
Teaching 'soft' skills to engineers

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Abstract Engineering departments widely recognise an increasing need to equip students with effective study skills early in their university education and basic professional skills prior to graduation. These, however, are traditionally difficult modules to teach successfully to larger groups through traditional lecturing. Observations suggest a poor absorption rate from the students and thus a lack in their ability to benefit from these skills both personally and professionally. This paper documents the findings of an initiative which aimed to improve the success of study skills teaching by combining academic and commercial leanings into a modified teaching approach. The results and specific techniques described in this paper can be easily integrated into most types of teaching material.

Keywords presentation skills; professional skills; project management; report writing; study skills; teamwork

Over the past 10 years there has been an increase in emphasis on 'soft' skills in HE engineering programs. Reflecting both the demands of potential employers and professional bodies, as well as the creativity of course designers, modules such as first year 'study skills' and final year 'professional skills' have become more and more common. The greatest focus has been placed on fundamental topics such as presentation skills, effective report writing, teamwork, and time/project management. Whilst this change is certainly a positive one, these modules seem to be among the more challenging to teach and assess successfully, the criteria for success being that the student can understand the concepts presented, apply them using exercises, and demonstrate the resulting competence through assessment. In a recent survey carried out by the University of Hull and involving engineering students from five universities, less than 10% of students reported having found study skills teaching useful whereas 41% found it to be of no use.

It seems that such modules are not popular with students or with engineering staff. The situation appears strained, especially at first year level, with students reluctant to attend and claiming that the subject is irrelevant or that they have covered the material before. There are several observations relevant to the perceived lack of penetration. First, most engineering students are male, and male first year engineering students report a high level of confidence in their own ability in both 'academic' and 'soft' subjects.¹⁻³ Secondly, young men are reported to experience difficulty in taking advice from parents and teachers.⁴ It also seems likely that engineers as teachers fail to respond to students' attitudes and do not teach topics such as teamwork and presentation skills in a way that is palatable to students; a particular lecturing 'manner' may be appropriate when teaching, for example, circuit theory, but this manner may be inappropriate to the teaching of soft skills. For this reason the investigation reported here combines both the experiences of academic staff at the University of

Hull and those from SP Consulting, an international consulting and training company with significant experience teaching 'soft' subjects to professional engineers.

A modified teaching approach is required that addresses the observed difficulties. The approach needs to add interest and obvious relevance; students need to feel that any guidelines presented can solve a pressing issue or concern that exists in their world. Above all, to be successful the teaching approach must be dynamic, interesting, practical and organised to manage tactically the attention span of the audience.

Modifying the approach

Keeping a large number of undergraduate students continually engaged is not the easiest of tasks, particularly considering the challenges above. It was decided that a different and more dynamic teaching approach was required to stimulate students in place of traditional lecturing styles based essentially on one-way communication. If students frequently had to respond, discuss, react or participate they would be far less likely to disengage or go to sleep! Allowing them to make mistakes in a supportive environment would also go some way to convincing them that they needed to improve their skills and were doing so by attending the learning sessions. Some might argue that a high level of interaction is only practicable with smaller audiences. Whilst smaller groups are indeed easier to manage this was found not to be the case, although an experienced lecturer is required who is willing to engage in open discussions and deviate from a detailed lecture plan if necessary.

The investigators began by identifying a practical toolkit comprising 8 well-documented techniques that can be used flexibly to transform any 'standard' lecture into a more dynamic one. These techniques are summarised below.

An emphatic and captivating introduction

A successful training session must begin by creating a sense of urgency and somehow capturing the interest of the audience, usually by emphasising the importance of the topic and its relevance. What rewards can be obtained by applying the content of the session? What pitfalls exist for those who lack the competence? However, it is important that in emphasising the importance of a topic the presenter is not perceived as 'finger wagging'. For example, 'when you're in industry you'll have to . . .' or 'you won't pass your final year project unless you learn to . . .' are unlikely to prove engaging whereas 'would you like me to help you get more marks for your lab reports without doing any more work' is.

Use of relevant examples and 'storytelling'

Examples, stories and anecdotes turn theories and guidelines into perceived reality by providing a true-to-life basis for their application. They will also capture the full attention of most audiences. Use plenty of these – at least one for each principal point covered – and, wherever possible, focus on real examples rather than hypotheses.

Group exercises

Have students perform short exercises in groups to try out the application of concepts presented, followed by a de-brief where each group reports its findings, progress and difficulties to the audience. Exercises of this type break up the session, increase engagement and can be easily conducted – even in a lecture theatre. They also force the students to admit their errors, even if these errors are not reported to the audience, and this helps to establish for them the fact that they have learnt something.

Brainstorming

This is another interactive technique to provide stimulation and variation. Provide an open question and have students brainstorm in small groups (usually together with those sitting next to them) before beginning a discussion session.

Demonstrations/simulations

It is much more effective to demonstrate an idea than to talk about it. Documentation could include some type of physical simulation, a simple game, or even a video clip. Role playing is particularly effective as it involves the students in an active way, provided that a risk-free and supportive environment is provided to those who participate. This in turn is dependent on the lecturer's making sure that students are never embarrassed by 'failure' during an activity.

Opinion polls

This is a 'quick change' and helps students to engage in a new activity or a new aspect of a topic. For example a quick show of hands: 'How many people think. . .?'

The mind break

Used to refresh the listeners' attention span during more demanding presentation components, for example, 'take a 2 minute break to chat with your neighbour before we move on . . .'

Facilitation vs. lecturing

Whenever possible, lean towards the process of facilitation rather than lecturing. Prompt the audience with relevant questions, challenge their ideas, and shape an understanding based upon the responses and active discussions rather than reading a script. It is, however, important to be respectful towards students who give wrong or poor answers.

The techniques presented above provide some of the most important ingredients for an engaging lecture. They are well documented and widely used in isolation.⁵ Not all are applicable to all situations and types of material, and the next step is, therefore, to devise session plans into which they are woven appropriately. The choice of techniques will depend largely on the topic to be presented and to some extent the lecturer's personality and individual style.

Planning and delivery: four sessions

The initiative reported here involved the design and delivery of four study skills sessions, each lasting 1.5–2 hours. The sessions formed just under half of a 10-credit, compulsory, first year module. The following fundamental topics were covered:

- Presentation skills and personal impact
- Report writing
- Teamwork
- Working on projects

The original approach to teaching ‘soft skills’ at the University of Hull also involved 1.5–2 hour sessions. It involved delivery largely via OHP and discourse although students did a project planning activity and, later, made (assessed) group presentations on those plans. By and large, students were told ‘good’ ways to do things rather than being given demonstrations of ‘good’ and ‘bad’ practice or being actively encouraged to contribute to discussions.

Tables 1 to 4 contain outlines of the four sessions as presented in the modified approach. All sessions took place in a large lecture theatre, as had been the case previously. Although this may be viewed as a far from ideal setting it did not, in reality, present extreme difficulties as far as participation and group work were concerned.

Presentation skills

In the presentation skills session demonstrations of desirable and undesirable behaviours were given by the lecturer, sometimes assisted by a student playing a particular role. Small ‘prizes’ were given to students who assisted. Interactive presentation activities involved posing questions to the students as a whole (for example, ‘Why do people ask awkward questions?’) to draw the important points from them, and then synthesising and summarising important guidelines.

Report writing

The report writing session was perhaps the most challenging to present. The two sections of interactive presentation again used a questioning style to draw out important points from the students. Examples included ‘What do you think is most persuasive about the deductive argument?’ Or more specifically, ‘How do you make your readers look at a graph’ and ‘How do you make sure they notice what you want them to notice about the graph?’

Throughout the session reference was made to the departmental guidelines on report writing as a pertinent example of writing to the expected style. Emphasis was also placed on having the maximum impact on the reader while minimising the writer’s effort; this was felt to be important since students claim to spend a disproportionate amount of time writing reports.

Teamwork

The third session used open discussion as to the role of teamwork, since by this stage students required relatively little prompting to offer their opinions. The shield exer-

TABLE 1 *Outline of the presentation skills session*

Content	Teaching approach
<p><i>Making a professional impact (30 min)</i></p> <ul style="list-style-type: none"> ● Importance in daily work, interviews, etc. ● Making a good first impression ● Visual factors – appearance ● Movement and behaviour ● Speech, tone, articulation ● Demonstrated listening and feedback 	<ul style="list-style-type: none"> ● Interactive presentation. Opinions polled from the students. ● Discussions facilitated regarding the impacts of different behaviours on the impression created. ● Specific examples provided on how to avoid poor impressions. Simple demonstrations provided through role playing with a volunteer.
<p><i>Delivering an explanation (30 min)</i></p> <ul style="list-style-type: none"> ● Making something complex sound easy ● Precautions when making assumptions ● Adapting to audience needs ● A clear, step-by-step approach ● Taking regular checkpoints ● Anticipating and addressing concerns ● Using different angles, where necessary 	<ul style="list-style-type: none"> ● Role playing using a short case (books such as <i>The Chicken from Minsk</i> have several suitable examples) which students have been asked to consider beforehand. ● Volunteers explain their solutions to the problem, then the group comment on the strengths and weaknesses of each explanation. ● A set of guidelines demonstrating good practice are derived from the various views presented.
<p><i>Designing formal presentations (20 min)</i></p> <ul style="list-style-type: none"> ● Building a structure ● Content and slides ● Appearance, look and feel ● Use of effects and animations 	<ul style="list-style-type: none"> ● Interactive presentation. Opinions polled from the students regarding the difficulties associated with presentations. ● Examples provided to back up each of the principal guidelines put forward. ● Discussion on the nature and causes of nervousness followed by demonstrations of characteristics of nervous behaviour.
<p><i>Delivering formal presentations (20 min)</i></p> <ul style="list-style-type: none"> ● Managing nervousness ● A captivating introduction ● Platform techniques ● Question handling ● Summary and conclusion 	<ul style="list-style-type: none"> ● Participation in nerve calming activities (e.g. pulse counting). ● Demonstration of platform techniques including language and audiovisual techniques.

cise involves placing a few words or an image in each of the four sections of a shield to outline one's strengths, weaknesses, desired contributions and preoccupations which might prove to be distracting. This highlighted the importance of individuals and their motivation towards any team activity. The tower building activity, allowing 45 minutes for a group-based project and then 15 minutes for feedback, was very popular with the students. Most were quite willing to admit their mistakes and share their learning experiences in the supportive atmosphere which had been established.

Project work

The final session on project work involved discussion on the nature of a project and the skills necessary to manage a project effectively. Project planning was incorpo-

TABLE 2 *Outline of the report writing session*

Content	Teaching approach
<p>Reporting basics (45 min)</p> <ul style="list-style-type: none"> • What should a report achieve? • Anticipating the needs of the audience • Doing the work: Planning and logistics • Developing a structure and outline plan • Writing the detailed content/paragraphs • Good and bad use of language • The role of charts, diagrams, illustrations and appendices • Reviewing your work 	<ul style="list-style-type: none"> • Interactive presentation. Opinions polled from the students regarding why they dislike report writing. • Emphasis placed on how to make the process easier and more time efficient with better results. • Examples on the use of structure and the subsequent addition of detailed content. • Examples given on the results of good and bad report writing in the industrial/commercial world. <p>A 2-minute mind break was used to separate this and the following section.</p>
<p>Developing argumentation (25 min)</p> <ul style="list-style-type: none"> • The role of argumentation in reports • Strong vs. weak arguments: making your case • The deductive argument style • The inductive argument style • Defending an argument 	<ul style="list-style-type: none"> • Two fundamental approaches presented for building an argument: deductive and inductive. • Students encouraged to question and challenge the examples presented. • Guidelines subsequently derived for presenting and defending arguments.
<p>Group work (40 min)</p> <ul style="list-style-type: none"> • Building and structuring a strong argument 	<ul style="list-style-type: none"> • Students work in small groups to build an argument to support a proposal of their choice. • Instructor coaches each group as they work. The groups conclude with a brief summary of their progress at the end of the session.

rated in the ‘meeting’ activity in order to give students experience at formulating agendas and other meeting related skills.

Materials and assessment

The materials for each of the four teaching sessions comprised presentations, slides and written exercise descriptions. In accordance with good presentation design practice, slides were kept simple and informative, illustrating key points and examples but avoiding excessive detail and the resulting overload of information on the screen. The specific objectives of each session are clearly stated at the beginning, and learning points were crisply summarised at the end. Copies of the slides were provided to students in the form of handouts, containing plenty of white space so that students could add their own notes related to more detailed content.

Study and professional skills modules are difficult to assess on a stand-alone basis as the skills would normally be applied in conjunction with other tasks or material. Some skills are almost impossible to assess formally without a physical demonstra-

TABLE 3 *Outline of the teamwork session*

Content	Teaching approach
<p><i>The importance of teamwork (20 min)</i></p> <ul style="list-style-type: none"> ● The role of team-based work in industry ● What is it like to be part of a team? ● Acting as a competent team player ● Personal shield exercise 	<ul style="list-style-type: none"> ● Open discussion, and opinions polled from students as to what it is like to work in a team. Conclusions drawn regarding each individual's responsibilities towards the success of a team. ● Personal shield exercise.
<p><i>Using a teamwork model (30 min)</i></p> <ul style="list-style-type: none"> ● The use of a model to simplify team analysis ● Consideration of each phase/activity <ul style="list-style-type: none"> – Getting started – The team environment – Goals, roles and approach – Commitment and follow-through – Collaboration – Results 	<ul style="list-style-type: none"> ● Different educational institutions favour different teamwork models. ● During this part of the session students are introduced to the chosen model with an emphasis on its practicality and when and how to use it. ● Solid true-to-life examples of team situations are provided in each case to prevent the discussion from becoming too theoretical.
<p><i>Exercise: Tower build project (1 hour)</i></p> <ul style="list-style-type: none"> ● Execution of a team-based project ● Analysis of how the team performed <ul style="list-style-type: none"> – Strengths – Weaknesses 	<ul style="list-style-type: none"> ● Students perform a team-based project assignment requiring them to design and build a small tower, able to support the weight of a brick for one minute, using card and tape. ● A single copy of the specification is available, pinned to the wall so that students have to queue to read it and take notes. Similarly, a budget is allocated for materials and students have to queue to buy them. ● The exercise is competitive and performed under time pressure. Upon completion each team analyses and rates its performance using a scoring sheet, weighted towards the theories previously discussed. The teams then briefly report their progress and final conclusions are drawn.

tion such as the individual delivery of a presentation. This is clearly difficult if larger student numbers are involved.

An approach was adopted to assess a selection of the skills introduced across the study skills sessions using a single written report. Essentially, the students were asked to write an analytical report about a team that they had participated in, identifying its strengths and weaknesses, and presenting recommendations as to how it could have been improved.

A marking scheme which emphasised the application of the concepts introduced was provided to direct them in this assignment. To score highly students would need to apply the guidelines from the report writing session to produce a good and well-structured report. The selected teamwork model was to be applied effectively as the

TABLE 4 *Outline of the project work session*

Content	Teaching approach
<p>Initial thoughts (15 min)</p> <ul style="list-style-type: none"> • What is a 'project'? • What skills are required for successful project work? • What common things cause projects to fail? 	<p>Students spend 5 minutes brainstorming these 3 questions. A discussion is then facilitated based upon students' opinions, highlighting the need for an organised approach to project work.</p>
<p>Planning and task management (20 min)</p> <ul style="list-style-type: none"> • The role of a project plan • Pinning down clear objectives • Task planning: What? Where? Who? • Managing external resources • Risks and assumptions • Quality criteria 	<ul style="list-style-type: none"> • Presentation delivered interactively. Examples provided. Opinions polled: What would be compromised if there was no project plan? • A particular focus placed on the process of creating a task plan, with examples.
<p>Effective meetings (15 min)</p> <ul style="list-style-type: none"> • Stating the objectives • A clear agenda • Conducting productive discussions • Time management • Note taking and summarising • Action points 	<ul style="list-style-type: none"> • Presentation supported by discussions and specific examples, particularly those highlighting the effects of poor practice, e.g. long meetings that produce little constructive output. • Examples of the type of meetings which pertain to undergraduate project work, with emphasis on the need to build these skills to a professional level prior to graduation.
<p>Working in teams (5 min)</p> <ul style="list-style-type: none"> • Recap of teamworking strategies • Challenges in the project environment 	<p>A brief recap of the thinking presented in the teamwork session, with a particular view towards the impact on the project environment. Examples of the most common difficulties experienced in industry.</p>
<p>The project environment (10 min)</p> <ul style="list-style-type: none"> • Understanding the context • Managing external resistance • Knowledge transfer 	<ul style="list-style-type: none"> • Reference to the need for engineers to think beyond the boundaries of a project or solution to ensure its usability and acceptance. Examples provided to illustrate each point.
<p>Group work (40 min)</p> <ul style="list-style-type: none"> • Conduct a meeting to produce a basic project plan 	<ul style="list-style-type: none"> • In groups, students conduct meetings to create a project plan for an upcoming event of their choice. The plan should include definition of scope and objectives, a task plan, identification of external resources, dependencies and any risks or assumptions. Upon completion each group briefly summarises their plan and comments on the effectiveness of the meeting.

basis of their analysis. Finally the learning points from the presentation skills module should be followed to present their ideas and recommendations in a coherent, step-by-step fashion. Although the project work module was not directly assessed, students were encouraged to use its content in the planning and execution of their task.

The assignment and marking scheme are provided in Appendix A of this report.

Results

Metrics and observations

An evaluation exercise, identical to that carried out in previous years, was used. This asked students to respond to a series of statements stating whether they strongly agreed, agreed, disagreed or strongly disagreed. Two statements were viewed as being particularly relevant, both of which had previously been associated with low agreement:

'I can see how the lecture relates to the field of engineering',

and

'The lecture held my attention'.

Figure 1 illustrates responses to the first statement for the new and old approaches. Encouragingly, no student having experienced the new approach strongly disagreed with the statement, whereas 25% of students had strongly disagreed when the original approach had been used. Furthermore, the percentage of students strongly agreeing had risen from 8% with the old approach to nearly 50% with the new. Combining responses for 'strongly agree' and 'agree' shows an increase of approval from 46% to 94%. The sample size was a little over 30 for both approaches, this corresponding to nearly all students present, which yields a confidence level of over 95%.

The response to the second statement was also very positive (Fig. 2). Again, no student strongly disagreed by comparison with nearly 30% of students who had

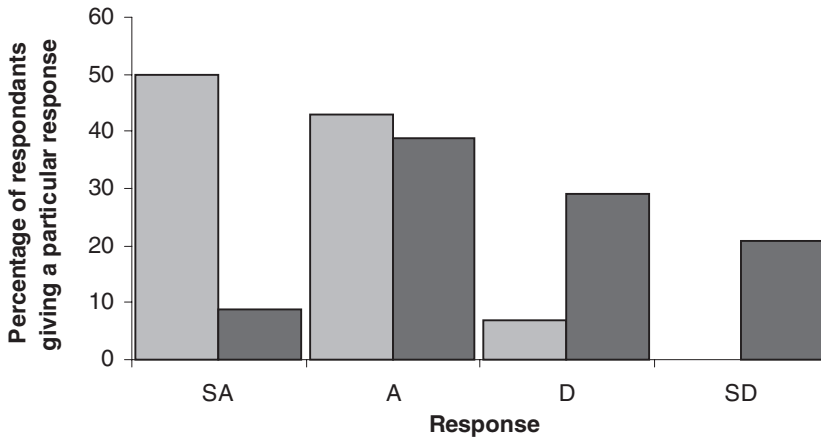


Fig. 1 Response to the statement 'I can see how the lecture relates to the field of engineering'. Pale bars correspond to the new approach and dark bars to the old approach.

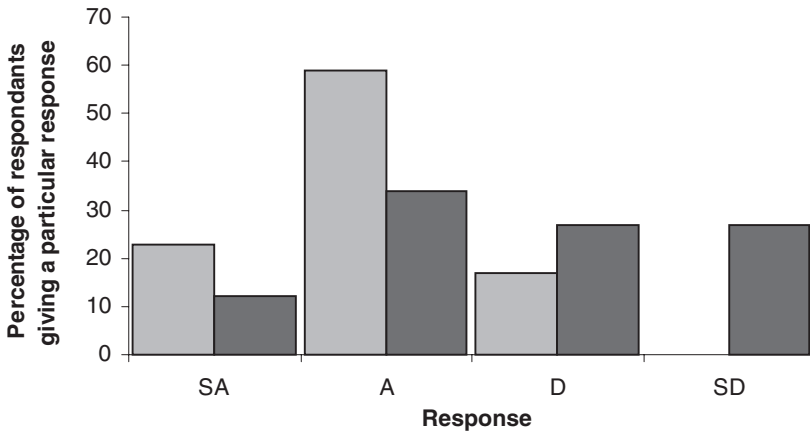


Fig. 2 Response to the statement 'The lecture held my attention'. Pale bars correspond to the new approach and dark bars to the old approach.

experienced the original approach and the percentage strongly agreeing rose from 12% to 22%. Again, combining the responses for 'strongly agree' and 'agree' gives an increase of approval from 42% to 82%. Given a sample size of over 30, this gives a confidence level of approximately 95%.

Discussion

It could, of course, be argued that the soft skills which are the subject of this paper should be embedded in the overall degree structure rather than taught in semi-isolation as considered here. There is an element of truth and an element of validity in this suggestion. Soft skills develop in engineering students through their engineering courses, in particular during project work. However, the authors would argue that some explicit teaching, embedded or otherwise, is very beneficial to 'kick-start' them in these activities; furthermore, unless soft skills development is taught and assessed explicitly there may be a temptation to allow students to continue to perform badly in related topics without highlighting the reason for the poor performance. Explicit teaching does not preclude embedding, but soft skills are a relatively new addition to engineering degree courses and perhaps the soft skills culture is not yet mature enough for effective embedding.

It is difficult to measure the true effectiveness of this type of teaching since its impact is only apparent in the longer term; in the approach students take to the remainder of their studies and in their professional lives. However, the evaluation exercise showed very clearly that the students' immediate response was significantly improved. Observation of the classes also suggested that the students were much more actively engaged with the material and were, by and large, enjoying the sessions. The atmosphere was good and the small 'prizes' were astonishingly popular, encouraging participation while injecting an element of light-heartedness.

However, difficulties remain. The principal difficulty is attendance, with only approximately 50% of the students attending any of the sessions. Observations suggested that the same students attended each session so that, although sessions were well received, it appears that many students did not feel that the topics could hold any interest for them, and did not attend at all. Furthermore, they were not persuaded otherwise by those students who attended and continued to attend.

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APPENDIX A

Assessed work assignment

Dept. of Engineering

Study Skills

Coursework Assignment: Autumn 2002

TEAM ANALYSIS & IMPROVEMENT

This assignment requires you to produce a report on the subject of team improvement.

You are asked to select a team that you have been a part of (at work, school, university or during your spare time) which you believe was ineffective or unsuccessful in some way.

Begin by providing a brief background on the team, its composition of people, principal goals, challenges and surrounding environment.

Then perform analysis using the team management model provided and pinpoint specific issues that the team was facing. Describe and document these clearly, with specific reference to the corresponding stage in the model in each case.

Finally, present good and actionable recommendations of things that could have been done to solve the 3 most pressing issues that you have identified. Be clear on what actions could have been performed, how they could have been carried out and by whom.

Complete your report professionally with a summary briefly re-emphasising the main themes of your findings and conclusions, and suggesting any follow up actions or further considerations.

Target Length: 5 pages (maximum) + appendices (optional)

Submission Deadline: 09 December, 1200 hrs (Departmental Office)

Marking scheme

Category	Criteria for high score	Marks
Abstract	Concise introduction explaining the purpose of the report, what will be covered, and the type of findings to be presented.	10
Issue Analysis	Good analytical description of 3–5 separate team issues with details of the observed symptoms, probable causes and the resulting effects on the team.	15
Use of the model	Description of how the model was used in your analysis, referring in particular to the stages in which the team had issues.	10
Recommendations	Recommended actions that the team could have taken to resolve the 3 most pressing issues. Details of What? How? Who?	15
Supporting arguments	Justification of the recommended actions. Why these actions and not something else? Clear indication of the expected changes/benefits.	10
Summary/Conclusions	Summary of the main themes and conclusions. Any follow-up actions or other considerations.	10
General presentation	Professional packaging and presentation. Good use of fonts, layout, page numbers, diagrams etc. 'Good look and feel'.	10
Report structure	A logical structure which is easy to follow. Good choice of sections, use of headings, numbering, table of contents, etc.	10
Use of English	Clear presentation of the facts clearly and fully using the fewest words necessary to do so. No long-winded sentences or redundancy. Good use of spelling, punctuation and language structure.	10
TOTAL MARKS		100

Important note: Late submission of the report will result in a deduction of 10 marks.