

PBL as Rules or Reasoned Pedagogy: Some Constellations

Barrows and Tamblyn's (1980) study and the approach adopted at McMaster University, Canada, marked a clear move away from problem-solving learning, in which individual students answer a series of questions from information supplied by a lecturer. In early versions of PBL, certain key characteristics were essential (Schmidt, 1983). Since its inception in the 1980s, PBL has developed in diverse ways worldwide, yet there has been relatively little mapping of its theories, practice, or disciplinary differences. This has led to confusion within the academic community about which constellation to adopt or what will be the best fit for a given curriculum. Merely listing specific and narrowly defined characteristics does not, in fact, untangle the philosophical conundrums of PBL. Further, PBL is an approach to learning that is affected by the structural and pedagogical environment into which it is placed (that is, the discipline or subject, the instructors, and the organization). While PBL is still undergoing a process of change worldwide, such change has been analysed by few in the field of higher education. In some areas, possibly most notably in some medical curricula, there is a sense of performative rules about how PBL should be used, but instead it would seem that we need pedagogically informed guidelines. Perhaps first it is important to understand what is around and on offer, some of which are delineated in Table 1.

The concept of locating different formulations of PBL as a series of constellations arises from the idea that there is a broad range of PBL approaches. The notion of constellations embraces the overlapping nature of differing PBL practices that relate to one another and intersect in particular configurations or patterns. The constellations help us to see that there are patterns, not just within the types of PBL, but across the different fields of practice (Savin-Baden, 2007a). The idea of grouping PBL approaches in this way is drawn from Bernstein (1992), who argued for the use of constellations as "a juxtaposed rather than integrated cluster of changing elements that resist reduction to a common denominator, essential, core or generative first principle" (**[page?]**). The use of constellations (rather than constellations *per se*) allows for the categorisization of PBL approaches according to problem type, form of interaction, knowledge focus (Barnett, 2004; Gibbons et al., 1994; Savin-Baden, 2007b), form of facilitation, focus of assessment, and learning emphasis. An important factor when considering the grouping of PBL practices in this way is the mode of knowledge that is to be designated as disciplinary knowledge.

Table 1
Current Forms of Active Learning That May Be Linked With Problem-Based Learning (adapted from Savin-Baden & Major, 2004)

Approach to Learning	*Organization of Knowledge*	*Forms of Knowledge*	*Related Theory*	*Theorist*	*Role of Student*	*Role of Tutor*
Problem-based learning	Open ended situations and problems	Contingent and constructed	Critical pedagogy and social action	Freire (1972, 1974); Hooks (1994)	Active participant and independent critical inquirer who owns his or her own learning experience	Enabler of opportunities for learning
Project-based learning	Tutor-set, structured tasks	Performative and practical	Cognitive learning theories	Vygotsky (1978); Ausubel, Novak, & Hanesian (1978)	Completer of project or member of project team who develops a solution or strategy	Task setter and project supervisor

Table 1 (*continued*)
Current Forms of Active Learning That May Be Linked With Problem-Based Learning (adapted from Savin-Baden & Major, 2004)

Approach to Learning	*Organization of Knowledge*	*Forms of Knowledge*	*Related Theory*	*Theorist*	*Role of Student*	*Role of Tutor*
Problem-solving learning	Step-by-step logical problem-solving through knowledge supplied by lecturer.	Largely propositional but may also be practical	Cognitive learning theories	Vygotsky (1978) Ausubel, Novak, & Hanesian (1978)	Problem-solver who acquires knowledge through bounded problem-solving	Guide to the right knowledge and solution
Action Learning	Group-led discussion and reflection on action	Personal and performative	Change management	Revans (1983)	Self-advisor who seeks to achieve own goals and others to achieve these via reflection and action	Facilitator of reflection and action

[You need a Table 2 reference in this para.]

Conceiving of the different formulations of PBL as a series of constellations makes sense because many of these formulations relate to one another and overlap in particular configurations or patterns. Further, they also share characteristics in terms of having some forms of focus on knowledge, more or less emphasis on the process of learning, and the fact that each constellation begins by focusing on some kind of problem scenario. Defining constellations helps us to see that there are patterns not just within the types of PBL, but across the different modes of knowledge. Modes of knowledge have been defined in a host of ways. Gibbons et al. (1994) have argued for Mode 1 and Mode 2 knowledge. Mode 1 knowledge is propositional knowledge that is produced within academe separate from its use in the world; academe is considered the traditional environment for the generation of Mode 1 knowledge. Mode 2 knowledge is knowledge that transcends disciplines and is produced in, and validated through, the world of work. Knowing in this mode demands the integration of skills and abilities in order to act in a particular context. Barnett (2004) argues for Mode 3 knowledge, whereby one recognises that knowing is the position of realising and engaging with epistemological gaps. Such knowing produces uncertainty, because "No matter how creative and imaginative our knowledge designs, it always eludes our epistemological attempts to capture it" (Barnett, 2004, p. 252). What is particularly important here too are the modes of knowledge in operation, as delineated in Table 3.

What is missing from these four arguments and formations of knowledge and knowing is not only the way in which the spaces between these forms of knowledge are managed, but also what it is that enables students and faculty to make the connections between all of them. It might be suggested that the missing links here are disregarded forms of knowledge; for example, Cockburn (1998) suggests that knowing when to keep your mouth shut and the virtues of tact are forms of knowing that are required in many professions, but these are not forms of knowing that are made explicit in the academy. Disregarded forms of knowledge might be termed Mode 4 knowledge, because they transcend and overlay Modes 1, 2, and 3 of knowledge, forming a bridge across the space between them. However, Mode 4 knowledge is also a mode in its own right, because it involves not only realising and producing epistemological gaps, but also realising the ways in which these gaps, like knowledge and knowing, also have hierarchical uncertainty. In contrast, Mode 5 knowledge is a position whereby one holds a number of modes together in a complex and dynamic way. Gaps, like knowledge, have hierarchical positions, and this makes both the gaps and the knowledge, and the knowing and the knower, eminent-

Table 2
Constellations of Problem-Based Learning

	Constellation 1: *Problem-Based Learning for Knowledge Management*	***Constellation 2:*** *Problem-Based Learning Through Activity*	***Constellation 3:*** *Project-Led Problem-Based Learning*	***Constellation 4:*** *Problem-Based Learning for Practical Capabilities*	***Constellation 5:*** *Problem-Based Learning for Design Based Learning*
Problem Type	Designed to promote cognitive competence	Designed to promote learning through activity	Project-led	Practical resolution	Design-based
Level of Interaction	Problem-focused	Activity-focused	Project team	Practical action	Activity-focused
Focus of Knowledge	**Mode 1:** Propositional knowledge that is produced within academe separate from its use	**Mode 2:** Knowledge that transcends disciplines and is produced in, and validated through, the world of work	**Mode 2:** Knowledge that transcends disciplines and is produced in, and validated through, the world of work.	**Mode 2:** Knowledge that transcends disciplines and is produced in, and validated through, the world of work.	**Mode 2:** Knowledge that transcends disciplines and is produced in, and validated through, the world of work.
Form of Facilitation	Directive	Activity-focused	Project management	Guide to practice	Project management
Focus of Assessment	Testing of knowledge	Competence for the world of work	Project management	Competence for the world of work	Design critique and professional capabilities
Learning Emphasis	Knowledge management	Development of capabilities	Completion of project	Development of capabilities	Development of design-based capabilities

	Constellation 6: *Problem-Based Learning for Critical Understanding*	***Constellation 7:*** *Problem-Based Learning for Multimodal Reasoning*	***Constellation 8:*** *Collaborative Distributed Problem-Based Learning*	***Constellation 9:*** *Problem-Based Learning for Transformation and Social Reform*
Problem Type	Knowledge with action	Managing dilemmas	Defined by team in relation to practice	Seeing alternatives
Level of Interaction	Integrations of knowledge/skills across boundaries	Taking a critical stance	Collaborative	Exploring structures and beliefs
Focus of Knowledge	**Mode 3:** Knowing in and with uncertainty, a sense of recognising epistemological gaps that increase uncertainty	**Mode 3:** Knowing in and with uncertainty, a sense of recognising epistemological gaps that increase uncertainty	**Mode 4:** Disregarded knowledge, spaces in which uncertainty and gaps are recognised	**Modes 4 and 5:** Disregarded knowledge/ Holding diverse knowledges with uncertainties
Form of Facilitation	Coordinator of knowledge and skills	Orchestrator of learning opportunities	Enabler of group reflection	Decoder of cultures
Focus of Assessment	Use of capabilities across contexts	Integrate capabilities across disciplines	Self analysis	Flexible and student-led
Learning Emphasis	Synthesis across boundaries	Critical thought	Effective team work	Interrogation of frameworks

Table 3
Modes of Knowledge

Mode 1	Propositional knowledge that is produced within academe separate from its use and the academy is considered the traditional environment for the generation of this form of knowledge.
Mode 2	Knowledge that transcends disciplines and is produced in, and validated through, the world of work.
Mode 3	Knowing in and with uncertainty, a sense of recognising epistemological gaps that increase uncertainty.
Mode 4	Disregarded knowledge, spaces in which uncertainty and gaps are recognised along with the realisation of the relative importance of gaps between different knowledge**[s?]** and different knowledge hierarchies.
Mode 5	Holding diverse knowledges with uncertainties.

ly uncertain and liquid. Modes of knowledge, learning emphasis, type of problem, as well as ways in which students are expected to interact are all factors that affect the way in which different constellations are played out. These nine PBL constellations are discussed in detail next.

Constellation 1: Problem-Based Learning for Knowledge Management

The constellation of Problem-Based Learning for Knowledge Management is characterized by a view of knowledge that is essentially propositional, with students being expected to become competent in applying knowledge in the context of solving, and possibly managing, problems. In this constellation, students are expected not just to be able to solve the problem and find out the given answer, but also to understand the knowledge behind it. PBL is thereby used as a means to help students learn the required curriculum content and to enable them to become competent in knowledge management. Knowledge is perceived by students as being "solid" and "out there," largely independent of themselves as learners. Students will, therefore, come to see themselves as capable of receiving, reproducing, and researching knowledge supplied by experts, and of using PBL to develop their understanding of the relationship between that knowledge and its practical application.

Constellation 2: Problem-Based Learning Through Activity

A second approach, Problem-Based Learning Through Activity, is designed to improve students' engagement in learning and is currently being used in such disciplines as computer studies and engineering (Booth & White, 2008). The focus on activity is designed to delineate forms and types of activities that enable teams of students to engage more effectively with what is to be learned and to enable the needs of those from diverse backgrounds to adapt to higher education. This constellation of problem-based learning is often seen as focusing the learning on a particular problem, project, research question, or works-based activity. Invariably, but not always, the activity crosses subject boundaries and is designed to encourage students to develop self-directed research capabilities. Much of the focus in this constellation is on ensuring the relevance of the learning activity to the world of work.

Constellation 3: Project-Led Problem-Based Learning

Constellation 3, Project-Led Problem-Based Learning, emerged from work undertaken with media practice educators in the UK. It is a model that involves the exploration of the relationship between the use of "live" project work in media practice and PBL (Hanney & Savin-Baden, 2012 **[Says "forthcoming" in references.]**). It began initially because of the realization of a conflict between the kinds of work-based learning that was being expected by skill-based external organizations and the kinds of PBL being practiced in universities. This constellation is designed to provide a model for work-related learning that meets the needs of students, employers, and educators. In practice, this constellation focuses on students acquiring skills for practice in the context of a project that is work related, such as producing a media artifact, and which may involve a "live" client brief. Thus, it transcends constellations 2 and 4 by utilizing project management tools to structure the PBL exercise, wherein the technical knowledge and skills to be gained are clearly delineated by the instructor. But the learning itself is derived from utilizing opportunities, resources, and experiences encountered in the workplace and is led by the participating students.

Constellation 4: Problem-Based Learning for Practical Capability

The constellation of problem-based learning for Practical Capability has, as its overarching concept, the notion of practice. Students learn how to problem solve and to become competent in applying this ability to other kinds of

problem scenarios and situations within given frameworks. Thus, the students develop critical-thinking skills for the workplace, interpreted somewhat narrowly as the ability to use problem-solving abilities in relation to propositional knowledge as a means of becoming competent in the workplace, and as being able to turn on these skills at any given point **[somewhat confusing sentence.]** . The nature of this form of PBL is its emphasis on practicality, and, thus, the practising of these skills must be part of it. However, it is important in this constellation to ensure that skills-based learning does not become a form of behavioural training in which competence can be ticked off against a checklist. A further pitfall with this constellation is that it can be used just to develop narrow sets of skills that to the students may feel somewhat divorced from other forms of knowledge. For example, an overemphasis on communication skills or teamwork, without students being encouraged to engage with and reflect upon the related theory and current research, can result in an uncritical acceptance of the guidance given by instructors.

Constellation 5: Problem-Based Learning for Design-Based Learning

The focus of the constellation of *Problem*-Based Learning for Design-Based Learning is encouraging students to develop the capabilities of design-based thinking, which involves not only engaging with complex problems but also being able to apply solutions to real-life settings. Design processes often involve particular characteristics (De Vries, 2006), and in this constellation the activities and problem scenarios most commonly focused on are the *creation* of an artifact or product, the development of a *representation* of the artifact within the guidelines of the particular discipline, and a focus on the *function* of the particular production or artifact. Thus PBL is used to help students develop the ability to formulate a representation of an object or artifact, represent it through a plan or model, and create designs that have meaning in terms of function and manufacture. What is important in this form of problem-based learning is that the design problem be realistic so that the capabilities students learn will be transferable to the world of work; thus, the learning process in this constellation is seen as being one that strongly mirrors professional practice. Linking PBL with design-based teaching enables students to develop excellent design decision skills, justify their design, and, in particular, learn the communication and dialogic capabilities that are important when working with clients to understand what is required of the design. While this constellation can seem, at first glance, to be quite structured, many design problems are ill structured, thereby challenging students to think in creative and diverse ways.

Constellation 6: Problem-Based Learning for Critical Understanding

In the constellation of Problem-Based Learning for Critical Understanding, there is a shift away from a demand for mere know-how and propositional knowledge. Instead, PBL is a vehicle to bridge the gap between models of thinking and action. Learning is, therefore, seen as knowing and understanding knowledge from the disciplines and also as recognizing the relationship between them, so that students can make sense for themselves both personally and pedagogically. This kind of problem-based learning unites disciplines with skills so that students are able to see the relationship between their personal stance and the propositional knowledge of the disciplines. The students in this constellation, therefore, develop not only an epistemological position but also a practice-related perspective that integrates multiple ways of knowing and being.

Constellation 7: Problem-Based Learning for Multimodal Reasoning

In this constellation of Problem-Based Learning for Multimodal Reasoning, PBL is designed to enable students to transcend knowledge and capabilities in ways that are necessarily multimodal, so that through scenarios students recognize not only that textual and disciplinary boundaries exist, but also that they are also somewhat illusory, that they have been constructed. In this model, instructors encourage students to develop their own stance towards these multimodal discourses and to reframe them for themselves, but without risking the reframing of the infrastructure of the disciplines. This model will work well with most forms of PBL where transdisciplinary learning is important, and particularly for modules situated in later years of undergraduate degree programs or the early years of master's studies.

Constellation 8: Collaborative Distributed Problem-Based Learning

The Collaborative Distributed Problem-Based Learning constellation is based on the model by McConnell (2006), whereby students work in learning teams in order to define a problem relating to some form of professional or personal practice issue. The focus in this constellation is, therefore, on working collaboratively on a problem that can be shared with other PBL teams. There is also a strong focus on understanding and critiquing the nature and complexity of teamwork in order that team members are able to use this understanding to develop their own professional

practice. Finally, students are expected to both self- and peer assess and share their findings with one another. In this constellation, there is a high emphasis on reflexivity and accountability to one another in terms of the development of one's own learning.

Constellation 9:
Problem-Based Learning for Transformation and Social Reform

The final constellation, Problem-Based Learning for Transformation and Social Reform, is one that seeks to provide for students a kind of higher education that offers, within the curriculum, multiple models of action, knowledge, reasoning, and reflection, along with opportunities for students to challenge, evaluate, and interrogate these models. It embraces Pratt's **[and Associates'?]** (1988/2005) notion of teaching for social reform, in which effective teaching is designed to change society in substantive ways. Through this form of PBL, facilitators awaken students' embedded perspectives as well as the values and ideologies located in texts and common practices within their disciplines. "Texts," in the broadest sense of the term, are interrogated by students for what is said and what is omitted in order to explore who and what is represented and omitted from dominant discourses. Programs, modules, and scenarios in this constellation are designed in such a way as to prompt students to examine the underlying structures and belief systems implicit within a discipline or profession itself, in order to understand not only the disciplinary area itself but also its credence.

Re-Examining Curriculum Design

It is suggested that those wanting to improve problem-based learning need to understand its different constellations. In 2002, Barnett and Coate **["Coates" in references.]** argued for a view of curriculum that reflects the fragmented world of both the learners and the curriculum designers; this view would seem to be a sound fit for some PBL models. Barnett and Coate's **[Coates's?]** model is based on an understanding of modern curricula as an educational project forming identities founded in three domains: knowledge, action, and self. The "knowledge" domain refers to the discipline-specific competences. The "action" domain includes those competences acquired through "doing," such as an oral presentation in art history. The "self" domain develops an educational identity in relation to the subject area. What the authors suggest is that the weight of each of the three domains varies across curricula, that the domains may be inte-

grated or held separate (but it is not entirely clear how this works), and, finally, that curricular change tends to be dominated by epistemological differences in the disciplines. They explain what this means in practice as follows:

> The curricula in science and technology courses are heavily weighted towards the knowledge domain. The domains are held separate (there is little or no integration between the domains). The arts and humanities curricula are also heavily weighted by the knowledge domain, but here there is more integration with the self domain. In the professional subject areas, there is a high degree of integration across the three domains. (Barnett & Coate, 2002)

This was a radical model in 2002, but in 2012 it would seem we are in an even more performative space than we were back then. Questions need to be asked about how the university might begin to address issues of student engagement and identity production and to move away from performativity. To argue for such a position could be seen as a lone voice, yet a proliferation of stances have emerged (for example, see Haggis, 2006; Land, 2006; Manathunga, 2006; McWilliam, 2005; Nixon, 2005). Such voices are vital for reconceptualising and recasting what it means to be a university, but the difficulty remains as to how any of these ideas, ideologies, and arguments is to be acted upon. Higher education across the world continues to break ways of learning into linear chunks, a practice that invariably takes little account of learners' approaches as well as of research into learning that provides pedagogical guidance about the kinds of tools and approaches that work best. Although there have been many texts, articles, and discussions about the nature of the curriculum and of creative ways of managing curricula (for example, Barnett, 2007; Mann, 2008; Moore & Young, 2001), globally, many curricula remain unimaginative, constrained, and modular.

[Note: This paragraph comes across as a rather abrupt polemic that is not clearly related to what has come before.] The modular system, in particular, tends to fragment and striate learning and in many cases prevents the creation of disjunction in the mind of the student. Modules result in a tidy system of learning, where content is boxed into easily managed components that are not to be meddled with. Yet rather than just maintaining the *status quo*, there is a need to embrace "liquid learning" and create "smooth spaces" **[Whose terms are these?]** so that curricula can be designed in ways that introduce questions about practices and understandings of knowledge within and beyond disciplinary areas. Bauman (2000) suggested that in the age of solid modernity **[jargony terms like**

this need to be explained.] there was a sense that accidents, sudden or surprising events, were seen as temporary irritants, because it was still possible to achieve a fully rational, perfect world. To live in the liquid modern **[define.]** , we need to act under the conditions of uncertainty, risk, and shifting trust. Thus, liquid learning curricula need to be characterised by emancipation, reflexivity, and flexibility so that knowledge and knowledge boundaries are seen as contestable and always on the move.

The creation of liquid and smooth spaces for problem-based curricula requires considerable development. Furthermore, in-depth consideration is needed, not only in terms of the different constellations, but also the ways they are used in practice and how are they used. Questions need to be asked about how curricula are designed and which underpinning pedagogical frameworks are adopted, as well as more detailed questions, such as these:

- What kinds of activities are used and how might they be categorised?
- To what extent do particular activities improve student learning?
- How is learning taking place and what are students' views?
- Why are particular models located in particular disciplines and how and why might they be used in other disciplines?
- What are the similarities and differences in curricula design?
- What forms of scenarios are adopted, and why?
- What is the impact of discipline–based pedagogy on the way PBL is played out in practice?

If we can begin to explore some of these questions, it will generate insights as to the possible impact of different constellations of PBL on the higher education community and the factors that are important within them. For example, it may be possible to locate curriculum types not only through the way learning is seen and structured, but also through the way in which modes of knowledge are located in the curriculum. Yet there are other factors at play, missing stars that may help to understand these issues further.

While constellations of problem-based learning are vitally important,

those wanting to improve PBL and understand the impact of adopting a given constellation also need to appreciate different forms of student engagement and recognize the pedagogy of connectivity.

Student Engagement

Although there is a considerable body of literature on facilitation and problem-based learning (for example, Silen, **[accent over the "e" in references.]** 2006; Wilkie, 2004), there is relatively little research examining the issue of student engagement. Trowler and Trowler's (2010) literature review recognised that student engagement has received extensive attention internationally, and individual student learning dominates the evidence reported. In their review, definitions of student engagement are presented, which include the extent to which students are engaging in activities that contribute toward desired (high-quality) learning outcomes. Zepke and Leach (2010) similarly focus on "high quality learning," but broaden their accepted definition to include a focus on students' cognitive investment, active participation, and emotional commitment to their learning. However, it would seem that many current definitions promote an institutional focus centered predominantly on outcomes such as retention and success rates (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2007). Yet there has been little exploration of the relationship between forms of learning (such as PBL) and student engagement. However, a recent study on student engagement adopted Qualitative Research Synthesis (Major & Savin-Baden, 2010) to make sense of concepts, categories, or themes that recurred across the student engagement literature in order to develop a comprehensive picture of the findings (Wimpenny & Savin-Baden, in press). The study by Wimpenny and Savin-Baden (in press) found student engagement could be classified as follows:

- *Inter-relational engagement*—Student engagement was characterised and experienced through connection to a wide set of relationships, including student to instructor, student to student, student to family, and student to career.
- *Engagement as autonomy*—This related to how students shifted from unfamiliarity and self-consciousness to self-sufficiency in learning.
- *Emotional engagement*—This was illustrated by intra-personal capacity, in terms of student resilience and persistence.

- *Engagement as connection and disjunction*—There was a variety of student experience, from those who had a more troublesome, questioning approach to those who had experienced a strong sense of disjunction.

Trowler and Trowler's (2010) review of the student engagement literature identified the noticeable absence of the student voice. Instead, they report that the literature presents perspectives about students for a range of stakeholder groups. Yet issues such as chaos and cosmos (Silen, **[accent over "e"?]** 2001) and frame factors (Jacobsen, 1997) have been found to be central to enhancing learning and promoting student engagement in PBL. However, Boughey (2006) questions the extent to which engagement is an autonomous skill, because the rules of engagement are formulated by academic expectations and traditions that students need to learn in order to participate in academic dialogues, processes and practices. Thus, the way in which instructors present a text to students locates their position in terms of the values and purpose they accord to it. While academics are able to recognise and locate different voices, students are not always able to distinguish voices and see books and articles often as flat textual pieces. Boughey (2006) argues that the notion of skills is problematic and suggests that texts may be seen by students, in terms of students believing their work should reproduce regarded texts and thus feel discouraged when they are criticized for reproducing facts and the idea that an academic text comprises multiple voices, those voices used by the author to substantiate their position as well as the solo voice of the author **[a long and confusing sentence—please rewrite.]** . Thus, the uses of language are deeply related to issues of engagement—both for students and academics—and are not just a social, cultural, or political skill. Student engagement remains a complex and contested concept that requires further consideration, both in PBL and higher education in general.

The Theory of Connectivity

The central premise of connectivism is that learning takes place with and through networked information and resources. This means that learning is not seen as just accessing information, but also as evaluating its value and the relationships between different forms of knowledge. Siemens (2008a, b) argues that learning takes place through the connections that students make between knowledge, opinions, resources, and views accessed via search engines and online sources. Connectivist pedagogy suggests the need to ensure the following principles:

- Learning and knowledge rest in diversity of opinions.
- Learning is a process of connecting specialised nodes or information sources.
- Learning may reside in non-human appliances.
- Capacity to know more is more critical than what is currently known.
- Nurturing and maintaining connections are needed to facilitate continual learning.
- The ability to see connections between fields, ideas and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.
- Decision making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality.

Web 2.0 and Web 3.0 technologies (if one chooses to use these terms) are also largely absent from published studies on problem-based learning. I believe we need to embrace a pedagogy of connectivity that includes learning in immersive virtual worlds, linking PBL with simulation and engaging with Massively Open Online Courses (MOOCs), which are founded on the theory of connectivism and on networked learning. There would seem to be strong pedagogical links between connectivist principles (Downes, 2006; Siemens, 2008a, b) and PBL in that in both approaches to learning, the focus is on the students' ability to make connections between the forms of knowledge(s) they encounter. However, what those who have adopted PBL can learn from connectivism is the need to begin to ask, whatever constellation is being adopted, the following questions suggested by Downes (2011) in relation to connectivism:

> How are connections formed?
>
> What does a particular constellation of connections represent?
>
> How important is technology in enabling connections?
>
> What, if anything, is transferred during an interaction between two, three, or more learners?
>
> What would learning look like if we developed it from the worldview of connections?

(p. 677) **[Is this an exact quotation, including the list format?]**

Discussion

To include issues of engagement and connectivism in the PBL discussion means that we can develop the idea of new conceptualisations of curricula further, as presented in Table 4. While this is not comprehensive, it does begin to address some of the issues about the kinds of learning theories needed for an information age (for more discussion around this, see Kop and Hill, 2008). At the same time, however, we need to be aware of technological determinism. Questions remain as to the merit of the developments in the use of digital technologies and new approaches to learning—whether they are educationally valuable and have the potential to engage students effectively. Furthermore, theorists such as Castells (1996) have argued that flows of capital, information, technology, organizational interaction, images, sounds, and symbols go from one disjointed position to another and gradually replace a space of locales. This has led some authors to suggest that change has resulted within curricula with relatively little pedagogical underpinning (Land, 2004, 2006), and others have argued that there is a trend toward technological determinism. The argument is that changes in technology arise independently, with the result that there is a tendency to adapt, rather than shape technology (MacKenzie & Wajcman, 1999). Yet at the same time, all institutions are concerned about how students engage with their studies, how learning is designed, and student retention (Tinto, 2006); this is also set against a backdrop of widening participation **[in what?]** (Bryson & Hand, 2007). Perhaps what is needed is a mapping of the PBL constellations in ways that locate them with particular theorists and activities so that those using or wanting to develop PBL can be clear(er) about the purpose, practices, and pedagogies involved.

Conclusions

The growing constellations of problem-based learning illustrate the value placed on this approach to learning. Yet there is relatively little understanding of the different constellations available, and the terms of inquiry-based, problem-based, and enquiry-led learning are still being used willy-nilly across the higher education landscape. There is a sense worldwide that criminal profit seeking is undesirable, yet in the case of piracy the practice of pirate slavery ultimately led to progressive racial practices (Leeson, 2009). While I agree that pedagogical piracy has many

Table 4
(New) Types of Curricula

Curriculum Position	*Curriculum Focus*	*Types of Learning*	*Conceptions of Knowing*	*Types of Prompts to Learning*	*Position of Student*
Striated: Highly bounded and controlled	Outcomes and organisation	Solid Learning	Retention and application	Routine preparation and rehearsal	Inert
Borderland: Control with open endedness	Boundary transcendence	Serrated Learning	Finding connections	Deconstructing structures	Finding connections
Smooth: Open, flexible and contested, spaces	Space creation	Liquid Learning	Gap realisation	Invitation to discover	Locating gaps
Troublesome: Learning through stuckness **["stuckness"?]**	Disjunction and uncertainty	Liquid Learning	Active adventuring	Messy dilemmas	Actively alert
Connectivist: Learning through making connections	Capacity to know more critically that what is known	Liquid Learning	Shifting realities	Connections	Creator and aggregator

undesirable outcomes in relation to PBL, the overarching tolerance of such piracy has resulted in many desirable additions to this as a learning approach. **[You lost me when you turned to a discussion of piracy. This seems to come out of nowhere.]** This article suggests that the breadth of the constellations of PBL needs to be embraced, while at the same time be underpinned by reasoned pedagogy. Issues such as problem and curricula design remain troublesome and warrant further development. However, missing elements such as new and emerging technologies, supported by the theory and practice of student engagement and connectivism, perhaps offers a way forward.

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