Graphical analysis of UKES Survey data

Brief summary

Using the CI map software developed at LJMU, we produced two probabilistic graphical models of the UKES survey data. One which included the Department variable and another which did not, the latter was produced because the large number of associations with Department may conceal more interesting relationships between other variables. These graphs were used to identify interesting or important relationships between variables.

Key findings

- Department is associated with a large number of variables in the dataset, suggesting that there is considerable variability in indicators of student engagement across departments. However, it should be noted that the large number of possible states for the Department variable (15) creates a higher risk of false positives in the χ^2 and G^2 tests for pairwise and conditional independence on which the PC algorithm is based.

- Indicators of Learning with others were mostly correlated with each other, suggesting a subset of strongly collaborative learners, with students who reported explaining course material to others often reporting asking other students for help a little over half of the time, compared to around a quarter of students who reported rarely explaining course material to others.

- There is an association between all four Critical Thinking questions and the question "How much has your course challenged you to do your best work?" These are all positive correlations, with students who perceived that their course focused on any of the four Critical Thinking skills quite a bit or very much being more likely to feel that their course challenged them to do their best work, while all of these associations have a relatively low PMI, the consistency across the category makes this noteworthy. The strongest association is with "Applying facts, theories or methods (for example to practical problems or new situations", students who felt that their course emphasised this area were 29% more likely to think that their course challenged them to do their best work than those who did not think so (PMI = 0.0319, p <0.0001, Spearman's R = 0.2286).

- The Critical Thinking variables also all correlate with each other, suggesting that students who report that their course strongly emphasises one set of critical thinking skills are likely to report that their course emphasises others.

- Some indicators of collaborative learning are associated with indicators of engagement with teaching staff. Around half of students who report explaining course material to others compared frequently report that they often ask questions in taught sessions or otherwise contribute to in class discussions, compared with 3 in 10 students who report explaining course material to others rarely.

- Older students seem to engage with their course differently to younger students. Students aged 26 or older are 61% more likely to report frequently asking questions or engaging in discussion during taught sessions, 29% less likely to report often asking other students for help in understanding material and 50% more likely to spend 10 or more hours in independent study each week compared with younger students.

- In general, variables in the same category associate reasonably strongly with each other, of the 28 associations with PMI>0.05, 24 were between variables in the same category.

Data pre-processing and methods

The initial data consisted of 1,988 responses by students to 43 questions. However, due to the nature of the CI map software (which requires no missing data), 235 survey responses with missing answers were removed from the data. 3 questions were eliminated from the data for technical reasons (discussed below). This left a data matrix with 1753 rows and 40 columns.

Reducing the state space of variables

Reducing the number of states for variables in the data improves the computational efficiency of the PC algorithm and ameliorates the risk of false positives in the final model. In particular, we aim to have no state with a prevalence of less than 5% in the data.

The variables "If [you have a disability], please choose one or more from the following options" and "Please indicate, which of the following most closely matches your discipline" had too large a number of states for which there was no clear strategy for reducing and were eliminated. The variable "What is your gender?" had two states ("Prefer Not To Say" and "Other") which were too rare for inclusion in the analysis (see [heading name] below), since these could not be resolved to one of the other two categories and concerns existed about biasing the data by removing these answers, the gender variable was removed instead.

For the remaining 40 variables:

- The 8 questions relating to how students spend their time were reduced to two states corresponding to whether the student reported spending more than either 5 hours (for two questions) or 10 hours (for the remaining six questions) on the relevant activity
- The 24 engagement questions were initially answered on a four point engagement scale, this was reduced to a binary scale where 1 corresponded to either "Very often/often" or "Very much/Quite a bit" and 2 corresponded to either "Some/Very little" or "Sometimes/Never"
- The coding used for 6 of the 8 demographic variables is shown in Table 1, the Department and Face to Face/Distance variables were left unchanged.

Table 1: Coding of demographic variables

Variable	Coding
Age	1: Under 26
	2: 26+
Disability	1: Yes
	2: No
Place of residence	1: UK resident
	2: EU international resident
	3: Non-EU international resident
Ethnic group	1: White
	2: Black
	3: Asian
	4: Any Mixed background
	5: Arab
	6: Other
Qualification	1: Bachelors degree
	2: Other
Year of study	1: 1st
	2: 2nd
	3: 3rd or more

Building a graphical model

The two graphical models discussed in the report were found using the CImap software developed at LJMU. This software implements a modified form of the PC algorithm, which begins with a fully connected directed acyclical graph (directions are not particularly important) where the nodes represent variables and the edges represent conditional independence assumptions (the absence of an edge between two variables indicates that they are independent given some other set of variables in the data). Edges are then eliminated by testing each pair of variables, first by pairwise χ^2 tests for independence and then a series of G^2 conditional independence tests with increasingly large conditioning sets for each pairing in order of strength of association, so that the weakest associations are eliminated as early as possible. Tests for the models in this report were carried out at the 5% level of significance.

Univariate analysis

This section discusses the distribution of some of the key variables in the dataset, particularly in the areas of critical thinking, course challenge, collaborative learning and interaction with staff.

Critical thinking

The critical thinking category consisted of four questions of the form "During the current academic year, how much has your course emphasised the following activities?", which students answered on an agreement scale. The distribution of answers to these questions is shown in Table 2. In general, the vast majority of students agreed that their course emphasised these critical thinking skills very much or quite a bit, with the lowest level of agreement being on "Evaluating or judging a point of view, decision or information source" (7 in 10) and the highest being "Applying facts, theories or methods (for example to practical problems or new situations)" (8 in 10).

Table 2: Critical thinking

	Applying facts, theories or methods (for example to practical problems or new situations)	Analysing ideas or theories in depth	Evaluating or judging a point of view, decision or information source	Forming a new understanding from various pieces of information
Very Much/Quite a bit	81.06%	76.90%	70.56%	77.98%
Some/Very little	18.94%	23.10%	29.44%	22.02%

Learning with others

The learning with others category, similar to the Critical Thinking category, consisted of four questions, asking students how often they engaged in learning activities with other students. Answers are shown in Table 3. Answers in this category were more mixed than the others, with 6 in 10 students reporting frequently working with other students on assignments and only 4 in 10 agreeing that they asked other students for help often or very often.

Table 3: Learning with others

	Worked with other students on course projects or assignments	Explained course material to one or more students	Asked another student to help you understand course material	Prepared for exams or assessments by discussing or working through course material with other students
Very often/Often	61.04%	53.85%	40.62%	51.34%
Sometimes/Never	38.96%	46.15%	59.38%	48.66%

Course Challenge

Table 4 shows the distribution of answers to the Course Challenge questions, around 9 in 10 students agreed that their course emphasised taking responsibility for their own learning very much or quite a bit and a similar proportion had the same level of agreement that their course had challenged them to do their best work.

Table 4: Course Challenge

	During the current academic year, how much has your course emphasised taking responsibility for your own learning?	During the current academic year, how much has your course challenged you to do your best work?
Very Much/Quite a bit	93.04%	86.20%
Some/Very little	6.96%	13.80%

Interaction with staff

The Interaction With Staff category consisted of 6 questions, the questions and the distribution of responses are shown in Table 5.

Table 5: Interaction with staff

	Asked questions in taught sessions or contributed to discussions about course material in other ways	Discussed your academic performance and/or feedback with teaching staff	Talked about your career plans with teaching staff or advisors	Discussed ideas from your course with teaching staff outside taught sessions, including by email/online
Very often/Often	43.13%	36.11%	22.42%	24.53%
Sometimes/Never	56.87%	63.89%	77.58%	75.47%

Table 5: Interaction with staff cont.

	Worked with teaching staff on activities other than coursework	Made significant changes to your work based on feedback
Very often/Often	15.06%	46.26%
Sometimes/ Never	84.94%	53.74%

Associations between variables

This section will discuss particularly interesting associations between variables that emerged from the graphical model

CI map excerpts

For each of the three excerpts in this section, one variable of interest was chosen and all variables with at least a 2nd order connection to that variable were then included in a graph based on the larger graphical model found by the CI map software. This subgraph of the larger graphical model allows us to gain an intuitive grasp on some of the relationships between variables in the survey data. The three subgraphs are shown in figures Figure 1, Figure 2 and Figure 3 and show conditional independence relationships between variables with at least a 2nd order association with "Worked with other students on course projects or assignments", "How much has your course challenged you to do your best work" and "Age" respectively. The first two were chosen because they seemed representative of two particular areas of interest (interest in collaborative learning and course challenge), while age was chosen because it was the only demographic variable in the graphical model excluding Department that had multiple associations with non-demographic variables.

These subgraphs were used to identify interesting relationships between groups of variables, discussed in the rest of this section.
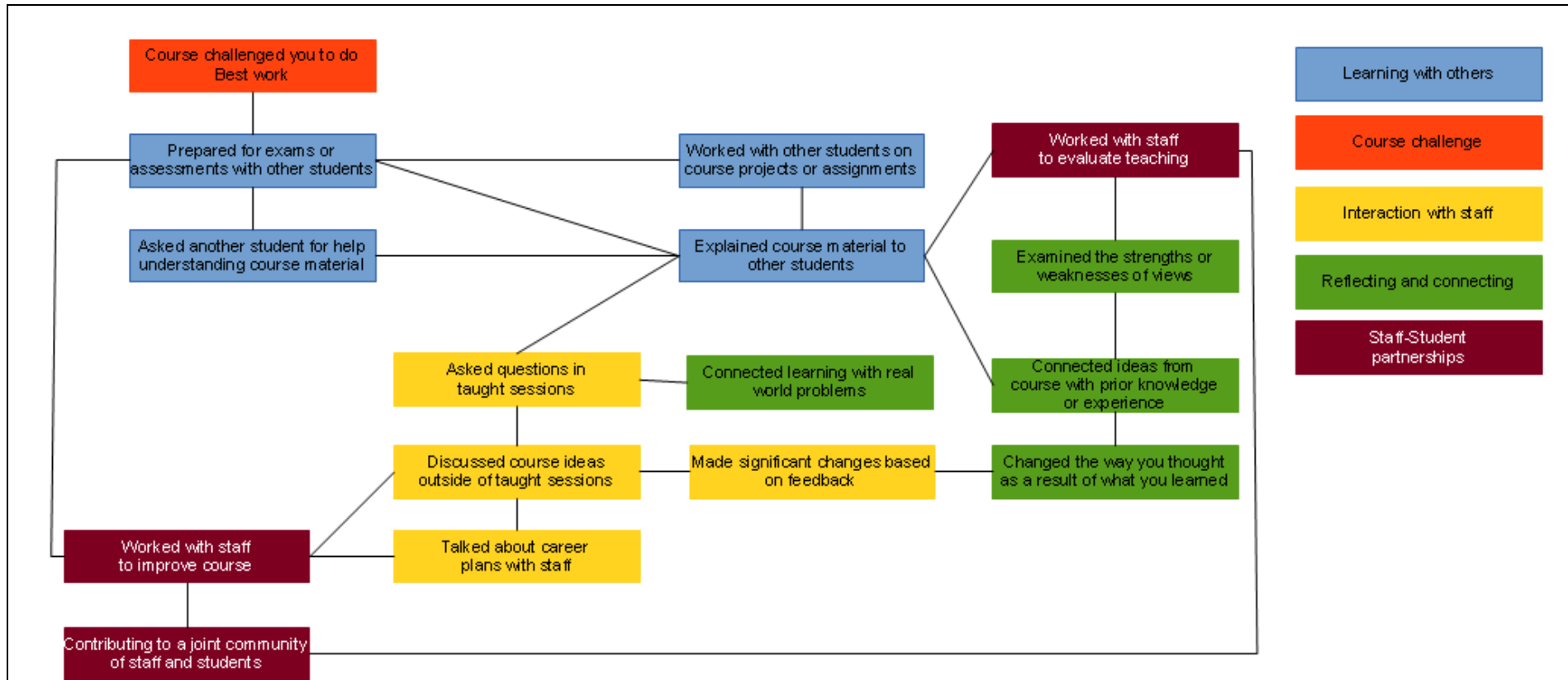
Figure 1: Subgraph - All variables with at least 2nd order connection to "Worked with other students on course projects or assignments"

"Explained course material to other students" appears to be associated with a large number of other variables across several categories, suggesting a relationship between being likely to provide other students with help and broader course engagement.
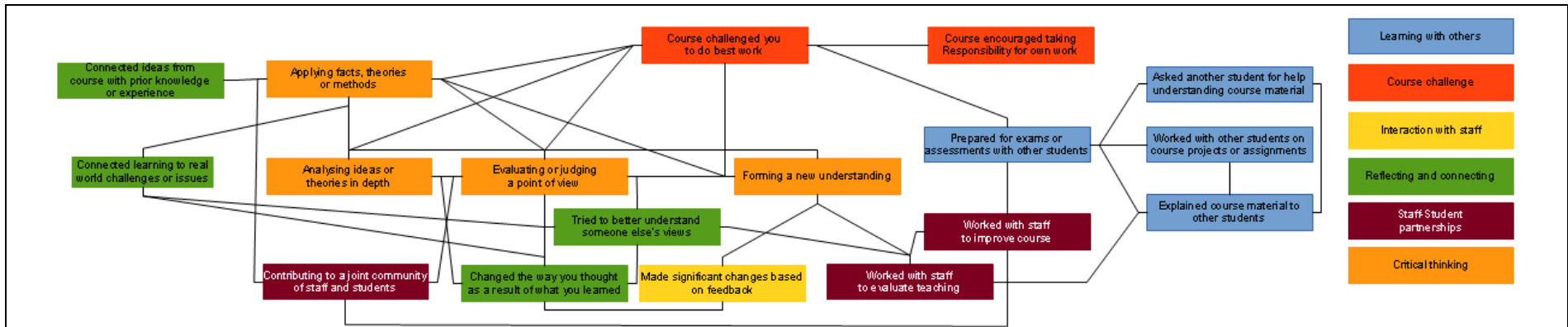
Figure 2: Subgraph - All variables with at least a 2nd order connection to "How much has your course challenged you to do your best work?"

This subgraph shows strong relationships between the Course Challenge and Critical thinking categories, as well as between Learning With Others and Interaction With Staff.
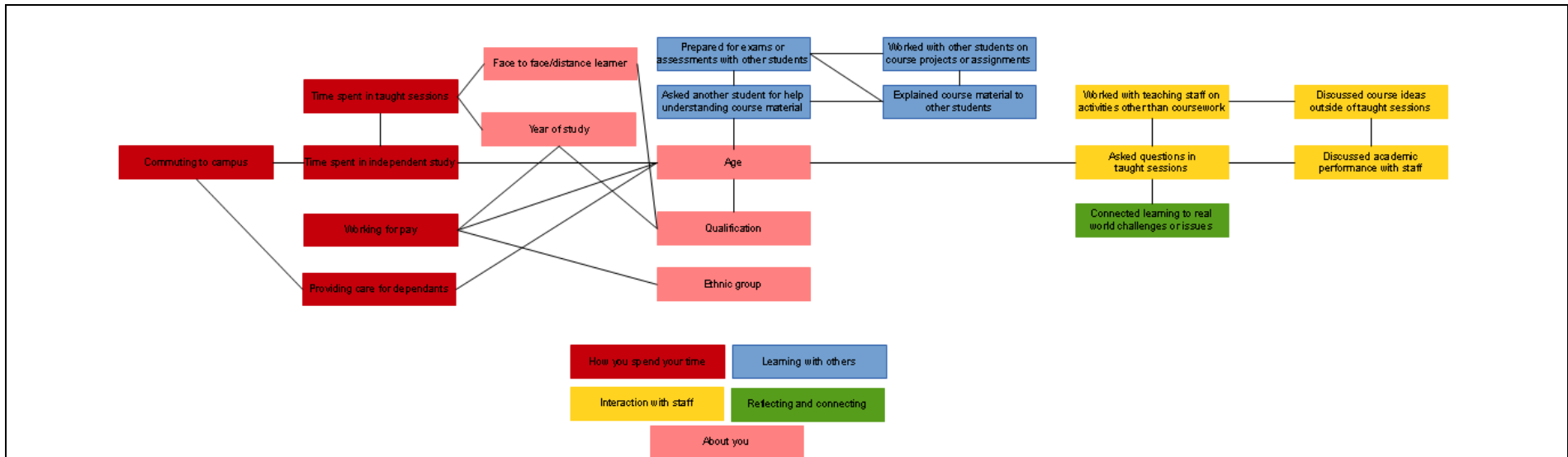

Figure 3: Subgraph - All variables with at least 2nd order connection to "Age"

We have good evidence that students over the age of 26 differ in how they engage with learning and in how they spend their time outside of lectures.

Department

In the graphical model including Department as a variable, a large number of variables connect to Department, including 4 engagement based questions, 3 questions on how students spend their time and 3 demographic variables, shown in Table 6. Due to the large number of associations with Department, we felt it was appropriate to carry out all further analysis using a graphical model omitting Department.

Table 6: Variables significantly associated with Department (questions highly associated with Department variable)

Department	'Evaluating or judging a point of view, decision or information source'	'Worked with other students on course projects or assignments'	'Asked questions in taught sessions or contributed to discussions about course material in other ways'	'Connected your learning to real-world problems or issues'	'Time spent in taught sessions'
	Very much/Quite a bit	Very Often/Often	Very Often/Often	Very Often/Often	>10 hours
Humanities and Social Sciences	85.98%	57.32%	48.17%	43.90%	49.39%
School of Law	81.74%	33.04%	49.57%	63.48%	27.83%
Liverpool Business School	71.92%	87.19%	55.67%	64.04%	58.62%
Liverpool School of Art and Design	80.87%	50.43%	60.00%	53.91%	53.04%
Liverpool Screen School	79.31%	82.76%	56.90%	62.07%	53.45%
Nursing and Allied Health	83.33%	80.16%	59.52%	84.13%	42.86%
Education Leisure and Sports Studies	73.84%	72.09%	51.74%	54.07%	46.51%
Centre for Public Health	84.62%	23.08%	76.92%	76.92%	30.77%
Teacher Education and Professional Learning	62.07%	55.17%	79.31%	65.52%	51.72%
Natural Sciences and Psychology	64.26%	53.19%	19.57%	42.55%	54.89%
Sport and Exercise Sciences	60.38%	30.19%	20.75%	35.85%	11.32%
Pharmacy and Biomolecular Sciences	59.00%	70.00%	31.50%	51.00%	81.00%
Engineering Technology and Maritime Operations	58.97%	57.69%	55.13%	70.51%	71.79%
Computing and Mathematical Sciences	53.99%	39.88%	20.86%	44.17%	67.48%
Built Environment	72.41%	68.97%	37.93%	51.72%	79.31%
All departments	70.56%	61.04%	43.13%	54.99%	54.93%

Department	'Working for pay'	'Doing volunteer work'	'Age'	'Qualification'	'Year of study'
	>10 hours	>5 hours	26+	BA/BSc	3rd or more
Humanities and Social Sciences	26.83%	6.71%	6.10%	92.07%	0.00%
School of Law	37.39%	11.30%	11.30%	79.13%	2.61%
Liverpool Business School	45.32%	5.91%	11.82%	98.52%	1.48%
Liverpool School of Art and Design	16.52%	3.48%	7.83%	97.39%	1.74%
Liverpool Screen School	22.41%	6.90%	3.45%	98.28%	0.00%
Nursing and Allied Health	31.75%	16.67%	42.86%	74.60%	3.17%
Education Leisure and Sports Studies	29.07%	14.53%	10.47%	90.70%	2.33%
Centre for Public Health	30.77%	7.69%	61.54%	84.62%	0.00%
Teacher Education and Professional Learning	44.83%	24.14%	31.03%	100.00%	3.45%
Natural Sciences and Psychology	23.40%	5.96%	5.11%	90.21%	2.55%
Sport and Exercise Sciences	22.64%	7.55%	3.77%	100.00%	0.00%
Pharmacy and Biomolecular Sciences	14.50%	3.50%	12.50%	96.50%	15.00%
Engineering Technology and Maritime Operations	24.36%	3.85%	11.54%	76.92%	6.41%
Computing and Mathematical Sciences	25.15%	3.07%	8.59%	96.32%	1.23%
Built Environment	34.48%	6.90%	10.34%	96.55%	6.90%
All departments	27.61%	7.59%	12.09%	91.50%	3.54%

Learning with others

Of the four Learning with others variables, all pairings correlate with each other with the exception of "Worked with other students on course projects or assignments" and "Asked another student to help you understand course material", which were conditionally independent, given other variables in the data. Overall the evidence supports the idea that there is a distinct subset of students who are more likely to engage in collaborative learning.

Of particular interest is that there is a positive correlation between "Asked another student to help you understand course material" and "Explained course material to one or more students" (PMI 0.0674). In other words students who report seeking help from others are more likely to report having helped others at other points, indicating truly collaborative learning in these cases. 54% of students who reported explaining course material to others "very often" or "often" reported asking other students for help "very often" or "often", more than twice the proportion amongst students who reported explaining course material "sometimes" or "never." The distribution of answers over these variables is shown in terms of conditional probability in Table 7.

Table 7: Conditional probabilities - $P(Asked\ another\ student\ for\ help|Explained\ course\ material\ to\ others)$

		Explained course material to one or more students		
		Very Often/Often	Sometimes/Never	All students
Asked another student to help you understand course material	Very Often/Often	54.34%	24.60%	40.62%
	Sometimes/Never	45.66%	75.40%	59.38%

In general, "Explained course material to one or more students" appears to be a key variable, with edges to 6 other variables in the graphical model excluding department. These associations include 3 of the other 5 Learning With Others variables and 3 variables from other categories, as summarised in Table 8. All of these associations are monotonic and positive (positive Spearman's ρ), with agreement with "Explained course material…" being associated with higher likelihood of agreement with the other questions.

Table 8: Variables associated with "Explained course material to one or more students"

Variable	Category	PMI	Spearman's ρ
Asked another student to help you understand course material	Learning With Others	0.0674	0.3019
Prepared for exams or assessments by discussing or working through course material with other students	Learning With Others	0.0465	0.2526
Asked questions in taught sessions or contributed to discussions about course material in other ways	Interaction With Staff	0.0405	0.2354
Worked with other students on course projects or assignments	Learning With Others	0.0329	0.2131
Working with staff to evaluate teaching and assessment practices	Staff-Student Partnership	0.0263	0.1896
Connected ideas from your course to your prior experience and knowledge	Reflecting And Connecting	0.0195	0.1644

Learning with others and Interaction with staff

In the graph without Department, the Learning with others variable "Explained course material to one or more students" is correlated with the Interaction with staff variable "Asked questions in taught sessions or contributed to discussions about course material in other ways" (PMI 0.0405) and the Learning with others variable "Worked with other students on course projects or assignments" is correlated with the Interaction with staff variable "Worked with teaching staff on activities other than coursework" (PMI 0.0226).

Students who reported explaining course material to others frequently were 1.77 times more likely to also report asking questions in taught sessions frequently (see Table 9). This may be a result of greater confidence on the part of some students; it seems plausible that students who feel that they understand course material well enough to explain it to others may also feel confident in contributing to discussions in class.

Table 9: Conditional probabilities - P(Asked questions in taugh sessions|Explained course material to others)

		Explained course material to one or more students		
		Very Much/Quite a bit	Some/Very little	All students
Asked questions in taught sessions…	Very Much/Quite a bit	53.92%	30.53%	43.13%
	Some/Very little	46.08%	69.47%	56.87%

Students who reported working with other students on course projects or assignments frequently were 2.67 times more likely to report that they worked with teaching staff on non-coursework activities frequently (see Table 10). This may be of particular interest, since students who report working with staff on non-coursework activities seem to be relatively rare in general (only 15% of students).

Table 10: Conditional probabilities - P(Worked with teaching staff|Worked with other students)

		Worked with other students on course projects or assignments		
		Very Much/Quite a bit	Some/Very little	All students
Worked with teaching staff on activities other than coursework	Very Much/Quite a bit	19.91%	7.47%	15.06%
	Some/Very little	80.09%	92.53%	84.94%

Critical Thinking and Course Challenge

All Critical Thinking variables are positively correlated with each other, of the six pairings, the strongest is between "Evaluating or judging a point of view, decision or information source" and "Analysing ideas or theories in depth" (PMI 0.1350), this is the 7th strongest association found in the graphical model with department excluded. All associations between Critical Thinking variables are relatively strong, with PMI≥0.05 bits and p-value from χ^2 test for pairwise independence of less than 0.0001. There is particularly strong evidence of a distinct subset of students who report that their course emphasises all four identified critical thinking skills.

In the graph without department, all Critical Thinking variables are correlated with the Course Challenge variable "How much has your course challenged you to do your best work?" In general, students who agreed that their course emphasised critical thinking skills as defined in the survey were more likely to agree that their course challenged them to do their best work. The strongest of these associations is with "Evaluating or judging a point of view, decision or information source, with a PMI of 0.0322. Figure 4 displays this relationship as a subgraph of the larger graphical model.

The distribution of answers over these variables is shown in terms of conditional probability in Table 11. 9 in 10 students who agreed that their course emphasised this particular skill also agreed that

their course challenged them to do their best work, compared with 7 in 10 students who did not agree that their course emphasised evaluating points of view.
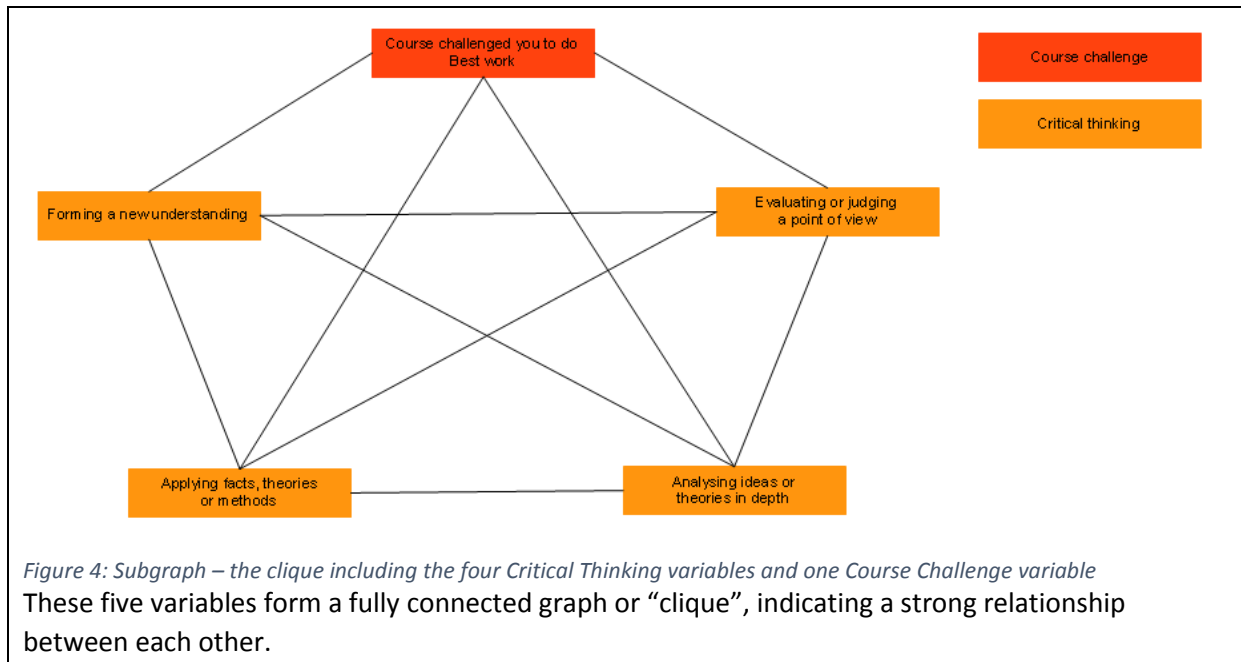

Figure 4: Subgraph – the clique including the four Critical Thinking variables and one Course Challenge variable
These five variables form a fully connected graph or "clique", indicating a strong relationship between each other.

Table 11: Conditional probabilities - P(Course challenged to do best work|Evaluating a point of view)

		Evaluating or judging a point of view, decision or information source		
		Very Much/Quite a bit	Some/Very little	All students
How much has your course challenged you to do your best work?	Very Much/Quite a bit	91.11%	74.42%	86.20%
	Some/Very little	8.89%	25.58%	13.80%

Age

In the graphical model excluding department, evidence can be seen of some differences in how older students engage with their course and in how they spend their time (see Figure 3). Table 12 illustrates these differences, in particular older students appear to be less likely to seek help from other students in understanding course material, but more likely to ask questions or contribute to discussions in taught sessions. In terms of how time is spent, older students are more likely to spend more time engaging in independent study and paid work and nearly ten times more likely to spend a larger proportion of their time providing care for dependants.

This is not entirely surprising, but provides us with a profile of older students:

- More likely to have life commitments outside of their course
- More likely to engage in discussion during taught sessions

- Less likely to seek help from other students

Table 12: Conditional probability for several variables given age

Age	Asked another student to help you understand course material	Asked questions in taught sessions or contributed to discussions about course material in other ways	Time spent in independent study	Working for pay	Providing care for dependants (children, parents, etc.)
	Very often/Often	Very often/Often	More than 10 hours	More than 10 hours	More than 10 hours
Under 26	42.12%	40.17%	34.20%	25.83%	4.09%
26+	29.72%	64.62%	51.42%	40.57%	39.62%
All ages	40.62%	43.13%	36.28%	27.61%	8.39%

Appendix: Tables of associations

This section contains two tables showing all associations present in the two graphs of the data discussed in this report.

Table 13: Pairwise associations in graph including department, ordered by PMI

Variable 1	Variable 2	PMI
Working with staff to make improvements to your course	Working with staff to evaluate teaching and assessment practices	0.3792
Contributing to a joint community of staff and students	Working with staff to make improvements to your course	0.1801
Contributing to a joint community of staff and students	Working with staff to evaluate teaching and assessment practices	0.1798
Discussed your academic performance and/or feedback with teaching staff	Talked about your career plans with teaching staff or advisors	0.1613
Discussed your academic performance and/or feedback with teaching staff	Discussed ideas from your course with teaching staff outside taught sessions, including by email/online	0.1412
Analysing ideas or theories in depth	Evaluating or judging a point of view, decision or information source	0.1350
Examined the strengths and weaknesses of your own views on a topic or issue	Tried to better understand someone else's views by imagining how an issue looks from his or her perspective	0.1324
Talked about your career plans with teaching staff or advisors	Discussed ideas from your course with teaching staff outside taught sessions, including by email/online	0.1239
Evaluating or judging a point of view, decision or information source	Forming a new understanding from various pieces of information	0.1121
Discussed your academic performance and/or feedback with teaching staff	Made significant changes to your work based on feedback	0.1116
Asked another student to help you understand course material	Prepared for exams or assessments by discussing or working through course material with other students	0.1075
Discussed ideas from your course with teaching staff outside taught sessions, including by email/online	Worked with teaching staff on activities other than coursework	0.1057
Applying facts, theories or methods (for example to practical problems or new situations)	Analysing ideas or theories in depth	0.1048
Tried to better understand someone else's views by imagining how an issue looks from his or her perspective	Changed the way you thought about a concept or issue as a result of what you learned	0.1015
Place of residence	Ethnic group	0.0992
Combined ideas from different modules when completing assignments	Connected your learning to real-world problems or issues	0.0990
Talked about your career plans with teaching staff or advisors	Worked with teaching staff on activities other than coursework	0.0976
Asked questions in taught sessions or contributed to discussions about course material in other ways	Discussed your academic performance and/or feedback with teaching staff	0.0969
Connected your learning to real-world problems or issues	Examined the strengths and weaknesses of your own views on a topic or issue	0.0936

Worked with other students on course projects or assignments	Department	0.0936
Combined ideas from different modules when completing assignments	Examined the strengths and weaknesses of your own views on a topic or issue	0.0900
Changed the way you thought about a concept or issue as a result of what you learned	Connected ideas from your course to your prior experience and knowledge	0.0890
Examined the strengths and weaknesses of your own views on a topic or issue	Connected ideas from your course to your prior experience and knowledge	0.0855
Providing care for dependants (children, parents, etc.)	Age	0.0819
Asked questions in taught sessions or contributed to discussions about course material in other ways	Department	0.0811
Connected your learning to real-world problems or issues	Connected ideas from your course to your prior experience and knowledge	0.0810
Made significant changes to your work based on feedback	Combined ideas from different modules when completing assignments	0.0810
Asked questions in taught sessions or contributed to discussions about course material in other ways	Discussed ideas from your course with teaching staff outside taught sessions, including by email/online	0.0796
Analysing ideas or theories in depth	Forming a new understanding from various pieces of information	0.0785
Discussed your academic performance and/or feedback with teaching staff	Working with staff to evaluate teaching and assessment practices	0.0771
Time spent in taught sessions	Department	0.0765
Discussed ideas from your course with teaching staff outside taught sessions, including by email/online	Working with staff to make improvements to your course	0.0714
Made significant changes to your work based on feedback	Examined the strengths and weaknesses of your own views on a topic or issue	0.0685
Explained course material to one or more students	Asked another student to help you understand course material	0.0674
Worked with teaching staff on activities other than coursework	Working with staff to evaluate teaching and assessment practices	0.0644
Applying facts, theories or methods (for example to practical problems or new situations)	Forming a new understanding from various pieces of information	0.0644
Combined ideas from different modules when completing assignments	Connected ideas from your course to your prior experience and knowledge	0.0636
Worked with teaching staff on activities other than coursework	Contributing to a joint community of staff and students	0.0565
During the current academic year, how much has your course emphasised taking responsibility for your own learning?	During the current academic year, how much has your course challenged you to do your best work?	0.0564
Age	Department	0.0554
Made significant changes to your work based on feedback	Changed the way you thought about a concept or issue as a result of what you learned	0.0538

Discussed ideas from your course with teaching staff outside taught sessions, including by email/online	Combined ideas from different modules when completing assignments	0.0519
Qualification	Department	0.0517
Year of study	Department	0.0503
Worked with other students on course projects or assignments	Prepared for exams or assessments by discussing or working through course material with other students	0.0498
Connected your learning to real-world problems or issues	Department	0.0459
Explained course material to one or more students	Asked questions in taught sessions or contributed to discussions about course material in other ways	0.0405
Forming a new understanding from various pieces of information	Working with staff to evaluate teaching and assessment practices	0.0395
Evaluating or judging a point of view, decision or information source	Department	0.0395
Forming a new understanding from various pieces of information	Made significant changes to your work based on feedback	0.0353
Worked with other students on course projects or assignments	Explained course material to one or more students	0.0329
Applying facts, theories or methods (for example to practical problems or new situations)	During the current academic year, how much has your course challenged you to do your best work?	0.0319
Working for pay	Department	0.0296
Time spent in independent study	Department	0.0288
Applying facts, theories or methods (for example to practical problems or new situations)	Connected your learning to real-world problems or issues	0.0266
Explained course material to one or more students	Working with staff to evaluate teaching and assessment practices	0.0263
Worked with other students on course projects or assignments	Combined ideas from different modules when completing assignments	0.0239
Analysing ideas or theories in depth	Changed the way you thought about a concept or issue as a result of what you learned	0.0235
Prepared for exams or assessments by discussing or working through course material with other students	Working with staff to make improvements to your course	0.0225
Face to face/distance	Department	0.0223
Doing volunteer work	Department	0.0204
During the current academic year, how much has your course challenged you to do your best work?	Working with staff to evaluate teaching and assessment practices	0.0196
Explained course material to one or more students	Connected ideas from your course to your prior experience and knowledge	0.0195
Providing care for dependants (children, parents, etc.)	Commuting to campus (driving, walking, etc.)	0.0137
Time spent in independent study	Commuting to campus (driving, walking, etc.)	0.0119

Participating in extra-curricular or co-curricular activities (societies, sports, etc., via the institution or the students' union)	Doing volunteer work	0.0116
Qualification	Year of study	0.0114
Disability	Ethnic group	0.0097
Working for pay	Age	0.0078
Time spent in taught sessions	Year of study	0.0062
Asked another student to help you understand course material	Age	0.0051

Table 14: Pairwise associations in graph excluding department, ordered by PMI

Variable 1	Variable 2	PMI
Working with staff to make improvements to your course	Working with staff to evaluate teaching and assessment practices	0.3792
Discussed your academic performance and/or feedback with teaching staff	Talked about your career plans with teaching staff or advisors	0.1613
Examined the strengths and weaknesses of your own views on a topic or issue	Tried to better understand someone else's views	0.1324
Talked about your career plans with teaching staff or advisors	Discussed ideas from your course with teaching staff outside taught sessions, including by email/online	0.1239
Discussed your academic performance and/or feedback with teaching staff	Made significant changes to your work based on feedback	0.1116
Asked another student to help you understand course material	Prepared for exams or assessments by discussing or working through course material with other students	0.1075
Applying facts, theories or methods (for example to practical problems or new situations)	Analysing ideas or theories in depth	0.1048
Tried to better understand someone else's views	Changed the way you thought about a concept or issue as a result of what you learned	0.1015
Place of residence	Ethnic group	0.0992
Talked about your career plans with teaching staff or advisors	Worked with teaching staff on activities other than coursework	0.0976
Asked questions in taught sessions or contributed to discussions about course material in other ways	Discussed your academic performance and/or feedback with teaching staff	0.0969
Examined the strengths and weaknesses of your own views on a topic or issue	Connected ideas from your course to your prior experience and knowledge	0.0855
Providing care for dependants (children, parents, etc.)	Age	0.0819
Connected your learning to real-world problems or issues	Connected ideas from your course to your prior experience and knowledge	0.0810
Made significant changes to your work based on feedback	Combined ideas from different modules when completing assignments	0.0810
Asked questions in taught sessions or contributed to discussions about course material in other ways	Discussed ideas from your course with teaching staff outside taught sessions, including by email/online	0.0796
Analysing ideas or theories in depth	Forming a new understanding from various pieces of information	0.0785
Discussed your academic performance and/or feedback with teaching staff	Working with staff to evaluate teaching and assessment practices	0.0771
Discussed ideas from your course with teaching staff outside taught sessions, including by email/online	Made significant changes to your work based on feedback	0.0702
Asked questions in taught sessions or contributed to discussions about course material in other ways	Worked with teaching staff on activities other than coursework	0.0663
Worked with teaching staff on activities other than coursework	Working with staff to evaluate teaching and assessment practices	0.0644

Combined ideas from different modules when completing assignments	Changed the way you thought about a concept or issue as a result of what you learned	0.0642
Combined ideas from different modules when completing assignments	Connected ideas from your course to your prior experience and knowledge	0.0636
Applying facts, theories or methods (for example to practical problems or new situations)	Evaluating or judging a point of view, decision or information source	0.0630
Tried to better understand someone else's views	Connected ideas from your course to your prior experience and knowledge	0.0604
Worked with teaching staff on activities other than coursework	Contributing to a joint community of staff and students	0.0565
How much has your course emphasised taking responsibility for your own learning?	How much has your course challenged you to do your best work?	0.0564
Made significant changes to your work based on feedback	Changed the way you thought about a concept or issue as a result of what you learned	0.0538
Worked with other students on course projects or assignments	Prepared for exams or assessments by discussing or working through course material with other students	0.0498
Asked questions in taught sessions or contributed to discussions about course material in other ways	Connected your learning to real-world problems or issues	0.0487
Explained course material to one or more students	Prepared for exams or assessments by discussing or working through course material with other students	0.0465
Examined the strengths and weaknesses of your own views on a topic or issue	Working with staff to evaluate teaching and assessment practices	0.0451
Explained course material to one or more students	Asked questions in taught sessions or contributed to discussions about course material in other ways	0.0405
Tried to better understand someone else's views	Working with staff to evaluate teaching and assessment practices	0.0398
Forming a new understanding from various pieces of information	Made significant changes to your work based on feedback	0.0353
Evaluating or judging a point of view, decision or information source	Changed the way you thought about a concept or issue as a result of what you learned	0.0335
Worked with other students on course projects or assignments	Explained course material to one or more students	0.0329
Evaluating or judging a point of view, decision or information source	How much has your course challenged you to do your best work?	0.0322
Forming a new understanding from various pieces of information	How much has your course challenged you to do your best work?	0.0321
Applying facts, theories or methods (for example to practical problems or new situations)	How much has your course challenged you to do your best work?	0.0319
Evaluating or judging a point of view, decision or information source	Contributing to a joint community of staff and students	0.0305

Applying facts, theories or methods (for example to practical problems or new situations)	Connected your learning to real-world problems or issues	0.0266
Explained course material to one or more students	Working with staff to evaluate teaching and assessment practices	0.0263
Analysing ideas or theories in depth	How much has your course challenged you to do your best work?	0.0256
Applying facts, theories or methods (for example to practical problems or new situations)	Contributing to a joint community of staff and students	0.0249
Worked with other students on course projects or assignments	Combined ideas from different modules when completing assignments	0.0239
Analysing ideas or theories in depth	Changed the way you thought about a concept or issue as a result of what you learned	0.0235
Worked with other students on course projects or assignments	Worked with teaching staff on activities other than coursework	0.0226
Explained course material to one or more students	Connected ideas from your course to your prior experience and knowledge	0.0195
Participating in extra-curricular or co-curricular activities	Doing volunteer work	0.0116
Qualification	Year of study	0.0114
Working for pay	Ethnic group	0.0110
Time spent in taught sessions	Time spent in independent study	0.0098
Disability	Ethnic group	0.0097
Time spent in independent study	Age	0.0095
Prepared for exams or assessments by discussing or working through course material with other students	How much has your course challenged you to do your best work?	0.0093
Working for pay	Age	0.0078
Working for pay	Year of study	0.0075
Doing volunteer work	Year of study	0.0067
Time spent in taught sessions	Year of study	0.0062
Asked another student to help you understand course material	Age	0.0051
Time spent in taught sessions	Face to face/distance	0.0043
Qualification	Face to face/distance	0.0033