Assessment and Feedback in Fully Online Undergraduate Mathematics: The Instructor Perspective

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Overview

Mixed-methods investigation of instructor perspective on assessment and feedback in fully online undergraduate mathematics courses.

Study 1:

- Survey of assessment practices: assessment schemes and feedback types.
- Massive variety and no clear relationship to approaches to teaching.

Study 2:

- In-depth interviews with six instructors experienced in teaching both FO and F2F.
- Main emergent issue concern about loss of short-cycle face-to-face interactions.

Argument that difficulties present an opportunity to rethink instruction in line with principles from student-centred classroom instruction.

Introduction

Introduction

Higher education is changing fast. In 2010:

- 31% of all US HE students were taking **at least one online course** (Allen & Seaman, 2011);
- 35% HE mathematics departments **offered FO mathematics** (Blair, Kirkman & Maxwell, 2012).

This might be positive because it has been argued that FO courses:

- Are well-suited to **promoting student-student discussion** (e.g. Swan et al., 2000);
- Can provide a **flexible and individualised** learning experience (e.g. Means et al., 2009);
- Encourage **creative approaches** to teaching and assessment (e.g. Gikandi, Morrow & Davis, 2011).

Introduction

However, FO mathematics courses suffer from:

- Low levels of **student satisfaction** (Mills & Raju, 2011);
- High levels of **attrition** (Mensch, 2010; Xu & Jaggers, 2011).

Mathematics is generally considered to be **challenging to teach online** (e.g. Glass & Sue, 2008).

Often studied via **outputs** such as retention or grades.

Here we study **inputs** via instructor decisions and experiences, because:

- Comparatively **little is known** about these;
- Whatever the affordances of FO teaching, individuals must implement it and an environment that does not meet their **perceived needs** is unlikely to be used effectively.

Introduction

Study 1 aimed to identify **typical practice** or identify individuals with a range of practices.

Study 2 aimed to **explore experiences of adapting** to FO teaching by asking instructors to compare their FO and F2F teaching experiences.

Focused on assessment schemes because we anticipated that:

- These could be compared at the macro scale;
- Discussing these would enable instructors to compare their intentions and actions at the level of whole courses while relating their comments to specific instructional decisions.

Asked **more specifically about feedback** because the literature identifies this as important in studying assessment.

Background

Potential of FO instruction

Institutional benefits:

- Can **teach lots of students** for comparatively small increase in costs (Bakia et al., 2012);
- Students like the **flexibility** (Young & Norgard, 2006).

Institutions **increasingly using FO teaching for on-campus students**; mainly asynchronous so that's the focus here.

(Claimed) pedagogical benefits:

- **Written discussion promotes** reflection, deeper discourse, development of sense of community, etc. (e.g. Swan, 2001; Harvard, Du & Olinzock, 2005);
- Many studies show **comparable learning outcomes** (Bernard et al., 2004).

But outcomes and standards of evidence variable.

Teaching mathematics

Compared with others, mathematics instructors are:

- **Least likely to emphasise deep approaches** to learning (Nelson Laird et al., 2008).
- **Most likely to prioritise learning of terms and facts** (Barnes et al., 2001).

Teaching mathematics

Ongoing effort to **discourage transmissive teaching** and encourage teachers to attend to learning resulting from activities (e.g. Jaworski, 1994).

But managing a student-centred classroom is a **complex task**:

- Need to balance respect for and promotion of student thinking with progress toward mathematically-sound conceptual understanding (Lobato, Clarke & Ellis, 2005).
- Requires skills in sequencing tasks, anticipating student responses, and linking those responses to key mathematical ideas (Stein, Engle, Smith & Hughes, 2008).

Teaching mathematics online

Possible **benefits of asynchronous written mathematical communication**:

- Assists in building higher levels of understanding (Miller, 2007) or conceptual understanding (Englebrecht et al., 2005);
- Anonymity can enable shy or anxious students to feel less threatened by prospect of live confrontations (Mayes, 2004);
- Can enable “playful exploration” (Rosa & Lerman, 2011);
- Can foster communication skills and awareness about own mathematical strengths and limitations (Mallet, 2008).

But **instructors are unlikely to intuitively know how to use it effectively**:

- Practical difficulties in communicating mathematics via symbols, gestures, etc. (Smith et al., 2008);
- Discussion often not used (Lowrie & Jorgensen, 2012);
- Discussion might or might not contribute to effective learning when it is used (Illowsky, 2007; Offenholley, 2012).

Assessing mathematics online

CAA is relied upon (Trenholm, Alcock & Robinson, 2015) and has made it much easier to set and provide immediate feedback on routine exercises, but **there are concerns**:

- About level of learning that can be addressed (Paterson, 2002);
- Repetitive attempts might discourage deeper understanding or even reinforce incorrect interpretations (Sangwin et al., 2010);
- That delayed feedback might be better when greater need to process the material (Kluger & DeNisi, 1996);

Wide variability in feedback effectiveness reported (Hattie & Timperley, 2007) but these **types generally distinguished**:

- Correct/incorrect;
- Full correct solution provided;
- Hints directed at learning process.

Assessing mathematics online

Little known about balance of feedback types in FO mathematics courses.

There are **reported instances** in which mathematics instructors have used online elements of regular teaching to:

- Involve students in **peer assessment** of responses to conceptual questions (Jones & Alcock, 2013);
- Involve **students in drafting**, answering and evaluating examination-like questions (Mallet, 2008).

Such approaches **likely to be unfamiliar to many**, however, because mathematics tends to emphasise summative assessment, quantitative questions and accuracy in grading (Iannone & Simpson, 2012).

Instructors in **other subjects might be better prepared** to take advantages of affordances as they'll be more accustomed to using qualitative questions and (more) subjective judgements.

Research questions

How do all these issues play out for instructors attempting to give high quality FO mathematics courses?

1. **How do mathematics instructors set up their FO assessment schemes and are these schemes related to their approaches to teaching?**
2. **Do instructors use discussion and feedback differently in their FO and F2F courses? If so, what do these differences tell us about the challenges of teaching mathematics in the FO context?**

Study 1

Study 1 methods

Survey targeting instructors with experience in FO mathematics teaching via existing contacts and institutions with well-established FO programmes.

Country/Group	"2 yr" (e.g. US community college)	"4 yr" (e.g. US state university)	"Online" (e.g. Open University)	Other	Unclear from response	Total
US (SLN)	25	7	0	3**	2	37
US (RODP/RUME)	6	10	0	0	-	16
IGI Global*	0	7	0	1	-	8
Other	0	2	7	0	-	9
TOTAL	31	26	7	4	2	70

*IGI Global is the publisher for the research compilation.
**Specified by participants as a combination of 2 and 4 yr institution.

Study 1 methods

Participants asked to:

- select a course they taught online;
- list their assessment instruments;
- document the feedback associated with each;
- complete the 16-item Approaches to Teaching Inventory (ATI), which has two subscales:
  - ITTF: information transmission/teacher-focused;
  - CCSF: conceptual change/student-focused;
  - Score 8 - 40 on each scale.

Study 1 results

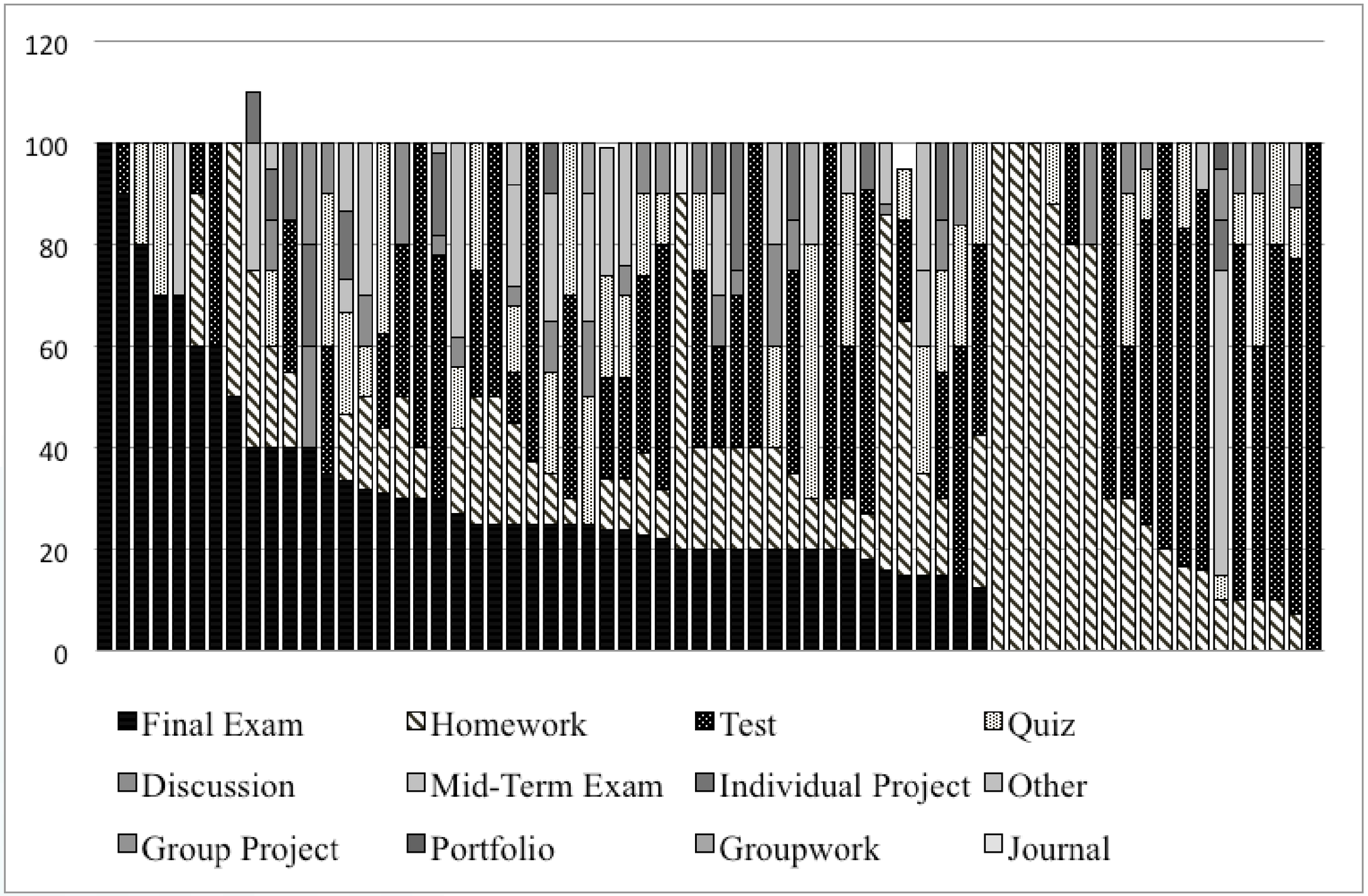
ATI behaved as expected, with caveats:

- ITTF scores 16 - 36 (M=26.8, SD=4.5);
- CCSF scores 10 - 39 (M=26.0, SD=5.9);
- Internal reliabilities ITTF .505, CCSF .789 (ITTF generally less reliable).

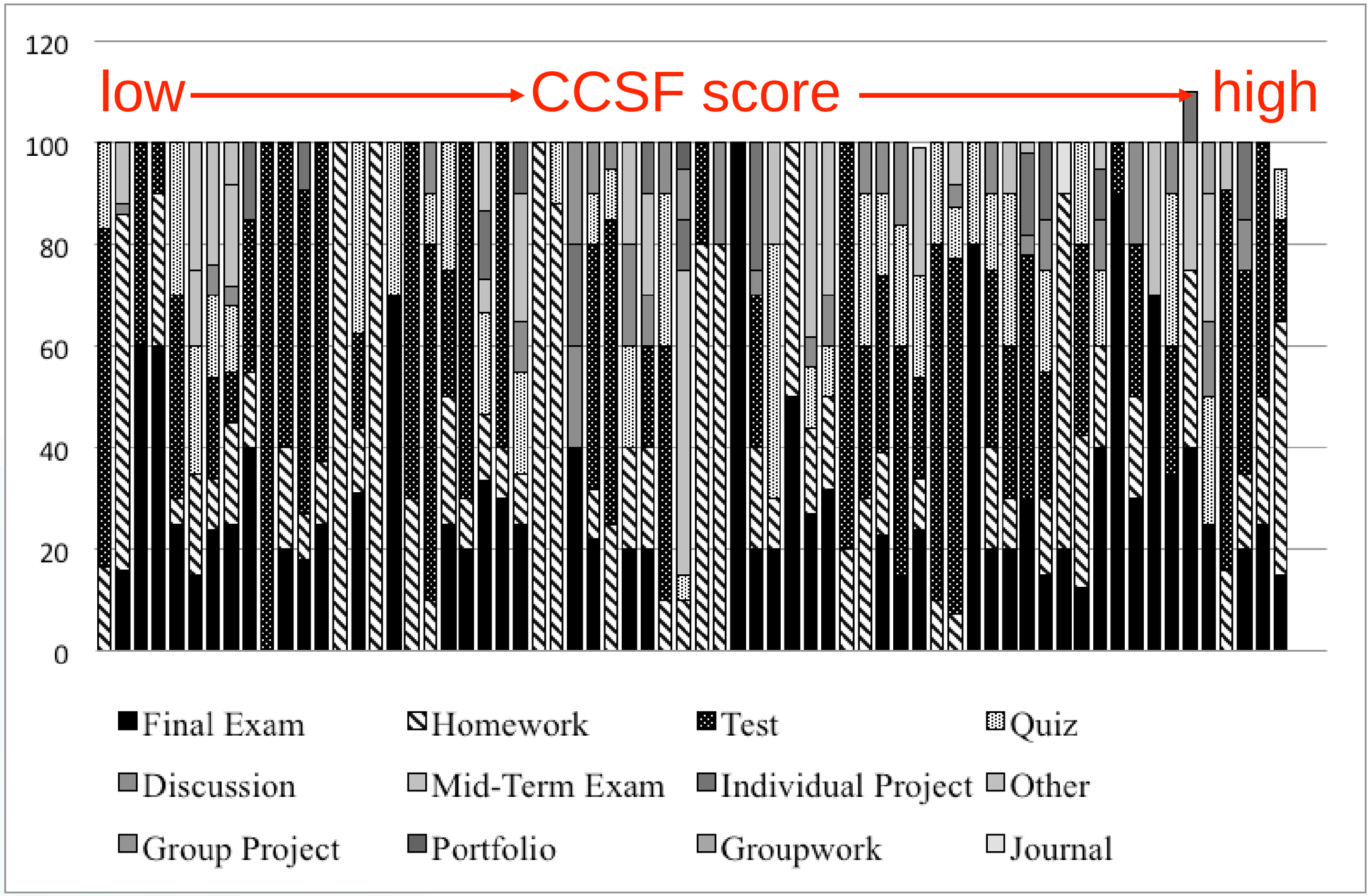
CCSF scores used in comparisons to follow.

Absolute comparisons of scores across subjects discouraged (Trigwell & Prosser, 2004) but there is variation here; it's not the case that all participants were highly student-focused in their approaches, for instance.

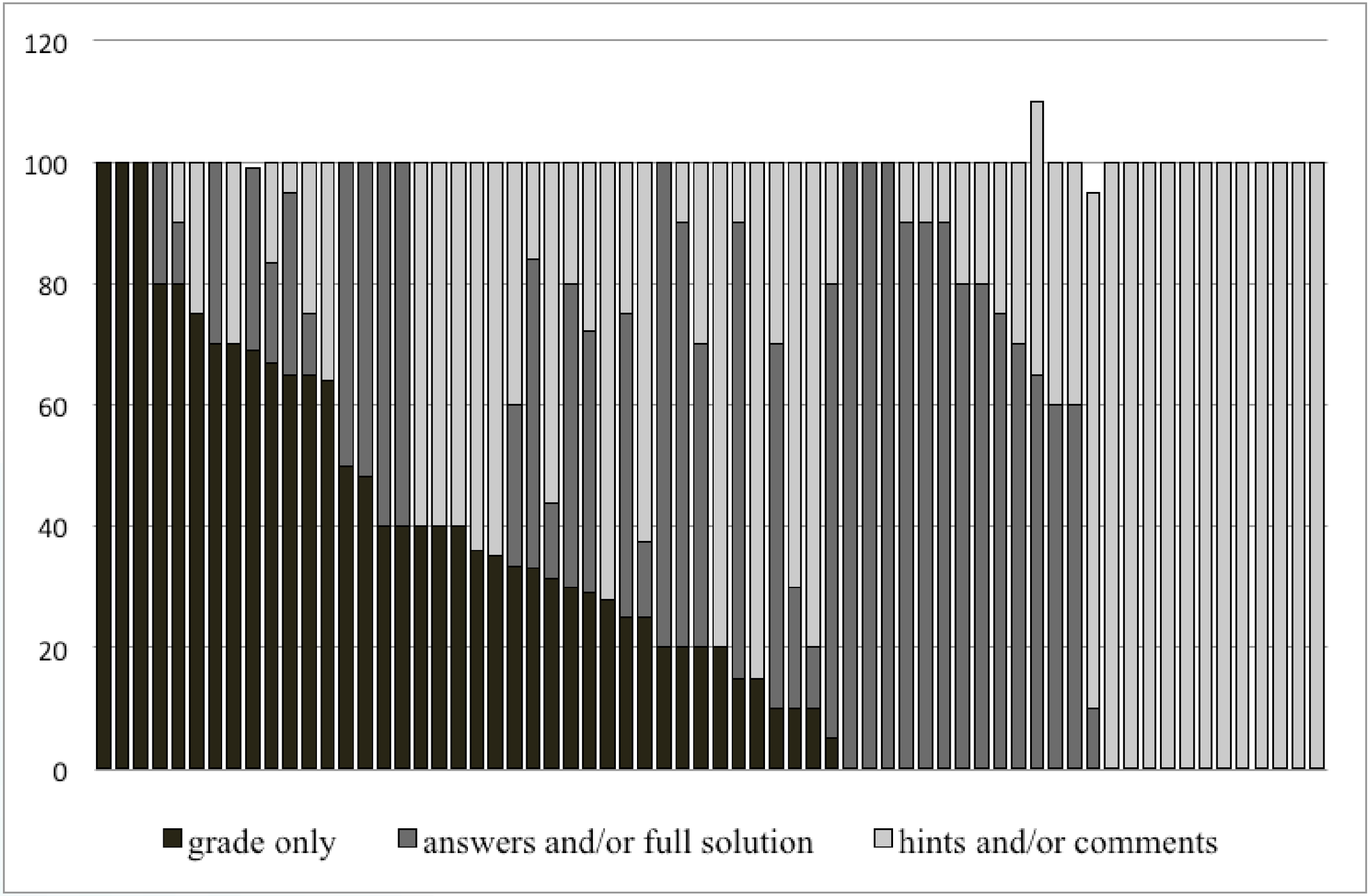
Assessment schemes



Assessment schemes



Feedback types



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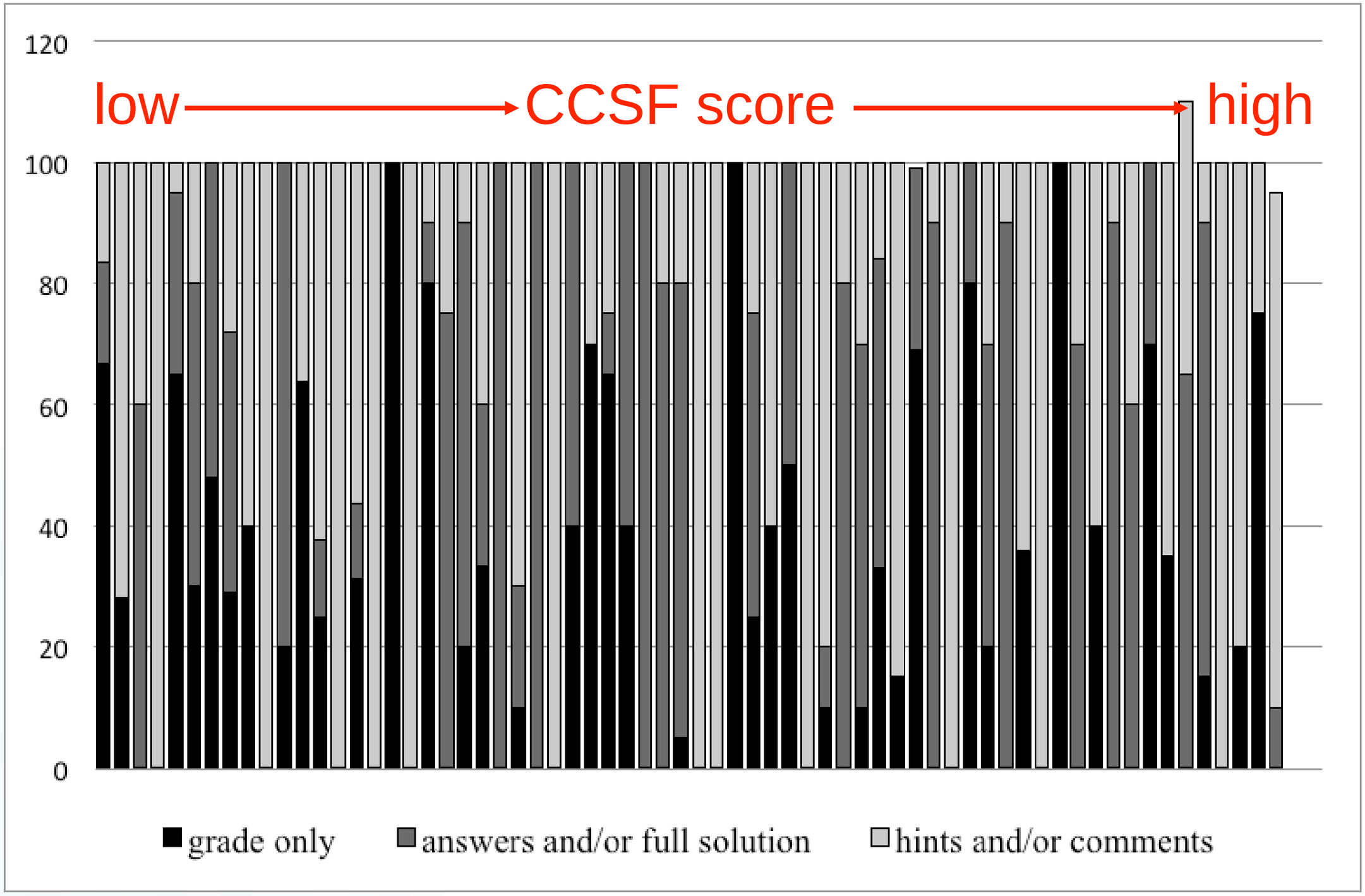

Study 1 discussion

It appears to be a mess.

Doesn’t make sense to talk about typical behaviours or even about trends in relation to approaches to teaching.

This could be a good or a bad thing:

- **Perhaps instructors are taking advantage of freedom** to adapt instruction to their own preferences and the needs of their classes in some way not picked up by simply looking at instruments and feedback types;
- **Perhaps they just don’t know** how to make mathematics instruction work in this modality.

What are instructor experiences?

Study 2

Study 2 methods

Interviews with six volunteers who left contact details from survey, selected from US context and with a variety of teaching experience, institutional contexts, approaches to teaching and feedback practices.

	Teaching Experience*	HE Institutional Context	Course Context for Interview**

Interview Participants' Teaching Approaches and Assessment Practices

Participant	CCSF*	ITTF*	Percent Assessment Weighting Associated with Kind of Feedback Used		
			Grade only	Answer or Full Solution	Hints or Comments
P1	20	30	64	0	36
P3	25	27	0	100	0
P2	26	25	70	0	30
P4	29	25	0	0	100
P5	29	24	69	30	0
P6	29	20	33	51	16

Notes: 1. Data appear in increasing order of CCSF and then decreasing order of ITTF measures. 2. With the exception of P6, the FO course context used for the survey data shown above is the same FO course context addressed in the interview.

*Based on online survey data.

**Though reflecting the actual content, course names have been changed to preserve anonymity.

Study 2 methods

Participants asked to **select a course** they taught in both modalities (the same course if possible), **list their assessment schemes and answer the tabulated questions**.

Discussion	In your F2F teaching, do you have "discussion" as a weighted part of your overall course grade? In your FO teaching, do you have "discussion" as a weighted part of your overall course grade? If so, what do you hope to **accomplish** through the use of discussion? What is different about how you encourage your students to interact F2F vs. FO? If different, are there any particular reasons you can share?
Kind of feedback	Is the **kind** (e.g. correct/incorrect vs. full solution vs. hints/comments) of feedback you provide F2F different from the **kind** of feedback you provide FO? If so, are there any particular reasons you can share? What is the difference between the **kind** of feedback you provide F2F vs. FO?
Purpose of feedback	Is what you are trying to **accomplish** with your F2F feedback different from what you are trying to **accomplish** with your FO feedback? If so, are there any particular reasons you can share? What is the difference about what you are trying to **accomplish** with your F2F vs. your FO feedback? In general, what **kind(s)** of assessment feedback do you consider most effective in helping students understand mathematics?
Timing of feedback	Do you find that you are quicker or slower giving feedback in your F2F vs. your FO courses? Are there any particular reasons you can share? Do you think immediate feedback (e.g. CAA) helps students understand mathematics? Are there any particular reasons you can share?

Study 2 methods

Data analysis:

- Interviews transcribed;
- Transcripts duplicated where necessary to bring together comments pertinent to the same questions;
- Atlas TI file created for each question;
- Constant comparative coding for emergent themes.

Study 2 results

Main emergent theme was concern about **loss of short-cycle face-to-face interactions**, specifically:

- **student-student** interactions;
- **student-instructor** interactions in day-to-day teaching;
- **student instructor** interactions following assessment.

For **each of these** we will show instructor comments on:

- perceived differences between F2F and FO;
- instructional responses to perceived problems caused by loss of interactions;
- satisfaction or otherwise with these responses.

[Theoretical generalisation only.]

Student-student interactions

Student-student interactions

Participants accustomed to using class time for collaborative activities:

P6: So in my face-to-face classes.... I go from group to group to group and I'm sort of able to challenge them…. Whereas, in an online course, a) there isn't dialogue just magically erupting because the students don't necessarily see each other and b) I don't have the opportunity to go from group to group... and sort of connect those pieces so I use the discussion as a way to connect those pieces....

Student-student interactions

Participants did identify some advantages of online discussion:

P4: ...by writing their thoughts down it forces them to be more thoughtful; so I think the discussion boards have great potential in terms of getting at deep learning...

Student-student interactions

But encouragement for students to work together had been unsuccessful and sometimes met with hostility:

P5: I have tried to encourage [FO] students to work together on projects... and it did not go very well, the students were extremely resistant. I had emails and phone calls saying things like this: 'This is an online class, you shouldn't expect me to work with my classmates' and 'We can't find time to work together' and 'We do not want to get together in person' - even though they were within 3 or 4 miles of each other - 'We want to do things electronically'.

Student-instructor interactions in day-to-day teaching

Student-instructor interactions

Participants accustomed to informally assessing student understanding and providing detailed feedback and scaffolding:

P6: I kind of need the students to recognize they don't understand something. […] In the F2F classroom, that's really easy for that to happen because I could see their faces and they can see mine and when I see that 'deer in the headlight' look, like 'oh, they're totally lost'.

Student-instructor interactions

They lamented the loss of this in FO teaching and did not believe that FO interaction could adequately address this need:

P2: The [FO] discussion board... can help fill the gap a little bit, but if there's a real issue or concept of something that needs some attention, I just want the student to have attention very quickly.

Student-instructor interactions

Participants went to considerable trouble to respond to online posts, at considerable costs in terms of their own time:

P6: So with the discussions in my online course, I reply to discussions every day. At the end of the day, before I go to bed, every discussion post and every email has been read and replied to...

Student-instructor interactions

Some had effectively reinstated F2F time using office hours:

> *P3: ... in [F2F] mathematics courses they get face-to-face feedback. In the [FO] course they get written feedback plus an encouragement to see me face-to-face.*

Student-instructor interactions after assessment

Post-assessment interactions

Participants often offered a second stage of informal feedback:

P6: In an F2F course, the feedback is very verbal. You know I sit down with the student and say 'You know, I looked at your homework and... You're having a really hard time'...it's more about the effectiveness of feedback.

Post-assessment interactions

In FO teaching they attempted to compensate for its loss by offering more detailed initial feedback, remarking on positive aspects of this change:

P5: ...in an online class, I'm much more likely to give detailed feedback because the students do not have me in person for that feedback so when I return an exam to the students, I'm going to be more deliberate with my notes, I will give them more feedback, more written feedback. Whereas in a F2F class, I'm more likely to give them oral feedback when I pass back examinations and assessments.

Post-assessment interactions

Again, however, rapidity and detail came at a high cost in instructor time:

> *P4: But it takes effort and time... I want to encourage them to look at what they're thinking and help them grow beyond that and then I also have to evaluate where they're at. So, I guess in the F2F, it's easier to do both.*

Study 2 discussion

Study 2 discussion

Participants **accustomed to teaching** that involved:

- asking students to collaborate;
- inferring student thinking in real time;
- following up initial feedback with more informal and interactive discussion.

They were **attached to these practices**:

- They believed them to be effective;
- They believed it important to replicate or replace them in FO teaching;
- They were troubled by their experienced inability to do this.

They expressed a **sense of insecurity**; they had responsibility for student learning but reduced ability to monitor and support it.

Study 2 discussion

Of course, **instructors might be wrong**:

- Could orchestrate discussion and have impression that correctly inferring student thinking when **actually many disengaged**;
- Could give feedback that **students do not really use or take in** at the time, so detailed initial feedback might be effective for some.

And not all instructors would have the same experience, e.g. in European countries with large classes, there is less interaction so a shift to FO teaching might be experienced as **less of a dramatic departure** from the norm.

But, as argued earlier, **instructor experiences should be taken seriously** because an environment that does not meet their needs is not likely to be used effectively.

Discussion

Discussion

How should instructors' concerns be addressed?

Not necessarily by trying to replicate the F2F environment, though this will doubtless become more possible via:

- improved audiographics;
- sensitive tutoring systems.

Perhaps, though, there's **an opportunity to do more**.

Instructors experiencing difficulties might be particularly open to input on pedagogical approaches, which is not to be sneezed at.

> *It is generally quite straightforward to convince a lecturer of the importance of student-centred teaching at a theoretical, espoused level. However, it is harder to change their beliefs at a more fundamental, practical and enacted level so that they also change their practice.*
>
> (Kensington-Miller et al., 2013)

Discussion

Principles from student-centred classrooms might offer what we need.

Not obvious on face of it as they typically rely upon:

- Synchronous student-student interaction (Lobato, Clarke & Ellis, 2005);
- Class-wide development of mathematical thinking via short argumentation cycles (Elbers & Streefland, 2000).

These are the very elements missing in FO courses.

But a typical student-centred classroom involves students answering open-ended questions and a teacher orchestrating a discussion. This demands:

- **Good anticipation of likely student solutions and misconceptions;**
- **Ability to relate these to the target mathematics amid a fast-moving discussion-based classroom (Elbers & Streefland, 2000).**

The very thing that makes this difficult - making good pedagogical decisions at speed - is *alleviated* in online teaching.

Discussion

Basic design could be used in FO mathematics:

- Set a task with a deadline;
- **Set up sharing of solutions with requirement to individually interact with these in some way**;
- Decide - at comparative leisure - how to construct and present an instructor response to a set of solutions.

Specific implementations of single online tasks within F2F courses:

- Answer a conceptual question then rank some responses (Jones & Alcock, 2013);
- Construct a potential exam question, answer one constructed by another student, discuss the questions and answers (Mallet, 2008).

Conclusion

Such designs, as in classrooms, could:

- **devolve mathematical power and responsibility to students**;
- **relieve pressure on the instructor by reducing the need for immediate, individualised attention**.

Approaches to teaching are in flux and instructors are looking for answers - this could be exactly the time to promote pedagogical changes of the types we'd like to see.

Thank you.

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