The Cone-of-Learning: A visual comparison of learning systems

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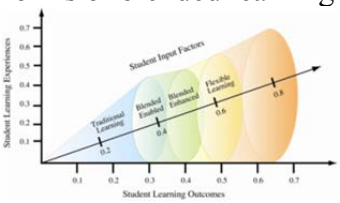
Abstract

Purpose - Four learning modes, interacting through students as different learning systems, are mapped into a cone-of-learning continuum that allows tertiary institutions to visually re-consider where within their cone-of-learning, they choose to position their learning approaches. Two forms of blended learning are also distinguished.



Design/methodology/approach - Undergraduate law, business, IT and creative arts student perceptions are structural equation modelled (SEM) into traditional, blended-enabled, blended-enhanced and flexible learning systems.

Findings - Within the SEM derived learning cone-of-learning continuum, a migration from traditional learning systems towards blended and flexible learning systems typically offers higher-net levels of undergraduate student learning experiences and outcomes.

Research limitations/implications - We do not capture learning system feedback loops, but our cone-of-learning approaches can position against chosen competitors. We recognise that benchmarking, positioning, and transferability differences may exist between different tertiary institutions; different learning areas; and different countries of operation. Cone-of-learning studies can expand to capture student perceptions of their value acquisitions, overall satisfaction, plus trust and loyalty considerations.

Practical implications - The cone-of-learning shows shifts towards flexibility as generating higher student learning experiences, higher student learning outcomes, and as flexible technologies mature this demands higher student inputs. These interactive experiential systems approaches can readily incorporate new technologies, gamification, and engagements which are testable for additional student deep learning contributions. Experiential deep-learning systems also have wide industrial applications.

Originality/value - Learning system studies remain complex, variable systems, dependent on instructors, students, and their shared experiential engagements environments. This cone-of-learning continuum approach is useful for educators, business, and societal life-long learners who seek to gauge learning and outcomes.

Keywords Tertiary teaching, flexible, blended, traditional, learning systems, experiences, biggs, outcomes

Article Classification Research Paper

1. Introduction

Tertiary institutions assist students by growing their knowledge, skills, and capabilities. They facilitate and assimilate learning, and they reduce impediments to learning (Barrie, 2006; 2007). They also provide enhanced student learning solutions (Holsapple and Lee-Post, 2006), that integrate quality, applied knowledge, and feedback solutions, into their learning systems (Trigwell and Prosser, 1991; Taylor, 1998; Deming, 2000; Hamilton and Tee, 2013).

The tertiary institution, the student, and the teacher (Dill and Soo, 2005), interact conjointly and form parts of the learning system, and through delivering quality learning experiences they build a suite of learning system outcomes (Shewhart, 1980; Johnson and Johnson, 1999; Deming, 2000; Biggs, 2003; Sun *et al*., 2008). Some learning systems often operating under tight budgetary constraints can also provide business training (Peterson *et al.*, 2008).

The learning systems differ across tertiary institutions, and can involve combinations of traditional (face-to-face) learning, or blended (mixed approach) learning, or flexible (personalised) learning (Cybinski and Selvananthan, 2005; Georgouli *et al*., 2008).

In tertiary institutions students learn via minimalist rote-learning knowledge acquisitions – termed surface learning, and by thorough knowledge acquisitions – termed deep-learning (Biggs, 2003). Student learning needs may include: ego gratification, grade achievements, self-esteem, and/or graduate-related goals (Beattie and James, 1997; Biggs, 2003; Barrie, 2006; 2007). Thus, a need exists for tertiary learning systems to include: (1) reasoned thought; (2) critical appraisal; (3) investigative capacity; (4) ideas and knowledge; (5) interpersonal skills (Martin *et al*., 2000; Cully, 2004; Douglas *et al*., 2008); (6) a focus on workplace and environmental agility (Beattie and James, 1997; Collis and Moonen, 2003; Brew, 2008; Lowry *et al*., 2008); and (7) flexible workplace solutions (Zipkin, 1991). To be effective such complex learning systems should be individualised (Boyatzis and Kolb, 1995), and they should engage experiences, skills, and quality deep-learning (Johnson and Johnson 1999; Sun *et al*., 2008). In such situations student satisfaction with the learning process outcomes can increase (Hamilton and Tee, 2010).

Web-based technological options add further learning approaches, and can extend the connectivity between tertiary learning systems and students (Zipkin, 1991; Ansari and Mela, 2003; Biggs, 2003; Pine *et al*., 1993; McLoughlin and Luca, 2002; Hamilton and Selen, 2002; Murthi and Sarkar, 2003; Kiili, 2005). Tam and Ho (2006) and Jackson (2007) show on-line learning systems enhance the decision-to-engage in learning, and can further influence the actual service/product selection by the student (Pine *et al*., 1993; Thirumalai and Sinha, 2009). This dynamic environment allows teachers to incorporate additional technologies and experiences into their learning approaches (Stella and Woodhouse, 2008), and also exposes tertiary students to learning under mixes of traditional, blended and flexible approaches. Hence this study explores factors that influence the progression from traditional learning towards a flexible learning environment.

2. Tertiary learning approaches

2.1 Traditional learning

In tertiary learning environments, degrees of flexibility can exist across the learning continuum (Collis and Moonen, 2003). These can also engage up to four learning quadrants (Hamilton and Tee, 2009). Traditional or teacher-directed live, synchronous-rich, face-to-face learning environments (Beattie and James, 1997; Miller and Groccia, 1997; McCarthy and Anderson, 2000; Bonk and Graham, 2005; Gamliel and Davidovitz, 2005) and teaching measures (Novak, 1998; Allen *et al*., 2002; Theroux, 2004) commence the continuum. Blended-enabled captures

the what, where, and when aspects of learning (Hill, 2006). It is infused with instructional media, computer-assisted learning-management-systems, and face-to-face aspects of learning that can deliver further engagement through fixed educator-selected and student-accepted outcomes (Baugher *et al*., 2003; Bonk and Graham, 2005; Brew, 2008; Georgouli *et al*., 2008; Yudko *et al*., 2008). These somewhat student-centred, real-world learning systems often blur the continuum boundaries between traditional and blended-enabled learning. For example, computer-mediated learning tools such as Blackboard, Zimbra, and Moodle now encompass podcasts and virtual classroom connections, fit blended-enabled learning but they can be sometimes be applied in some traditional engagement approaches.

Beyond traditional and blended-enabled learning resides the blended-enhanced learning systems. Here, combinations of student-centred learning activities are jointly integrated to drive richer learning experiences. For example, executive role-plays; in-situ business assistance, gamified dynamically-changing multi-solution simulations, deep thought problem solving, and interactive virtual-world avatar teachers can each contribute across the learning experiences, and each can draw on their specialised media or interactive iPad cloud applications. Again, the learning boundaries are blurred, but the experiential learning is increasing from traditional to blended-enabled to blended-enhanced learning.

Lastly, learning is adjusting to an on-demand, anywhere, anytime, any mode, any reason approach which this study terms flexible learning. Here, teachers provide learning support, and some direction, as they provide assistance that contributes towards meeting each individual student's learning demands. Thus, the outcomes become individualised, and individualised curricula become an increasing necessity for academic staff. This is somewhat similar to the progressive learning of a PhD student, and in either case, such individualised programs must be managed by the tertiary institution.

Flexible learning relies on a negotiated uniqueness, and contributes to a pedagogical learning transformation – moving from where learners become receivers of teacher information, to where learners actively-construct their own learning and knowledge-acquisition demands for (or with) the teacher. This dynamic learning systems environment encompasses multiple learning experiences, and multiple technologies (Black, 1996). It also broadens the teaching/learning reach of participating tertiary institutions, and it draws active double-loop learning (or active learning that incorporates prior learning outcomes) into the learning engagement domain (Hamilton and Selen, 2002). Thus learning systems are operate across a continuum from traditional to blended-enabled to blended-enhanced to flexible and the tertiary institution chooses where it positions itself.

Virtual world gamification and virtual universities with the student as an avatar interacting with other student and teacher avatars is now possible (Hamilton *et al*., 2011). This new learning domain may further transform the flexible-end of the learning system continuum (Hamilton *et al*., 2013).

2.2 Learning continuum

Biggs (2003), Bonk and Graham (2005), Cybinski and Selvananthan (2005), Michinov and Michinov (2008), Georgouli *et al*. (2008), and Hamilton and Tee (2009; 2010) show the possible presence of four teaching and learning approaches along a learning continuum. This study terms these learning combinations as face-to-face, blended-enabled, blended-enhanced, and flexible. Each approach offers differences in the student's learning, experiences, skills and outcomes. These learning approaches also move from a teacher-directing (and student-accepting) approach

towards a student-directing (and teacher-mentoring) approach (with more dynamic and challenging student-teacher learning solutions residing towards the flexible-end of this student learning continuum).

As we progress along the learning continuum actual learning experiences become more dynamic, and experiential, and this results in higher learning rates (Hamilton and Tee, 2010). Further, this learning continuum progression can also provide measurable two-way (and dynamically-changing) learning (Hamilton and Tee, 2013) - inferring new dynamic learning assessment instruments are likely required and need to be developed. For example, in virtual universities real-time tracking/evaluation of each student's actions, activities, contributions, and research can be automated, mapped, and intelligently-interpreted against correctness, relevance and value/applicability. Hence, a blurring of progressive advances in learning between each of our four learning quadrants exists across the learning continuum, and the possible mix of student learning approaches remains complex.

2.3 The three P's of learning

Biggs (2003) suggests learning can be investigated via his 3P teaching and learning system, which, in theory, can be optimised to deliver best student outcomes (Bruner, 1996; Marton and Säljö, 1984; Piaget, 1985). Biggs (2003) further suggests information can also be specifically structured to motivate student learning. Here, tasks (rather than grades) build deeper learning experiences – with students more engaged in various 'want-to-learn' and 'want-to-understand' situations.

Biggs 3P learning system (Figure 1) shows a student's prior knowledge, skills and input commitments factors combine with the institutional teaching-mode-deployed and the teaching materials factor to generate a learning framework termed '*presage*'. These two *presage* factors build the learning ethos, and drive both the teaching and learning activities and the experiences. This learning or *process* factor, along with the two *presage* factors, together drive the final student learning outcomes - delivering *product* combinations of student-acquired skills, and student-perceived learning qualities.

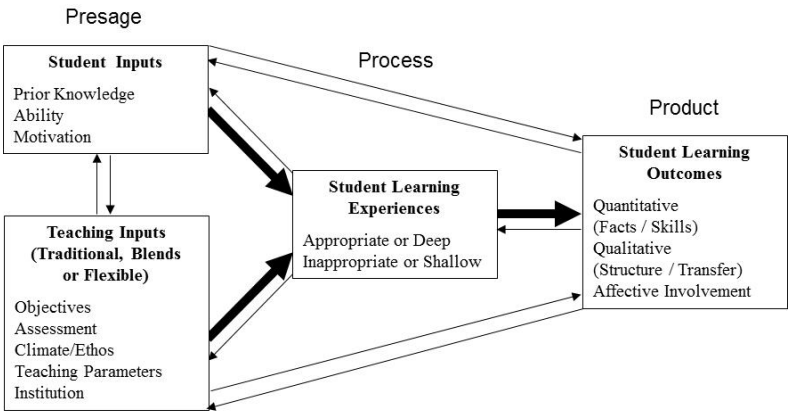


Figure 1. Biggs 3P learning system (adapted from Biggs, 2003)

Heaviest arrows indicate strongest paths, and reverse arrows indicate possible feedback loops. Thus, the Biggs 3P learning system builds across what students do (or experience), rather than what teachers do, and it is affected by the kind of learning on offer. Here the student acquires a new set of capabilities (possibly: new knowledge, new skills and new attitudinal capacities), but

does so within the institutional and curriculum confinements that govern goals, teaching strategies, assessment structures, and the levels of teacher-student engagement.

2.4 The cone-of-learning conceptual framework

To further understand student learning, this study combines Biggs (2003) 3P learning system (Figure 1) across its proposed learning continuum, and it now proposes a three dimensional learning system mapping of student input, with student learning experiences and student outcomes. This study adopts four teaching comparison domains with learning under either traditional delivery, or blended-enabled delivery, or blended-enhanced delivery, or flexible delivery. This study seeks to establish that as one moves along the learning continuum towards flexible delivery, all aspects of the learning system increase. We present this concept as our cone-of-learning continuum conceptual framework *model* (Figure 2). We present each of these three dimensions as being independent of the other. Hence each is shown operating at right angles.

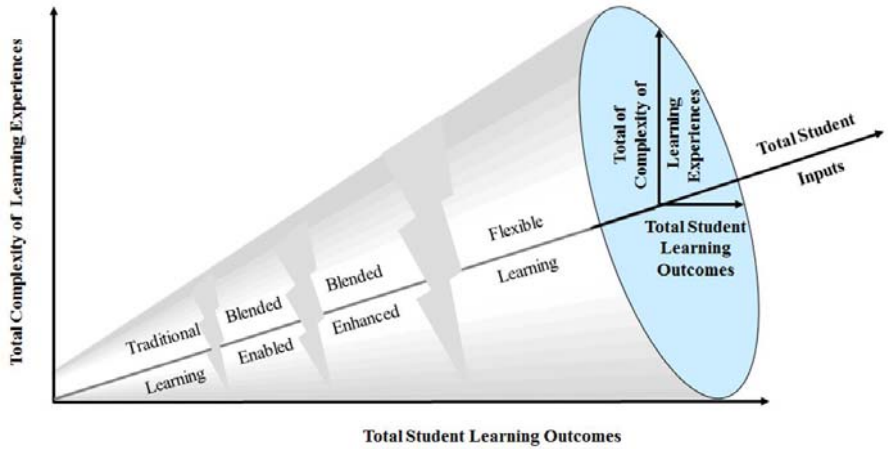


Figure 2. Cone-of-learning continuum conceptual framework model

The cone-of-learning continuum shows a transitioning of learning complexities which generally increase as teaching moves from less-complex traditional learning systems towards more-complex flexible learning systems. Michinov and Michinov (2008) support overlapping boundaries between the face-to-face and blended learning approaches, and Georgouli *et al*. (2008) support overlapping between blended and flexible learning approaches. Hence, this study's four learning approaches are displayed with overlapping (blurred) boundaries, and in combination they represent an overarching continuum of possible learning approaches.

Towards the flexible end of the cone-of-learning, learning is typically deeper, engaging and multi-faceted. Here, mixes of timing and flexibility, content and flexibility, entry requirements, instruction and resources deployment, and delivery and logistics (Collis and Moonen, 2003) all contribute towards net-student-learning (Hamilton and Tee, 2009). Hence, flexible learning normally yields considerably stronger student learning outcomes (Hamilton and Tee, 2010).

Thus, using the 3P model, we now hypothesise student learning experiences and student learning outcomes grow positively in conjunction with shifts student inputs, and that this occurs in line with a migration from traditional, to blended, and through to flexible learning environments.

3. Theoretical basis

The cone-of-learning is a visual representation of the continuum of approaches to student learning systems and deliverables. It adds understanding and measurement capabilities to the relative strengths of each different learning system. The cone-of-learning suggests the teaching mode of delivery is likely most effective when *all* aspects of the student's individually-interpreted learning system are optimised – including the Biggs feedback systems between teachers, the institution and students. It also suggests the learning the student consumes is assessable by gauging/measuring the degree to which the experiential learning remains active, relevant, and pertinent. Hence, under flexible delivery mode, learning experiences can be stimulating, interactive, and memory-embedding. Similarly the assessment processes can gauge important experiential learning transfers, and not focus on memory-recall or question- answer tests.

This study's research contribution first splits blended learning into two learning approaches – blended-enabled and blended-enhanced. Emanating from the above discussions, it theorizes that blended-enhanced learning delivers greater learning outcomes than blended-enabled learning (**H_1**). Next, it tests whether the overall combined-effects of a Biggs 3P learning system delivers higher total student learning effects as the system moves from traditional, to blended-enabled, to blended-enhanced, to flexible learning (**H_2**). Lastly, this study tests support for our proposed cone-of-learning as a means of visually understanding transitions, and differences, between each of the four learning mode systems (**H_3**).

4. Research study

Using a seven-point Likert scale approach the item measures of four constructs of the Biggs 3P learning system were captured for each learning mode. Of the 526 business students attending this regional university's campuses on this day for business (management, economics and accounting) lectures, only 372 complete and valid undergraduate business student (242 female and 130 male) responses were received across three campuses (each in a different city). Little's MCAR ($\chi 2 = 3821$, $p < 0.000$) indicated this cleaned data set to be suitable for subsequent structural equation modelling (SEM) analysis (Cunningham 2008; Hair *et al*., 2010).

Student respondents below 30 years of age numbered 228, those 31 to 40 years numbered 104, and 40 students were over 40 years of age. Most students (251) worked around 20 hours per week in casual jobs, 75 students had full-time jobs, and 35 students were in managerial or ownership positions. Overall, 312 students were high school graduates, 278 students attended university daily, and 94 only attended university for course lectures and tutorials.

Table 1 shows the seven-point, strongly-agree (1) to strongly-disagree (7), literature developed (and dual focus group pre-trialled) Likert scale measures for each Biggs 3P learning system construct (and for each learning-mode-deployed).

Under CFA maximum likelihood, and 25 oblimin rotations, every construct development underwent elimination of any cross-loads < 0.25. At CFA completion each construct had a KMO > 0.6 and a Bartlett $p < 0.05$, and had all residuals < 0.05 (Cunningham, 2008). Each construct's congeneric shape was internally checked, and cross-checked. Munck's (1979) equations were used to build each construct's single indicator composite (Grace and Bollen (2008). Each of the four Biggs 3P learning systems was separately structural equation modelled - using 2000 bootstraps to further validate each resultant model.

Table 1. Learning mode constructs, items, item references and measures

Item Development	Mesurement Item	Item Load	Mean	Std Dev	Cronbach Alpha
	TEACHING MODES				
Novak, 1998; Allen, Bourhis, Burrell & Mabry, 2002; Theroux, 2004	**Traditional Mode**		**4.83**	**1.03**	**0.76**
	Teacher controls/manages all aspects of the student learning tasks	0.78			
	Teacher is only decision maker, directs students throughout all learning experiences	0.65			
	Power and responsibility is primarily teacher-centered	0.64			
	Teacher acts as instructor of all learning tasks	0.63			
Caladine, 1999; Bonk & Graham, 2005; Delialioglu & Yildirim, 2007, 2008	**Blended Enabled Mode**		**5.73**	**0.93**	**0.84**
	Teacher uses on-line and off-line library resources	0.81			
	Teacher provides a range of borrowable library resources	0.77			
	Teacher provides on-line resources suitable for student's mobile or remote downloads	0.75			
	Teacher uses course websites and on-line Blackboard course support site	0.62			
	Teacher provides a range of texts and course support materials	0.61			
	Blended Enhanced Mode		**4.78**	**1.20**	**0.83**
	I use on-line interactions with my fellow students to complete course task activities	0.89			
	I communicate with my lectue on-line via email, phone, skype, texting, etc.	0.88			
	Teacher combines web, library, CD Rom,simulations within my course learning activites	0.60			
	I have access to multimedia, podcasts and prerecorded lectures in my course	0.58			
Wade, et al.,1994; Collis & Moonen, 2001; Hill, 2006	**Flexible Mode**		**5.85**	**0.80**	**0.80**
	I negotiate the mix of theory and practices to best suit my learning needs	0.81			
	I negotiate the sequencing of topics to best suit my learning needs	0.75			
	I vary my chosen suitable learning resources to best suit my learning needs	0.69			
	I negotiate course topics and content to best suit my learning needs	0.67			
	STUDENT PERSONAL INPUT SKILLS				
Boyatzis & Kolb, 1995; Duke, 2002; Kretovics, 2006; Lowry, Molloy & McGlennon, 2008	**Personal Learning Skills**		**5.88**	**0.75**	**0.78**
	My past learned skills allow me to acquire new knowledge across my learning tasks	0.80			
	My past learned skills allow me to reflect and to refine my learned concepts	0.72			
	My past lerned skills allow me to think critically and to make relevant learning decisions	0.65			
	STUDENT LEARNING EXPERIENCES				
Arbaugh, 2000; Miller & Groccia, 1997; Marks et al., 2005; Davis & Wong, 2007; Douglas et al., 2008; Sun et al., 2008	**LEARNING Experience**		**5.62**	**0.89**	**0.75**
	Face-to-face instruction to the class by my lecturer	0.81			
	Learning experiences	0.74			
	Face-to face individual instruction from the lecturer	0.68			
	Face-to-face student study group activities	0.56			
	STUDENT LEARNING SKILLS OUTCOMES				
Boyatzis & Kolb, 1995; Duke, 2002; Kretovics, 2006; Lowry, Molloy & McGlennon, 2008	**Traditional Learning Skills**		**5.64**	**0.93**	**0.88**
	Face-to-face learning is the best way to improve my information acquisition skills	0.89			
	Face-to-face learning is the best way to improve my analytical skills	0.86			
	Face-to-face learning is the best way to improve my interpersonal engagement skills	0.85			
	Blended Learning Skills		**5.46**	**1.17**	**0.86**
	Face-to-face and on-line learning mixes best improve my behavioural skills	0.89			
	Face-to-face and on-line learning mixes best improve my Interpersonal engagement skills	0.87			
	Face-to-face and on-line learning mixes best improve my analytical skills	0.83			
	Flexible Learnng Skills		**5.45**	**0.96**	**0.85**
	I personally negotiate my course delivery to best improve my analytical skills	0.92			
	I personally negotiate my course delivery to best improve my information acquisition skills	0.86			
	I personally negotiate my course delivery to best improve my behavioural skills	0.74			
	STUDENT LEARNING QUALITY OUTCOMES				
Holsapple & Lee-Post, 2006; Alves & Raposo, 2007; Sun et al., 2008	**Learning Quality Experienced**		**5.62**	**0.80**	**0.79**
	Contacts with my lecturer, instructor and/or mentor consolidates my course learning quality	0.81			
	Students always best learn content that is strongly linked to its most appropriate contexts	0.72			
	Face-to face discussions with the lecturer, instructor and/or mentor affect learning quality	0.72			
	Students master their knowledge acquision by drills and practice	0.62			
	Learning course content is very important	0.61			

5. Analysis and discussion

Under Biggs (2003) the *presage* of teaching-mode-deployed and student inputs, the *process* of learning experiences (activities) and the *product* learning outcomes (made up of skills and quality blocks) we generate four one-way SEM learning systems. Figure 3 displays our blended-enhanced model and its standardised beta weight paths. Strongest paths are as predicted by Biggs. This Table 2 finding, and Figure 3 approach, applies across *all* four learning systems.

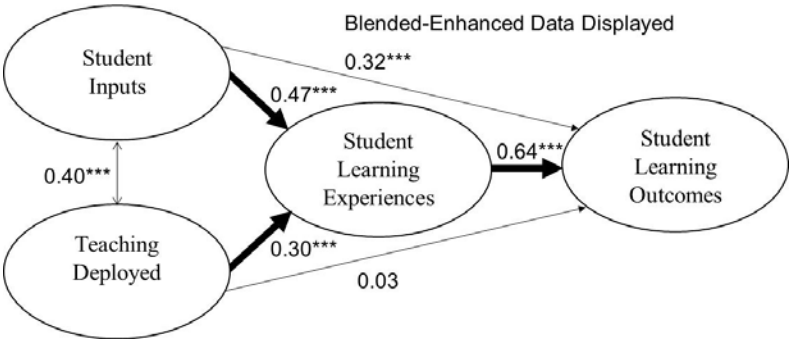


Figure 3. Biggs 3P learning system modelled under SEM

Table 2. Biggs 3P learning system regression path measures for each teaching mode

Learning Pathway			Teaching Mode			
			Traditional	Blended-Enabled	Blended-Enhanced	Flexible
Student Input Factors	<--->	Teaching-Mode-Deployed	0.30***	0.59***	0.40***	0.74***
Student Learning Experiences	<---	Teaching-Mode-Deployed	0.29***	0.27*	0.30***	0.32*
Student Learning Outcomes	<---	Teaching-Mode-Deployed	0.08	0.24**	0.03	0.18
Student Learning Experiences	<---	Student Input Factors	0.50***	0.43***	0.47***	0.36*
Student Learning Outcomes	<---	Student Learning Experiences	0.62***	0.59***	0.64***	0.61***
Student Learning Outcomes	<---	Student Input Factors	0.32***	0.22*	0.32***	0.21

Table 2 SEM models show some uni-directional pathways display significance variations, but all Table 3 models show excellent fit ($1.0 < \chi 2/df < 2.0$), and each model supports sample invariance (all Bollen-Stine p's > 0.05, and bootstrapped 2000 times) (Table 3). As the learning modes progress towards a flexible learning systems approach the *presage* to *process* to *product* paths become stronger.

Table 3. Biggs 3P learning system goodness-of-fit measures for each teaching mode

Traditional Mode Parameter Estimates					
Chi Sq/df	1.426			Bollen-Stine p	0.838
RMSEA	0.041	RMR	0.045	TLI	0.974
CFI	0.986	GFI	0.971	AGFI	0.951
Blended Enabled Mode Parameter Estimates					
Chi Sq/df	1.597			Bollen-Stine p	0.703
RMSEA	0.051	RMR	0.036	TLI	0.978
CFI	0.991	GFI	0.98	AGFI	0.943
Blended Enhanced Mode Parameter Estimates					
Chi Sq/df	1.839			Bollen-Stine p	0.572
RMSEA	0.061	RMR	0.034	TLI	0.972
CFI	0.987	GFI	0.978	AGFI	0.938
Flexible Mode Parameter Estimates					
Chi Sq/df	1.256			Bollen-Stine p	0.945
RMSEA	0.032	RMR	0.037	TLI	0.983
CFI	0.994	GFI	0.977	AGFI	0.952

Again, as predicted, Table 2 also shows as the learning system shifts towards flexible, the covariance synergies between teaching and student inputs (*presage*) constructs increase, and compared to teaching, student inputs consistently show stronger path influences. This suggests

student pre-course preparation and background skills are likely valuable ingredients when achieving high learning outcomes. As suggested by Biggs, the direct *presage*-to-*product* student learning outcomes effects (of Figure 3) remain lower than the corresponding *process*-to-*product* contribution.

The Biggs 3P learning system applies directly to traditional and blended-enabled learning approaches, but under either blended-enhanced, or flexible approaches variations can arise as more variations to the learning experience are incorporated. In addition, as the learning systems become more flexible, the student's learning experiences are the key drivers of learning outcomes. For example, under flexible learning mode systems only the three bold pathways of Figure 4 show significance. This implies the higher the student experiences (*processes)*, the higher are the student learning outcomes (*products*).

To test our hypotheses, we next investigate the 'Total Effects' measures of Table 4. Here, the student-perceived learning effects of each construct are gauged against the relevant teaching-mode-deployed. This study shows the blended mode system exists in two different forms. It also shows the blended-enhanced learning system delivers greater learning (construct or 'average') outcomes when compared to the blended-enabled learning system. Hence, hypothesis one ($\mathbf{H_1}$) is supported.

Table 4. Biggs 3P learning-system total effects measures for each teaching mode

Constructs	Traditional	Blended-Enabled	Blended-Enhanced	Flexible
Student Inputs	0.34	0.41	0.62	0.74
Student Learning Experiences	0.43	0.42	0.52	0.60
Student Learning Outcomes	0.30	0.40	0.48	0.51
Average	**0.35**	**0.41**	**0.54**	**0.62**

Table 4 shows the 'average' learning effects of each Biggs 3P learning system increase as the learning approaches increase from traditional, to blended-enabled, to blended-enhanced, and finally to flexible. Similarly, the three student-related constructs show the same increasing trend. Thus, hypothesis two ($\mathbf{H_2}$) is supported, with the highest student-perceived learning achieved under flexible learning approaches.

Strong increases in student learning experiences, and student learning outcomes, are possible when the teaching-mode-deployed migrates towards the higher student-engaging levels. This typically occurs under blended-enhanced or flexible learning systems. Hence, researchers may investigate additional strategies to grow student inputs – possibly by pre-developing student knowledge/ability levels before the learning experience is undertaken, and/or by adopting pre-course student motivational approaches. Such approaches are typically enabled using interactive technologies, and experiential applications, and these may then drive greater desires to learn, and possibly deepen the resultant learning outcomes.

Next we model Table 4's 'Total Effects' in three dimensions, and plot these against the teaching deployed, thereby constructing the cone-of-learning (Figure 4). The cone-of-learning is somewhat distorted – possibly due to our limited number of measures, or the ability to fully capture comparable components of each learning system. Nevertheless, the cone-of-learning is constructible, and visibly shows transitions towards greater learning occur at the open and flexible-end of the cone-of-learning. Hence our third hypothesis ($\mathbf{H_3}$) is established.

The cone-of-learning supports the views of past researchers (Bonk and Graham, 2005, Georgouli *et al*., 2008) regarding the presence of a learning continuum, with overlapping

boundaries between the teaching-modes-deployed. As the teaching-mode-deployed shifts along the cone-of-learning it enters the flexible (and open-ended) mode where higher levels of student learning experiences, and student learning outcomes (indicated by an increase cross-sectional area), are generated. Thus tertiary institutions should ideally position their teaching-mode-deployed approaches towards the flexible-end of the cone-of-learning.

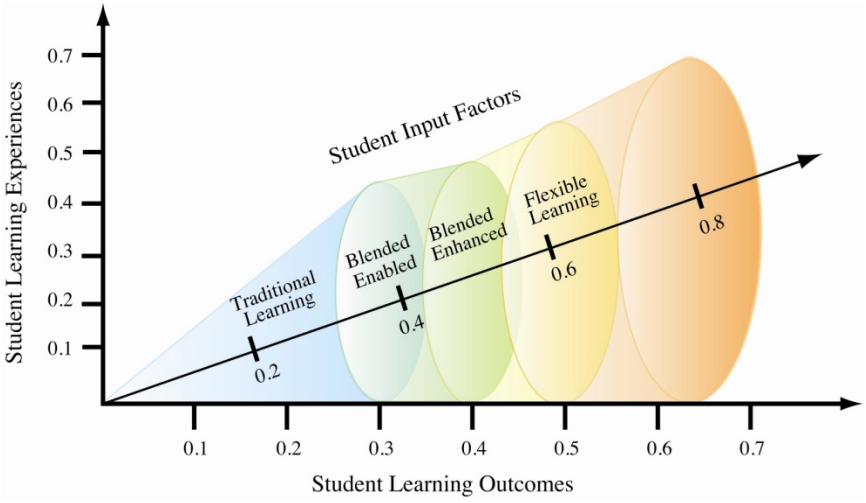


Figure 4. Learning mode effects built into cone-of-learning

Past static views of learning, that traditional approaches are different to blended approaches, are not always accurate, and should be addressed within cone-of-learning continuum considerations - by recognising that with no clear cut-offs, clear boundaries between different learning approaches may not exist.

6. Implications of research

6.1 Theoretical implications

This study supports learning as an interacting system, which varies from year-to-year (and sometimes even within one year-level and then between different classes). This complex teaching and learning arena can be considered through four teaching modes - with each incorporating differing technologies, ideas and interactions that extend across the student's learning experiences.

The cone-of-learning visually summarises learning as a complex system of interrelated contributors that combine, and conjointly influence student learning. It also displays the approaches pertinent to an appropriate learning mode, and displays a relevant position along the learning continuum. At times, a superbly taught traditional learning program may offer greater student learning than that available through one delivered by one of the remaining three learning modes. This situation creates extreme learning mode overlaps, and removes the notion of mutual exclusivity between differing learning modes. It also supports both the learning continuum and the cone-of-learning interpretations.

When well 'targeted' *presage* or *process* learning developments are added to the learning system, then both student learning experiences, and student learning outcomes, can rise (but not necessarily in linear relationship). This is supported by Tumen *et al*. (2008) who view student

experiences as success drivers towards a student's degree completion, and by Black (1996) who sees teaching-modes-deployed as a driver of significant student learning experiences, and of student learning outcomes. Such targeted changes remain a rich area for additional research, and for multi-level modelling (in SEM or Mplus). In addition Biggs learning products can extend into value, satisfaction, and loyalty considerations; or into graduate attributes, workplace-desired graduate skills, and/or business or workplace outcomes.

6.2 Practical implications

Along the lines suggested in this study, tertiary institutions can consider repositioning their courses into ones that best pre-equip their student cohort, and then engage these students with expanded, experiential learning tasks that involve deep- or embedding/reinforcing-learning offerings. They can also specifically-target positioning their learning towards the flexible-end of the learning continuum. Such approaches can mix-and-match chosen learning activities against specific quests to drive knowledge and learning, from the institution, through to the student. Here, new models such as all lectures on-line with institution-based (or on-line) collaborative workshops reinforcing materials, or gamified scenario-based instruction and consolidation, or mobile iPad and cloud connectivities, can add to existing multi-learning mode options, and can add to the global interactive learning solutions. In such environments, assessment within the learning process also requires shifts towards the value of experiential collations.

For example governments such as Australia and the UK are working towards standardising learning outcomes for all university courses. In addition, students are demanding more flexible learning options. These requirements are now driving universities towards more engaging learning and increased flexible delivery approaches - such as fully online learning with webinars social networking. The cone-of-learning shows such shifts towards flexibility will likely generate higher student learning experiences, higher student learning outcomes. As emergent innovative technologies (and approaches) are adopted, student input capabilities will likely require upgrades before they enter such new learning environments.

7. Future research

7.1 Measurement aspects

The measurable relationships between the Biggs 3P learning system constructs move this research beyond the past studies of Black (1996) and Wang and Braman (2009). The literature-based measures within this Biggs 3P learning system study and their subsequent SEM-developed relationships can both be extended over time to assess learning modes in new ways such as using value deliverance, satisfaction, and loyalty in assessment.

Tertiary institutions adopting a particular cone-of-learning strategy (and measurement set) can benchmark themselves against chosen competitors, and can incorporate additional student learning experiences into their learning strategies. By testing these approaches against measurable outcomes, new 'optimal' student learning outcomes may emerge (Davis and Wong, 2007).

7.2 Theoretical aspects

At the educator level, best recipes of how to appropriately package and customise this form of learning system is now achievable. This approach also allows research into on-line learning (Arbaugh and Rau, 2007), and how on-line learning systems can best deliver suitable student learning experiences and student learning outcomes.

This study indicates blended and flexible learning systems deliver higher learning experiences and outcomes. This is supported by our current post-study testing using second and third year tertiary students. Here, coalescing higher levels of on-line interactive environments (as targeted, personal action-learning activities) does deliver measurable, improved, blended learning experiences (and outcomes), and comparison against prior blended approaches is now operational. Further, when post-study-questioned, students associated these approaches perceive them as helpful scaffolds towards their future targets, and they recognise contributing to this learning system can help them move towards achieving deep- and/or embedding/reinforcing-learning.

7.3 Management aspects

Compared to traditional learning systems, theories of blended and flexible learning systems have been sparingly explored. Tertiary institutions can use the cone-of-learning continuum as a guide to selecting their positional instructional space(s). They can then build their targeted teaching and instructional-mode systems. They can also use the cone-of-learning to benchmark themselves against other tertiary institutions.

The incorporation of any new technologies also warrants assessment in terms of the cone-of-learning, and the new technology's relative positioning as a blended or flexible learning tool.

8. Conclusions

Undergraduate year male and female tertiary student of diverse age and income levels perceived learning across traditional, blended and flexible approaches. This study gauged the effects of teaching and student inputs as contributors to student learning experiences and to student learning outcomes. This Biggs 3P learning system is measurable, and it fits traditional and blended-enabled approaches, but variations arise further along the learning continuum within blended-enhanced or flexible approaches when differing blocks of student learning experiences further drive the *products* of the system.

This study presents learning as a system. It also builds a traditional-to-flexible learning continuum that offers increases in student *product* outcomes as one engages its flexible learning end (where higher student-perceived learning arises). Research into additional student input motivations, and into adding further prior knowledge/ability levels, can now be gauged through the experiential collations perceived by each student - instead of just enacting assessing through teacher-decided outcome targets.

This study's research contribution splits blended learning into two learning approaches - blended-enabled and blended-enhanced, showing two blended learning systems exist. Supporting hypothesis one, it shows the blended-enhanced learning system delivers greater learning (construct or 'average') outcomes. Supporting hypothesis two, all three student-related learning constructs build the 'average' learning effects of each Biggs 3P learning system.

Using 'total effects' we capture learning systems within the cone-of-learning continuum, and visibly show transitions towards greater learning occur towards the open, and flexible-end, of the cone-of-learning. Hence our third hypothesis is also established.

The cone-of-learning supports past researchers' views regarding the presence of a learning continuum - with overlapping boundaries between teaching-modes-deployed. It successfully visualises existing teaching and learning modes - but as a learning system gauged in three learning dimensions. The more dynamic and complex learning systems (typically required

towards the flexible end of the cone-of-learning's continuum), likely require both the use of additional technologies, and further skilling for delivering teachers. Further, where the student is also appropriately pre-prepared with technologies support, then greater learning system acquisitions are likely. Thus, tertiary institutions can chose their learning experiences, and cone-of-learning 'position', and test these against differing teaching modes and/or engaged technologies.

As the teaching shifts from a traditional approach, and moves towards a flexible approach, higher levels of student learning (experiences and outcomes) are system generated. Hence, tertiary institutions should consider migrating their teaching into their interactive/engaging learning system applications - typically ones embedded within blended-enhanced or flexible learning modes. In addition, tertiary institutions may benchmark, and then shift their teaching towards the flexible-end of the cone-of-learning continuum, and then re-benchmark, thereby building new knowledge regarding their learning systems and also keep track of their chosen and benchmarked competitors.

The cone-of-learning shows shifts towards flexibility can generate higher student learning experiences, and higher student learning outcomes, and likely demand higher student and teacher inputs as innovative flexible technologies and approaches continue to develop into the future.

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