

FINAL REPORT FOR A 1997 NATIONAL TEACHING DEVELOPMENT GRANT

IDENTIFICATION

Name of Project Leader(s)

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Project Title

Improving learning in undergraduate physics using integrated 'studio' environments to replace traditional lectures, laboratories and tutorials.

Key words or phrases that describe the teaching innovation

Undergraduate Physics; professional science modeling; flexible delivery; active learning; information technology rich; student centered; computer based delivery.

2) Executive Summary

The Physics Studio project has established a model for the "workshop" or "Studio" teaching of undergraduate science and engineering units which attempted to:

1. reduce contact hours for undergraduate units.
2. rationalize the number of units and classes particularly in the first year.
3. develop flexible mode delivery materials to expand both on and off-campus delivery.
4. Emphasizes student centered rather than instructor centered instruction.
5. Improves or at least maintained student learning outcomes.
6. develop staff skills in the design and implementation of flexible mode delivery techniques

Studio instruction uses team teaching and student-centered, discovery type learning activities, integrated with information technology tools to replace conventional lectures, labs and tutorials for ~700 student contact hours per semester (mostly for students studying first year physics units). To achieve this over a two year period, the Department of Applied Physics, together with assistance from the Curtin Computing Center and the Division of Engineering and Science;

- converted an existing physics laboratory into a 24-seater Studio classroom.
- selected and purchased a range of computing hardware and software.
- redesigned unit objectives and undertook development and a reworking of computer based and other teaching resources.
- undertook construction and preparation of necessary laboratory apparatus.
- instigated and evaluated the quality of learning and student staff acceptability of the studio environment.
- instigated and evaluated a staff development program to assist with familiarization of staff with necessary software and the development of the studio model in other physics units.

Physics was selected to for the project because of the many existing computer-based resources already and being developed around the world. Physics at Curtin was targeted because several of the Physics teaching staff had extensive interest in teaching with technology and student-centered instruction.

During 1997 and 1998, the typical student who used the Physics Studio was enrolled in two or three, 2-hour workshops per week (i.e. 4 to 6 contact hours per week) compared to the 6 -9 hours in the original units. The fact that students did not have to wait a week or more before they see the practical application of the theory and/or obtain feedback on their progress made the studio a richer and more meaningful learning environment. This feature of the Studio was clearly identified in student evaluation of the Studio experience. Many lecture components of the workshops were also placed at the end of the workshops, which also helped students to better consolidate knowledge constructed during the studio.

This approach to teaching undergraduate physics units was evaluated in terms of learning outcomes, student and staff appeal, and educational and cost effectiveness. In addition, the Studio project models and provides information for the redesign of existing science and engineering courses, teaching facilities and staff development programs in science teaching throughout Australia. The most significant achievements were in reducing formal student contact without any loss in student academic performance, as measure by conventional assessment techniques, and in reducing early withdrawal rates. Perhaps the least successful aspect of the project was the difficulty in maintaining interest and continuity in staff development, an issue common to many areas of tertiary education.

3) Justification and Educational Rationale

A simple and commonly used mechanism available to improve tertiary education productivity has been to increase student numbers in increasingly larger lecture, tutorial and laboratory groups. While this approach has been successful in reducing, or at best maintaining, the unit cost of education, it has failed to address the fundamental issues of the effectiveness of the learning in these environments. The lecture, tutorial, laboratory model has been used for more than 100 years but it remains largely a 'passive environment'. The classes where students spend most of their time 'doing' (tutorials and laboratories) often have problems because they are supervised by less experienced sessional staff. Optimal learning occurs in creative '**active learning environments**', where students continually participate in constructing their own understanding, and where the role of the lecturer becomes one of facilitator/mentor rather than deliverer.

Another characteristic of university science and engineering courses is the addition of more units, and more content and skills into many existing units. While some of these have resulted from the information explosion others have arisen because of the recent recognition that many generic skills required by graduates are not learned during their undergraduate years. One unfortunate outcome of this has been an increase in student contact hours which has often resulted in highly stressed students and staff. There is little evidence that increased contact has improved learning or has advantaged recent graduates. The increasing numbers of course objectives need to be addressed by rethinking what is taught so students are prepared for future employment demands in which communication, information technology literacy, teamwork, negotiation skills and problem solving ability will be of equal importance to discipline specific knowledge and understanding (Candy et al. 1994). The increased contact approach has largely failed because it has not addressed the root of the problem, i.e. the way that learning currently takes place. Effective models of learning which take advantage of advances in technology **in conjunction** with guided discovery offer a way to reduce direct contact time while placing students in charge of their learning. These types of learning environments also allow for the development of courses and units which will cater for 'new' emerging student populations. These include students who cannot attend conventional 15-week full-time semesters, who are from even more diverse educational and cultural backgrounds and who may wish to pick and choose from a wider range of units and course components.

The student's response to many of these problems have been largely to avoid classes where possible, many to the point where they simply drop out. In contrast to all of this, Studio instruction provides a highly stimulating learning environment where students are actively involved with the concepts and learning materials. While increasing attendance rates directly benefits students, the studio model also improves physics understanding by integrating theory, problem solving activities and practical work. Studio learning makes extensive use of information technology tools integrated into learning activities while the use of team work in planning and problem solving also simulates a professional working environment. An additional benefit is that the studio retains considerable instructional capability outside normal class hours enabling students to review and consolidate the concepts studied during class.

The Studio environment trailed in this project was based largely on the Rensselaer Polytechnic Institute (RPI) 'Studio' learning environment (see Wilson 1994, and DeLoughry, 1995). Rensselaer has received international recognition and awards for its innovative approach to 're-engineering' the way undergraduate science and engineering programs are delivered. RPI has used the studio model since 1991 when they set as their goals, improved

educational efficiency from both the student and instructors perspective, greater student involvement in the learning process and increased emphasis on team-work, with no decrease in educational standards. An extensive independent evaluation of their Studio System over a three to four year period has shown significant improvements in, student attendance, student feedback on satisfaction with their courses and teaching staff satisfaction while student learning outcomes were comparable if not improved over the traditional approach. (Cooper 1995).

Target Student Group

The Studio project initially targeted the 5 major units (~80 individual students) studied by first year students majoring in Geophysics, Physics, and the Physics/Engineering double degree:

- Physical Measurements 101 and 102 (PM101/102) - a first semester unit on electricity and magnetism.
- Particles and Waves 101 (PW101) - a first semester unit on mechanics and waves.
- Structure of Matter 102 (SOM102) - a second semester unit on thermal, atomic and nuclear Physics
- Computational Physics 152 (CP152) - a second semester.

During the project, the Studio instruction model was extended to include other units including, Astronomy 201 (AS201), Scientific Data Analysis 101 (SDA101), Scientific Data Acquisition 202 (SDA202), and a new Web based unit, Web Science 101 (WS101). The later 2 units being fully on-line & paperless. The Studio is also used for Astronomy 201 (AS201), Planet Earth 101 (PE101), and Planetary Science 101 (PE101), Medical Imaging units and on an occasional basis by Foundation Studies are also made by the students. The total number of students currently involved are now around 250 in first semester and 200 in the second semester of each year.

An analysis of the Studio Web server activity logs shows that students make extensive use of the Studio outside normal class hours and also well into the evenings using home computers and remote access.

Technical Soundness

For students the major problems and dilemmas include:

- 1. The wide range of student IT backgrounds.** This was a major hurdle to overcome and is expected to remain so the case for a number of years with projected increases in mature age entry and the increasing IT resource gaps between secondary schools and individuals. The implementation of a three day IT orientation program at the beginning of first semester helped significantly but the additional 24 hours of instruction required during this orientation program may well be better spent on basic physics!
- 2. Initial focus by students is on IT, not Physics.** After the first few weeks of semester ~10% of the students were concerned that they were not learning much physics but this attitude eventually seemed to evaporate by the end of first semester.
- 3. Students quickly “drown in data”.** This is mainly a problem in units where the computer based data acquisition system enable students to collect many megabytes of data in just a few minutes of experimental work. This problem is a general outcome of the IT age. It is also present in the same and other ways in conventional courses and is an aspect of IT that instructors need to be aware of and that students need to be taught how to handle.

4. Networking & IT Problems. This has been a **MAJOR** problem, some of which was due to requiring us to have to start from scratch in establishing a network. Setting up an entire network (computers, servers, student accounts and Web facilities) required considerably more time than expected. Problems with computer security necessitated upgrading the computer security and access. It is estimated that approximately 6 hours a week of the teaching time release and 20 hours a week of departmental IT support was dedicated to maintaining a viable network and Web presence. The question of IT support was a major outcome of the Studio project - just how is this important IT infrastructure component to be managed, supported and funded in the future.

5. Time for students to familiarize with software. Use of any new media especially software has this problem. New software has to be intuitive or to be used on more than a few occasions before students will bother to learn how to use it effectively and explore it willingly.

6. Ineffectiveness of Computer Based materials. Our experience has shown that very few physics content CDs are worth the time necessary for students to bother learning how to use them. Independent research done within the Studio suggests that most students revert too readily to "click - read - click" (Yeo et al 1998). This appears to be a problem for most current commercial computer-based content. In general we believe that placing a large volume of content on CD or on the web rarely results in effective learning from these formats. Most students do not seem to interact with large volumes of computer-based content in a meaningful enough manner unless given highly specific relevant learning tasks and activities. Computers appear to be much more effective for communication purposes, data manipulation and graphics, simulation, etc than for bulk content delivery. This is another significant outcome of this project.

From an instructor's perspective the major problems and dilemmas are:

7. Wide range of staff IT backgrounds. The majority of staff still do not know how to make the best use of most of the software packages available on the studio computers and few have made an effort to come to grips with them. More staff training in this area is required.

8. Reverting too readily to "traditional instruction". This is a **MAJOR** problem for instructors and students. Most instructors still do not appreciate that **FEW** students are likely to be learning effectively when they are talking or lecturing. As soon as instructors step into lecture mode (even within the Studio environment) most students will "glaze over" and just write things down without really paying attention.

9. Significant time required for staff to

1. develop student centred materials. This is also related to dilemma 3.8. Studio Instruction preparation is more difficult and time consuming than writing out OHP based notes especially for staff who are not familiar with this style of teaching.
2. familiarise with software: See above
3. enable training via team teaching: Initially it was planned to cycle a number of staff through the studio alongside more experienced staff but due to funding restrictions this was not possible to the same degree in 1998 as it was in 1997.

Administrative Convenience

There has been little obvious impact on the overall organizational infrastructure of our Department or School. The programming/timetabling difficulties of fitting ~70 students into the (initially) smaller Studio classroom have largely been alleviated by modifying the Studio

to take larger (up to 36 students) classes. As far as general management is concerned, the Studio model offers increased flexibility for staff and students as they are not continually fighting for space within the entire university for large lecture theatres (which are at a premium at our institution). The reduced class contact has also freed up physical space elsewhere in the University at a time when general space is at a premium.

Political Acceptability

The Studio project has received widespread support and interest from across the University as listed in the Acknowledgements (see Appendix B). From a Departmental perspective the Studio was the subject of a special staff meeting held towards the end of 1998. Despite the questionable economic viability of retaining the Studio in its existing format, the staff unanimously supported the retention of the Studio and supported its expansion to accommodate ~50% more students at each sitting. The staff believed that despite its problems the Studio was preferable than placing first year students back into mainstream lectures. Our experience with students and instructors from other Departments has not been as positive. Most of these Departments did not particularly care how we "did it" as long as our instructors adequately "covered the syllabus".

Evaluation

An evaluation of student learning outcomes was only one of a number of aspects of the overall evaluation of the Studio undertaken during 1997/98. Other aspects included:

1. Effectiveness in the use of computer based instruction packages
2. An analysis of the financial viability of the Studio and its operations
3. An Assessment of the overall perceptions of staff and students on the Studio method
4. The overall IT awareness of students studying in the studio

Data collection and feedback from both students and instructors were obtained from

1. 5 "general" on-line surveys held at the beginning and the end of first semester, and at the end of second semester in both 1997 and 1998. The response rate for all of these survey after many emailed reminders was generally >80%. A copy of the general survey questions used is shown in the Appendix G while some results are shown in Appendix H.
2. Detailed observations of classes and instructors, by other instructors when their participation as instructors was not required.
3. Interviews of small groups of students and individuals on their perceptions of the effectiveness of the studio.
4. Student feedback through a system of student class representatives and/or email.
5. A comparison of the overall achievements of students studying units in studio mode with the results from previous years and with other students taking the lecture streams of the same units. (NB students studying in Studio mode only received 2/3rds of the formal instructional contact time compared to the other students)

Most of the detailed aspects of the evaluation cannot be dealt with in this report. Some details are available in the references listed in Appendix D while a number of "problem" findings with regard to the Studio are listed in Section 3. The major findings in regard to student learning and student perceptions from these assessments were;

1. The majority of students preferred the Studio Learning environment compared to other (conventional) instruction modes.
2. The attendance rate for Studio classes was consistently better than 90% compared to around 70% for conventional classes (See Appendix I).
3. The Studio environment appears to reduce student dropout rates (See Appendix F)

4. There was NO significant change in student understanding of "content" as measured by conventional assessment tools (assignments, laboratory reports and exams - see also Appendix F)
5. The Studio environment does not suit all students. Students less likely to achieve in a Studio environment are those that have poor self-direction or are studying a subject because they are required to.
6. Students clearly identify the benefit of mixing the theory immediately with practice in the Studio environment.

And from an Instructor perspective the major evaluation outcomes were;

7. Preparation for Studio classes requires more work than lectures. This is quite understandable as all student-centered activities require more preparation than just talking at (to) students or letting them work through a cookbook experiment.
8. "Instructor despair" syndrome (i.e. just how little the students seem to know) is arrived at much earlier in the semester. This is because instructors in the Studio are much closer to students from the very beginning of semester than in conventional courses where there is limited scope for interaction between instructors and students.
9. Even though this aspect was difficult to assess, the belief that students working in the Studio environment were learning skills that were going to make them better senior and postgraduate students employees. Two of the specific skills are those of "working in teams" and the early integration of IT into academic work.
10. Clear recognition of the use of IT in education a "learning tool" rather than as a replacement of the instructor.

4) Other Significant Project Outcomes:

- 1) The list of 17 publications and seminar presentation arising from the wide range of evaluation surveys and assessments of the project are listed in Appendix D.
- 2) A major Web site, showcasing the Studio and some of the teaching materials used is available at <http://www.physics.curtin.edu.au/teaching/studio/>
- 3) The development of a new Electronic Information Literacy Unit, (Web Science 101, See Kovler, M, and Loss, R. 1998 and the Web Science 101 Web site at <http://www.physics.curtin.edu.au/teaching/units/ws101/index.html>)
- 4) Sections of the Studio have been used for detailed "in-situ" studies of student use computer based physics instructional packages (Yeo et al., 1999). Of particular interest has been the double image AV capture (images and vocalization of student users simultaneously with the screen of the computer and their activity) system established during the Studio project. This has been a very powerful method to analyse student use of IT and has been used

5) Appendices

APPENDIX A Acknowledgments,

The project team would also like to acknowledge the special assistance and financial support of the following:

- a) **Curtin University: Open & Flexible Learning Initiatives 96-97:** for additional funds for teaching release and evaluation.
- b) **Curtin University Computing Centre:** for assistance with financial support towards information technology hardware and software.
- c) **Curtin University: Division of Applied Science & Engineering,** for assistance with the purchase of a laboratory server and software.
- d) **Macsyma Software:** for their contribution of a 10-site software licence pack.

The project team also wishes to acknowledge the special support of the following persons;

Dr Ian Bailey (also Head of Curtin Applied Physics during 1997-8) for his support and assistance in promoting Studio Physics instruction and supporting the staff through a difficult period of the project

Mr Stefan Deylitz (University of Bremen) Stefan visited us during the second semester of 1998. Stefan, in conjunction with several project members, participated in a collaborative educational research and development program in the Physics Studio whereby Atomic Physics was taught using an instructional model developed in Germany.

Mr James Holmes (IT support Curtin Department of Applied Physics 1997-98) for quality IT support and keeping the network and user accounts afloat when all else was collapsing.

Mr Mariusz Kovler (IT support Curtin Department of Applied Physics, 1997-98) for special assistance with IT hardware and software and setting up and managing the Department of Applied Physics Webserver and Teaching and Learning Website. Mr Mariusz Kovler also made a very special contribution during the establishment and teaching of the innovative Web Science Unit in 1997 and 1998.

Mr Glen Lawson (Physics Technical support Curtin Department of Applied Physics 1997-98) for assistance in establishing the physical layout of the Physics Studio and also for putting up with our constant short notice demands for laboratory equipment – all with a smile.

Professor Brian O'Connor (Head of Curtin School of Physical Sciences, 1997-8). For his support and continuing encouragement with the Studio Project.

Professor Joe Reddish (Department of Physics, University of Maryland USA) for introducing us to Studio Physics and inspiring us during OzCUPE1, (Sydney University, 1993).

Professor Kevin Rosman: (also Head of Curtin Applied Physics in 1996) for his assistance in promoting the Studio Physics instruction project and special support with staffing the studio during 1997.

Mr Mark Tabb (IT support Curtin Department of Applied Physics 1997-98) For assistance with Novell Network Accounts, the setting up of the Novell School Server and general IT support.

Professor David Treagust (Science and Mathematics Education Centre). For general support and encouragement with the Studio Project, and involvement with a wide range of Educational Research aspects of the Studio.

Professor Jack Wilson (Director of Academic programs, Rensselaer Polytechnic Institute, USA) for the vision and inspiration provided to us during a visit to Curtin in 1996.

Associate Professor John Winship (Director of the Curtin Computing Centre 1997-8) for his inspiration and persistence in "kick-starting" the project, assistance with IT hardware and software and general promotion of "Flexible Delivery" modes of undergraduate instruction.

Ms Shelley Yeo (ARC Research Associate and Studio Instructor, Science and Mathematics Education Centre and Department of Applied Physics - 1997/1998). Shelley's enthusiasm and tireless dedication to task were exemplary. Shelley was involved at a number of levels including, teaching, interviewing students, assessing IT packages and has recently begun a PhD on more detailed aspects of Studio evaluation

Ms Helen Chedzey, Ms Hwee Lim and Mr Steven Best (Research assistants 1997-1999) For their assistance with the preparation, and collation of surveys and survey data and in the preparation of various graphics.

Ms Tiki Swain (Schools Liaison Officer, Curtin University Department of Applied Physics 1997 -1999) for her enthusiastic promotion of the Physics Studio and in assisting with the 3 day orientation program for New Students at the beginning of each first semester.

Ms Leanda Wright (Web Developer, School of Physical Sciences and Department of Applied Physics) for rewriting the Main Physics Web site and revamping the Physics Studio and *WebScience 101* Web sites in 1998-99.

APPENDIX B Project Participants

The following members of the project team and staff of the Department of Applied Physics have participated in Studio instruction over the period (1997-1998) of the project.

Staff member	Position	Units Taught
Dr Craig Buckley	Curtin Research Fellow	Particles & Waves 10 Structure of Matter 102
Mr James Browne	Part-time lecturer	Foundations Physics Aviation Physics Physical Measurements 101
Mr Sandro Ghiotto	Part time Laboratory assistant	Web Science 101
Mr Justin Hofmann	Part time Laboratory assistant	Structure of Matter 102
Mr James Holmes	Part-time lecturer	Scientific Data Analysis 101 Scientific Data Analysis 202
Dr Yarra Korczynskyj	Lecturer	Particles & Waves 101 Structure of Matter 102
Mr Mariusz Kovler	Part-time lecturer	Web Science 101
Dr Bob Loss	Senior Lecturer	Physical Measurements 101 Particles & Waves 102 Physical Measurements 102 Web Science 101
Mr Des Thornton	Senior Lecturer	Physical Measurements 101 Physical Measurements 102
Dr Arie Van Riessen	Senior Lecturer	Physical Measurements 102
Mr Rabi Rivett	Part time Laboratory assistant	Web Science 101
Prof. Kevin Rosman	Professor	Physical Measurements 101
Ms Shelley Yeo	Part-time tutor	Particles & Waves 101 Structure of Matter 102
Dr Marjan Zadnik	Senior Lecturer	Particles & Waves 101

APPENDIX C References and Publications,

* Publication arising directly from the Studio Project

Candy, P. C., Crebert, G. and O'Leary, J. (1994) *Developing life long learners through undergraduate education*. (Commissioned Report 28). Canberra: National Board of Employment, Education and Training, Australian Government Publishing Service.

Cooper, M. A. (1995) An evaluation of the implementation of an Integrated Learning System for Introductory College Physics, Doctoral Dissertation, State University of New Jersey. Oct 1995.

DeLoughry, T.J. (1995) *Studio Classrooms*, Chronicle of Higher Education, March 31 1995, A19-A21

*Loss, R. and Thornton, D. (1997a) *Physics Studio Instruction*. Poster Presentation, Annual Teaching and Learning Forum, Murdoch University, Feb 1997

*Kovler, D., Loss, R. and Zadnik, M. (1997) *Development of Interactive Web Based Physics Instruction*. Paper presented at the OzCUPE3, QUT, Brisbane, April 2-4 1997.

*Loss, R. and Thornton, D. (1997b) *Studio Format Undergraduate Physics Instruction*. Paper presented at the OzCUPE3, QUT, Brisbane, April 2-4 1997.

*Loss, R. and Thornton, D. (1998a) *Physics Studio - 2 years on*. Annual Teaching and Learning Forum, University of Western Australia, Feb 1998.

*Kovler, M. and Loss, R. (1998) *Web Science 101*. Annual Teaching and Learning Forum, University of Western Australia, Feb 1998.

*Loss, R. and Thornton, D. (1998b) *Physics Studio - 2 years on*. Paper presented at the Australian Institute of Physics Biennial Congress, Esplanade Hotel, Fremantle, Oct 4 1999.

*Loss, R. and Thornton, D. (1999) *How Do You Manage Electronically Submitted Student Work?* Annual Teaching and Learning Forum, University of Western Australia, Feb 1999.

*Yeo, S., Loss, R., Zadnik, M., Harrison, M. and Treagust, D. (1998) *What do students really learn from interactive multimedia? A physics case study*. National Association for Research in Science Teaching, San Diego: CA April 19-22, 1998.

*Yeo, S., Loss, R., Zadnik, M. & Treagust, D. (1999) *Changing conceptions with an "Intelligent Tutor"* Annual Teaching and Learning Forum, University of Western Australia, Feb 1999.

Wilson, J. (1994) *The CUPLE Physics Studio*, The Physics Teacher, 32, p518-523

Studio related Presentations and seminars

*Loss, R. (1997) *Studio Physics Instruction*, Australian Institute of Physics Monthly Seminar Series, Curtin University Library, June 1997.

*Loss, R. (1997) *Electronic information literacy skills for the 21st century*, HERDSA WA Monthly Seminar 1998. Curtin University, November 1997.

*Loss. R. (1998) *Electronic information literacy skills for the 21st century*, CONSTAWA 1998. Muresk, WA, 2May 23 1998.

*Loss. R. (1998) *The Curtin Physics Studio*, Department of Applied Chemistry Seminar series, Curtin University. August 5 1998.

*Loss. R. (1998) *Teaching on (with) the Net*, University of Western Australia Department of Physics Seminar series. November 12 1998.

*Loss. R. (1997) *The Curtin Physics Studio*, Staff Development Seminar, Curtin University Sarawak Campus (Miri), April 23 1999.

*Loss, R. (1999) *IT infrastructure and support in the School of Physical Sciences*, Department of Applied Physics Seminar Series, March 3 1999.

*Loss. R. (1999) *Teaching on the Net*, Sir Charles Gardiner Hospital Medical Technology and Physics Seminar Series. July 8 1999.

APPENDIX D Contact Details

The project team are most willing to be contacted for advice regarding this project and any of the details.

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APPENDIX E Resources

The most useful and accessible resource with regard to the Physics Studio is the Physics Studio Web site at

<http://www.physics.curtin.edu.au/teaching/studio/>

This Web site is generally accessible (i.e. no password required) and details

1. The physical arrangement of the studio
2. List of software used by staff and students
3. Details of the computer interface data acquisition systems used
4. Student and Instructor resources (Notes, assignments, Worksheets, PowerPoint presentations. Laboratory manuals and tests and solutions).
5. And, in the case of Web Science 101, samples of student work.

Copies of some of the presentations used to describe and development and evaluation of the Physics Studio in *PowerPoint* and *Acrobat* format are available at:

<http://134.7.115.24/Presentations.htm>

APPENDIX F: Comparison of student results 1994 - 1999

Any attempt to measure changes in student performance due to the effect of Studio instruction is likely to be fraught with statistical difficulties. The following tables (F1 and F2) show a number of statistics for two first year physics units taught primarily by the same instructor over the period 1994 to 1998-9. The years designated by the letter "s" are the years in which these subjects were taught in Studio mode. These tables show;

N: the number of students enrolled in week 1 of semester

W: the number of students who withdrew by week 5 of semester

D: the number of additional students who did not complete the semester

C: the % of student in week one who completed semester

The mean and standard deviation of the final semester marks for each group and % of students at C who passed are listed in the last 3 columns. All marks are out of 100.

Table F:1 Physical Measurements 101 (PM101)

Year	Number of Students (N)	Withdrawals by week 5 of semester (W)	Did Not Complete the semester (D)	% of N completing semester (C)	Mean	Standard deviation	% of C which Passed
1994	72	12	4	78	63	12	92
1995	57	6	6	79	59	14	95
1996	49	6	6	76	63	14	90
1997s	53	3	6	83	62	15	86
1998s	52	2	6	85	61	14	87
1999s	54	5	2	87	60	14	80

Table F:2 Physical Measurements 102 (PM102)

Year	Number of Students (N)	Withdrawals by week 5 of semester (W)	Did Not Complete the semester (D)	% of N completing semester (C)	Mean	Standard deviation	% of C which Passed
1994*	63	10	4	78	69	12	84
1995*	53	3	5	85	65	13	86
1996	53	4	10	74	62	13	85
1997s	42	1	7	81	55	15	71
1998s	46	1	5	87	55	17	81

s: Studio Instruction, * different instructor

In the case of PM101 (see Table F1) the means for the Studio groups range from 61 to 62 while the non-Studio years range from 59 to 63. Considering the standard deviations of the means are consistently around 14 there does not appear to be any significant difference between these results. However, the PM102 results (see Table F2) do appear to show some possible differences although it should be noted that different instructors ran these units in 1994 and 1995.

Perhaps the only significant difference in the statistics between units taught in Studio and conventional mode instruction, are the reduced initial withdrawal rates of students early in the semester. To some extent these decreases in student dropout are negated by reduced overall pass rates. This suggests that the weaker students that may be coached along by the Studio environment and survive until the end of semester where they appear to fail in the final overall assessment. Confirmation of this will required further analysis.

APPENDIX G: General Survey Instrument

The following survey form was administered "on-line" 5 times over the two years of this project. The survey periods in each year were; i) week 5 of first semester, ii) the end of first semester and, iii) the end of second semester. Students studying more than one unit in the Studio were required to complete a copy of the survey for each unit they attended.

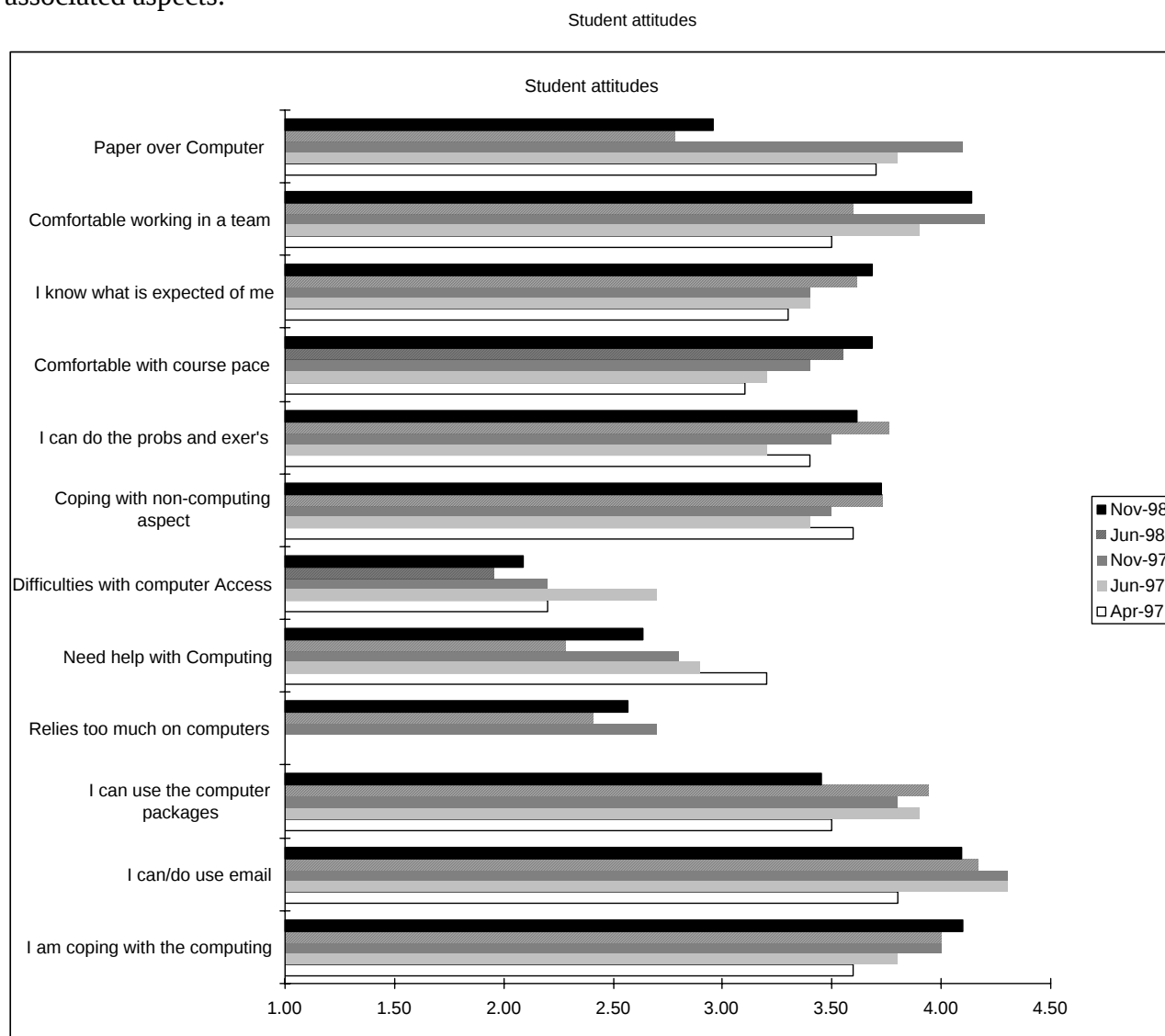
Physics Studio Survey SEMESTER X 199X					
Group: (please circle)					
SOM102(Mon) PM102(Mon) SOM102(Tues) PM102(Wed)					
Computing					
		Disagree		Agree	
1	I am coping with the computing demands in this subject?	1	2	3	4 5
2	I can/do use email in this subject?	1	2	3	4 5
3	I feel comfortable with the computer packages used in this subject?	1	2	3	4 5
4	There is too much reliance on computers in this subject?	1	2	3	4 5
5	I would like additional help with my computing skills?	1	2	3	4 5
6	I have problems getting access to computers for this subject?	1	2	3	4 5
My biggest Computing concern in this subject has been:					
Physics					
		Disagree		Agree	
1	I am coping with the Physics in this subject?	1	2	3	4 5
2	I can do the problems and exercises?	1	2	3	4 5
3	I feel comfortable with the pace of this subject?	1	2	3	4 5
4	I know what is expected of me in this subject?	1	2	3	4 5
5	I feel comfortable working in a team?	1	2	3	4 5
6	I would prefer notes to be handed out on paper?	1	2	3	4 5
My biggest Physics concern in this subject has been:					
Other Comments:					
My biggest Other concern in this subject has been:					
The best thing about the Studio in relation to this subject is:					
The Studio setup in this subject could be improved greatly by:					
Any other Feedback in relation to this subject) you want to give:					

A summary of the responses to this survey over the period 1997-1998 are shown in Figure H1 in Appendix H.

APPENDIX H Graphical summary of student responses to the general Student Attitude Survey.

This survey was collected in April, June and November of 1997, and June and November of 1998. Students were asked to respond to each question using 5-point scale once for each subject they undertook in the Studio. The specific survey questions are listed in Appendix G.

Figure H1: Average responses to 5 surveys of student attitudes to the Physics Studio and associated aspects.



This figure effectively summarizes the results from ~185 individual survey responses from ~100 different students. Unfortunately a complete analysis of these results is not possible here. Of particular interest are changes in student attitudes during each year and in some cases from 1997 to 1998 (as we hopefully got our act together).

Some definitive trends include increasing student comfort in:

- the use of IT
- working in teams
- the pace of the course.
- working in a paperless manner

APPENDIX I Attendance rates in studio classes

The following figure (Figure I1) shows the weekly attendance rate of 2 first year physics classes (A and B) for a unit run in a Studio environment. The Unit is the 1999 Particles and Waves 101 (Mechanics and Waves). The initial student numbers (week one) were 33 for the Studio A class and 29 for the Studio B class.

The dotted lines refer to the **absolute attendance** rate (includes students who have dropped out) while the solid lines refer to a **relative attendance** rate, Studio (rel). The latter refers to the attendance rate relative to the total number of students remaining in that class i.e. ignores students who have withdrawn or dropped out of that unit.

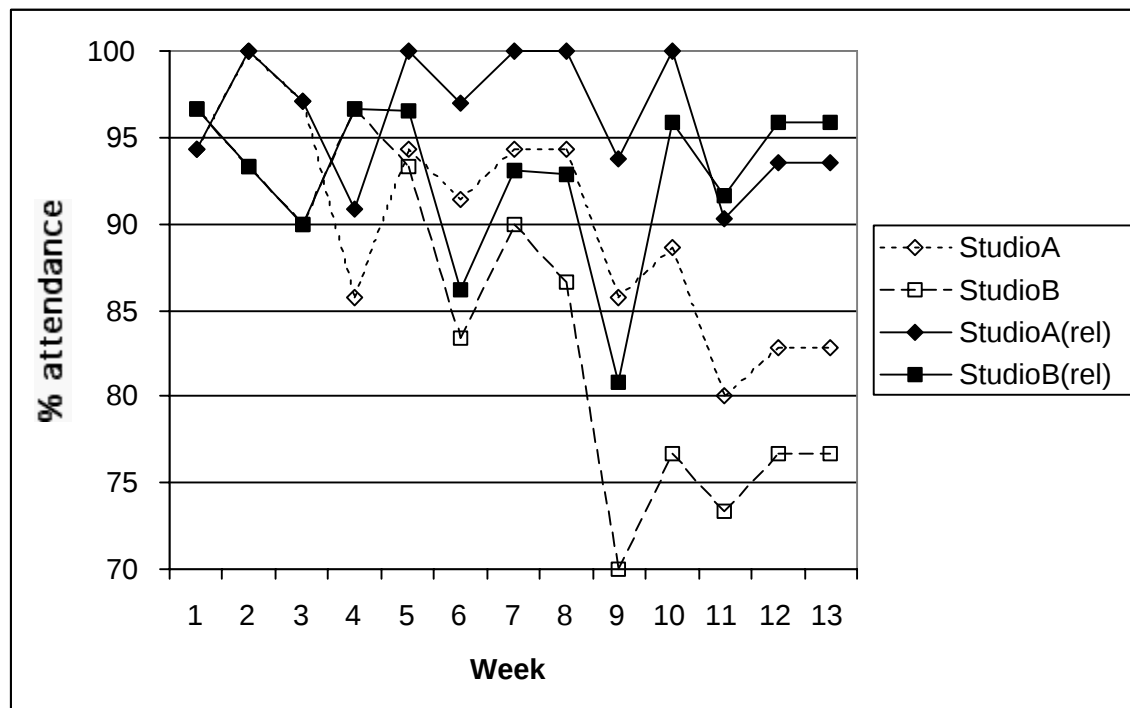


Figure I1 Attendance in a Physics Studio Class (Graph courtesy of Shelley Yeo)

The average attendance rate of >90% is typical of Studio classes compared to conventional lecture classes where rates of around 50% are common. The large dips in attendance around weeks 6 and 9 (especially for students from the Studio B class) can be traced to major work pressures in other units. This type of data is typical of the interesting and valuable information being extracted from the Studio Project.