An Evaluation of Blended Learning Components of the Cisco Network Academy Using a Rasch Model

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***Abstract*—The blended model of e-learning espoused by the Network Academy curriculum involves the interaction of students with its various components - online content, laboratory exercises, simulations, online assessment, texts and most importantly instructors. These components were evaluated from the student viewpoint using two surveys and data from the final online examination. The analysis used a Rasch probabilistic model. This was done in the West Australian, and in the case of the online examination, an Australia-wide context.**

Keywords-curriculum evaluation; blended learning; Rasch model, student

I INTRODUCTION

This is part of a wider study to evaluate the Network Academy curriculum in secondary and post-secondary academies in Western Australia, looking at the intended, implemented, achieved and perceived curriculum [1][2] from the point of view of various stakeholders - students, instructors, employers and Cisco.

Considerable research has been carried out into the value of the Network Academy in various educational settings [3][4]. In this study students were asked to respond to two online surveys [5], one at the beginning of their course and another later in their course. For the first survey, the 175 respondents comprised 12 secondary students (7%), 109 Technical and Further Education (TAFE) students (62%) and 54 university students (31%). 135 of these students (76%) studied full time and 42 part time (24%). 20% of these students (36) were in full time employment, 38% in part time employment (66) and 42% not employed (73). In the second survey, the 93 respondents were comprised of 13 secondary (14%), 56 TAFE (60%) and 24 university (26%) students. The responses to the final online examination for the Exploration curriculum for the first semester, 2010, were also analysed. This involved 750 students drawn from academies across Australia.

Analyses of surveys and examination were performed using a Rasch probabilistic model, which yields precise, interval-level measures of both person (ability) and item (difficulty). This model was used to investigate if it could give additional insight beyond that derived from standard analysis.

II WHY DO STUDENTS STUDY THE CURRICULUM? THE INTENDED CURRICULUM

It was anticipated that students would take the Network Academy course for a wide variety of reasons, chiefly centred on their current and future study goals and their employment considerations

In order to gain further insight into the survey responses, the data was analysed using RUMM2030[6]. The summary of the analysis indicates that the data fits the Rasch model [7]. Both the reliability indices and the power of test-of-fit indicate that the data was suitable for analysis using this approach.

TABLE 1. FIRST SURVEY RESULTS

Survey Item	Description	Location (Difficulty to Endorse)	Fit Residual (Rasch Model Fit)	Standard Error of Estimate
7	Graduation	-0.28	0.24	0.087
8	Further Education	0.008	-0.204	0.086
9	Job	-0.662	0.24	0.098
10	Current Job	0.55	2.211	0.074
11	Interest	0.714	1.057	0.081
12	Peers	1.529	2.294	0.082
13	Practical	-0.798	-0.206	0.107
14	Theory	-0.852	-0.913	0.112
15	Certification	-0.209	0.389	0.082

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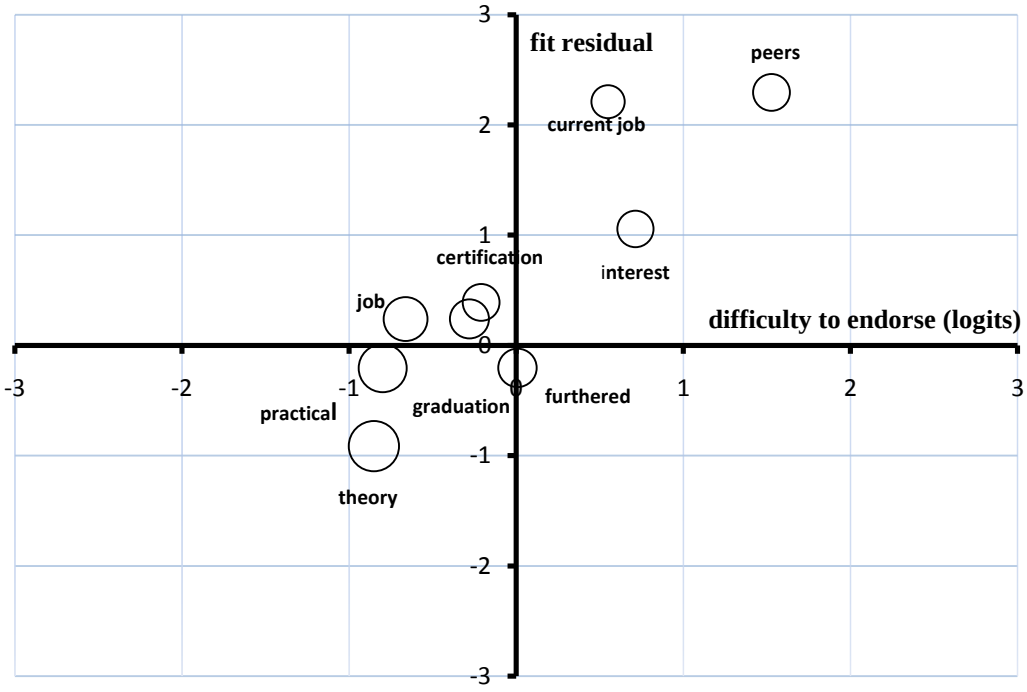

Figure 1. Intended curriculum

Table 1 shows the item details for the first survey. This displays the difficulty to endorse (Location), the test of fit (Fit Residual) and the standard error of the measurement of the Location. The unit of measurement for Location is logit (log odds). In this context, the more negative the Location for an item the easier it is for the respondent to endorse the body of the item. That is, the more negative the item's Location the stronger is the agreement of the respondent to the item's statement. The Fit Residual, as listed here, measures the correspondence of the data with the model. It represents the standardized difference between the actual data and the values calculated using the item estimates and the mathematical model. It is considered acceptable fit if the Fit Residual lies between +2 and -2. Values between 2 and 2.5 and between -2 and -2.5 are considered marginal. Values above 2.5 and below -2.5 are considered to represent poor fit to the model. The standard error estimates are meant to indicate the degree of uncertainty in the Location values for a particular item. It is considered a bonus for this method of analysis that each item has its own estimate of error. With classical test theory the standard error is calculated to be the same for all items.

It can be seen from Table 1 that the items vary significantly in difficulty to endorse, and that most items fit the model, with the exception of items 4 and 6, which have only marginal fit. If the data is presented as a bubble plot (Fig. 1), the differences between the items become more evident.

In this plot difficulty to endorse is plotted horizontally and fit residual vertically. The width of the bubbles represents the standard error (each bubble's width is approximately shown as double the value of the standard error).

It is evident that the strongest intentions of the students were to gain theoretical and practical knowledge and to enhance their employment prospects. To a lesser extent, the opportunity to progress towards graduation and certification and also to prepare for further education were seen to be important. Pursuing the course as a matter of interest was not well endorsed. The fact that three quarters of the cohort were not employed means that the responses to the item asking whether they thought that the course would help in their current employment was less reliable. This item did not have a good fit to the model. The influence of peers on their decision to take the course was not endorsed, and the relevant item was not a good fit to the model. Perhaps this reflects the large age range and variability of maturity and experience of the cohort. Table 2 shows the results for the analysis of the second survey. These results are used to investigate the implemented and perceived curriculum.

III HOW DO STUDENTS STUDY THE IMPLEMENTED CURRICULUM?

Subjecting the data from the second student survey to analysis using RUMM2030 indicated that the data had an excellent fit to the model. Once again, graphical representation of the data indicates significant differences in endorsement of the items by students. Although the item data is shown in the one table, different groups of items represented particular features of the analysis.

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TABLE 2. SECOND SURVEY RESULTS

Item	Description	Location (Difficulty to endorse)	Fit Residual	Standard error	Item	Description	Location (Difficulty to endorse)	Fit Residual	Standard error
5	Online	-1.513	0.057	0.137	37	Explain Solutions	-1.141	0.399	0.146
6	Texts	0.264	0.194	0.114	38	Teamwork	-1.933	1.15	0.127
7	Lecture	-0.19	-0.345	0.125	39	Work/Others	-1.479	3.446	0.125
8	Labs	-1.594	-0.783	0.13	40	Learn/Others	-1.791	2.655	0.127
9	Packet Tracer	-0.27	5	0.121	41	Self Paced	-2.235	1.156	0.134
10	Tests	-0.336	-0.022	0.124	42	Relate/Contexts	0.977	0.092	0.112
11	Cases	0.509	0.087	0.109	43	Interest	0.692	-0.199	0.126
12	Others	0.318	0.089	0.121	44	Ability Match	0.292	-0.308	0.135
13	Explanation	-0.298	-0.156	0.125	45	Control/Learning	0.206	-0.212	0.124
14	Icg	0.72	0.128	0.114	46	Use Feedback	0.036	-0.064	0.127
15	Other Networks	0.567	0.082	0.108	47	Understanding	0.071	-0.222	0.127
16	Online	-0.042	0.001	0.165	48	Relevant	-0.351	-0.116	0.134
17	Packet Tracer	-0.837	0.234	0.199	49	Important	-0.029	-0.252	0.122
18	Tests	-0.309	-0.002	0.175	50	Weaknesses	0.005	0.044	0.119
19	Discussions	-0.614	-0.214	0.19	51	Explain	0.198	-0.152	0.104
20	Labs	-0.776	-0.285	0.199	52	Pace	0.408	-0.311	0.122
21	Texts	-0.001	-0.058	0.188	53	Examples	0.488	-0.37	0.124
22	Lectures	-0.447	-0.495	0.179	54	Involvement	0.524	-0.221	0.134
23	Quest/Contrib	0.298	0.397	0.144	55	Texts	0.88	0.213	0.116
24	Presentation	1.863	0.126	0.135	56	Effective	0.09	-0.395	0.107
25	Presentation	1.815	0.142	0.13	57	Prepared	-0.581	-0.35	0.141
26	Unprepared	1.198	0.741	0.132	58	Clear Course	0.524	-0.161	0.125
27	Worked/ Others	0.181	0.614	0.132	59	Good Answers	-0.602	-0.73	0.131
28	Mentor	1.543	0.155	0.149	60	Difficulty	0.281	-0.213	0.129
29	Extra-Curricular	1.88	0.134	0.141	61	Activities	-1.395	-1.619	0.147
30	Challenged	-0.99	1.534	0.225	62	Cases	0.413	-0.106	0.145
31	Discuss Ideas	0.872	-0.117	0.126	63	Working/ Others	0.187	0.104	0.124
32	Give Opinions	1.104	0.054	0.124	64	Well Matched	-0.025	-0.118	0.147
33	Inst Questions	0.823	0.164	0.125	65	Understanding	-0.277	-0.12	0.143
34	Ideas Used	1.894	-0.003	0.124	66	Available	-1.682	0.428	0.137
35	Quest/Contrib	0.246	0.276	0.118	67	Attitude	0.369	-0.172	0.111
36	Problem Solving	-0.999	0.664	0.166					

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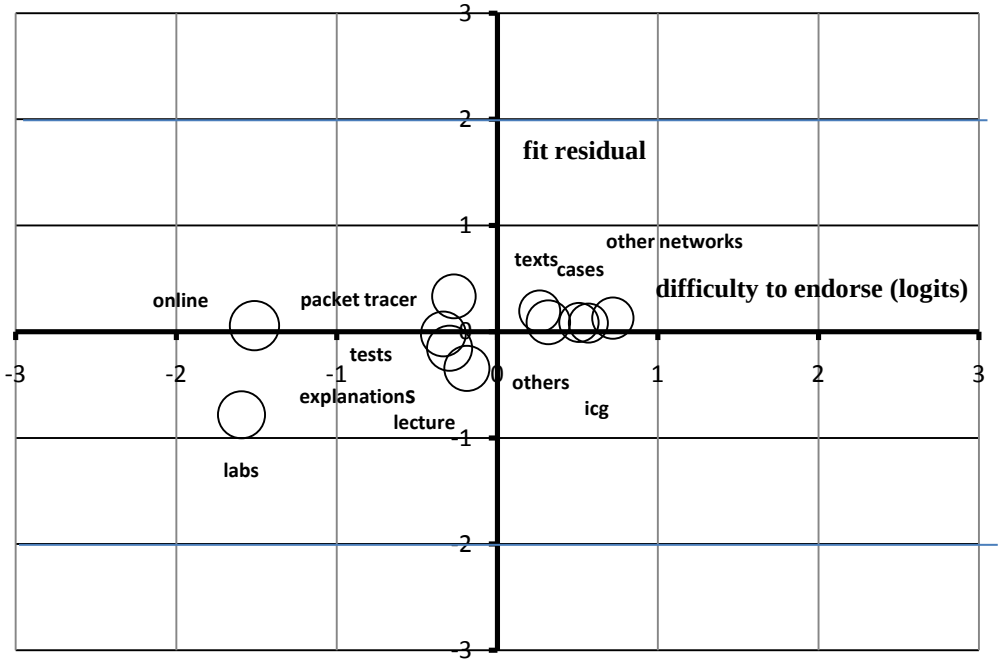

Figure 2. Implemented Curriculum

The items relating to student implementation of the curriculum (items 5 to 15) were concerned with the strategies found most effective by the students to proceed through the curriculum. The results of this analysis are shown in Fig 2. The fit residuals and standard errors indicate that all items have a good fit and that there are broadly three groups of items when comparing aspects relating to students' difficulty in endorsement. Clearly the online curriculum and the laboratory exercises were the most important resources for the students. The second most important group of resources included quizzes and chapter tests, simulations (Packet Tracer), explanations by the instructor and the lecture presentations by the instructor. The least important resources included texts, working with other students, case studies, working with other networks outside the laboratory and interactive course guides. This rating of importance of resources is confirmed by class observation. It is interesting to note that the online assessment resources are rated as highly as the interaction with the instructor. Interactive Course Guides were not commonly used by students as they were a recent innovation and targeted chiefly at the instructors.

Another group of items (items 23 to 37) were related to the students' engagement in the class. This could be considered to be another aspect of how the students implemented the curriculum. The most strongly endorsed items (most negative Location) relate to the degree of academic challenge of the curriculum. Students were challenged by the course and frequently engaged in problem solving and explained solutions to their classmates. To a lesser extent students worked with others, asked questions and made contributions to the class. It is notable that students considered that they always prepared well for the classes. The other group of items could indicate that students rarely made unsolicited contributions to the class and did not work with other members of the class outside of scheduled class times.

A third group of items (items 38 to 42) indicated the learning style adopted by the students. These items suggest that students embraced the self-paced aspect of the curriculum and that when working in groups they felt that teamwork was important.. However, the material learnt in class was not well related to the non-class situation. Items relating to working with and learning from others were poorly fitting items and thus no conclusions may be drawn from their values.

IV. How Do Students Feel About the Curriculum? The Perceived Curriculum

When asked to rate the effectiveness of the components of the curriculum (items 16 to 22), the students' responses indicated that they perceived all of the components as effective. Once again the fit residuals indicate a good fit to the model. The fact that all items have a negative Location shows that all components were strongly endorsed as being effective. The spread of the Location of the items is smaller than for those items discussed previously. It may be inferred that the laboratory exercises and the simulations with Packet Tracer and classroom discussions were perceived as the most effective components of the course. The lectures, online assessment and online curriculum were in turn more effective than the texts.

On the other hand, some aspects of the curriculum were not endorsed as strongly. These items (items 43 to 45)

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appear to indicate that the students' perception of the curriculum materials was that they did not match their ability and interests, and that very little was left to the students' initiative as far as progression through the course was concerned. In effect, the Cisco course materials and the order in which they are presented is very much controlled by the instructors and course developers.

As part of the online aspect of the curriculum, the online assessment materials form an integral part of the package. The responses to items 46 to 50 indicated that the assessments are viewed as well matched to the curriculum, and an important resource in the overall package. The feedback delivered with the assessment results and the use of assessment to discover weaknesses and generally help with the understanding of course material are not always perceived as helpful.

Instructors are an integral part of this blended e-learning initiative. The role and effectiveness of instructors, as perceived by the students, is an important aspect of the curriculum evaluation. The items relating to students' perception of the instructors (items 51 to 62) fit the model well and there is some significant variation in difficulty to endorse the statement in the item. The class activities chosen by the instructor were strongly endorsed. The preparation of the instructor and his/her response to in-class questions were well regarded. The pace at which the course was conducted, the student involvement in the class, the number and quality of the examples chosen by the instructor, the teaching effectiveness, the clarity of the scope of the course, the difficulty level of the course materials and the case studies used by the instructor were not endorsed. The printed material of the course was least strongly endorsed.

The final group of questions (items 63 to 67) relate to the overall perception of the curriculum. The most strongly endorsed perception was that the instructor was freely available for consultation. The course content was well matched to the abilities and expectations of the students and led to increase understanding of course content. The value of working with other students was less strongly endorsed. The overall attitude to coming to class probably reflects the challenging nature of the curriculum materials.

V. WHAT DO STUDENTS GET OUT OF THE CURRICULUM? THE ACHIEVED CURRICULUM

An analysis of the response from all of the students in Australia for the final Exploration examination (Semester one, 2010) were analysed using RUMM2030. All except two of the 120 items in the item bank returned an acceptable level of fit to the model. An analysis such as this might lead to a modification or removal of the poorly fitting items, which in the current situation merely add 'noise' to the assessment of student ability.

The person fit as estimated in the first analysis indicated that students' responses conformed well to the model. Those students with perfect scores (ten students) were classified as having a poor fit to the model, since the ability estimate could not be made. Only one other student in the group of 750 had a poor fit to the model.

The ability (Location) frequency graph (Fig 3) shows abrupt changes at 0, 0.4, 1.1 and 1.5. If these are used to signify boundaries of different ability groups, then those students above 1.5 (raw score 95) could be awarded an A, those between 1.1 (raw score 90) and 1.5 a B, those between .4 (raw score 70) and 1.1 a C, those between 0 (raw score 50) and .4 a D and those below 0 an E. Examination of the frequency distributions for each of the module tests suggests a very similar distribution of abilities and this suggests that this could be a feasible approach to awarding grades.

When managing the assessment for the class, the instructor can stipulate the form with which the students are confronted when they access the test. The data analysed for the Australian cohort consists of responses to three forms, each comprising a subset of the 120 items in the item pool. Rasch analysis of the data provides a means of comparing the ability estimates made with the different forms. The 'equating tests' option of RUMM2030 provides a graphical indication of the relative difficulty of different tests which are made up of different selections of items from a pool of calibrated items. The resulting graph for the three forms of the final module examination is displayed in Figure 4 and this shows that the ability measure (Location) over the whole range of scores is essentially independent of the form used. Students are not disadvantaged by being assigned one form rather than another.

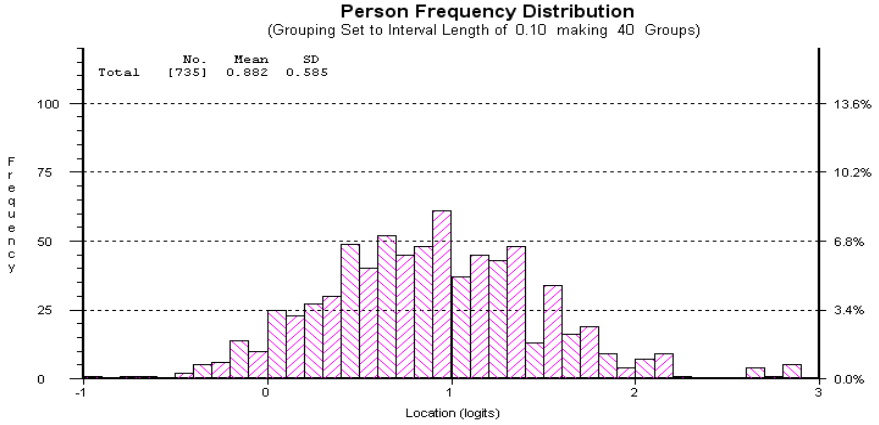

Figure 3. Ability Frequency Distribution

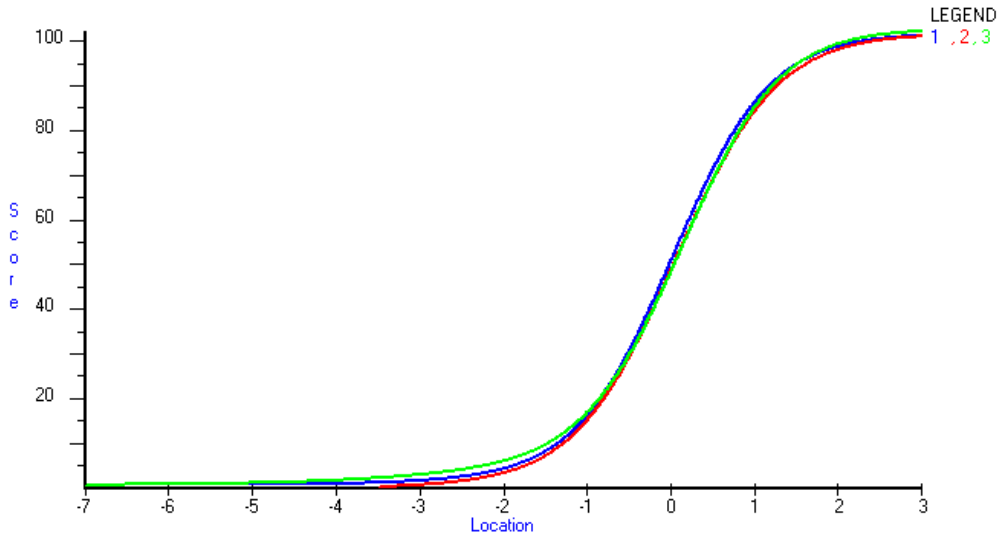

Figure 4. Comparison of Different Forms

VI. CONCLUSION

The study indicates that Rasch analysis is appropriate for an in-depth evaluation of the components comprising the blended model of e-learning used in the Network Academy curriculum. Such an evaluation may be useful in refining the various components, guiding the relative importance given to particular components by the different stakeholders and modifying student recruitment strategies of educational institutions.

The chief expectations for students were that the curriculum would enhance their practical skills and theoretical knowledge as well as improve their prospects for employment. The online content and laboratory exercises, online assessment and instructor centred activities provided the means by which the students progressed through the program. The importance of the instructor's role is evident in the students' perception of this style of e-learning. Analysis of the online examinations shows that they are a fair and reliable tool for assessing student ability. It is clear, however, that a Rasch analysis of the data adds value to the procedure.

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