Factors Affecting LMS Tool Use in Online Classes

Analysis of Faculty Use in University Systems

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February 2019

My Objectives Today

Introduce

- Introduce you to analytic techniques possible with LMS data
- Discuss my role in a larger study of LMS use at the university

Work Completed

- Identified the factors which contribute to tools enabled in online classes.
  - More tools enabled in online classes that are
    - Liberal arts
    - Upper level u/grad
    - Teaching campuses
  - LMS tools more likely to enabled in online classes at **teaching campuses** (i.e., the regionals) compared to **research campuses**, after controlling for discipline, course level, time trend and class size. (Table 6.)

Current Status

- Cluster analysis
  - Joint decision – variables and clusters (Brudvig et al., 2019 – forthcoming)
  - Binary data (Brusco et al., 2016)
- Manuscript targeted to
  - *Computers & Education* or *Teaching in Higher Education*

Research Design

Study Design

- Non-experimental case study

Unit of Analysis

- Online courses (Oncourse)

Data

- LMS logs of >5K online courses offered over 8 semesters
  - ~225K Oncourse sites
  - ~160K actual course sites
  - ~11K were online courses
    - OI, OA, WW codes
  - ~5K online classes were active, had 10+ students, & had tools enabled
- 5,346 online courses, which enrolled 153,531 students at eight different campuses

Variables

- Classes categorized by
  - *Discipline* – STEM, Professions, Liberal Arts
  - *Course level* – lower u/grad, upper u/grad, graduate
  - *Campus type* – research campus or teaching campus
- Tools enabled in each course
  - Coded by presence or absence (1,0)
  - Index variables to reflect
    - Variety of tools (i.e., the number or frequency)
    - Types of tools (student-content or student-other, see Moore, 1989)
- Covariates
  - Class size
  - Time trend

Table 1.

Disciplines Aligned to Biglan Classification (Top Panel) and Subject Areas (Bottom Panel)

Discipline:	STEM	Liberal Arts	Professions
Biglan:	Hard-Pure-Life	Soft-Pure-Life	Soft-Applied-Life
	Hard-Pure-Non-Life	Soft-Pure-Non-Life	Soft-Applied-Non-Life
	Hard-Applied-Non-Life		
Subjects:	Biological Sciences	Art, Music, Theatre	Business
	Chemistry	Communications	Education
	Computer Science	English	Health Professions
	Earth Science	Humanities	Journalism & Speech
	Engineering	Interdisciplinary Studies	Law & Public Administration
	Environmental Studies	Languages	Library Science
	Information Systems	Liberal Arts & Sciences	Parks & Recreation
	Mathematics	Philosophy	Social Service Professions
	Statistics	Social Sciences	
	Technology (all fields)		

Note: The sample contained no Hard-Applied-Life courses, such medicine or dentistry, which are clinical, non-STEM Professions.

Table 2.

LMS Tools by Enablement and Interaction Type

Default Tools (i.e., Level 0)	**Available Tools** (i.e., Level 1)
Content Tools	*Content Tools*
Syllabus	Calendar
Resources	Modules & Lessons
Library Resources	Podcasts
Interaction Tools	News
Announcements	Web Content
Assignments	eTexts
Gradebook	Publisher DLTs
Messages	Student-Generated Content
	Interaction Tools
	Dropbox
	Tests & Surveys
	Post'em
	Virtual Office
	Email
	Forums
	Chat Room

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Table 3.
Summary Statistics of Online Course Sample

	Distribution		Class Size		LN of Class Size	
	Frequency	Percent	Mean	Median	Mean	Median
Total (*N*)	5,346	100.0%	28.7	25	3.22	3.22
Disciplines						
STEM	927	17.3%	29.5	25	3.22	3.22
Liberal Arts	1,570	29.4%	31.7	26	3.32	3.26
Professions	2,849	53.3%	26.8	24	3.16	3.18
Course Level						
UG Lower	2,478	46.4%	31.6	26	3.31	3.26
UG Upper	1,542	28.8%	29.2	25	3.23	3.22
Graduate	1,326	24.8%	22.6	21	3.03	3.04
Campus						
Research	3,194	59.7%	29.5	24	3.22	3.18
Teaching	2,152	40.3%	27.5	25	3.21	3.22

Table 4.
ANCOVAs and Estimated Marginal Means

	Total Tool Variety	Enablement		Tool Type	
		Default	Available	Content	Interaction
Model Test					
Overall $F_{7, 5338}$	39.2***	19.2***	76.2***	25.1***	56.6***
Between-Subjects Tests					
Factors					
Disciplines $F_{2, 5338}$	18.5***	11.5***	9.7***	22.1***	9.9***
Course Level $F_{2, 5338}$	55.0***	19.9***	100.2***	23.9***	140.2***
Campus Type $F_{1, 5338}$	32.4***	24.7***	95.2***	79.9***	1.4
Covariates					
Time Trend $F_{1, 5338}$	0.4	8.7**	1.2	2.1	0.0
Class Size $F_{1, 5338}$	3.7	18.1***	0.2	0.3	6.2*
Grand Mean	**8.76**	**6.35**	**2.41**	**3.32**	**5.44**
Disciplines					
STEM	8.55 $_a$	6.29 $_a$	2.25 $_a$	3.23 $_a$	5.31 $_a$
Liberal Arts	9.01 $_b$	6.46 $_b$	2.55 $_b$	3.47 $_b$	5.54 $_b$
Professions	8.72 $_a$	6.30 $_a$	2.42 $_b$	3.25 $_a$	5.47 $_b$
Course Level					
UG Lower	8.81 $_a$	6.22 $_a$	2.60 $_a$	3.17 $_a$	5.65 $_a$
UG Upper	9.13 $_b$	6.36 $_b$	2.78 $_a$	3.39 $_b$	5.74 $_a$
Graduate	8.33 $_c$	6.47 $_c$	1.85 $_b$	3.39 $_b$	4.94 $_b$
Campus					
Research	8.59 $_a$	6.43 $_a$	2.17 $_a$	3.17 $_a$	5.42 $_a$
Teaching	8.93 $_b$	6.27 $_b$	2.66 $_b$	3.46 $_b$	5.46 $_a$

Note: Model F-value is for a univariate ANCOVA with 3 groups (disciplines, course level, campus type), controlling for the time trend & class size. Pairwise multiple comparisons were computed with a Bonferroni adjustment, and the subscript letter denotes the subset of means within a group that do not differ. Means are estimated at the covariates and may differ from simple means reported elsewhere. (n = 5346)

Table 5.
Course Tool Enablement by Discipline, Course Level, and Campus

		Discipline				Course Level				Campus		
	Total (n=5346)	$\chi^2_{(df=2)}$ †	STEM (n=927)	LibArts (n=1570)	Prof (n=2849)	$\chi^2_{(df=2)}$ †	UG Lower (n=2478)	UG Upper (n=1542)	Grad (n=1326)	$\chi^2_{(df=1)}$ †	Research (n=3194)	Teaching (n=2152)
Default Tools												
Syllabus (c)	96.4%	28.2*	95.7% a	98.5% b	95.4% a	6.7	95.9% d	97.4% d	96.0% d	4.3	96.8% g	95.7% g
Resources (c)	93.5%	8.4	91.5% a	94.4% a	93.7% a	31.7*	91.8% d	93.6% d	96.5% e	10.0*	94.4% g	92.2% h
Library Resources (c)	67.1%	33.5*	59.4% a	66.8% b	69.7% b	97.8*	62.0% d	66.0% e	77.8% f	19.0*	69.4% g	63.7% h
Announcements (o)	95.7%	20.0*	97.2% a	96.9% a	94.6% b	2.6	95.4% d	95.7% d	96.5% d	2.4	95.4% g	96.2% g
Assignments (o)	86.4%	1.4	85.7% a	85.9% a	86.9% a	28.6*	83.7% d	88.2% e	89.3% e	43.8*	89.0% g	82.6% h
Gradebook (o)	97.8%	9.8	97.5% a	96.9% a	98.3% a	14.7*	97.1% d	98.9% e	97.7% d	2.1	98.0% g	97.4% g
Messages (o)	96.3%	13.3*	96.3% a,b	94.8% b	97.0% b	13.8*	95.4% d	96.4% d,e	97.7% e	52.9*	97.8% g	94.0% h
Available Tools												
Calendar (c)	13.4%	86.6*	20.2% a	16.4% b	9.5% c	81.7*	15.8% d	15.7% d	6.0% e	0.0	13.4% g	13.2% g
Modules & Lessons (c)	29.2%	62.9*	21.3% a	35.8% b	28.2% c	41.6*	28.2% d	35.0% e	24.4% f	296.3*	20.4% g	42.2% h
Podcasts (c)	4.4%	1.1	4.9% a	4.5% a	4.1% a	0.8	4.5% d	4.5% d	3.9% d	2.3	4.0% g	4.9% g
News (c)	1.0%	11.2	0.4% a	0.5% a	1.4% a	1.8	0.9% d	1.2% d	0.8% d	1.7	1.1% g	0.7% g
Web Content (c)	2.5%	12.6*	1.8% a	3.6% b	2.0% a	1.6	2.2% d	2.9% d	2.5% d	4.5	2.1% g	3.0% g
eTexts (c)	3.4%	9.6	1.9% a	4.3% a	3.4% a	16.4*	4.1% d	3.8% d	1.7% e	44.2*	2.0% g	5.4% h
Publisher DLTs (c)	2.6%	194.7*	9.3% a	0.8% b	1.5% b	61.1*	4.3% d	2.1% e	0.2% f	113.6*	0.7% g	5.5% h
Student-Generated (c)	12.1%	44.4*	8.5% a	16.6% b	10.9% a	10.6	10.9% d	14.3% d	11.9% d	44.1*	9.7% g	15.8% h
Dropbox (o)	13.1%	36.0*	7.4% a	15.7% b	13.6% b	0.5	13.3% d	13.4% d	12.6% d	7.7	14.2% g	11.6% g
Tests & Surveys (o)	53.9%	28.0*	55.2% a	58.9% a	50.7% b	598.4*	61.6% d	66.3% e	25.0% f	59.3*	49.6% g	60.3% h
Post'em (o)	0.9%	7.1	1.4% a	1.2% a	0.6% a	18.7*	1.5% d	0.2% e	0.7% d,e	0.1	0.9% g	1.0% g
Virtual Office (o)	1.1%	63.1*	3.5% a	1.3% b	0.3% c	36.1*	2.1% d	0.6% e	0.1% e	48.2*	0.3% g	2.4% h
Email (o)	2.7%	4.2	3.3% a	3.0% a	2.3% a	1.3	2.9% d	2.3% d	2.7% d	10.7*	2.1% g	3.5% h
Forums (o)	65.8%	60.3*	59.3% a	73.2% b	63.8% a	188.5*	70.4% d	71.7% d	50.3% e	154.2*	59.2% g	75.6% h
Chat Room (o)	37.9%	88.5*	40.8% a	46.3% b	32.3% c	161.2*	43.1% d	42.2% d	23.2% e	54.9*	33.8% g	43.9% h

† A Bonferroni adjustment was made for the chi-squared proportion difference tests for each categorical variable. This lowered the p-value of the individual chi-squared tests from 0.05 to 0.0023 (i.e., 0.05⁄22), with significance represented by an asterisk (*), such that a chi-squared value ($df = 2$) ≤ 12.21 is ns and a chi-squared value ($df = 1$) ≤ 9.35 is ns.

Table 6.

Logistic Regressions Predicting Enablement of Four Available LMS Tools

	Modules & Lessons		Tests & Surveys		Chat Rooms		Forums	
	B	*OR*	*B*	*OR*	*B*	*OR*	*B*	*OR*
Discipline								
STEM	−0.335	0.715***	−0.130	0.878**	−0.012	0.988	−0.364	0.695***
Liberal Arts	+0.227	1.254***	−0.129	0.879**	+0.155	1.167***	+0.176	1.193***
Professions	+0.109	1.115*	+0.259	1.296***	−0.143	0.867***	+0.187	1.206***
Course Level								
UG Lower	−0.311	0.733***	+0.495	1.640***	+0.205	1.228***	+0.263	1.301***
UG Upper	+0.188	1.207***	+0.661	1.937***	+0.271	1.311***	+0.326	1.386***
Graduate	+0.123	1.131*	−1.156	0.315***	−0.476	0.621***	−0.590	0.555***
Campus Type								
Research	−0.585	0.557***	−0.026	0.975	−0.089	0.914**	−0.251	0.778***
Teaching	+0.585	1.795***	+0.026	1.026	+0.089	1.094**	+0.251	1.286***
Covariates								
Time Trend	+0.040	1.041**	+0.043	1.044***	−0.098	0.907***	+0.030	1.031*
Class Size (ln) ‡	+0.283	1.328***	+0.558	1.747***	+0.032	1.033***	−0.336	0.715***
Constant	−1.052	0.349***	−0.266	0.767***	−0.056	0.946	+0.439	1.550***
Nagelkerke R^2	0.106		0.175		0.063		0.083	

Each tool has sample size, n = 5346 ‡ The natural log of class size is mean-centered for interpretability.
Note: Deviation (effect) coding is used (Menard, 2009). OR is the Odds Ratio, which is Exp (B).
*p < 0.05, **p < 0.01, ***p < 0.001

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Cluster Analysis

Decision Problems

- Variable selection decision
  - Poor treatment in applied areas
  - Most methods are single variable and are sub-optimal
- Number of clusters decision
  - Decision is made in isolation from variable selection
- Evaluate variables and clusters *jointly*

Brudvig et al., 2019 (forthcoming), in *Journal of Marketing Analytics*

Data Problems

- Scales
  - Interval or better assumed for most methods, e.g, *K*-means
  - Binary data (0,1) performs better with *K*-median partitioning methods

Brusco et al., 2016, in *Psychological Methods*

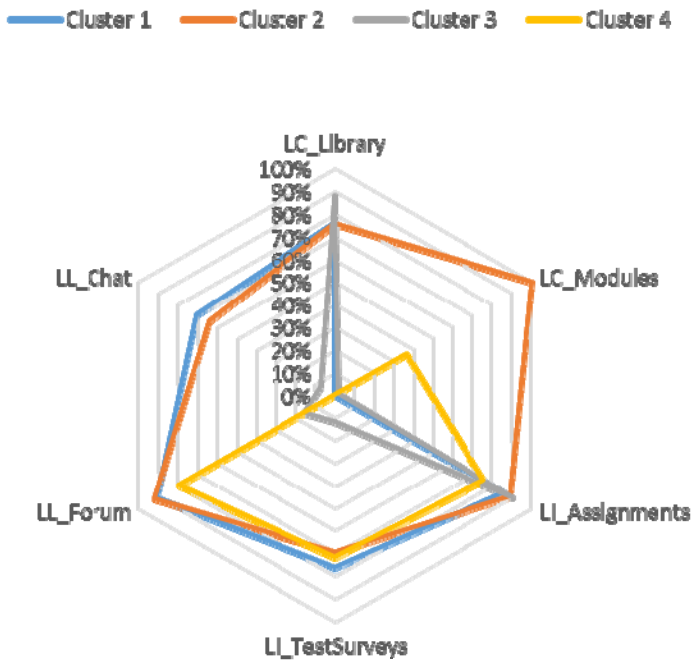
Cluster Solutions

Joint Selection (Brudvig et al., 2019)

Binary Data (Brusco et al., 2016)

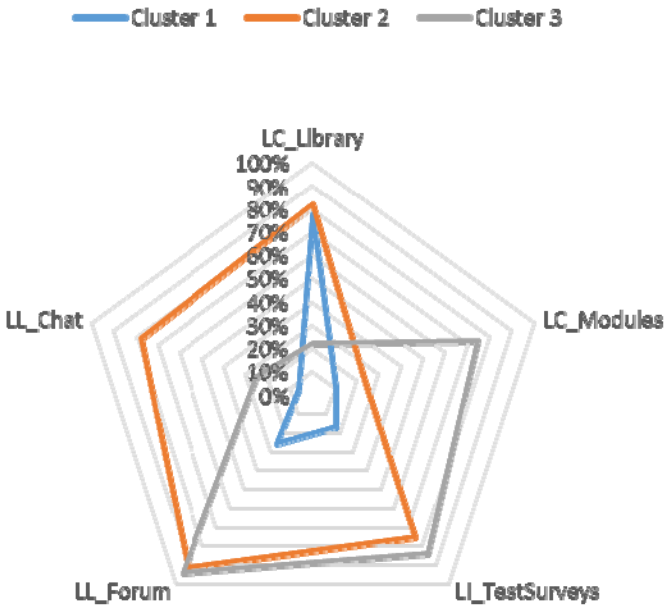
6 variables

4 clusters



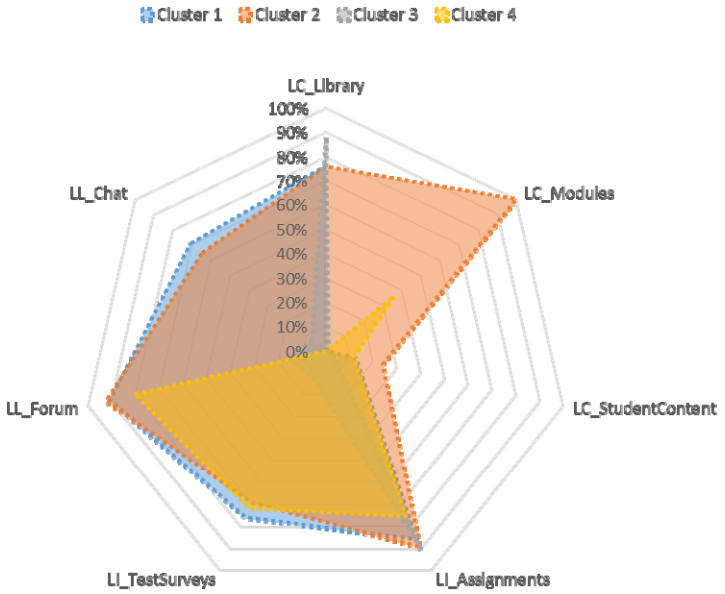
5 variables

3 clusters

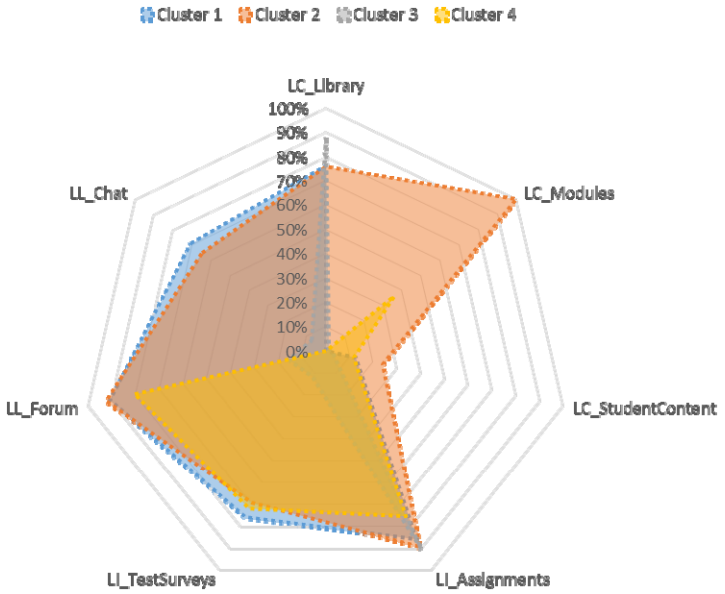


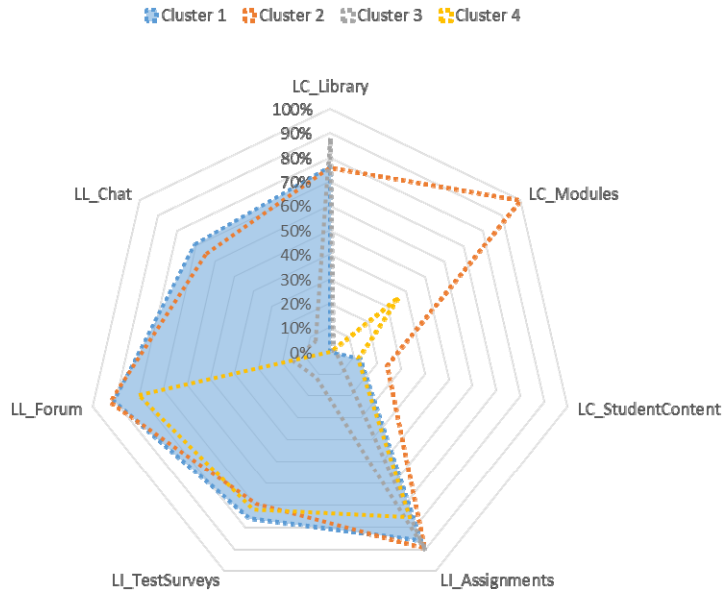
Back-up

4-cluster, 6-variable solution



4-cluster, 6-variable solution





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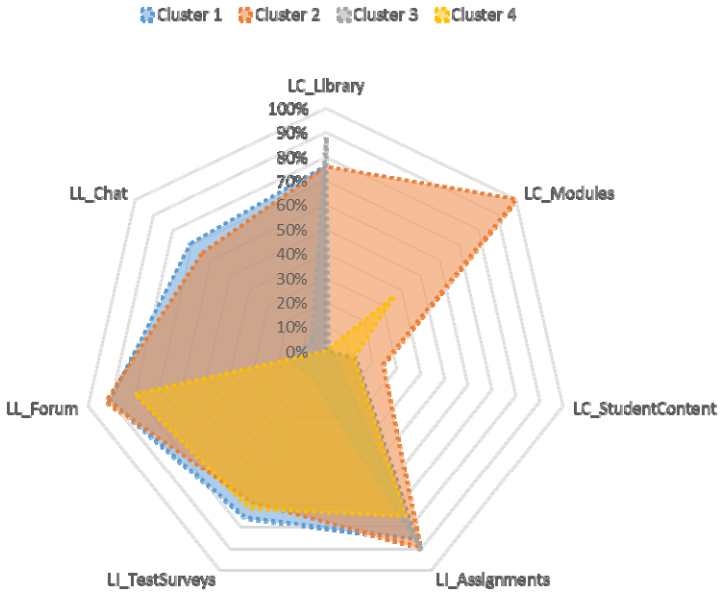

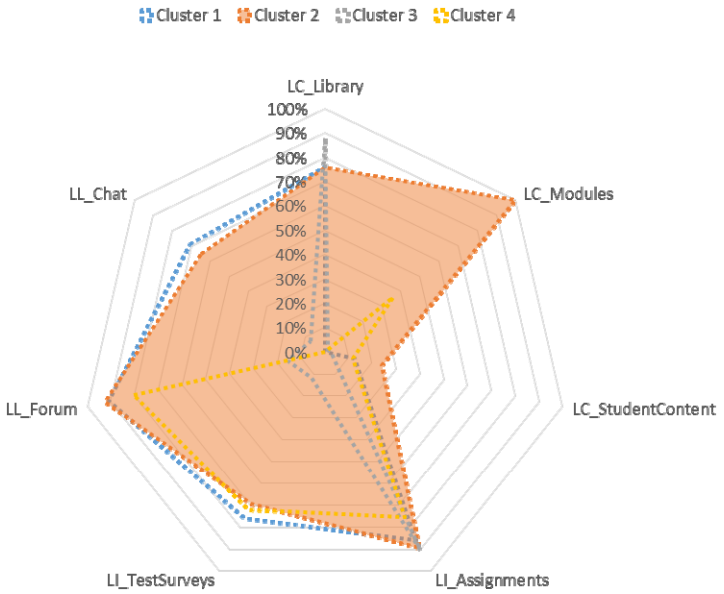

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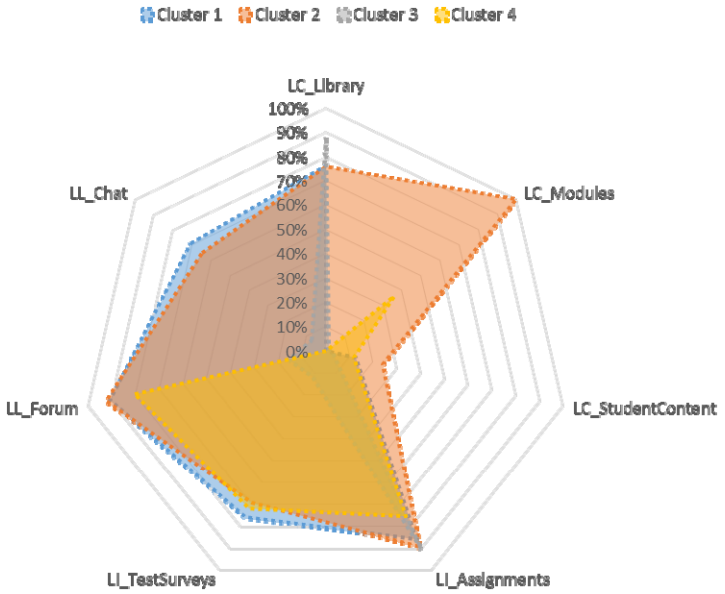

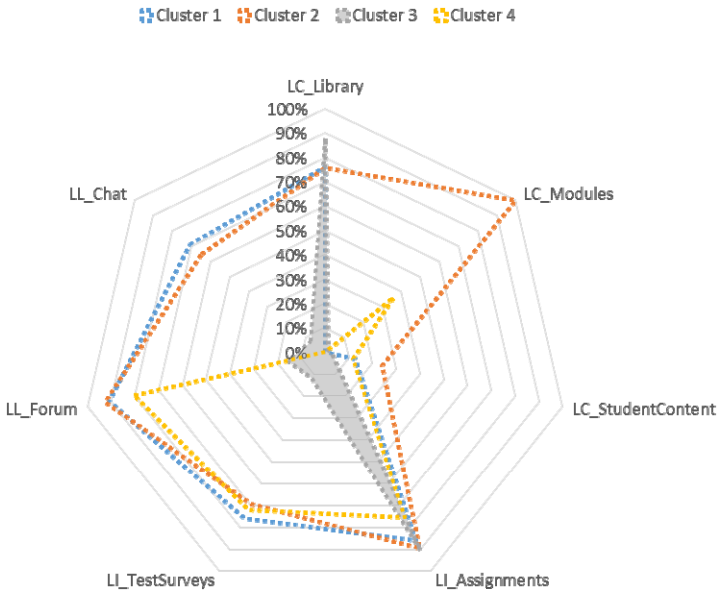

4-cluster, 6-variable solution