Mathematics and Literacy

the problems associated with transition into university

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Identifying the problems

University staff have expectations.

Students have a history of school-style teaching.

University courses have an agenda.

Identifying the problems at UEA – biological sciences

Students are assessed in numeracy and in their ability to write.

Numeracy:

A test with four sections of increasing difficulty. It assessed their ability to deal with numbers, basic algebra and graphs; no calculators were allowed.

Literacy:

Students were asked to write on the subject of their induction to university.

Results of the numeracy assessment – Section A

Amalgamation of two years of data, a total of 244 students took the numeracy test.

Section A questions	Number of students getting the answer wrong	% of students getting the answer wrong
	9	3.28
	3	1.23
	17	6.97
	1	0.41
	26	10.66
	17 (33 also getting units wrong)	6.97 (13.52)

Results of the numeracy assessment – Section A

Section A questions	Number of students getting the answer wrong	% of students getting the answer wrong
Calculate 8 x 13	9	3.28
Express 0.5 as a fraction	3	1.23
Express $^{24}/_{100}$ as a percentage	17	6.97
Calculate 50% of 40	1	0.41
Rearrange $y=mx$ to allow you to calculate m	26	10.66
If a square as sides of 2 cm, what is its area?	17 (33 also getting units wrong)	6.97 (13.52)

Results of the numeracy assessment – Section A

Section A questions	Number of undergraduates getting the answer wrong (out of 244)	Numbers of Year 6 school children getting answers wrong (out of 30)
Calculate 8 x 13	9	0
Express 0.5 as a fraction	3	0
Express $^{24}/_{100}$ as a percentage	17	0
Calculate 50% of 40	1	0
Rearrange $y=mx$ to allow you to calculate m	26	26
If a square as sides of 2 cm, what is its area?	17	0

Why are so many first year undergraduates so poor at very basic numerical skills?

What the School of Biology at UEA is doing to tackle the problem

A course has been designed to:

- build confidence
- provide a considerable amount of support.
- provide varied styles of teaching.
- work alongside a custom book to accompany the course.
- fully integrate the course in the biology degree programme.
- assess by course tests that are cumulative.

Does it work?

Evaluation of the mathematics course

Students were asked to rank their confidence in mathematics on a scale of 1 to 10 from low to high confidence.

Mean confidence of student as they started the course: 4.54

Mean confidence of students as they finished the course: 6.75

48 returns from a course of 94 students.

Some comments from the students

Loads of help and encouragement. Lots of practice questions helped too.

Unit made relevant to BIO – so we feel we're learning what we need to, not just learning maths and stats to fill in time.

The small seminar groups were useful as problems could be dealt with.

Frequent course tests help evaluate progression in maths. Seminars and workshops also help because of the smaller groups.

Tackling problems of poor literacy

Three types of writing exercises in the first 2 weeks:

Assessment pieces

Science log

Practical write-ups

Assessment pieces

In their first semester, students were asked to write on a given topic:

Week 1 – their experiences of the induction days

Week 12 – highlights of the first semester

They were instructed to pay attention to grammar and sentence structure.

After eight minutes they were told to stop writing.

Assessment of assessment pieces

All pieces of work were scrutinised by three people, looking for mistakes in spelling, grammar and punctuation.

Pieces were scored as A, B or C:
A - good with few or no errors
B - a few significant errors or many minor errors
C - many significant errors

Results of the assessment exercises

Number of students scored A, B or C for the initial and final writing assessments.

	Number of students	
Score	Initial assessment	Final assessment
A	25	40
B	47	23
C	23	13

A = good B = fair C = poor

Science log

Students were instructed to write for 10 min each day on a science-based subject of their choice.

In the first week they were supposed to only use full-stops.

In the second week they could use any punctuation.

They had to write directly on to the page, not write a rough copy and transcribe it.

Day 1

There are many hypothesise concerning the origins of life. The first debate centers around how monomers evolved. ~~It has been suggested that~~, The first organic molecules could have been produced from early atmospheric gases in the presence of strong energy sources. There are four main suggestions for potential energy sources on early earth. Heat from volcanoes and meteorites is a possibility. Powerful electric discharges in lightening is another. Solar radiation and radioactivity from isotopes is also discussed. This idea is called abiotic synthesis.

The evolution of polymers is another area of debate. There are two main hypothesis. There is the protein first hypothesis. This assumes DNA genes came after protein enzymes arose. Evidence shows that the heat of the sun can cause amino acids to form proteinoids. Proteinoids in water form microspheres. Microspheres are structures composed of only protein.

There is also the RNA-first hypothesis. This suggests that only RNA was needed to progress towards formation of first cell.

Day 2

Darwins theory of natural selection was once hotly contested. On the origins of species gave no ~~real~~ hard evidence of natural selection. Darwins ideas were based on logic and not fact. In the last 50 years this situation has been rectified. Extensive research on the Galapagos Islands has been undertaken. The Grants have succesfully shown natural selection in progress. They have managed to highlight that this process can occur happen quickly. ~~Their~~ Their research shows evolution in action.

The Finch is the subject of their study. Beak size and shape are shown to affect the food the Finch can obtain. They have not been able to show hereditary of these features. ~~Other studies involving the swapping of eggs.~~ The swapping of eggs has been performed by other researchers. These studies point strongly to hereditary.

Day 3

The endosymbiont theory is important in the discussion of the origins of life. It suggests that mitochondria originated from bacteria invading a cell. The mitochondria of the eukaryotic cell were once free-living aerobic prokaryotes. ~~The~~ chloroplasts ~~also originated~~ were once free-living photosynthetic prokaryotes. The endosymbiotic hypothesis states that a nucleated cell engulfed these prokaryotes which then became organelles.

Evidence for this theory lies in the similarity of size between bacteria and mitochondria. The double membranes of mitochondria and chloroplasts also gives weight to this theory.

This is an important idea in evolution. It means every cell has come from a previous one.

The eukaryotic cell originated around 2.2 bya. They are nearly always aerobic & contain a nucleus & other membrane bound organelles.

Day 4

The basic causes of bush fires are understood. The heating of vegetation causes the plant's carbohydrates & other organic ~~nutrients~~ molecules to rapidly vaporise. The result of this vapourisation is a mixture of water vapours & flammable gases such as hydrogen and carbon monoxide. These are called pyrolysis products. With continued heating the pyrolysis products will ignite and burn. The resulting fire can cause a repition of this process by radiating more heat.

There have been accounts of bush fires erupting across areas lacking vegetation. Combustion researchers are intrigued as to how this is possible with no vegetation to release pyrolysis gases.

One theory suggests the gases must have escaped from the fire and formed a highly flammable mixture with the air. Flares would then be fed by this mixture and an explosion could be caused.

Day 5

A review of early trilobite studies has shown that variability in appearance correlates to survival. During the Cambrian period trilobites had highly variable bodies. The trilobite numbers dropped after the Cambrian. By the Permian period the trilobites died out.

It has been suggested that this decline coincided with a decrease in ~~species~~ variation amongst species. If there is more variation then there is more for natural selection to operate on. The decline in variation may have been because most trilobites had evolved to exploit particular niches or lifestyles.

It has been shown that ~~for~~ a very specialized species may not be able to adapt to new conditions. During environmental change these highly specialised species may perish. When variation fell away so did the rate of evolution. This could have left the trilobites more susceptible to extinction by climate change.

Day 7

An article on brain electrodes raises ~~ethical points~~ some interesting ethical points. The electrodes work by artificially stimulating the thalamus. The thalamus is a region of the brain associated with wakefullness and arousal. ~~This technology~~

This technology has been used on coma patients. It has been shown that the electrodes can rouse a coma patient to a level where he can speak & control his limbs.

This technique is known as deep brain stimulation. It and its applications are varied. DBS can help conditions such as Parkinsons and depression.

~~Implied~~ There are concerns over this ~~treatment~~ treatment. There are patients who may not wish to prolong their life in a state of partial recovery and deciding when to intervene could be difficult.

Advisor's signature Andrew Bourke date 4.10.07

Day 8

The concern over climate change has received a lot of media attention over the past few years and public perceptions vary from panic to complete ~~disbelief~~ disbelief. This response is not really surprising, considering the amount of contradictory information to be found in newspapers and on the television. However, ~~there~~ despite the difficulties in predicting the effects that climate change will have on the planet, there are still many certainties in this area.

There is no doubt that there is a change in the atmospheres composition and that the amount of pollution has been increasing greatly over the last few centuries. Scientists understand the methods by which greenhouse gases lead to global warming and have a good idea of the main sources of these gases, although, there is an area of uncertainty which has ~~come from the~~ arisen with the difficulty in balancing the carbon budget.

Day 10

An article in the ~~sea~~ magazine 'New scientist' delves into the story of Daniel Rolander, a budding scientist ~~working~~ who worked for the eminent Carl Linnaeus. Rolander was one of 17 Swedish scientists who went on scientific expeditions for Linnaeus. The intrigue of the story centers around Rolanders obscurity in relation to the ~~same~~ attention given to the other 16 'apostles', as they are commonly known.

~~In a effort to Rolander's journal had never been published too~~

For the 300th anniversary of Linnaeus's birth the Ik foundation set about publishing all the apostles' journals in English. Most of these journals had already been published, apart from Rolander's. However, his manuscript was recovered from the Natural History Museum in Copenhagen and after two years translating it from latin to English his story was finally revealed

Day 11

Carbon is a key element in all organisms. Carbon dioxide makes up about 0.03% of air volume in our atmosphere. However, most organisms cannot use carbon dioxide directly which is why the carbon cycle is of such importance.

The carbon cycle begins with photosynthesising plants, the producers, incorporating the atmospheric CO_2 into carbohydrates with a proportion being released back as CO_2, as a waste product of respiration

These producers are the first link in the food chain. The plants are then eaten by primary consumers and the carbon is passed along to the primary & subsequent consumers. The carbon can be used in tissues, respired or excreted.

Saprobiotic bacteria & fungi respire, using organic chemicals found in excrement and dead organisms, and so & more CO_2 is released back to the atmosphere. Also the combustion of fossil fuels, made through the compression of organisms millions of years ago, releases CO_2 back to the atmosphere

It is the return of CO_2 back to the air that completes the cycle of carbon.

Day 12

The agricultural revolution and the subsequent advances in fertilizer have ~~caused~~ been a long term issue with regards to water pollution. Run off, from fields containing fertilizers, enters rivers and causes have a polluting effect caused by the nitrates ~~and phosphates~~ resulting in eutrophication.

These nitrates are absorbed by plants in the rivers promoting their growth. Algae population growth causes a blanket effect, covering the waters surface and blocking the sunlight. Bottom dwelling plants die and are broken down by decomposers and bacteria thus increasing bacterial population and the amount of oxygen taken from the river.

Low Oxygen content cause fish to die and the rotting dead fish then contribute to even lower oxygen levels in a positive feedback loop.

Day 13

Biotechnology is pivotal in the commercial production of many substances. The fermentation processes of microorganisms are used to produce products such as ethanol, pharmaceutical chemicals and enzymes for biological washing powder.

In commercial fermentation batch fermentation takes place in closed vessels. Optimal conditions are maintained until a maximum yield has been reached at which point the product is harvested.

The advantages of batch fermentation are that if the culture becomes contaminated, just one batch is spoiled and also the fermenter can be used for a variety of fermentation processes

Disadvantages of this mode of production relate to the expense in lost time of cleaning and sterilising each vessel at the end of every production.

Day 14

Succession is an important concept in ecology, relating to the process by which ~~a~~ a community of organisms in a particular habitat will be replaced by another.

The process begins when primary colonisers begin to exploit a 'new' habitat. This 'new' habitat could, for example, be newly exposed heathland soil and the primary colonisers would have adaptations to this environment. As these colonisers grow eventually organic matter will fall & to decompose adding nutrients to the soil and increasing acidity. to

In time these changes make conditions unsuitable to the primary colonisers and the community of organisms will be replaced by another, more suitable to the new conditions.

This is an example of succession and is a process which will eventually lead the way to a final, stable stage called the climax community.
An example of a climax community is Sherwood Forest where Oak has stood for 400 years.

Results of the science log

A total of 83 students completed the science log exercise.

Type of improvement	% students showing this improvement
Fluidity of writing	24.1
Handwriting	26.5
Grammar, incl. punctuation, paragraphs, sentence structure	18.1

Students' comments on the Science Log

I found the science log really useful in developing my writing skills

I thought the science log exercise was extremely useful. It really showed how to structure sentences and paragraphs.

Practical write ups

A practical class very early in the semester with a full write-up requirement.

A lecture on how to write up a practical based on shared knowledge of their school experiences.

A low word count limit to encourage concise writing and help fast turn around for marking.

Fast marking to allow feedback into the subsequent assignment.

A course designed to give students support in literacy

In addition to the assessment pieces, science log and practical write-ups:

Students were also given:

- A lecture on writing essays
- An exercise in a seminar session on basic grammar
- Précis exercises
- Grammar-correcting exercises

Does it work?

Definitely!

Students respond well to shared knowledge, and being guided through something they find difficult.

Students appreciate knowing that we understand it is difficult for them.

Results of the writing programme

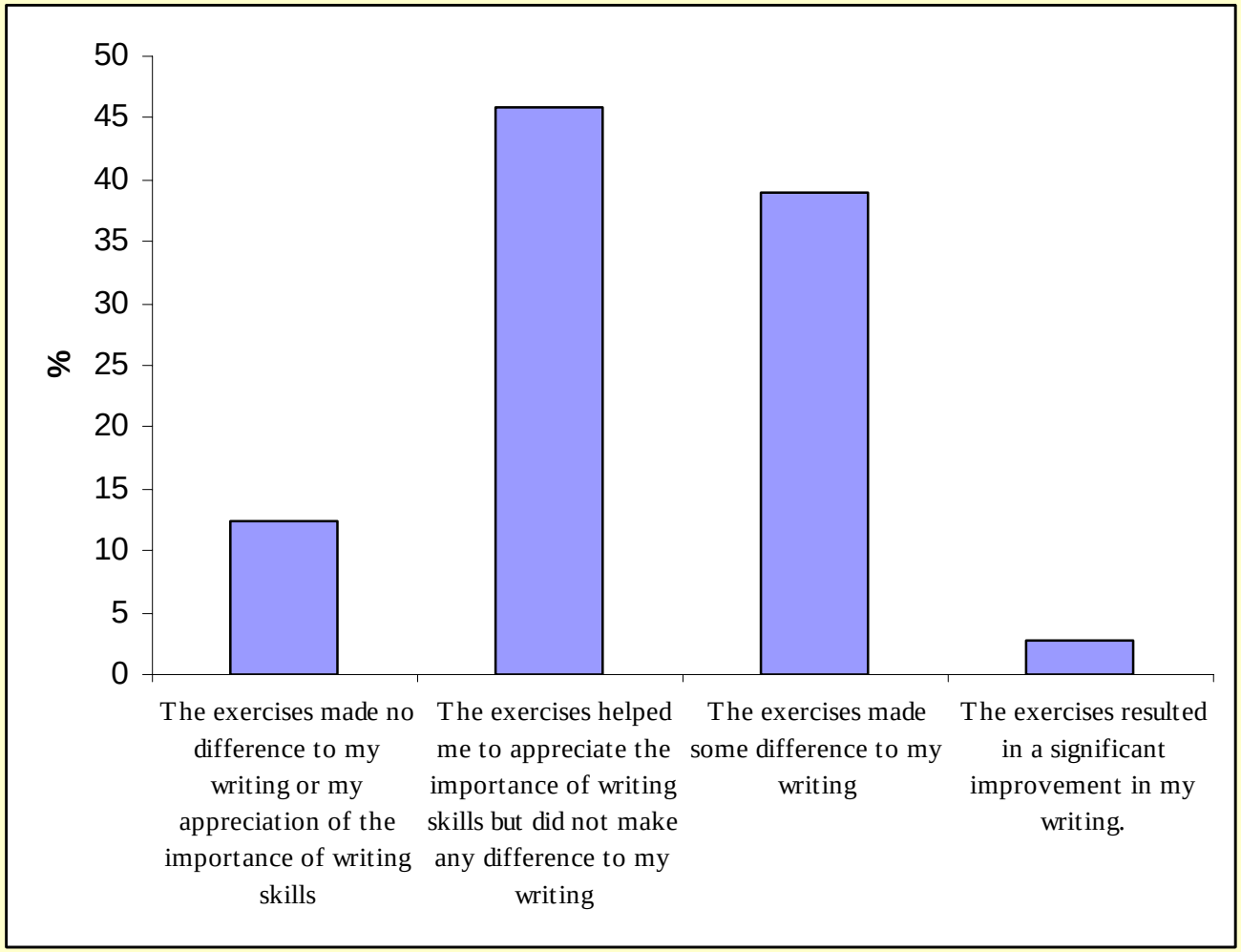
Students are keen at the beginning of the semester and that keenness is used and built on.

Feeding forward into each assignment produces rapid improvements.

Having high expectations can help students achieve more.

By the end of the first semester most students produce clear, concise write ups with critical discussions. Many base their discussions on the primary literature.

Results of an evaluation of writing exercises



Percentage of students selecting the statement that applied to them relating to the writing exercises they carried out in the first half of the semester.

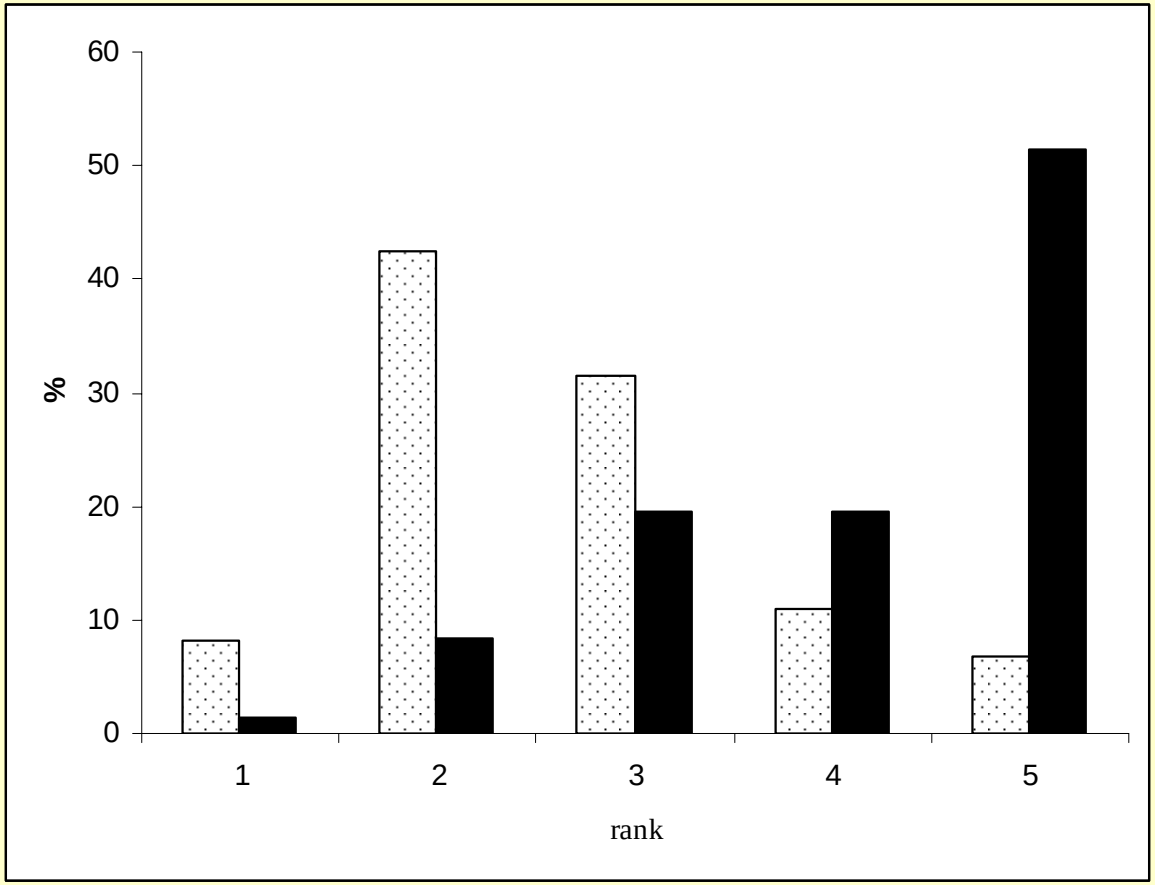
Issues needing further investigation

Different types of writing require different skills. Students who are good at one exercise are not so good at another.

Students can be very defensive about their literary abilities. Exercises had to be dressed up as ‘scientific writing’ exercises.

Some students had already resigned themselves to not being able to write and therefore did not respond to help offered.

Students' assessment of the importance of writing and mathematical skills



Percentage of students giving each ranking out of 5 to the importance of being able to express ideas clearly in a written form (dotted) or being mathematically capable (solid). (1 = most important).

Development of current courses

Literacy:

Assessment is probably not necessary – everyone can improve their writing, and scientific writing will be new to all.

Students responded well to writing exercises.

Mathematics:

Through encouragement, plenty of support and enforcing the relevance to the course, students can go from poor basic skills, to tackling simple calculus.

Are we addressing the problems?

University staff have expectations.
These expectations must be realistic, based on admissions criteria and school teaching.

Students have a history of school-style teaching.
There are positive and negative aspects to the teaching children receive at school. We need to have a shared understanding with students of them of both.

University courses have an agenda.
We should not have to dumb-down courses. With the right approach staff can have high expectations of students and students can meet these expectations.

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