Learning With Model-Supported Case Studies

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ABSTRACT

Management Flight Simulators (MFS) are now being used together with model-supported case studies in learning laboratories as part of undergraduate, graduate and executive courses, and also with managers in learning organisations. This paper reports results with three groups of undergraduate and postgraduate students, in a business school environment. With one group, a multi-stage experimental design is used to collect a variety of process data, including:

- students' evaluation of the learning experiences
- students' perception of learning achieved
- objective testing of students' understanding

Objective testing includes knowledge about the subject material and case-studies, and the direction of the relationships between variables in the MFS. The process data collected is analyzed and both quantitative and qualitative results are summarised. The results provide insights into the relative effectiveness of learning experiences that use model-supported case studies, as compared to conventional case-study discussion. Two further groups of students are used to compare performance in the MFS with scores on structured assignments (including questions on both the case study and the use of the MFS). A description of workshop protocols provides indications of how model-supported case studies may best be delivered in management teaching curricula.

Integrating Model-Supported Case Studies into Management Teaching

Courseware utilising model-supported case studies and management flight simulators (MFS) is being introduced into teaching programmes in business schools, as an alternative to conventional teaching of case studies (Graham et al 1989). But the use of computer-based simulations has traditionally been met with scepticism by many management educators, partly because of crude modelling and the generic context of many simulations (Thorne 1992). Keys and Wolfe (1990) review the management gaming literature, and discuss trends and future developments. They report that the business gaming literature is both wide-ranging and extensive, but they found about 60 rigorous studies that provide evidence as to business games' general yet problematic efficacy (for example see Neuhauser (1976) and Wolfe (1976)). Keys and Wolfe continue - "As equivocal as these findings are, many

of the claims and counterclaims for the teaching power of business games rest on anecdotal material or inadequate or poorly implemented research designs" (p.311). Wheatley et al. (1988) report recently that the debate over the instructional value of gaming ranges unabated. They suggest that rigorous research methods can be used in evaluating the effectiveness of gaming in business policy instruction. For example using the pretest-posttest research design on experimental groups allows for randomisation, a control group, control of the treatment variables, and a measurable performance variable.

The workshops reported in this paper are part of an initiative to integrate model-supported case studies into teaching programmes in the London Management Centre (LMC) at the University of Westminster. The LMC hosts 12 undergraduate and postgraduate degree programmes, with 60 full-time and 80 part-time teaching staff, and over 1600 full-time and part-time students. Such an initiative raises issues relating to resourcing (computer hardware, software and staffing), training of staff to deliver the teaching, and the acceptance of gaming as a valid learning experience. Colleagues are very concerned that there is an opportunity cost for student learning in spending time playing games. On the positive side, there is much interest within the LMC (and indeed the university as a whole) in new technologies that enrich the students' learning experiences (particularly in those that are computer-based). The LMC is well resourced for delivering computer-based teaching, with 9 PC labs, 3 Apple Mac labs, teaching staff involved in computer-based learning research and development projects, several technicians and applications programmers, generous budgets to buy software and courseware, and adequate budgets to fund teaching staff development and training.

Workshop Design

Morecroft (1992 and 1993) discusses the design of workshops that include appropriate briefing materials, and the need for a gaming protocol to encourage reflection, discussion and discovery. Similarly, Andersen et al (1990) stress the importance of not expecting students to learn from outcome feedback alone (ie. just playing the game), and to focus on cognitive debriefing to help student reflection. In using the People Express MFS (Sterman 1988) and the B&B Enterprises MFS (Sterman 1991a), we have the benefit of comprehensive and well prepared briefing materials, and an acceptable computer gaming interface. Our workshops were designed to conform to best current practice as suggested in the recent literature, and involved: student preparation of the case study and briefing materials at home prior to the workshop, small group work on the case (considering 8 questions set to guide their discussion), plenary discussion of the case using a systems thinking and feedback loop structure framework, demonstration of the MFS protocol using a projection palette, student experiential learning using the MFS (supervised by two tutors for each group of 20 students), reflection and discussion through a debriefing which included student presentations using electronically saved games, and an assignment on the case study and MFS over an extended time period to consolidate the learning experience.

Peterson (1990) provides further suggestions for protocol design, particular for computer interfaces. One point relates to "using context to advantage". One group of students (personnel management specialists) were particularly interested in the human resource management issues in People Express. Another group, electronic and control engineering students who had been previously trained in control theory, were particularly interested in the feedback-loop structure approach to management policy. Also, as keen users of *Sega* and *Nintendo* products, they could relate to the duopoly competitive environment as presented in the B&B Enterprises MFS.

Evaluation

Evaluation of the game/learning protocols, and the measurement of the effectiveness of the model-with-case technique is discussed in Graham et al (1989, p.324). There are difficulties in using some measures of learning - "the closer a measure is to measuring actual usefulness, the more logistical and control difficulties it presents". Measurement instruments are also discussed in Bakken et al (1992), responding to criticisms of earlier effectiveness measurement research made by Wolfe (1976).

My evaluation questionnaires were constructed under guidelines from Gronlund (1982). I included a student self-evaluation of learning achieved, an objective multiple-choice test on the case study, an objective multiple-choice test on the direction of relationships between variables in the model driving the gaming simulator, and a structured assignment involving case study and game related questions completed over several weeks. Some of the assignment questions were based on prior work by Gould (1989). Game performance that is related to a clearly defined objective was also measured.

Game Performance

A word on the issue of measuring game performance. Although some older studies have reported that performance can be unrelated to understanding, Bakken (1989) found that game performance is a reasonable indicator of understanding of the structural dynamics of the model/game. These results were supported by Young at al (1992). My study looks at the link between performance and scores in objective tests, and more conventional assessment using class participation, coursework assignments, tests and exams.

A Personal Experience

My first experience of using the People Express model-supported case study was as a part-time MBA student in John Morecroft's Business Policy class, at London Business School in 1988. The People Express Management Flight Simulator was demonstrated using a projection palette to the whole class, and various groups were invited to "run" the software by calling out decisions to John. Although there was no "hands-on" use of the computer, there was much to learn. I was fascinated to watch a group of investment bankers "milk" the company as they built a formidable "cash cow". The demonstration seemed to fill an important gap in my understanding about portfolio strategies and corporate finance. I was interested in how a second group used various performance measures to drive their decision-making, asking John to rapidly switch between the different report screens. As an IT manager trying to develop decision-support systems in my own organisation, I though about how I could use a tool like this to prototype system designs with my users. I was intrigued that one couldn't hire and train people fast enough to deliver adequate service quality - my own mental model of "hiring is not a problem if there is an unemployed pool of people" was challenged. I'm afraid that I didn't learn much about feedback loop structures and delays - but I suspect that each student's learning is somewhat unique!

My own experiences with People Express influenced the design of this study. The overall approach was to gather data using a questionnaire about students who have used the MFS in various modules over the past year. The data gathered provided some interesting insights into the effectiveness of the various learning experiences, and some useful pointers to help improve the design of the learning environments that use this type of courseware.

Diploma in Personnel Management (DPM) Students

133 students taking the DPM course attended a block week module during June 1992, part of which involved the People Express case study and MFS. These students had just completed the first year of a two-year part-time course. People wanting to progress their careers in the Personnel Management field must obtain this Diploma. The first year of the course comprises mainly General Management modules, including Marketing, Accounting and Finance, Economics, Business Law, Managing Information, and Managing People. The second year consists of specialist modules in Personnel Management. The block-week involved a number of activities, and included a day spent on the People Express case study and MFS.

Student Demographics

20% of students were male, 80% female. 29% were aged 21-25, 42% were aged 26-30, and 29% were aged over 30. 13% had a postgraduate degree, 53% an undergraduate degree or professional qualification, and 34% had no degree (and left school at 18). 22% studied business studies or economics as their major, 6% science or engineering, 61% liberal or fine arts, and 11% did not state a major subject.

Student Evaluation of Learning Experiences

Students were asked 18 questions (on a 5 point Likert scale) about their evaluation of the subject matter of the case, the small group discussion, the plenary tutor-led discussion, the MFS workshop and subsequent debriefing, and the MFS briefing book. Scales used were useful/useless, boring/absorbing, difficult/easy, clear/confusing. Most of the feedback was positive. Students found the small group discussion of the case study questions very useful, and the MFS quite difficult to use but a very absorbing exercise. They found the explanations in the MFS briefing book very useful, but quite difficult to understand.

Students were also asked to state how long they had spent reading the People Express case study, and the People Express MFS Briefing book. The questionnaire was anonymous, and it was stressed in the rubric to these questions that "*the results would be used for research purposes only - please be truthful!!*". For the case study, 43% spent between 30 mins to 1 hour, 27% between 1-1½ hours, 18% less than 30 mins, and 12% greater than 1½ hours. For the MFS Briefing Book, 58% spent less than 30 mins, 29% between 30 mins to 1 hour, and 13% greater than 1 hour.

A multi-stage experimental design was used to evaluate students' interest in the subject matter, self-perception of learning achieved, knowledge of the case material, and understanding of direction of relationships between variables in the model. The students had been allocated to five groups at registration. Although not strictly a random group allocation, demographic data (age, sex, qualifications, major subject studied) showed little difference between the background and capabilities of students in the 5 groups. Each group carried out a number of similar activities in sequence - reading the People Express case at home, discussing the case in small groups of students with tutor assistance on demand, participating in a tutor-led plenary discussion of the case and watching Don Burr on video, and then participation in a workshop using the People Express MFS in pairs (supervised by two tutors) followed by a tutor-led debriefing. The MFS sessions were run by myself and a colleague, but the plenary discussions were conducted by five different tutors, all of whom had attended an induction session led by me to ensure that the case was taught in a similar fashion. The experimental design is shown in Table 1.

TABLE 1 - Experimental Design and Testing Schedule

X = Test after activity	Group:	1	2	3	4	5	Total
	No. Students:	30	24	27	27	25	133
Activity	**Time Spent**						
Read Case	(up to 3 hrs)	X					
Discuss Case in Small Groups	(1 hour)		X				
Plenary Case Discussion	(2 hours)			X			
Management Flight Simulator	(3 hours)				X	X	

New Learning Relative to Prior Knowledge

Students were asked to evaluate their own learning under 11 topic headings, on a 5-point Likert scale, ranging from "nothing" to "many points". To help students calibrate their own scales, they were given two worked examples:

EG1. How to fly an aircraft.

(1)	2	3	4	5
Nothing Learned		Several Points		Many Points

EG2. The management of an airline business.

1	2	3	4	(5)
Nothing Learned		Several Points		Many Points

Of course, there are problems with this using this kind of self-reported measure of learning - students will vary in their use of the scales, despite the attempts to calibrate the end-points. The purpose is to study the student's perception of new learning for different topics, and to see how the student's composite "new learning score" is related to performance in objective tests and in the game. The scores are reported in Table 2 for all groups 1-5, and also separately for groups 1,2,3 (who did not play the MFS), and groups 4,5 (who did play the MFS). Significant differences in the mean scores are indicated by a t-value in the "Significant Difference" column.

TABLE 2 - Student Self-Perception of New Learning

	Overall Groups 1-5 N=132 Mean Score	Did Not Play MFS Groups 1,2,3 N=81 Mean Score	Played MFS Groups 4,5 N=51 Mean Score	
	(1 = "learned nothing", 5 = "learned many points")			
				Sig. Difference
Human Resource Management Policies (Job rotation, share options, hiring)	2.7	2.6	2.9	(t = 2.01)
Capacity management (aircraft, employees)	2.6	2.4	3.0	(t = 3.60)
Service scope and quality	3.0	2.9	3.0	
Factors influencing productivity of staff	2.8	2.7	2.9	
Marketing (differentiation, pricing, advertising, word-of-mouth)	2.6	2.5	2.8	
Accounting/scorekeeping (profit/loss statements and balance sheets)	1.8	1.7	2.0	(t = 2.54)
Performance measures (market share, profitability, share price)	2.1	1.8	2.4	(t = 3.52)
Cost structure for an airline (fixed costs, variable costs)	2.2	2.2	2.2	
Business environment (attractiveness of industry, strength of competitors)	2.7	2.5	2.9	
Entrepreneurial activities (starting a business)	3.0	2.7	3.3	(t = 3.05)
Leadership qualities (charisma, vision)	3.0	2.8	3.4	(t = 2.84)

Given the nature and contents of the People Express case, the higher scores on human resource management issues, staff productivity and leadership are to be expected, as well as the low score on accounting/scorekeeping. Perhaps more surprising are the higher scores on business environment and entrepreneurship. The interesting differences between students who played the simulator, and those who did not, are the accounting/scorekeeping and performance measures, presumably directly related to feedback from the MFS report screens. It is also interesting to note that the increased learning reported on entrepreneurship and leadership topics, presumably related to playing the role of the CEO in the MFS.

Subject Content of the People Express Case Study - Students were asked 10 multiple-choice questions (6 items, with item 6 = "don't know").

Direction of Relationships - Students were asked 16 questions about their perception of the direction of relationships between key variables in the model. A particular variable was stated to be INCREASING or DECREASING, and the student had to indicate the most likely direction of change for a second variable, selected from INCREASING, DECREASING, NO EFFECT (or NO IDEA), assuming that other factors do not change.

Differences Between Experimental Groups
Each student had three composite scores calculated as follows:

New-Learning-Score	score on 11 questions scaled 1-5 (min 11, max 55)
Case-Content-Score	score on 10 multiple-choice questions (min 0, max 10)
Direction-of-Relationships-Score	score on 16 multiple-choice questions (min 0, max 16)

Groups 4 and 5 (who both played the MFS) had no significant differences between the means of their composite scores. Also, both groups 4 and 5 had a significantly higher mean New-Learning-Score compared to any of the groups 1, 2 or 3. Students do perceive that extra learning has taken place after playing the MFS. Group 3 showed a significantly higher mean Case-Content-Score, perhaps because they were tested immediately after the plenary discussion of the case study. The Direction-of-Relationships-Score was higher for groups 4 and 5 (who played the MFS), but was not significant. This is disappointing, given that we expect the use of the MFS to strengthen understanding about model structure - it may be a problem with the evaluation instrument. Group 1, who were tested after reading the case study at home, had both a significantly lower Case-Content-Score and Direction-of-Relationships-Score than any other group. Students do learn something from the workshop as a whole!

Further Investigation to Explain Variances in the Composite Scores
Possible explanatory variables included whether the student played the MFS or not, the level of education, whether the major subject was business studies/economics or some other subject, the time spent on reading the case study, and the time spent on reading the MFS briefing book. Students who played the MFS had a significantly higher New-Learning-Score than those who did not (30.8, 26.5, $t=-2.8$). Students who spent more than one hour reading the case study had a significantly higher Case-Content-Score (4.7, 3.7, $t=-2.4$), and a higher Direction-of-Relationships-Score (11.1, 9.9, $t=-2.5$) compared to those who spent less than 1 hour reading it. Students who spent more than 30 minutes reading the MFS briefing book had a significantly higher New-Learning-Score (30.7, 26.7, $t=-2.5$) compared to those who spent less than 30 minutes reading it. Again, these reading times were self-reported.

Correlations between the times spent reading the case study and the MFS briefing book were high (0.66, $p=0.001$), as we might expect - keen students prepare thoroughly, or perhaps weak students take longer than good students to read and prepare the briefing materials. Case-Content-Score and Direction-of-Relationships-Score are also correlated (0.31, $p=0.001$), which suggests that students performed similarly on both exercises.

The degree of confusion which students found with the MFS briefing book was negatively correlated to the New-Learning-Score (-0.39, $p=0.01$), ie. students don't perceive to have learned much if they are confused by the learning materials. Students who found the MFS absorbing also found it easy to use, or vice versa, (0.40, $p=0.01$).

Further Points
The feedback session was a very important part of the learning process, using both handwritten graphs of performance on overhead slides, and electronically stored games, displayed on a projection palette. The link between the case study and the game is the MFS briefing book. But this is too complicated for most students to digest prior to playing the game. The use of a systems thinking approach to teaching the case (ie. building simple

feedback loop structures for capacity expansion of the fleet, motivation and productivity of CSMs, hiring and training CSMs, and marketing the airline to new and established customers) all help towards understanding the underlying dynamics of the MFS. Students are then presented with a simplified model structure diagram (see "People Express Growth Machine" in Morecroft, 1993) which is an appropriate platform to launch the MFS workshop.

BEng Electronic and Control Engineering Students

36 third year undergraduate Engineering students undertook a 2½-day workshop as part of a module in General Management. The five 3-hour sessions involved playing the beer game, discussing the People Express case in small groups and plenary, playing the People Express MFS followed by a debriefing, discussing the Worlds of Wonder (A) and (B) cases (Sterman 1991b) and parts of the B&B Enterprises briefing book, and then playing the B&B Enterprises MFS followed by a debriefing. For B&B Enterprises, the important link between the case study and the MFS was achieved by discussing aspects of the model as presented in the B&B Enterprises MFS briefing book. Having met model structures through People Express, students now have a better understanding of the model structure diagrams, and a useful dialogue takes place. Students completed a structured assignment (**PE and B&B Assignment Score**) over a four week period, which counted for 30% of the total module grade (**Total Module Score**). Other components of the module grade, unrelated to this workshop, included in-class tests, coursework assignments, and a final examination. Performance data (**B&B MFS Performance Score**) for each student was collected for the B&B Enterprises MFS (cumulative net income playing against competitor no. 1). An additional questionnaire asked students 11 questions (scaled 1-5) about new learning from B&B Enterprises, and 11 questions on the direction of relationships between variables in the B&B MFS. Summary results are shown in table 3.

TABLE 3 - Scores in Objective Tests, Game Performance, Assignment, and the Module

	People Express			B&B Enterprises			Overall	
	New Learning Score	Case Content Score	Direction of Rel. Score	New Learning Score	Direction of Rel. Score	B&B MFS Performance Score	PE and B&B Assignment Score	Total Module Score
N=36								
Max Possible	55	10	18	55	11	N/A	100	100
Max	48	8	17	50	11	1541	72	78
Min	28	0	0	21	0	135	30	27
Mean	36.8	5.3	12.1	37.6	8.3	678	52.0	50.1
S.D.	5.5	1.8	3.1	7.2	2.4	213	10.7	11.1

There were a number of significant correlations. The times spent reading the PE case study, the PE MFS briefing book, and the B&B MFS briefing book are all highly correlated (> 0.62, $p=0.001$). **Total Module Score** is correlated to the **PE and B&B Assignment Score** (0.60, $p=0.001$), even after adjusting the Total Module Score for the Assignment Score component. Students who do well on the whole module also do well on the assignment related to use of the MFS. **B&B MFS Performance** is correlated to the **Total Module Score** (0.42, $p=0.01$), indicating that students who do well overall also perform better in the game. **B&B MFS Performance** is also correlated to the **B&B Direction-of-Relationships Score** (0.46, $p=0.01$), indicating that students who have a better understanding of model structure do better in the game.

BA Information Management and Finance Students

50 fourth year undergraduate students undertook two 3-hour classes using the People Express case study and MFS, as part of a module in Strategic Management. They also completed a structured assignment on the case study and MFS over a four week period, requiring them to develop and present a successful strategy. This assignment counted for 25% of the total module grade, and the performance in the People Express MFS (market value) over the four week period was recorded. This performance was not measured in a controlled environment, and some students may have "cheated" - it is possible to correct unsuccessful strategic decisions using the **GO BACK TO** option on *Microworld Explorer*. Summary results are shown in table 4.

TABLE 4 - Scores in Objective Tests, Game Performance, Assignment, and the Module

	People Express				Overall	
	New Learning Score	Case Content Score	Direction Relationships Score	PE MFS Performance Score	PE Assignment Score	Total Module Score
N=50						
Max Possible	55	10	18	N/A	100	100
Max	49	9	16	3482	74	70
Min	24	1	7	551	48	38
Mean	36.8	5.7	12.5	1275	56.9	54.4
S.D.	5.4	1.8	2.1	334	6.8	7.9

Game performance was again highly correlated with the overall module score and the structured assignment score (0.52, $p=0.001$). The Case-Content-Score was correlated to the overall module score (0.42, $p=0.01$), validating the use of the multiple-choice test to measure case knowledge - better students do well in the objective test. Again, the time spent studying the case study and the MFS briefing book were correlated (0.55, $p=0.001$).

Conclusions

This study has been very much a first attempt to measure the effectiveness of model-supported case studies and management flight simulators in teaching. My evaluations have been formative in nature (to facilitate continuous improvement of the workshop protocols and measuring instruments). In tackling the area of measurement of learning, we are always faced with criticisms of the measurement process - what are we <u>really</u> measuring? I am continuing to develop more sophisticated evaluations, including analysis of written and verbal comments on perceived learning, post-game/workshop interviews, and more focused tests to measure specific learning objectives. My results show that game performance is related to overall performance in the module, that performance in a structured assignment (based on the case study and game) is related to performance in the game, and that the use of the MFS enriches (but not necessarily improves) the overall learning experience for the student. Better understanding of the relationships between model variables (ie. model structure) does seem to improve game performance. Two key aspects of workshop design involve establishing a link between the case study and the MFS, and debriefing students after playing the MFS, to allow them to reflect on their results. Furthermore a structured assignment related to the case study and MFS, completed over an extended time period, provides a valuable consolidation of the learning experience.

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