# IMPROVING STUDENT SUCCESS THROUGH IMPLEMENTATION OF WEEKLY, STUDENT UNIQUE CAA TUTORIAL SHEETS

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## Abstract

This paper discusses a CAA application to actively support an existing structured learning package for a first year thermodynamics and fluid mechanics module. It discusses the background, the implementation, the issues and the effect on critical success factors. Students' observations on the implementation are discussed as are potential spin-off's from the implementation.

The conclusions from this study are very positive. The implementation has increased student attendance and participation at lectures and tutorials. The students readily accepted the continuous assessment regime and enjoyed the whole experience. Many students indicated a desire to see this approach transported to other modules and other years of their studies.

## Background.

Fluid mechanics and thermodynamics are core engineering subjects and are highly relevant to many engineering disciplines. In some instances they can be considered as discrete subjects whereas in others they can be seen as wholly inter-related. In this 'case study' module the temptation to compartmentalise the subjects is avoided and opportunities to draw the material together are sought. This approach, it is argued, is highly appropriate for a first course in the subjects. In the broadest sense the subjects deal with both the qualitative and quantitative behaviours of fluids and energy transfers. This, by definition, implies that the subjects rely on some mathematical capability. Further, the subjects both bring a language to the students which, for many, is new. The culmination of this new language, together with the

necessity for some mathematical competence, is that the students **are not** necessarily confused by the fluid mechanics and thermodynamics per se but more the tools required to undertake a fluid mechanics/thermodynamic study. The overriding outcome being the potential for poor student exam performance.

During the 2001/2002 session two of the four members of the newly formed teaching team actively sought to reduce the above problems and set about developing a structured teaching package to enhance the teaching and learning on the module. The opportunity to re-think the delivered and supporting material coincided with the recent launch of the Universities Managed Learning Environment - *StudyNet. StudyNet* offers an integrated module based portal with opportunities, for instance, to upload notes, provide course news, hold discussions, point to web sites and provide links to additional resources. Being module specific ensures that only those students enrolled on the module as well as appropriate teaching and support staff have access.

The structured materials developed to support this course included.

i) Active participation in the modules discussion forum. The team, (two of the four), guaranteed to respond to student questions within 48 hrs, provided 'hints and tips', gave 'did you know' type memory jogs as well as providing more open ended 'seeding questions'.

ii) Electronic copies of many of the lecture notes.

iii) Laboratory briefing sheets as well as generic guidance on 'how to write effective laboratory reports'

iv) Additional pointers to useful, subject and level specific, web sites.

v) Additional staff developed supplementary, not core, material.

The teaching and assessment arrangements were fairly traditional for this subject and included ~ 1:150 large group didactic teaching. This was supported by more informal, smaller group, ~ 1:20 tutorial sessions. 'Hands-on' experiential learning was provided by two laboratory sessions and the *supposedly* supporting assessment regime was a requirement to provide written laboratory reports (2), undertake a mid term test and sit a final examination. The structured range of the material given was not felt too overbearing and the materials were also felt to be fairly well organised within *StudyNet*. The laboratory provisions would undoubtedly help the students contextualise the class material and the mid-term test, would it was hoped, enable the students themselves to see where they are at.

All that was left for the teaching team was to sit back and wait for the obvious high success rates and plaudits from onlookers. A very long wait ensued!

The structured material had undoubtedly helped many of the students but did not manage to drag all the students through. It seems as though the 'better' students performed better and the weaker students simply did not engage with the all the materials. Failure rates after this session were still too high.

This was particularly disappointing given the efforts and the belief that the structured material was consistent with good practice (Barnett et al. 1996). The mid term test may have been a useful flag to gauge student performance but the ensuing results and identifiable weaknesses did not guide any remedial advice or re-orientation of the remaining teaching sessions. Additionally, for some of the students it may simply have been too late to allow them to help themselves.

It is disappointing also that personal evidence suggests the students did not actively engage in tackling the additional tutorial problems set by tutors. This was concerning because the additional problems were set to help -

i) bring ideas and concepts together

ii) test the students knowledge of the supporting lectures

iii) develop skills, knowledge and understanding of the subject.

Whilst for these first year students the reasons why they did not engage in this extra activity will have been varied it probably would have included –

i) It is simply 'not cool' to be studious

ii) there are no marks awarded for tutorial questions hence no motivation to tackle them

iii) they don't have sufficient experience of Higher Education (HE) to appreciate the value of 'reading around' and tackling questions from a variety of sources.

On reflection, it is clear that the assessment structure was not given as much attention as the other materials. For instance there was little motivation for the students to engage with all the materials nor was there any forcing mechanism requiring them to engage with the materials or tutorial questions on a regular basis. The outcome of which was that many of the students were probably learning the subject during the revision time. This, it is suggested, was a key factor in the high failure rates.

## Integrating a CAA regime into the structured learning package. (2002/2003)

To help overcome many of the problems outlined above a summative, continuous CAA regime was developed. The continuous nature of the regime effectively forced them to undertake the extra-curricula work on a weekly basis. Whilst this approach may not be completely consistent with the need to develop in HE students an inquiring mind i.e. by taking some of the time available to allow students to read around and develop their own road map of the subject, it is considered reasonably justifiable for first year undergraduates because it may -

i) help develop good studentship
ii) help show the students the benefit of studying regularly
iii) increase student participation in the range of supporting materials.

Use of a multiple choice question (MCQ) assessment was disregarded due to concerns over solution sharing, the distracters giving inadvertent tips and randomised questions from a bank not being able to give all the students an identical, and hence, fair test. A discussion of the appropriateness of MCQ's in HE can be found in (Davies 2002).

Further, the use of a mid-term test was dropped due to the student performance issues not being identified until too late in the module. This mid-term approach offers no drivers to ensure regular study patterns and it does not generally assess for the *right reasons*. With this mid-term approach the assessment may be more oriented towards *'assessing for gaining marks and internal purposes only'* rather than a more pedagogically sound approach of *'assessing for an analysis of the learning and understanding'*. This latter approach better suits the ability to provide prompt remedial advice thus moving towards closing the learning cycle.

The CAA format implemented here is a **student unique, Weekly Assessed Tutorial Sheet (WATS)**. The sheets are developed using the mail merge facility of Microsoft Office. Microsoft Word is used to construct a base question to which each student faces. Into this question is fed randomised data extracted from Microsoft Excel. The randomised data is constrained between appropriate limits thus ensuring both a sensible question and resulting answer. In simple terms there is no sense in asking students to calculate the volume of room whose length, width and height are, 100, 20 and 0.2m respectively!

The student uniqueness of the data coming from Excel stops at source the ability of students to share answers. *Student X's* answer to question 1 cannot, by definition, be the same as *student Y's*. The approach still allows the good practice of students helping each other via self-help groups. With this CAA regime it is the methodology behind the question that they will be discussing not the numbers.

The pilot study used 11 tutorial sheets, (an example of which is shown in figure 2), with each being issued via *StudyNet* on a weekly basis to match the current lecture. To maximise the learning opportunities for this project the standard university rules on lateness penalties were dropped. i.e. by following the universities standard policy meant that a student could submit a sheet up-to one week late. Add to this the time to mark and return the work and it is possible that two/three weeks could pass before the students get any marks or feedback on their performance. This was considered too long and hence a zero tolerance policy on lateness was implemented. If the sheet was submitted after the hand in date it did not get marked.

Each tutorial sheet typically comprised two major (parent) questions of which each parent question may include up to five sub (child) questions. Hence for each sheet the students were required to calculate up-to 10 'things'. The first 8 WATS were marked manually by comparing the **hard copy** submissions to an electronic solution master. For WATS 9– 1 inclusive a preliminary electronic student submission facility was configured, see figure 3. Hence, in addition to handing in their hard copy they were also required to enter their responses onto a dedicated computer.

The electronic collection facility 'date and time stamped' each student's submission and added a flag alongside the student to note they had undertaken an electronic submission. This was used to bar the student from making more than one submission. This electronic submission facility readily allowed the application of an parallel automated marking sheet. The use of an electronic marking sheet was not only useful in time savings terms but it also allowed each student to be faced with the same set of marking rules. i.e. the sheet currently awards 1 full mark for a student response that is ± 5% of the correct answer and 0.5 marks if their answer lies between ±5% and ±10% of the correct answer.

This approach gains the perceived generic benefits of CAA i.e. reduced time and hence staff costs and consistency of rules, without suffering some of the attendant problems. i.e. it does not tie students to a computer nor does it suffer issues of computer anxiety and biasing (Brown et al 1999).

It is interesting also to note that this first venture into an automated CAA regime appeared to raise more issues surrounding the security, hosting and access rights as it did the pedagogical aspects of 'question setting' and 'fairness of test'. Fortunately an honest plea to the students asking them '*not to attempt to seek to disrupt the good will or the hard work initiated for their benefit'* appeared to work.

For completeness, the current security aspects of the Excel electronic student submission sheet include

i) Allocating each student with a unique password.
ii) Not telling the students how the sheet works (apart from advising them on their data entry)
iii) Hiding the data that the student submits.
iv) Protecting the whole sheet to stop students for looking for any hidden data.
v) Updating a *hidden* backup after each student submission

Rather than just assess the students, the WATS project sought to be an integrated assessment project that complements the already existing managing learning package. With this in mind the WATS project currently comprises -

i) The actual tutorial sheets
ii) A solution master sheet.
iii) A fully worked example using the data for a fictitious student.
iv) Whole group performance data including analysis of the results.
v) Generic observations regarding common issues or failings in submissions.
vi) Evolving electronic student submission sheet.
vii) Evolving automated marking sheet.

## Critical success factors.

## Time savings.

One of the repeated arguments for the implementation of CAA is the reduction in staff time. The initial experiences here also support this view both on administrative and academic resources.

For instance, to help the students and the teaching team gain confidence in the electronic submissions, (available for sheets 9-11 Inc), the students were asked to submit both an electronic and a hard copy of their results. Hence some of the additional administrative time savings on collecting, date stamping, and 'signing in' of the sheet for ~ 150 students were not accrued this year. In future, however, having now gained sufficient confidence in the electronic submission process this is likely to attract administrative time savings in the order of 4 hours per week. i.e. for this 11 weekly sheet submission this will total a time saving in the order of 44 hours. Further, the use of the electronic submission sheet and automated marking sheet has reduced the time to mark and produce details on overall group performance for each of the weekly sheets from around 4 hours to around 1.5 hours.

The overhead associated with the preparation an the development of the sheets reduced as experience and familiarity was gained. The benefits, (return), on this overhead will of course increase as the number of students increases and as the years progress. This project has a long shelf-life and the randomness of the question data ensures the uniqueness of the question from student-to-student and year-to-year.

## Attendance.

Anecdotal evidence appears to suggest that attendance at both the lectures and the tutorial sessions is improved over last year. This is good for the WATS project but also for the subject per sé. If you have the students in front of you it is easier to teach them!

## Examination performance.

At the time of writing the examination marks were not available. It is hoped that this data be made available and bought to the conference for dissemination. Even without the data it is worth noting that **prior** to the examination the students thought that this WATS project *would* help in the exam and **after** the exam the following student comments were found on *StudyNet.*

*"No doubt at all that the WATS got me through the exam . The solutions for the WATS were the main factor and made brilliant revision material. It even made some of the complicated stuff look relatively simple. Why is that?*"

*"Having just completed the Fluids & Thermodynamics exam this morning, and hopefully passing it (just) I have agree with the WATS. I really felt they help me during the year and not only gave me a good mark for my coursework but were a useful revision tool for the exam.*"

*"Yes, I believe the WATS definitely have been proved to be helpful. it was well structured because not only let the student study constantly but also it showed (by publishing the correct solution for each WATS) where eventually the student went wrong. Plus they have been very useful in order to revise the entire module. All the modules should involve WATS."*

## Issues and opportunities.

### Question coupling.

On reflection it is disappointing that many of the questions were not chosen explicitly for converting into this WATS format. They had typically come from the existing tutorial question sheets. One of the identified problems with this approach, identified by both staff and students alike, is that no marks were awarded for working. A simple slip somewhere in the calculation results in the students getting a zero mark for that aspect of the sheet. Furthermore, and perhaps, more importantly is the linking of the *child* questions to the *parent* question. i.e. you have to answer Q1i) first before you can proceed to find the answer to Q1ii), and so on. Make one minor mistake at the parent level and all child questions will also be marked wrong.

Future improvements to the project will not necessarily look to de-couple the child from the parent but it will look at opportunities for the automated marking system to first check against the correct solution and then to use the submitted wrong parent answer to check for workings on the child answer. This will offset many of the concerns and will allow closer scrutiny of the students work.

### Student absenteeism.

By definition the project is dynamic and for each weekly sheet seeks to turn around the 'issue, student submission, marking, analysis of marks as well as feedback' within a little over one week. Anything more and it is believed that some learning opportunities will be lost. i.e. the student will have moved to the current weeks subject material and will now be focusing on sheet *n* and not sheet *n-1*.

This project *may* give rise to some issues with respect to serious illness and students being away from University for over a week. For lesser illnesses however, the remote access to students via *StudyNet* and the maturing automated submission opportunity will not be a disadvantage. This year for instance, the SARS virus kept one of our students from returning after his Easter break. This student would not have been disadvantaged if the remote log in facility had been ready this year.

### Additional student contact.

The university issues to all students an *@herts.ac.uk* e-mail address. It is the intention that the project will deliver more student specific feedback via these addresses. With many students using other e-mail addresses many general university broadcasts may become un-see and lost. To force students, via this project to collect feedback and results form their official e-mail address, may provide additional beneficial spins-offs to other non WATS-related university broadcasts.

## Student tracking.

The ability to see early on who is participating and who is not immediately allows a suitable nudge to be instigated. Previously this may have been done via checking scrawled signatures on a sent round class list. This automated approach will readily allow this to happen and also stops any signing in on an absentee's behalf's. Automating this nudge will take away from the lecturer this need to undertake the additional, time consuming, yet important task.

## Student observations.

Having undertaking the pilot study many opportunities were sought to gain the students' views on the WATS project. This included questions on the *StudyNet* discussion forum, questions in the corridor and inviting the students to complete a formal questionnaire. In most instances the feedback was very positive. An overview of students responses to a few of the questions is shown in figure 1.

To summarise this feedback -

i) many indicated that they wanted this approach transported other modules and other years (q9 & q10)

ii) the students 'bought in' to the WATS project because they genuinely believed it would help in their exam (q11).

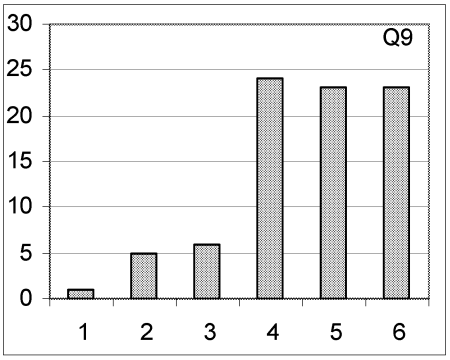
iii) Many indicated they liked the fact that it forced them to study and repeating students liked the format and thought this would have helped them pass first time around.

Interestingly concern on the project only really came when then students were required to submit their answers electronically (q14). This, it is believed, was due to the fact that the electronic student submission facility was only present on one pc and was not available on a server for remote access. This will be resolved next year.

## Figure 1. An overview of student responses to the WATS project.

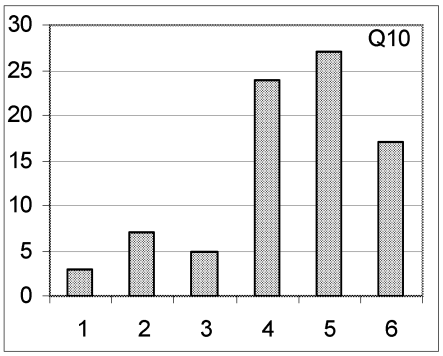
***9*** I think other subjects could benefit from this teaching learning and assessment approach.

Strongly disagree | | | | | | | Strongly agree



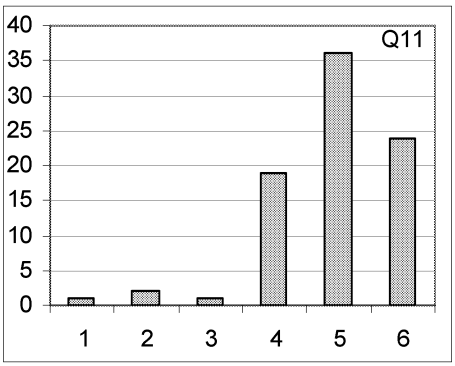

***10*** I really hope the WATS approach is followed through into other second and final year modules.

Strongly disagree | | | | | | | Strongly agree



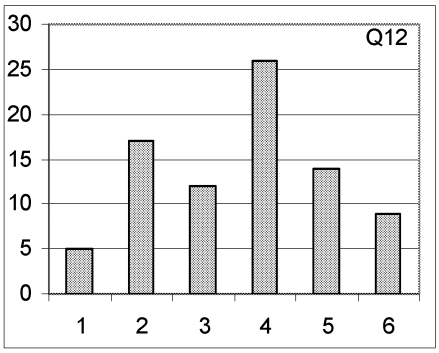

***11*** I believe the WATS will help me in the examination

Strongly disagree | | | | | | | Strongly agree



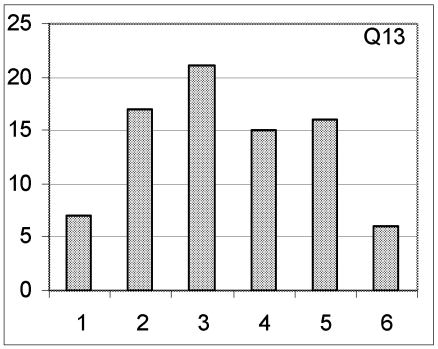
***12*** I really like doing the WATS and getting a mark each week

Strongly disagree | | | | | | Strongly agree



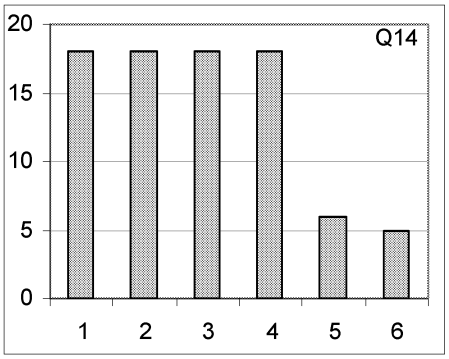

***13*** I would still do the WATS even if they did not count towards the final grade for the module.

Strongly disagree | | | | | | Strongly agree



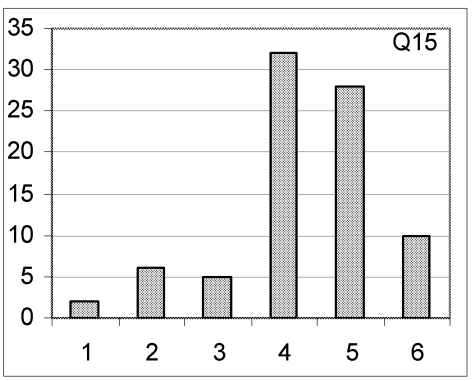

***14*** I like the new electronic WATS submission.

Strongly disagree | | | | | | Strongly agree




***15*** Overall I would rate the WATS as Excellent

Strongly disagree | | | | | | Strongly agree



## Future development work.

Although the most critical test of the success of this project is not yet available, i.e. the impact on exam performance, it has undoubtedly been a success in many areas. This project has forced the students to engage regularly with the material, attendance at lectures and tutorial sessions appears to be higher than last year and valuable lessons are already being learnt by the developing team. This is very encouraging

There are of course still many opportunities to develop this work and these come from resolving the issues discussed above. In particular the next phase will include -

1) Automating the entire submission for all the sheets. Hence ensuring opportunities for time savings are maximised.

2) Establishing an automated assessment regime that allow for the de-coupling of parent and child answers. This by definition will also check some of the student working.

3) Implementing the system on a server allowing remote multi student access.

4) Implementing automated pastoral nudges for those students not participating.

5) Automating a student unique feedback mechanism with specific pointers to identified weakness.

6) Consider implementing an '*assess for competence*' approach. i.e. set a threshold mark for each sheet which all students are expected to attain. Any student failing below the threshold will be required to re-submit their work until they reach the value which is considered to demonstrate competence (in that area). This approach will also ensure that the feedback and guidance provided is actively used by the failing student.

## Conclusions

There are many generic issues arising as a consequence of this work. This WATS regime is presently better suited to quantitative subjects but is not constrained to the subjects of fluid mechanics and thermodynamics. It uses non specialised computer tools and should be immediately transportable to others areas.

The pilot project has been successful in its implementation and in meting its main goal of increasing student participation. Student perofmance data is not yet available. There are still many areas to improve and these will be considered in the next phase. even at this pilot level this CAA approach exploits many of the good features of CAA without incurring many of the known CAA issues. The students welcomed this feature of the course.

**Figure 2.** An example of a typical Weekly Assessed Tutorial Sheet.

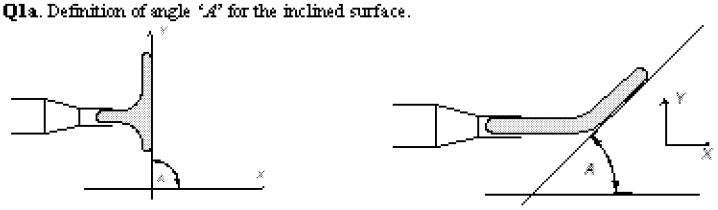
# Fluid mechanics and Thermodynamics.

## Weekly assessed tutorial sheet 9.

| | | | |
|---|---|---|---|
| ***Student Number*** | ***160*** | | |
| ***Print your name*** | | | |
| ***Hand out date*** | ***26 March 2003*** | ***Hand in date*** | ***30 April 2003*** |

Q1a). A fluid of relative density 0.98 flows through a pipe of diameter 149 mm at 0.44 m/s. After passing through a gradual reducer the fluid leaves a 72mm diameter pipe and discharges onto a stationary surface. Assuming that the surface slopes at an angle of '*A*' degrees from the horizontal plane, as shown below, and that the surface somehow acts as a vane in that the fluid is deflected along its surface - calculate the forces **acting on the surface** for the angles shown in the answer boxes. You may assume that friction effects are negligible.

**Figure Q1a**. Definition of angle '*A*' for the inclined surface.




| iii) $A = 90°$ (X force) | iv) $A = 10°$ (net force) | v) $A = 44°$ (Net force) | vi) $A = 76°$ (Net force) |
|---|---|---|---|
| | | | |

Q2. 9 l/s flows through a contracting elbow which has an angle, '*A*' of 29° i.e. as shown in figure Q2. Assume the inlet to the bend is 182 mm diameter and the outlet is 59 mm diameter and that the pipe lies in the horizontal plane. The static pressure at the pipe inlet is 4.20 Bar and the fluids specific gravity is 0.97. Calculate the net force and the direction of the force acting on the bend.


**Figure Q2**. Sketch of bend.

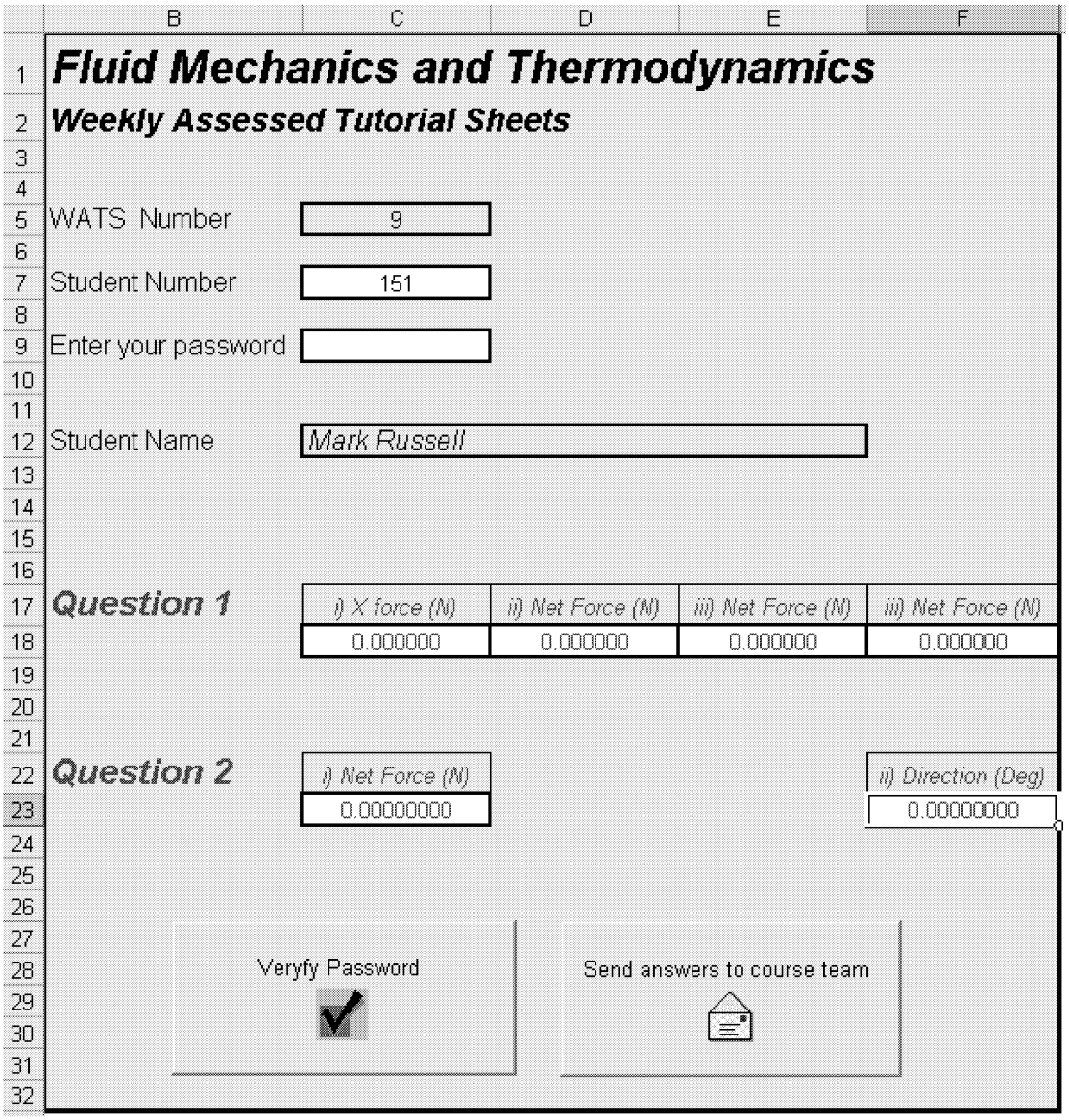
| i) Net force | ii) Direction of force. (As measured anti clockwise from the top of the horizontal plane. i.e. AS SHOWN in all above examples. |
|---|---|
| | |

I certify that the work submitted is my own and that any material derived or quoted from the published or unpublished work of other persons has been duly acknowledged.

**(ref. UPR 17.7, section on cheating and plagiarism)** **Signed**: . . . . . .

*Mail merged tutorial sheet 9.* *Student number*

**Figure 3.** An example of a typical student automated data entry sheet

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