INVESTIGATION OF FACTORS AFFECTING THE LEARNING OF FINAL YEAR ADVANCED MATERIALS AND MANUFACTURING STUDENTS

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ABSTRCT

An investigation was recently conducted into the delivery of an Advanced Materials and Manufacturing Processes module which was presented to a sub-group of the final year engineering students at Dublin City University (DCU). Results from the class which has just completed their final year studies were examined in relation to the method of delivery. This cohort consisted of 25 students, 13 which studied for the Computer Aided Mechanical and Manufacturing Engineering (CAM) degree and 12 which studied for the Business and Manufacturing Engineering (BME) degree. This paper presents an examination of some of the factors affecting the overall results of these students. Factors evaluated include attendance of the student, as well as individual performance in continuous assessment and examination. Overall attendance at the lecture, the organised seminar series, and practical work were recorded. Results indicate a direct link between attendance and marks awarded. Students with higher attendance achieved better grades. Good continuous assessment performance did not automatically indicate good exam performance. Contrary evidence to this is discussed in relation to student learning styles where students may show better ability in exams with poorer ability in continuous assessment and vice versa.

INTRODUCTION

During a recent in depth review of engineering faculty teaching practices in America the following facilitator recommendations were found to be most promising: (i) recognise difficulty in learning subject matter, (ii) increase complexity progressively through the module and make connections, (iii) contextualise the information, (iv) provide multiple representations to reinforce concepts, (v) make personal connections, and (vi) encourage interaction [1]. A Communities of Practice (CoP) was established several years ago with the aim of developing and sharing of resources to aid biomedical engineering education. The development of materials within this CoP was successfully guided by the How People Learn (HPL) framework which suggests that an effective learning environment should be learner centered, knowledge centered, assessment centered, and community centered [2]. A recent investigation has indicated that out of class experiences hold the potential to extend and reinforce what students experience in their coursework. Students' design, group and analytical skills were all found to improve with out of class as well as academic class work. Out of class experiences that were found to be beneficial included employment, internships or cooperative education opportunities, student design projects, and participation in a student chapter of a professional association or society [3]. An important method of increasing retention at third and fourth level is the use of student centred pedagogies. Similar to the trends in Ireland, the number of jobs in the American labor force requiring science and engineering skills is growing almost five percent per year, while the rest of the job market is growing at just over one percent while only 5 percent of

American degrees are in engineering, compared with 40 percent in China [4]. The ability to produce engineering graduates with educational standards comparable to the best in the world is critical to sustained economic growth with regard the formation, retention and attraction of high value added companies. In this paper, we present result of a review of delivery of one advanced materials and manufacturing module which is delivered to final year students at DCU. This research was conducted to identify the learning barriers for final year engineering students and to established possible ways to overcome these barriers.

METHODOLOGY

The advanced materials and manufacturing processes module is a full 5 credit course half of which is focused on materials and half on advanced manufacturing processes. The advanced materials part covers glass and ceramics, bio materials, materials characterisation, crystallography, and composites. The advanced manufacturing part of the course covers welding, design of experiments, laser processing, electron beam processing, and rapid manufacturing. Both parts of the courses include elements of research currently being undertaken within the Materials Processing Research Centre at DCU. As an example of this the students had to submit a continuous assessment reports on materials characterisation techniques for glasses and ceramics and on a high temperature and shear rate capillary viscometry laboratory experiment which they conducted. Some seminars complementing the course content were given by final year PhD students and postdoctoral researchers within the School. The final examination and continuous assessment were split equally between the materials and processes sections. The final exam accounted for 60% of the overall marks and 40% of the marks were awarded on the basis of the continuous assessments. Students' regular attendances were taken. The exam consisted of six questions. Question 3 was directly related to the continuous assessment report on glass and ceramic characterisation techniques. Question 6 was directly related to the high temperature and shear rate capillary viscometry laboratory continuous assessment report. Questions 1, 2, 4, and 5 were not related to the continuous assessment. Students had to answer two questions from section A (questions 1, 2, and 3) of the paper and two from section B (questions 4, 5, and 6). This review of performance was supplemented by a questionnaire survey of learners which assessed happiness with the course delivery method and sought written feedback on any good and bad aspects of the course delivery.

RESULTS

Table 1 shows the individual student marks and attendance levels. Students were attributed an overall attendance level of either 0-20, 20-40, 40-60, 60-80, or 80-100%. It can be seen from this table that among the 25 students, one student failed this module with a total mark of 32 %. This student had a relatively low attendance in the 20 – 40% range. Student S6 got the highest overall mark of 83%. Only two students secure a total mark above 80%. One was from the CAM group and one from BME group. Regardless of the group, both students attended 80-100% classes. In general students did better in the manufacturing assignment than the materials assignment. This table also indicates that students achieved a better result in the continuous assessment than the final examination. It is clear from this table that total marks are directly corresponding with the percentage of attendance. A pie chart for all the students' attendance is shown in figure 1. In this figure it is seen that only 4% of students attended 0-20% of the classes. The other four attendance ranges each accounted for approximately a quarter of the overall class. It is interesting to note that about 40% of the class attended less than 50% of the lectures. This may be somewhat accounted for in that all class notes for this module were supplied via the Moodle Virtual Learning Environment. However, given the strong correlation between high attendance and good grades and vice versa, improved attendance and methods of achieving this would appear to be useful. Somewhat higher overall attendance and better grades were noted from the BME students as compared to the CAM students.

Table 1: Students' total marks, exam marks, continuous assessment marks, and attendance.

Student No	Total Marks %	Cont. Assess. %	Final Exam %	Materials Assignment %	Manufacturing Assignment %	Attendance %
S1	48	59	40	58	60	40-60
S2	54	67.5	45	65	70	60-80
S3	62	60	62.5	60	60	80-100
S4	47	55	41	60	50	20-40
S5	42	59	31	68	50	20-40
S6	83	77.5	87	75	80	80-100
S7	52	51.5	52	43	60	60-80
S8	53	65	45.5	60	70	40-60
S9	50	50	50	40	60	40-60
S10	41	35	45	70	0	20-40
S11	49	47.5	50	45	50	0-20
S12	44	56.5	35	53	60	60-80
S13	57	64	52	68	60	60-80
S14	66	70	64	70	70	60-80
S15	82	80	82.5	70	90	80-100
S16	54	56.5	51.5	53	60	60-80
S17	52	57.5	48	55	60	20-40
S18	78	84	74.5	78	90	80-100
S19	63	71.5	57.5	73	70	80-100
S20	51	66.5	40	73	60	40-60
S21	57	51.5	60	53	50	40-60
S22	32	19	41	38	0	20-40
S23	62	76.5	53	83	70	80-100
S24	47	52.5	43	45	60	20-40
S25	57	62.5	53.5	65	60	60-80

Student performance for final exam questions 1 to 6 can be seen in Table 2. All the marks in this table are out of 25. Questions 1, 2, 4 and 5 were attempted more often than questions 3 and 6. Questions 3 and 6 related directly to the continuous assessment assignments for the materials and manufacturing sections respectively. Perhaps the students therefore did not expect this material to come up on the exam and did not prepare for this question content. A general trend of better performance from the students with a higher attendance levels was again noted in the results for question 3. Students that performed well with the materials assignment also performed well with question 3. No such trend was evident with question 6.

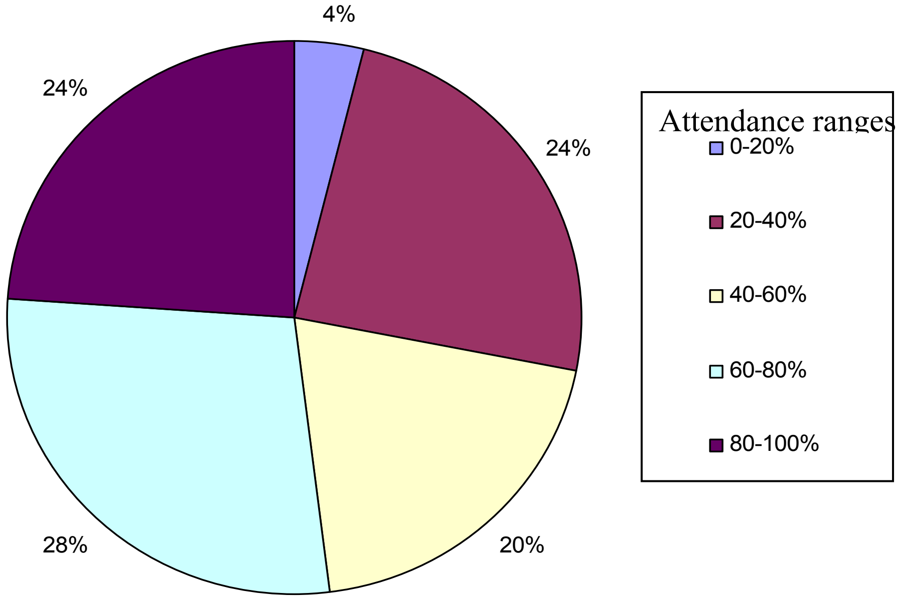

Figure 1: Pie chart showing the percentage of students' attendance.

Table 2: Students and their exam results for questions one to six; each question was marked out of 25.

Student No.	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6
S1	-	11	7	7	15	-
S2	8	11	-	21	-	5
S3	-	16	19.5	12	15	-
S4	11	-	7	17	6	-
S5	5	4	-	10	12	-
S6	20.5	-	16.5	25	25	-
S7	3	7	-	25	-	17
S8	3.5	9	-	15	18	-
S9	13	5	-	20	12	-
S10	13	8	-	12	12	-
S11	1	12	-	-	12	25
S12	2	10	-	-	16	7
S13	-	14	10	14	14	-
S14	10	19	-	23	-	12
S15	16	25	-	25	-	17
S16	14	5	-	16	17	-
S17	-	13	1	19	-	15
S18	17	22	-	-	18	18
S19	10	-	16	19	13	-
S20	4	5	-	19	12	-
S21	-	8	11	20	21	-
S22	12	12	-	12	-	5
S23	-	10	2	23	18	-
S24	2	4	-	21	16	-
S25	18	13	-	9	12	11

DISCUSSION & CONCLUSION

The materials assignment, question 3 and question 6 were descriptive and theoretical in nature whereas the manufacturing assignment was experimental and analytical in nature. Students that learn or perform better with project based and analytical work may therefore have performed better in the manufacturing assignment but still performed poorly in question 6. A general trend can also be seen where the results are on average higher on the manufacturing side of the module compare to the material half. This may be accounted for by the fact that more of the assessment on manufacturing side of the module (question 4, 5, and the assignment) was analytical compared to the more descriptive assessment on the materials half of the module. With a higher analytical content, as long as the student takes the correct approach to solving the problem, high marks are readily obtainable. A large number of methodologies for evaluating individual learning styles have appeared over the years. These include Three Representational Modes (TRiM); Visual, Auditory, Kinesthetic (VAK); Kolb's learning inventory; Myers Briggs Type Indicator (MBTI); and Howard Gardner's multiple intelligences. Kolb’s learning style model distinguishes between concrete experience and abstract conceptualisation on the one hand and reflective observation and active experimentation on the other. Student’s that learn better with active and concrete experience may be expected to have performed better in the manufacturing assignment but may not have performed as well with the associated exam question for which a more reflective and abstract learner could have performed better.

Figure 2 shows the correlation between the exam, continuous and overall results of the students and their attendance. It is clear from this graph that the students with higher levels of attendance gained higher results. Students in later years of University education show a preference for remote access to the course content. The main barriers to learning through remote access include lack of student motivation in a self learning environment and a lack of insight which can be gained though a backup scaffold of group and tutorial type learning. Studies have shown that with the introduction of module delivery via a Virtual Learning Environment (VLE) or for distance delivery, students are initially less likely to adopt a deep approach to learning and rated these courses as less favorable with regard to the workload and materials [6]. To achieve improved learning, the course content delivery structure needs to be reviewed on a regular basis and made as clear as possible. In reality if engineering educators are to meet the goals of increased student numbers and improved teaching methodologies, a readily implementable system of Continuous Improvement (CI) needs to be an integral part of engineering programme structures [7, 8]. Methods that have been shown to be effective in improving content delivery include blended learning and access to the latest technology for facilitator and students. These methods also encourage and in many cases require student attendance which has been found here to be strongly correlated to their level of learning.

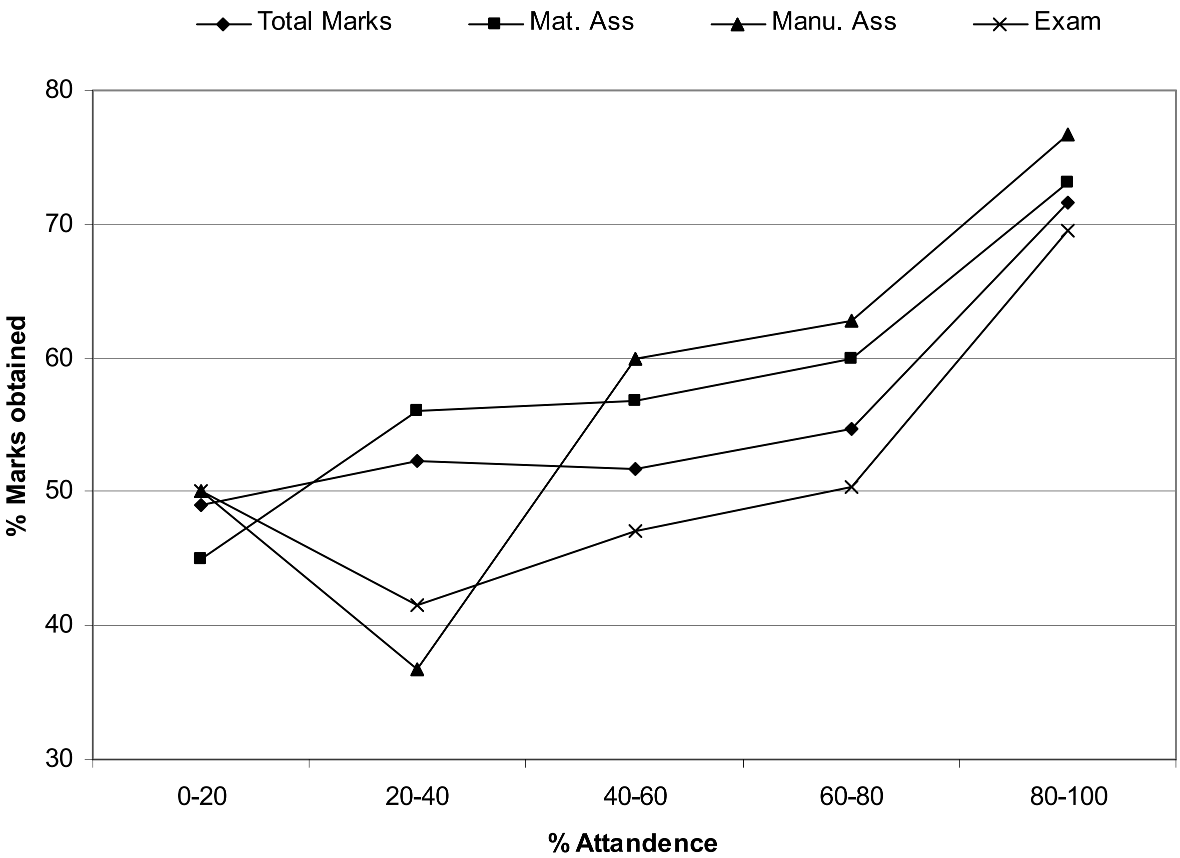

Figure 2: Correlation between results and percentage attendance.

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