CASE STUDY 2

'Outside Their Comfort Zone': Diverse and Engaging Approaches for Students Learning Through a Different Discipline.

Discipline:	An Engineering module in an Architecture Program
Student Numbers:	40

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Introduction and Context

I am an engineer and typically engineering students are assessed using calculation-based exams and written laboratory reports. However, I teach a 5-credit third year module which typically contains 60 architecture students and is compulsory. Simultaneously, these students complete a 20-credit module in studio design involving approximately 30 contact hours per week.

The purpose of this module is to provide architecture students with the necessary training in engineering to fulfil requirements at both a professional and accreditation level.

Whereas calculation-based exams are commonplace in the assessment of engineering students, using them to assess architecture students does not promote effective learning. It was not uncommon for architecture students to fail the engineering-style exam which suited those with a strong background in maths and physics. They seemed relatively unfamiliar with exams as a form of assessment as most of their submissions are studio portfolios. Exams tend to focus student attention on 'reproductive thinking' (Boud and Dochy, 2010). Students often end up cramming last minute, engaging in surface learning rather than the deep learning associated with 'slow scholarship' when assessment tasks require substantial involvement over time (Gibbs and Simpson, 2005).

An alternative, more inclusive assessment approach was required for this module to improve engagement, to allow equal opportunity to demonstrate learning, to cater for the diversity of students and to reduce the need for individual adaptations for specific students.

While the content of this module remains unchanged, my objectives in overhauling the assessment were as follows:

- To promote deep, more effective learning than the surface learning that occurs in exams (Multiple means of representation, CAST, 2018)
- To be transparent in assessment by developing the rubric with students
- To provide greater choice in assessment tasks (Multiple means of engagement , CAST, 2018)
- To empower students to be self-regulated learners (Multiple means of engagement , CAST, 2018)
- To be more inclusive of architecture students in the discipline of engineering

The assessment strategy in this module were therefore overhauled to include the use of rubrics, group-work, peer-review and feedback activities to promote a more inclusive learning environment for all. This case study presents details on the activities that I introduced to students, as well as some feedback from students on their effectiveness.

Design and Implementation of the Initiative

Rather than a final exam, students now complete an individual design report (60%), a group laboratory presentation (30%) and participation in classroom activities (10%).

Individual Design Report.

This authentic assignment (National Forum, 2017) is given to students in Week 1 and is due in Week 11 (Table 1). Students prepare a design report including the engineering scheme, assumptions and calculations of some typical building elements using a variety of materials.

Table 1: Individual Design Report

You are the architect and lead designer on a big project For this project, you must complete an individual design report, for your client, containing the following: — A stable structural scheme design for the project — Detailed design calculations for a range of beams and columns in timber, concrete and/or steel including - Cross-sectional sizes of members to resist bending stresses, by judging the significance of section modulus - Cross-sectional sizes of members subjected to either compressive stresses or combined compressive and bending stresses, by judging the effect of slenderness of the structural element - Calculations of the shear forces of structural elements and control them using appropriate cross-sectional dimensions - Evaluate the need to control deflection in members — Calculations for foundations and/or retaining walls The individual report must also contain — A detailed description of your architectural design for the public building that gives the reader context

- A description of your understanding of the philosophy of safe design
- A note on assumptions you've made
- A discussion on the efficiency of your solution
- Supporting images and sketches
- State the correct units in all calculations
- High quality writing and organisational layout as per any professional report

Choice is given to students about whether to complete their report on a design from their current studio work (e.g. a library, school, residential complex etc), or studio work completed in a previous year (Figure 1) Choice is one of the approaches used in inclusive assessment (CAST, 2018; Burgstahler, 2015) . The advantages and disadvantages of each option were also presented.

What project?

The public building you designed last semester in ARCT 20010 (Architectural Design IV)	OR	The public building you are currently designing this semester in ARCT 30010 (Architectural Design V)
Advantages: Can get started straight away as your architectural design is finished and you could finish early		**Advantages:** The architectural and structural design will be completed simultaneously so one can inform the other
Disadvantages: You may find some parts of your public building are very difficult to design structurally		**Disadvantages:** You could end up doing a lot of work late in the semester when you have other deadlines

Figure 1: Choice in assessment provided to students

During Weeks 1-8, content was delivered to students on design calculations and codes of practice in timber, steel and concrete, used in the competent design of any structure. Students brought a draft report to class in Week 9 to engage in the process of the two-stage assignments and peer feedback (Table 2). These activities promote the concept of 'feed forward' (Jackel et al., 2017) and offer an opportunity for selfreflection, analysing a peer's work, exchange of peer feedback, and then revision of their own work before submitting a final assessment (Reinholz, 2016). While students are commenting on the drafts of peers, they will at the same time be reflecting back on the work they have produced themselves (Nicol, 2014). The use of peer and self-assessment increases students' responsibility for their own work and reduces the number of 'am I done yet' questions (Andrade, 1997).

Table 2: Peer-Review Details

This is a two-stage assignment — The first deadline is **9am Monday of Week 9, bring two copies of your draft report to class** for feedback. Participating in this feedback contributes to 10% of your grade for the module. This promotes the concept of feed-forward to help you prepare for your final submission. — The second deadline is **3pm Friday of Week 11, submit your final report** including changes as a result of feedback to the school office G79. Include a cover sheet outlining how the feedback you received was taken into account. This report is worth 60% of your grade for this module.

Group Laboratory Submission

Traditionally, engineering students complete laboratory reports (introduction, methodology, results, conclusion) for each lab they attend. In this module, students attend a laboratory on timber and concrete (Week 7) and prepare a group submission which is due in Week 10. To make the assessment more exciting, authentic, effective and relevant, students choose to prepare either a video or presentation based on their laboratory, rather than a report (Figure 2).

Group Laboratory Submission

You will be on the team of technical experts involved in a court case

A building collapsed during construction and the client is suing the engineer. Samples of the concrete and timber used in the construction are being tested in your lab. Prepare the video evidence that will be shown in the courtroom.

Include the following:

- Video footage of the lab tests
- Technical explanations of the theory
- Calculations based on your results
- Methodology, Results and Conclusions
- Students will work together in assigned groups to create the laboratory submission project.
- For your submission, you have a choice:
  Made a 3min Video to play in class OR Prepare a 7min presentation to deliver in class
- Both options should include appropriate photographs, video from the labs, music, graphs, and other visual aids.
- Make sure to include your group number and the names of the students who contributed.
- If making the video, it should be embedded in a single powerpoint slide

Figure 2: Group Laboratory Submission

To support effective group-work, I engage students in activities ahead of their laboratory. I present them with an essay on hitchhikers (Oakley et al., 2004) and request a reflection from each student. This encourages students to think critically about group-work, and how they as individuals can contribute. A team policies statement (Oakley et al., 2004) is drafted by each group which sets expectations, provides guidance on effective group functioning, assigns roles and develops strategies for dealing with uncooperative group members. The signed agreement serves two purposes; it sets student-generated expectations that they agree to honour and serves as a 'quasi-legal document' so students can't claim they didn't know what they were supposed to do.

Interactive Rubric Development with Students

I created the rubrics for both assessment tasks in class with students. Each group was given an envelope of cards. Each card contained an assessment criterion on one side and its definition on the reverse (Figure 3).

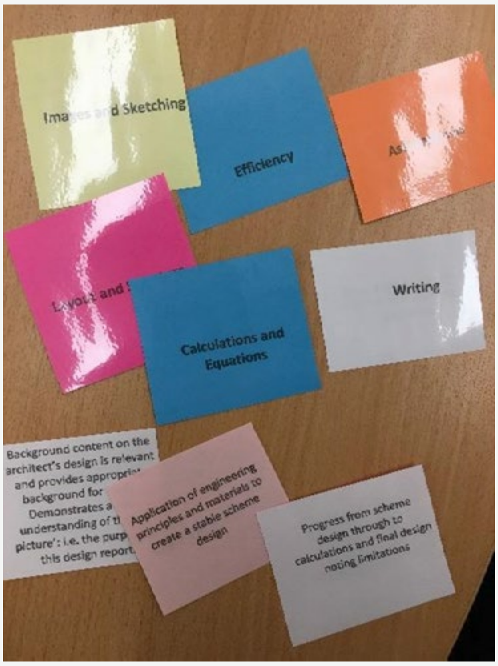


Figure 3: Cards used with Students to Create Rubric

Students spent time in groups deciding the criteria and respective weighting to be used in the rubric (Figures 4 and 5). This achieved buy-in from students in the assessment process, a greater understanding of the expectations for the assessment, as well as getting students started much earlier. This also supports students engaging in a discipline that is less familiar to them, i.e. architects experiencing more engineering types concepts and practices.

Furthermore, the activity achieves the objectives of being transparent, inclusive and empowering students to be self-regulated learners. The full rubrics used for each assessment can be found below in Appendix A.

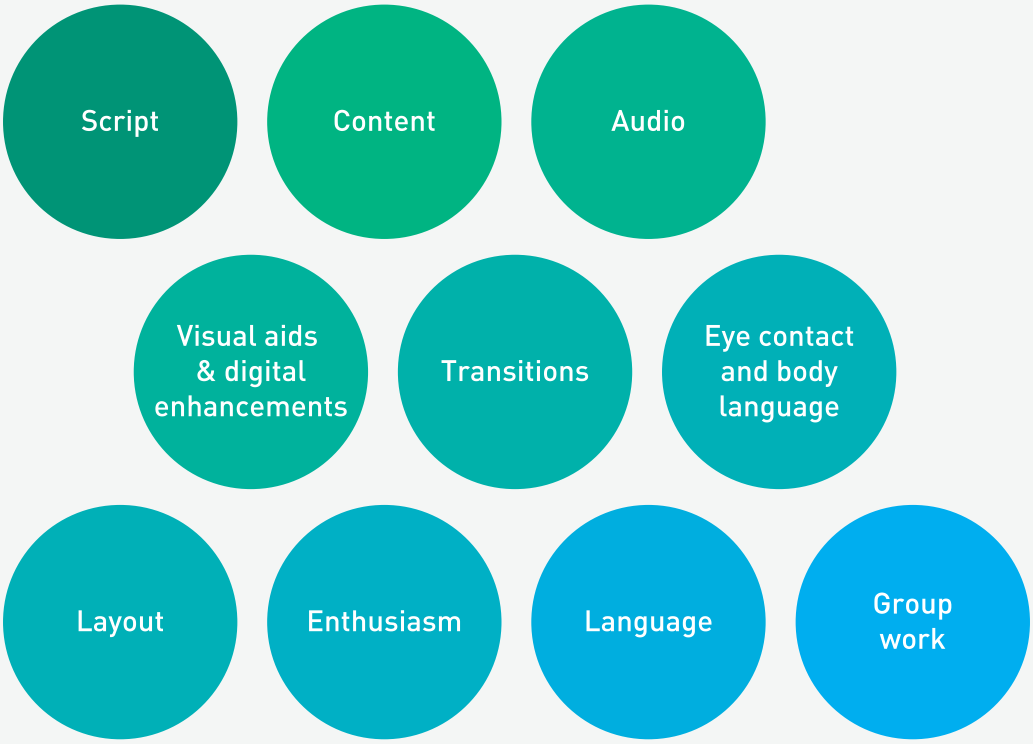


Figure 4: Criteria used in Group Laboratory Submission

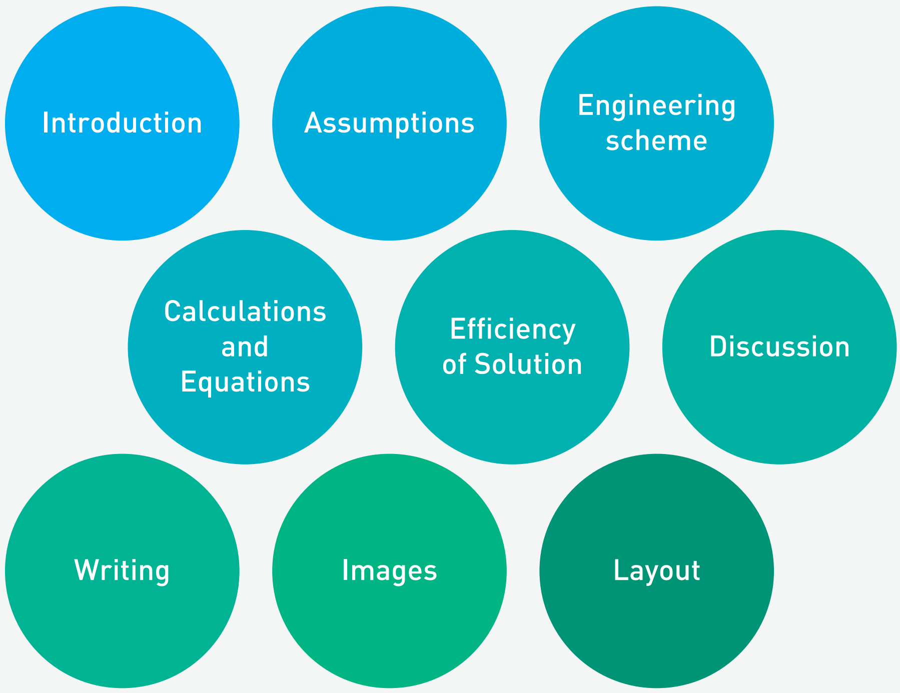


Figure 5: Criteria used in Rubric for Individual Design Report

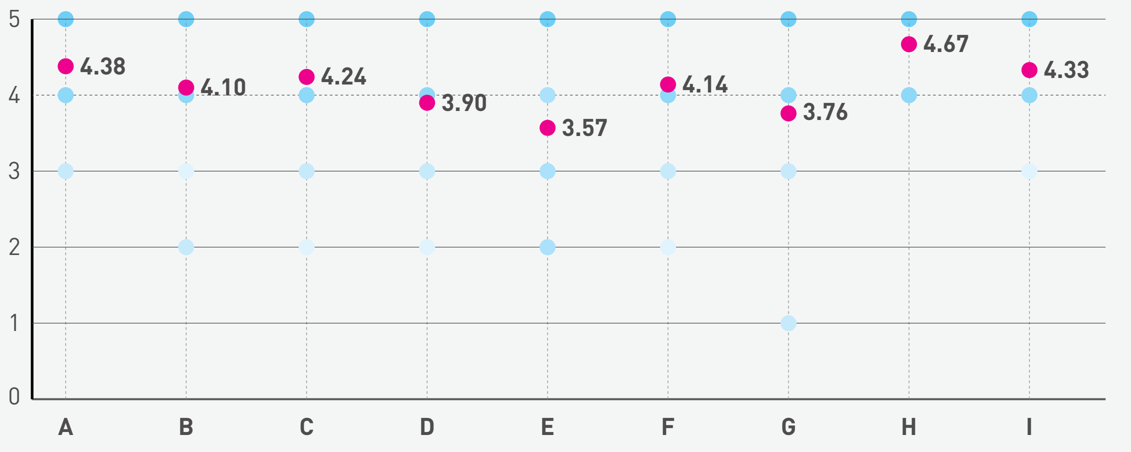
Link to Universal Design (Inclusive Assessment)

The assessment tasks in this module were designed adhering to the principles of inclusive design:

- **Variety –** the assessment approach expands the variety of assessments students are exposed to as well as there being multiple methods of assessment: an individual design report using peer feedback and two-stage submissions as well as a group lab submission in either a video or presentation format (Multiple Means of Representation, CAST, 2018)
- **Transparent –** the rubric for both assessment tasks was developed in class with students and so students choose how they wish to be assessed. This empowers them to become partners in assessment and to become self-regulated learners. (Multiple Means of Representation and Multiple Means of Engagement, CAST, 2018)
- **Authentic –** the group laboratory submission sought a script from students that played out a likely scenario they will encounter in their careers – i.e. being involved in a court case associated with one of their designs. (Multiple Means of Engagement, CAST, 2018)
- **Choice –** students have choice in both of the assessment tasks which enables students become partners in assessment and select the method that best suits their strength. Allowing students choice is in line with Universal Design for Learning principles of multiple means of engagement. (Multiple Means of Action and Expression, CAST, 2018)
- **Scaffolded–** students are supported in the completion of their assessments using peer review of an early draft that promotes feed-forward for the final submission. This also empowers them to become self-regulated learners (Multiple Means of Representation and Multiple Means of Engagement, CAST, 2018)

Results/Findings/Feedback

At the end of the semester, students provided feedback on the module. On a scale of 1 (poor) to 5 (excellent), students were asked to rate their response to the questions illustrated in Figure 6. It is clear that the goals of reforming the assessment practices to promote more effective learning, to offer choice and to implement feed-forward and peer-review activities have been achieved. Furthermore, having completed the assessment grading, no students failed the module this year and the average grade for the class was a B-. It is clear to me that their learning has been excellent as evidenced by their submissions.



Total Students: 60

A. I learned a lot about engineering, for the benefit of my architecture education
B. Do you have a greater understanding of structures now?
C. I understand more about the relationship between engineers and architects
D. Groupwork help develop working relationships
E. Reviewing the hitchhiker essay a good idea
F. Have you learned from participating in the lab work?
G. Was the peer review of draft reports a good idea?
H. Did you learn more from having continuous assessment rather than exams?
I. Overall, I am satistied with the quality of the module

Figure 6: Results of feedback from students

In addition, students made following additional comments, which are overwhelmingly positive:

— 'Really super module. Clear, well run and super lecturer. Thank you!'
— 'Teaching instructions very clear and enabled easier understanding of topics. All lectures were explained thoroughly. Lecturer was very understanding and was very happy to provide as much help as needed. Best teaching I've experienced in 3rd level'
— 'couldn't have imagined an exam in this module as the content is so vast and difficult'.

The results, therefore, have been extremely positive from students and I have been very happy with how much the students appear to have learned. I hope that my initiatives will inspire others to use some of these ideas in their own classroom.

Advice to others for implementation

If you are considering implementing some of my ideas, please find some suggestions below:

- Engaging students in developing the rubric for the assessment tasks worked really well. It achieved great buy-in from students and they had a much greater understanding of the expectations as a result. To prepare for this; it is a good idea to have the criteria prepared (Figure 3) ahead of time, and to guide students through the activity.
- It's a good idea for students to put their student number (and not their name) on their draft reports for peer review. The reports are then shuffled and anonymously handed out. Students really liked thr peer-review process as it gave them a target to work towards as well as getting an appreciation for the level of work their colleagues were putting into their reports.
- I prepared a timetable for the semester (Figure 7) which helped me to make sure that all of the inter-linked activities were scheduled in an organised manner, which students liked.

Week	Topic
1	Lecture 0: Overview of module Lecture 1: Philosophy of safe design Introduce design report
2	Lecture 2: Timber
3	Lecture 3: Concrete
4	Class Trip
5	Lecture 4: Steel Lecture 5: Rubrics for Design Report
6	Lecture 6: Foundations Lecture 7: Retaining Structures Introduce Group Video assignment and lab-work Lecture 8: Groupwork
7	Labs
8	Bank Holiday
9	Lecture on Peer-Review Peer review of individual design reports
10	Peer Review of lab reports
11	Tutorial for submission of final report
12	Finish

Figure 7: Timetable for Semester

References and Resources

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Appendix A

Rubric – Design Report

Definition of Criteria	Excellent
Introduction: Context and Relevance (10%) Background content on the architect's design is relevant and provides appropriate background for reader. Demonstrates a clear understanding of the 'big picture': i.e. the purpose of this design report.	Background information has the appropriate level of specificity to provide concise and useful context to the reader
Suitability of Assumptions (5%) Clear, logical and justified assumptions for design decisions	Explicitly describes assumptions, provides compelling rationale for their appropriateness, and shows awareness that conclusions are limited by the accuracy of the assumptions
Engineering Scheme (20%) Application of engineering principles and materials to create a stable scheme design	Critical selection and application of engineering principles ensuring a completely stable and efficient scheme design Complete understanding of material and design constraints
Calculations and Equations (20%) Correct use of equations and units. Accurate calculations and numeracy	Skilfully converts relevant information into appropriate and accurate mathematical equations Calculations are presented clearly, concisely, correctly and are sufficiently comprehensive to solve the problem Accurate use of units Accurate numeracy throughout the report
Efficient Solution (7.5%) Both the overall scheme design and the detailed design of elements should be efficient in their use of materials	Final design achieved after review of reasonable alternatives ensuring the most efficient design Effective implementation of resource conservation

Good	Fair	Poor
Background information may contain minor omissions that do not detract from the report Background information has the appropriate level of specificity to provide relevant context	Background omits information which detracts from understanding the report Background information is only partially relevant	Background information is missing Background information is irrelevant or too disjointed to make relevance clear
Explicitly describes assumptions and provides rationale for why these assumptions are appropriate	Explicitly describes assumptions	Attempts to describe assumptions
Effective application of engineering principles resulting in a stable scheme design Reasonable understanding of material and design and constraints - does not significantly impair solution	Serious deficiencies in proper selection and use of engineering principles Stable scheme but without understanding why Poor understanding of material and design constraints	Erroneous application of engineering principles yielding unstable solution Little or no grasp of material and design constraints
Converts relevant information into appropriate and accurate mathematical equations Calculations attempted are essentially correct and sufficiently comprehensive to solve the problem Mostly accurate use of units Mostly accurate numeracy throughout the report	Completes conversion of information but resulting mathematical equations are only partially appropriate or accurate Calculations attempted are either incorrect or represent only a portion of the calculations required to solve the problem Infrequent and inaccurate use of units Numeracy inaccuracies are frequent	Completes conversion of information but resulting mathematical equations are inappropriate or inaccurate Calculations are attempted but are both incorrect and are not comprehensive No use of units Inaccurate numeracy
Alternative efficient designs identified or investigated to some degree Moderately effective utilisation of resource conservation	Little evidence of exploring and identifying alternative more efficient designs Minimal utilisation of resource conservation	Only one design presented with no evidence of exploring more efficient options No implementation of resource conservation

Definition of Criteria	Excellent
Discussion and Development (15%) Progress from scheme design through to calculations and final design noting limitations	Final design is clearly and logically drawn from interpretation of results from calculations. A logical chain of reasoning and good judgement is clearly and persuasively explained. Discussion is comprehensive and takes the limitations of assumptions into account
Use of Images, Quality of Sketches (10%) Appropriate use of high quality images and sketches to communicate to the reader	All images are appropriate for the content and target audience. Informative text is supplied for all graphics. All images are displayed with appropriate sizing and resolution Sketches are of a high quality All images and sketches are appropriately referred to and labelled
Layout, Organisational Structure and Typography (7.5%) Organisation facilitates the reader's understanding of the report	A clear organisational strategy is present with a logical progression of content. The layout follows a consistent pattern. Informative subheadings significantly aid reader's understanding. Titles, subheadings, text and equations are displayed in sizes that reflect the content hierarchy. Excessive text blocks are avoided. There is evidence of an active planning for presenting information; this paper is easier to read than most.
Writing quality (5%) Grammar, spelling, word usage and use of technical terminology	Correct grammar, spelling, punctuation and use of technical terminology. Word usage facilitates reader's understanding.

Good	Fair	Poor
A reasonable and clear chain of logic from scheme design to calculations and final design Some discussion on limitations of assumptions	Connection between scheme design, calculations and final design is present, but weak Limitations of assumptions are discussed in a trivial way	Final design does not take on board the results from calculations Connection between the scheme design, calculations and final design does not exist, is limited, vague or otherwise insufficient Limitations of assumptions are not discussed
All images are appropriate for the content and target audience. All images have some text. Images are displayed with appropriate sizing and resolution Sketches are of a good quality Most images and sketches are referred to and labelled correctly	Most of the images are appropriate and several have text. Not all images are displayed with appropriate sizing and resolution Sketches are of a poor quality Some images and sketches are referred to and labelled	Some images are appropriate for the content and have few if any text Poor use of sizing and resolution of images No use of sketches No referencing of images or labelling evident
A clear organisational strategy is present with logical progression of content. The layout follows a consistent pattern. Distinct sections of the paper are delineated by information subheadings. Most of the titles, subheadings, text and equations are displayed in sizes that reflect the content hierarchy. Very few large text blocks exist.	There is some evidence of an organizational strategy though it may have gaps or repetitions. Subheadings are used and aid the reader somewhat. Titles, subheadings, text and equations are displayed in the same size. Some large text blocks are utilize.	Information is presented in a haphazard way. Subheadings are not used or poorly used. Titles, subheadings, text and equations are displayed in various sizes that are inconsistent with the content hierarchy. Excessive blocks of text exist.
Grammar, spelling, punctuation and use of technical terminology have few mistakes. Word usage is accurate and aids the readers understanding	Grammar, spelling and punctuation mistakes do not hinder the meaning of the report. General word usage is appropriate, although use of technical terminology may have occasional mistakes	Grammar, spelling and punctuation errors detract from the meaning of the report. Word usage is frequently confused and incorrect