

Group projects in mathematics

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Summary

- About the module
- Literature about skills and what group work and projects can achieve
- What I did
- Results from student evaluation of project

“Problem Solving”

- 20 credit
- year long
- second year module
- BSc (Hons) Mathematics
- no pre-, post- or co-requisites
- Module outcomes do not refer to any particular mathematical topic but to more general skills

Knowledge and understanding.

1. Express problems in the language of mathematics.
2. Select, adapt, and apply standard techniques in a variety of problem areas.
3. Identify assumptions in a mathematical argument.
4. Evaluate, select, and implement appropriate numerical and software techniques for a range of problems.

Skills, qualities and attributes.

5. Use reference information from a variety of sources.
6. Communicate effectively using reports and presentations.
7. Work effectively as an individual and as part of a small team.
8. Collect, evaluate and analyse data.
9. Effectively manage your time.
10. Reflect on your learning and personal professional planning skills and goals.

Transferable skills

- As well as academic knowledge, professional mathematicians require transferable skills to "use their knowledge effectively" (Challis, et al, 2002; p. 89).
- Employers have "voiced their perceptions/criticisms that students/graduates are technically competent but lack professional skills, awareness of business issues, communication skills [and] problem solving skills" (Lowndes and Berry, 2003; p. 20).

- It is "incumbent on us, as teachers, to help our students to learn and develop these skills" (Challis, et al, 2002; p. 80).
- Some staff and students "[question] the assumption that the purpose of a mathematics degree was to develop such 'skills' at all" (MacBean, Graham and Sangwin, 2001; p. 3).
- Mathematics students "are often surprised to see the emphasis placed on the acquisition of transferable skills" and so "the reasons for this emphasis must be clearly explained" (Challis, et al, 2002; p. 89)

What can and cannot be achieved with group work and projects?

- Traditional maths teaching is "strong" for "the attainment of knowledge" but makes "more limited contributions to other elements" (Hibberd, 2005; p. 6)
- Project-based work can bring together techniques and ideas which "leads students into a more active learning of mathematics" (Hibberd, 2002; p. 159).
- Active learning can help develop deep learning (Kahn, 2002; pp. 99-101).

- Projects "foster organizational and research skills, communication and mathematical insight."
(Ahmed, Holton and Williams, 2002; p. 47).
- Some "see group work as an opportunity for students to develop communication, teamwork and organisational skills"
(MacBean, Graham and Sangwin, 2001; p. 3)

Content

- Advisable not to try to teach difficult new mathematics “for a realistic expectation that students will be able to grasp... the wider skills base” (Hibberd, 2002; p. 163)
- And to avoid the "difficulties" for students of applying new knowledge directly to project work (Kahn, 2002; p. 96)
- Skills are "not readily taught in, for example, a lecture/seminar environment, but are best accommodated within student-based learning activities" (Hibberd, 2002; p. 159)

- “It is not sufficient to put students into groups and ask them to undertake tasks“ so give guidance on how groups operate (Challis, et al, 2002; p. 89).
- “Many of the students will not have worked as groups in a university environment before and simple guidance like this can be helpful" (MacBean, Graham and Sangwin, 2001; p. 9)

Distribution of work

- Issue of whether all students are contributing equally or whether the group is carrying “passengers” (MacBean, Graham and Sangwin, 2001; p. 7).
- Peer assessment of individual contributions is suggested by Hibberd (2002)
- Lowndes and Berry (2003) recommend teams have a chair and a minute taker, and “keep formal minutes clearly indicating actions and progress identifiable with each team member” (p. 21).

Assessment

- Challis, et al (2002) suggest the importance of assigning marks on all of the transferable skills to show "the value attached to them by staff" (p. 90).

What I did

Session 1

- Gave a talk on transferable skills and employability

Lucky NTU students

- Employers think you will lack transferable skills that you need to apply your mathematical knowledge
- To be a strong candidate for employment, you need a way to write a CV and walk into a job interview with evidence that you do have skills employers will expect that you lack
- Luckily for you, you are doing **Problem Solving!**

- Gave the students a 'team building' task:
Zin Obelisk (Nrich, 2008)
- Cards that hold incomplete information.
Must work as a group to draw a
conclusion.
- Followed by discussion Belbin Team
Roles (Belbin, 2001)

How did you get on?

- What roles did you each take in the task?
- Did one team member take charge? Who had the good ideas? Who sorted out disagreements?
- I am going to ask you to appoint a Chair and a Minutes Taker
- What characteristics should a Chair have?

Team structure

Decide now in your group who will take the roles:

- **Chair**
 - in charge of the meeting, responsible for making sure everyone answers to their actions
 - confident, good communicator, delegates well, keeps the group on task
- **Minute taker**
 - keeps a record of the meeting and records actions and work completed
 - good attention for detail, conscientious, trusted by all
- Both must be reliable (i.e. likely to turn up each week!)

Session 2

- Opened with Birthday Problem. Used this to provoke discussion of assumptions in a mathematical argument.
- Then gave the project

Which bet would you take?

A. Birthdays

- There are 36 students in the two groups taking Problem Solving
- I bet two of them share a birthday

B. Coins

- I toss a fair coin
- I bet it will come up heads



What do you think about the validity of this result?

- What assumptions have been made?
- How realistic do you think this is?

This process

- We have:
 - Taken a real world scenario
 - Expressed it in mathematical language
 - Come up with a mathematical solution
 - Related that solution back to the problem
 - Critically examined the assumptions we made in arriving at our solution
- In this module, we are interested in the solution but we are particularly interested in the first 2 and last 2 steps

Art Gallery Problems

- What are the minimum number of guards needed to guard every point in a room?
- This is a pure maths problem dressed up as a real scenario - but is not really applicable
- Thus, plenty of room for critical thinking and evaluation, interpretation and expansion
- Not related to other degree work but mathematically simple
- Phrased as problem from a 'client'

Other sessions

- Mostly self-directed group learning
- Regular group meetings
- Also “skills expert” sessions on:
 - Finding and using references
 - Report writing
 - Giving presentations

Assessment

1. Plan (one week after problem is set) outlining what must be done and how it will be done (400 words) (5/90)
2. One team meeting is held each week. Minutes from these meetings (5/90)
3. A report (2,500 words) to the client, giving the solutions to 12 specific museum layouts (25/90)
4. A report (2,500 words) to fellow mathematicians (within same company) outlining the mathematics used, giving a critical analysis and suggesting an extension to the original model (25/90)
5. A presentation to fellow mathematicians on your chosen extension (30/90)

Feedback to students

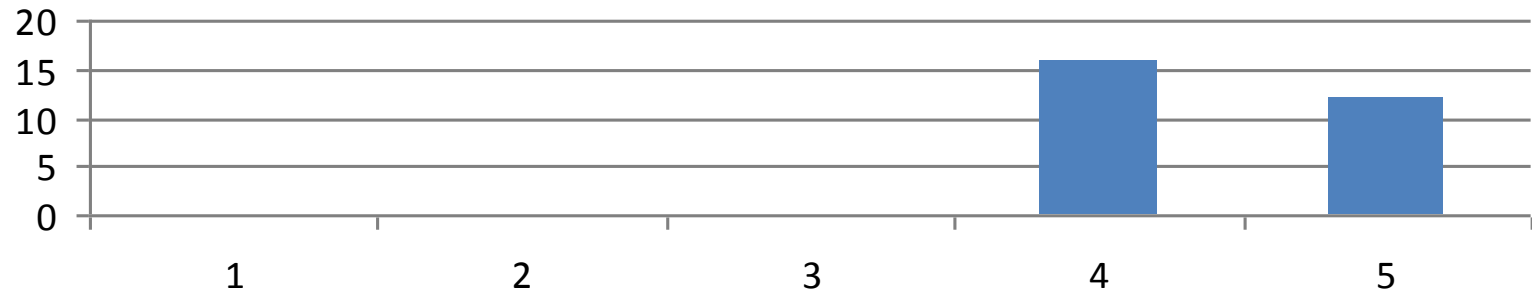
- I made sure to give written feedback and a breakdown of marks addressing each transferable skill

Student feedback

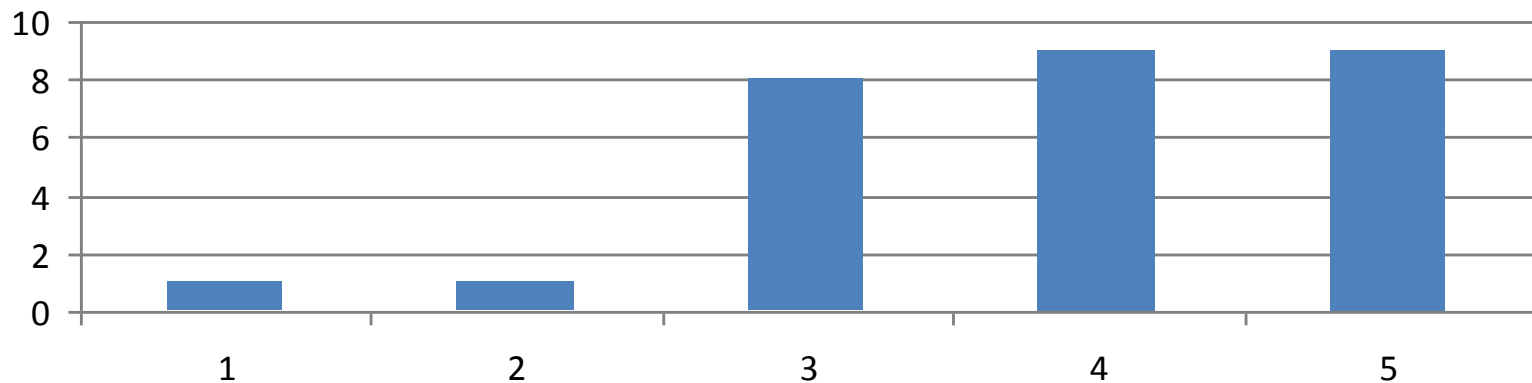
- Gave a student feedback questionnaire immediately after handing marked work back to the students, first session after Easter

Developing skills

A mathematics graduate should have transferable skills

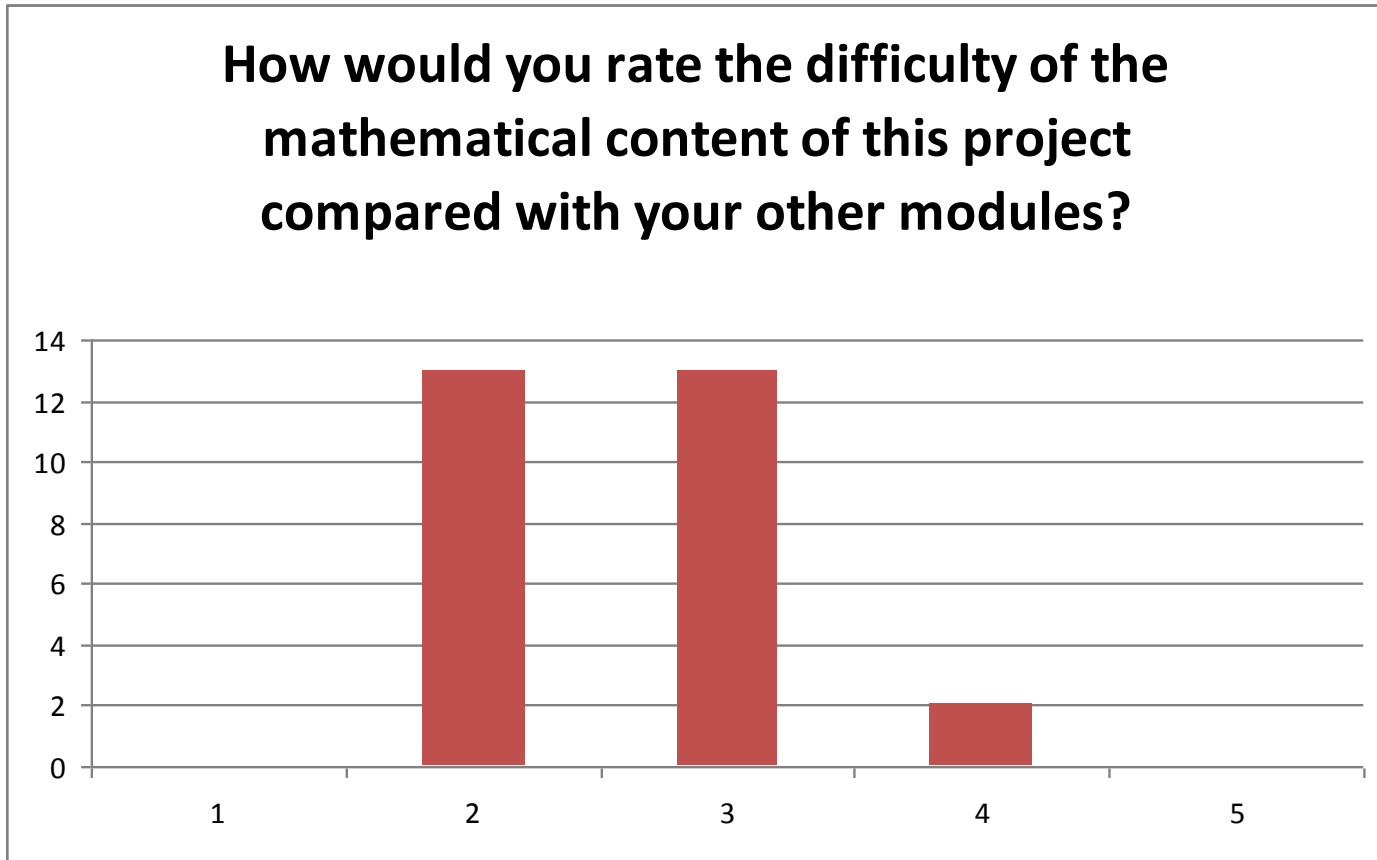


A mathematics student should be taught transferable skills as part of their degree (for credit)



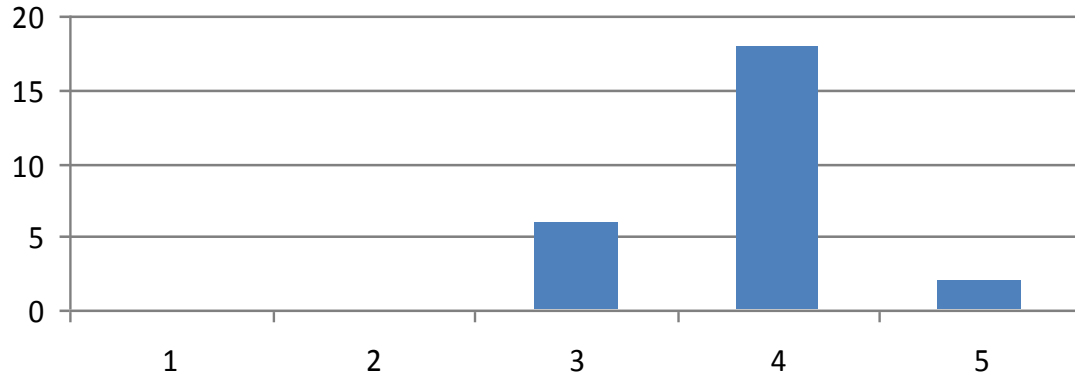
Difficulty of work

- “This project required me to use knowledge or skills gained in previous modules”
- All students who agreed listed transferable skills not mathematical ones.

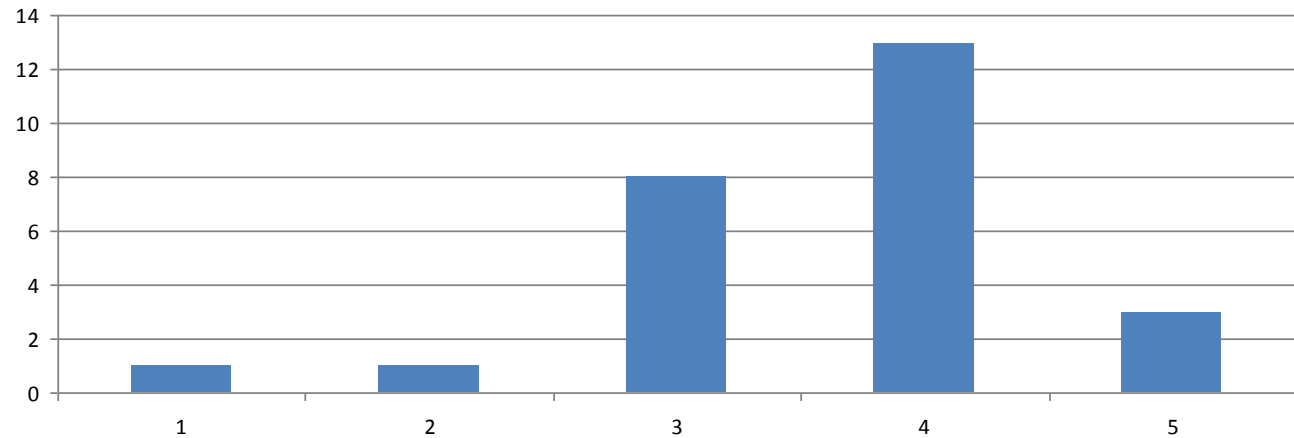


Group management

How helpful did you feel the plan of work was in organising the project?

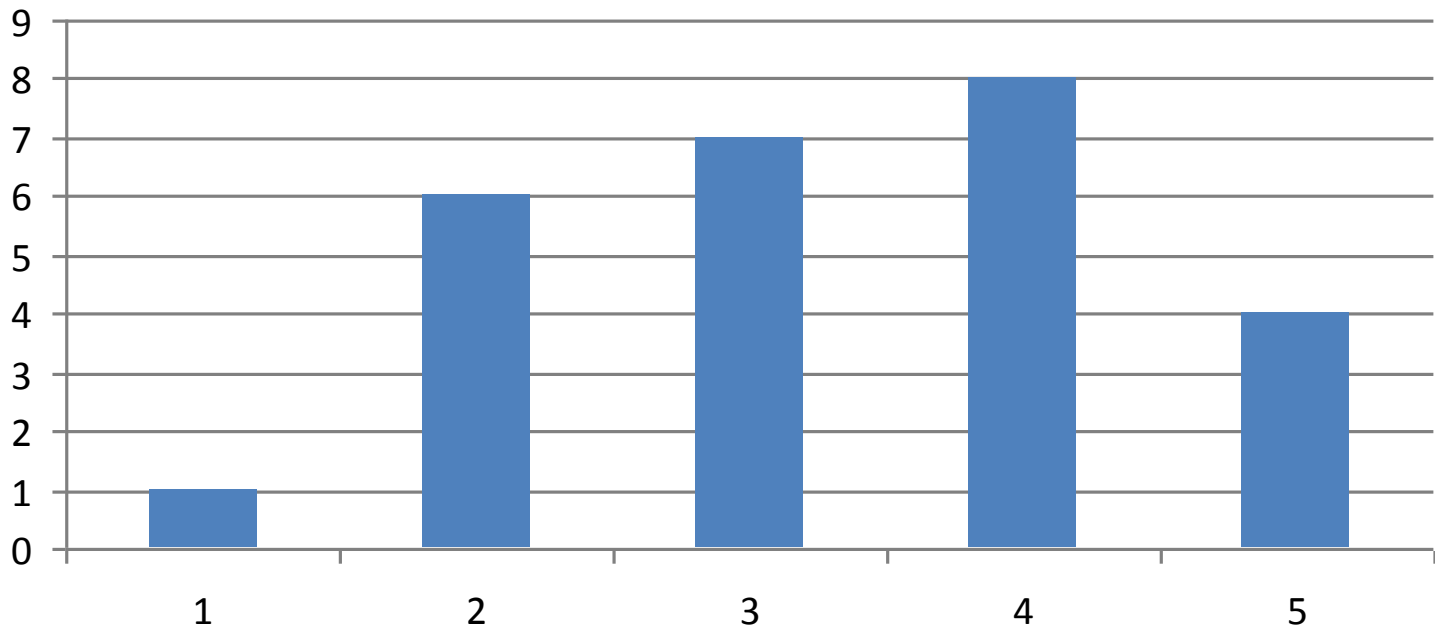


How helpful did you feel the minutes of meetings were in ensuring team members completed their assigned tasks?



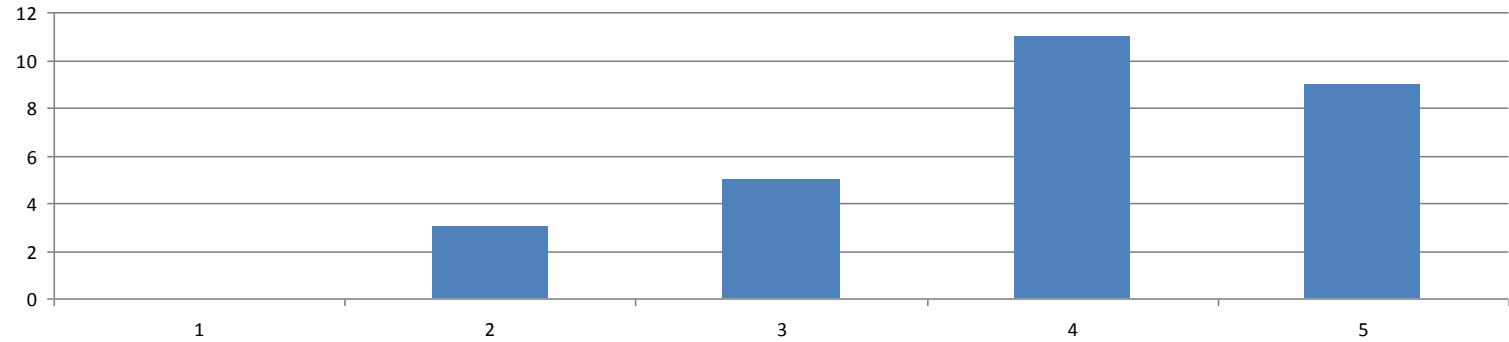
Individual contribution

All team members contributed to the project equally

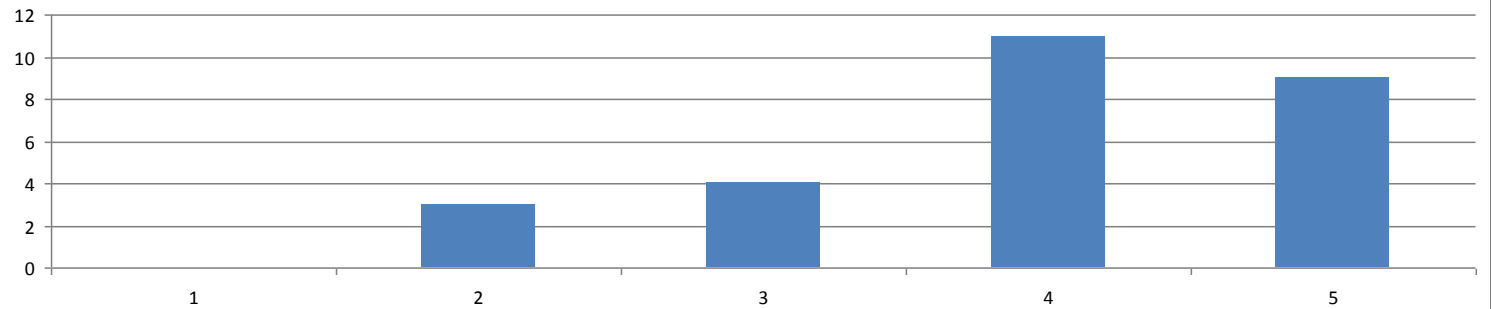


Usefulness of skills sessions

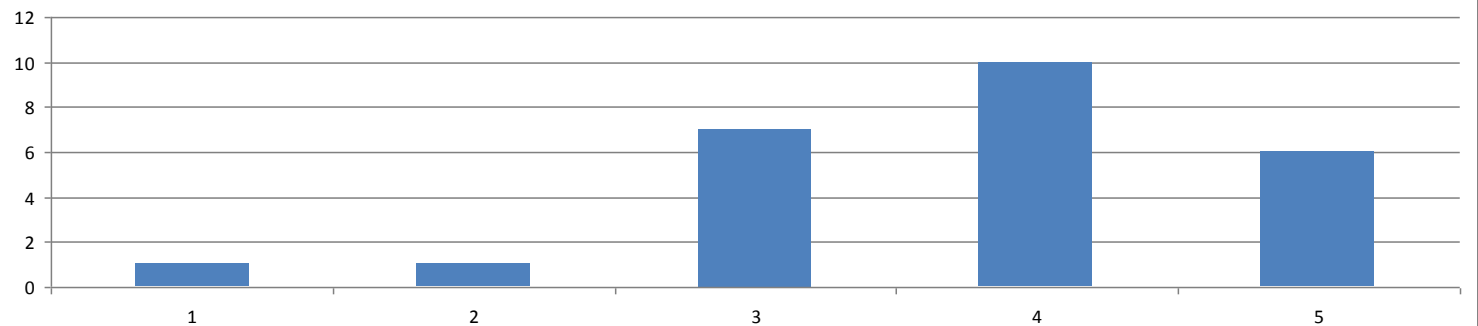
Finding and using references (Library)



Writing reports



Giving presentations



Did the project meet the learning outcomes?

- I asked the students to rate themselves against 'competencies' before and after they completed the project (retrospectively)
- Compare whether they have improved
- 'Competencies' in fact the module learning outcomes
- Project was not designed to hit all module learning outcomes

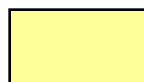
Scoring

- Gave higher score for improving “poor” students over improving students already “good”
- Deducted more marks from score for “poor” student remaining the same than for “good” student
- -1.5 and below: Not even improving students who are average or poor (strong indication of lack of positive effect)
- -1.5 to -0.5: Not improving students who are good (some indication of lack of positive effect)
- -0.5 to 0.5: Inconclusive.
- 0.5 to 1.5: Good students becoming better (some indication of positive effect)
- 1.5+: average or poor students becoming better (strong indication of positive effect)

Competence / learning outcome	
1. Express problems in the language of mathematics.	0.92
2. Select, adapt, and apply standard techniques in a variety of problem areas.	0.19
3. Identify assumptions in a mathematical argument.	0.04
4. Evaluate, select, and implement appropriate numerical and software techniques for a range of problems.	1.65
5. Use reference information from a variety of sources.	3.31
6. Communicate effectively using reports and presentations.	0.75
7. Work effectively as an individual	0.13
8. Work effectively as part of a small team.	0.50
9. Collect, evaluate and analyse data.	0.04
10. Effectively manage your time.	0.75
11. Reflect on your learning and personal professional planning skills and goals.	0.79



No effect indicated



Some indication



Strong indication

References

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