



School of Computer Science & Engineering

**COMP9242 Advanced Operating Systems (AOS)**

2020 T2

**AOS Course Survey Result**

@GernotHeiser

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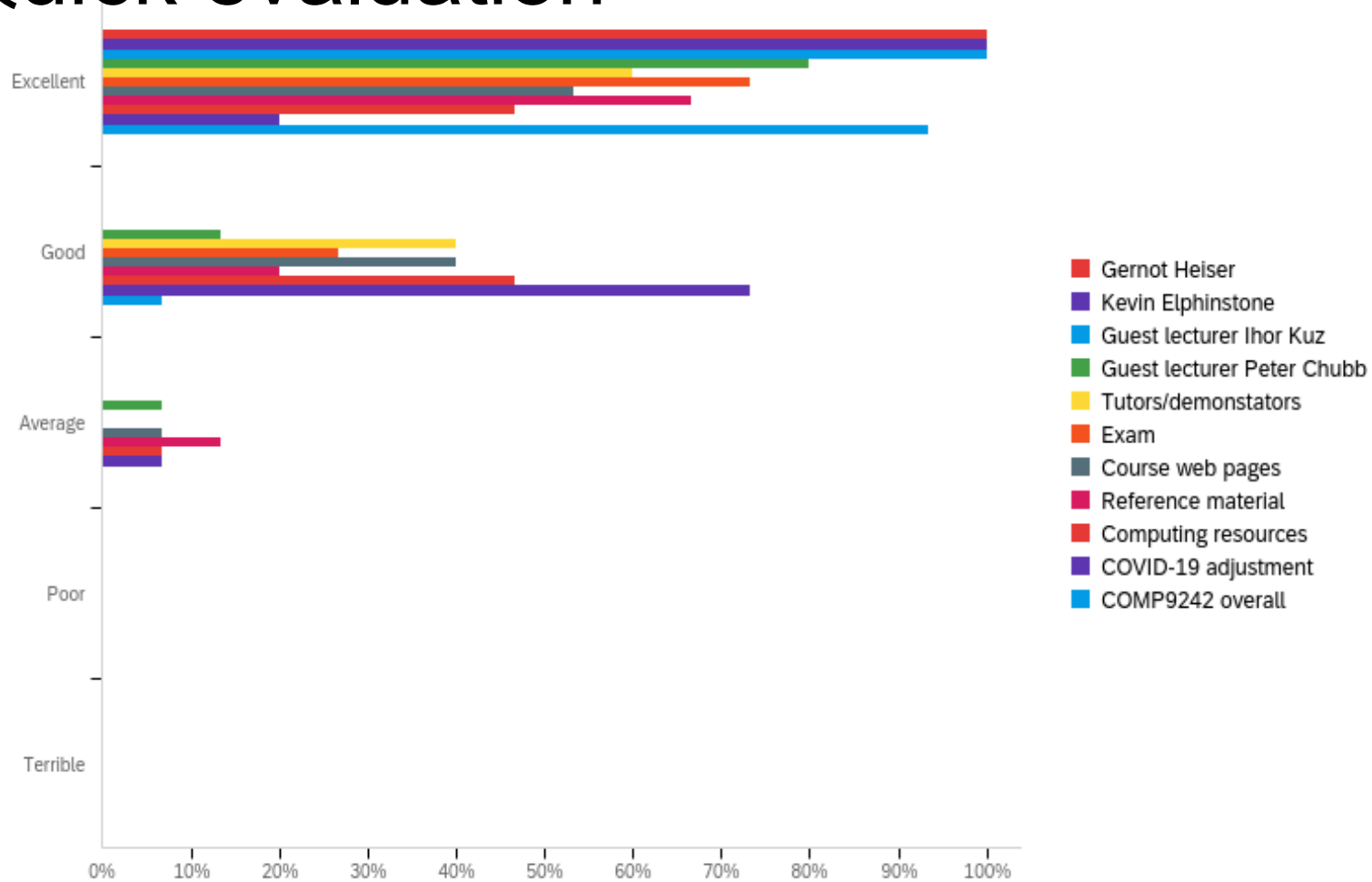
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# 1: Quick evaluation



# 1: Quick evaluation

Question	Mean	Excellent	Good	Average	Poor	Terrible	Total
<b>Gernot Heiser</b>	5.0	100%	15	0%	0	0%	15
<b>Kevin Elphinstone</b>	5.0	100%	15	0%	0	0%	15
<b>Guest lecturer Ihor Kuz</b>	5.0	100%	15	0%	0	0%	15
<b>Guest lecturer Peter Chubb</b>	4.7	80%	12	13%	2	7%	15
<b>Tutors/demonstrators</b>	4.6	60%	9	40%	6	0%	15
<b>Exam</b>	4.7	73%	11	27%	4	0%	15
<b>Course web pages</b>	4.5	53%	8	40%	6	7%	15
<b>Reference material</b>	4.5	67%	10	20%	3	13%	15
<b>Computing resources</b>	4.4	47%	7	47%	7	7%	15
<b>COVID-19 adjustment</b>	4.1	20%	3	73%	11	7%	15
<b>COMP9242 overall</b>	4.9	93%	14	7%	1	0%	15

## 2: Your main reasons for taking AOS

#	Answer	%	Count
1	Interest in operating systems as an area of study	93%	14
2	Chance to build a complete system (almost) from scratch	93%	14
3	Chance to get fingers *really* dirty	80%	12
4	Considering doing systems research	33%	5
5	Looking for a challenge	53%	8
6	Looking for an easy course	7%	1
7	Friends told me to do it	7%	1
8	General reputation of the course	53%	8

### Other factors not mentioned above?

Reputation of the course in Industry

You get a shirt at the end to remember the pain of AOS long into your career.

Chance to really get to know microkernels

### 3: Enrolment was down 50% this year...

It's obvious to suspect an effect of the pandemic, but less obvious what this effect was, given that the student pool hasn't shrunk.

If you're aware of any fellow students who would likely have taken the course in normal circumstances but decided not to, and you're aware of their reasons, please let us know what they were. You may also want to comment whether with the benefit of hindsight you think their concerns were valid. please leave empty if nothing to add

I know that I personally put the course off for a year because it was running for the first time in trimesters, and probably would've done the same taking potential covid changes into consideration

I know one person who dropped because it was more difficult than they expected it (comparing it to EOS). I do know that for EOS the advanced components of the assignments are optional now as opposed to required, and these are more representative of the difficulty of AOS. Advertising this and getting more students to try them could help students consider if AOS would be right for them.

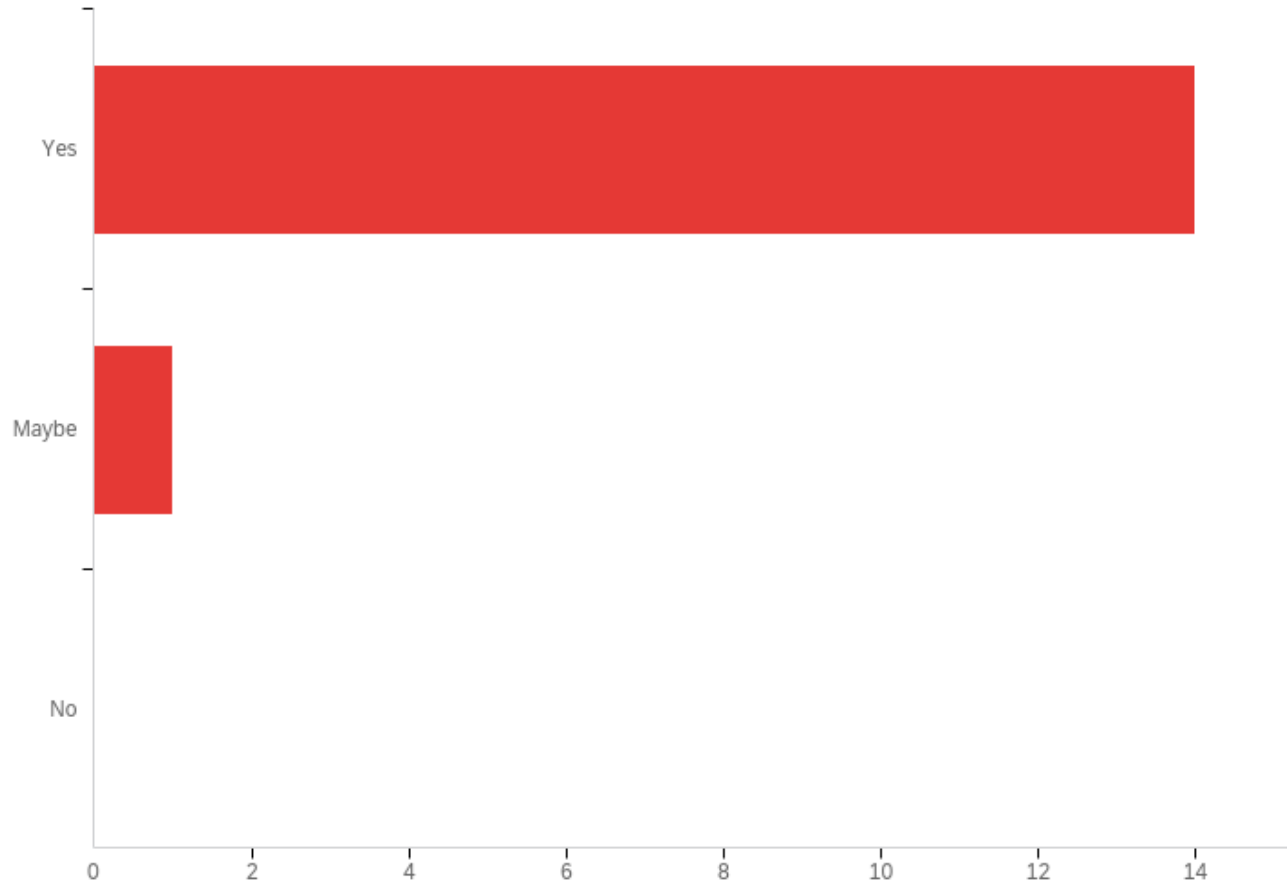
A friend of friend said that they will consider enroll to this course next year instead, because he believes AOS is a "hands-on course", where we attend the labs and get to play with the development board. They don't like the idea of operating the device remotely.

I'm not explicitly aware of any such situation, but I suspect that students who are able to complete this course another time (e.g. T2 2021) might have opted for that rather than completing it this year during the pandemic.

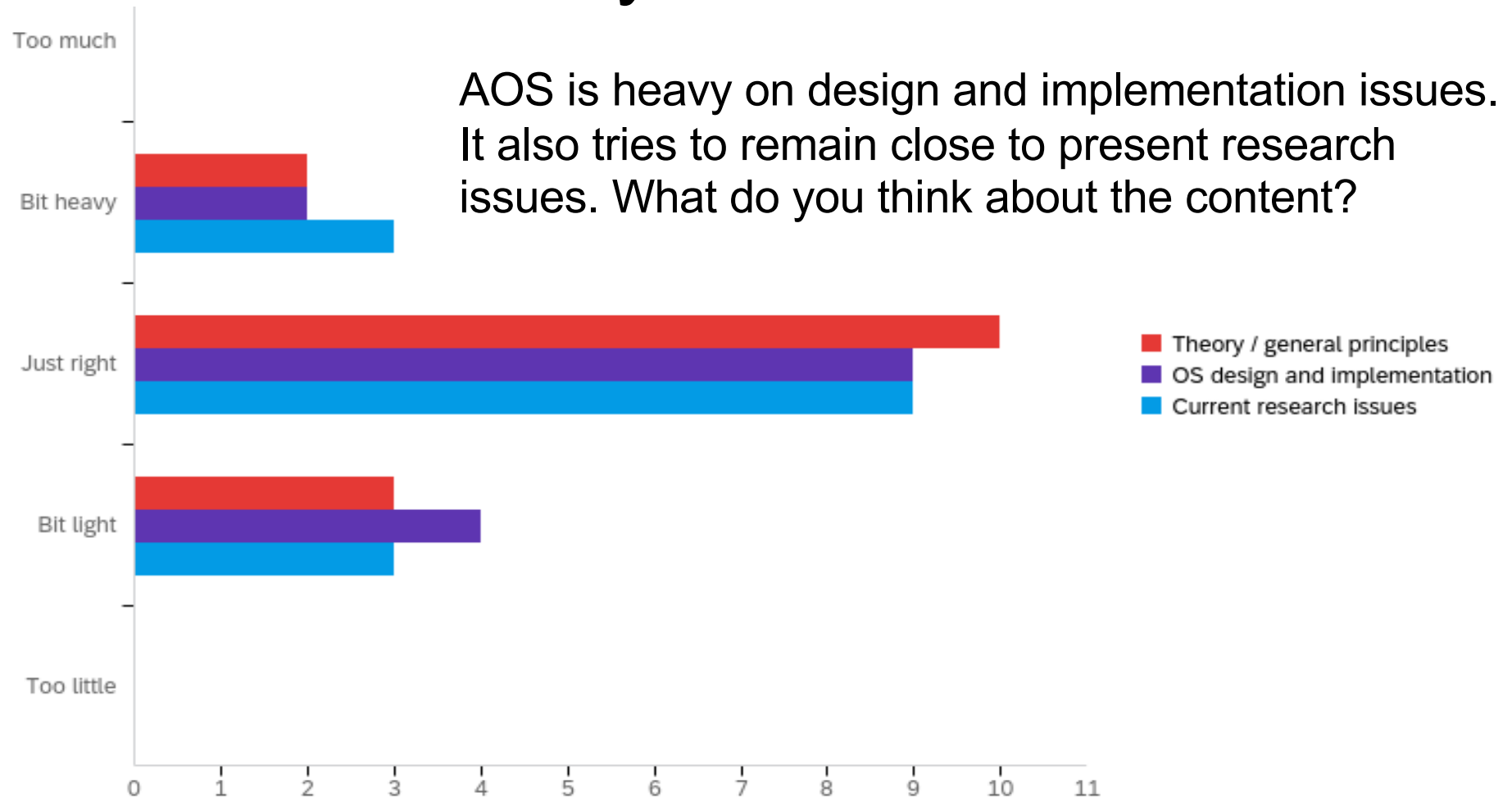
It's possible that an all-online AOS didn't appeal as much to students, or they were dealing with their own personal issues as a result of the pandemic and wanted to postpone taking AOS when the pandemic (hopefully) dies down. Taking AOS for the first year that it's being run all-online might have seemed to risky.

If I were able to take AOS next year rather, I probably would have (in the hopes that we'll be back to in-person teaching in T2 2021). I graduate before the next offering of the course though, so I couldn't do that.

# 4: Would you recommend COMP9242?



# 5: OS D&I vs theory vs research issues





# 6: What were the best things in AOS? 1/3

## What were the best things about this course?

Theory, and the project, with reading the papers

Loved the project

project, broad range of topics covered in lecture content

This course was seriously challenging and let us really take our own paths in our implementations for better or worse, which was a really valuable learning (and personal development) experience. I learnt so much from the freedom to make monumental mistakes and have to really understanding things to fix them. I also learnt that I can fix many seemingly insurmountable problems with enough determination (and lack of sleep), which really does boost my confidence in my ability as a programmer.

The theoretical and research content was so well presented and made the research papers accessible in a way I'd probably never have found them without this introduction. I learnt even more than I expected from it, and I expected to learn a lot.

I have sat a LOT of university exams on my long path to computer science, and the AOS exam is by far the best I've ever taken. It felt like it drew on the culmination of the knowledge we'd gained throughout the course, and I got to really learn something new during an exam which was awesome. I've never before enjoyed an exam, but I really enjoyed the AOS exam.

The odroid infrastructure was really good.

The level of detail taught for various areas of OS theory, and then able to apply it.

# 6: What were the best things in AOS? 2/3

## What were the best things about this course?

The materials and contents, as well as the main project throughout the course which was very practical

This course introduced knowledge related operating system in a very detail and deep way, which broadened my horizons. Furthermore, thanks to the well designed project, we have chance to build an OS from scratch and can access to the most cutting-edge research. And the exam is amazing as well, giving us a chance to analyze a research paper. In general, I think the best thing is the design of the course, every part is awesome .

The project itself was amazing as well as having good support from tutors during consultation hours

The tutors! Specifically Damon, Jarod and Ed. I learnt a lot from them and they were hyper friendly and open to shooting the shit when we were demonstrating our milestones, leading to me actually looking forward to demonstrating.

Lab is excellent. The way it is structured and the amount of information you are given really does push you to learn on your own. Lecture content is delivered in an engaging fashion and covers (as far as I know) a broad range of topics. Forum messages received quick responses.

Getting to build a simple operating system, getting to know seL4, and learning about current OS research.

the project

hacking

# 6: What were the best things in AOS? 3/3

## What were the best things about this course?

The lectures: highly detailed and very up to date. I really didn't expect things like virtualization and the Spectre vulnerability to be included in the course, and yet they are (and now I understand what the fuss is all about!). Current issues are discussed in a great detail. I also got a new motto here, that is before designing something, ask yourself "what can go wrong here?" and try to find at least one answer!

The project: its very challenging with very tight schedules. However, it is absolutely worth it. Twofold advantages: we got to learn what a microkernel really is, and we also got to learn how to build a device driver for a real hardware.

The exam: when did the last time you experienced an fun exam? If the answer is nope, then you should consider enrolling to this course! Being forced to review a set of fresh research papers utilizing the bleeding-edge features the latest generation chips has to offer is really eye-opening and fun!

- \* The breadth of the content covered in the lectures.
- \* The project's pacing.
- \* The exam format.

I was very impressed with how few hickups there were with the odroid boards. Curtis' setup must have been really excellent. When I did encounter issues with the odroid/s Curtis was pretty quick to respond and resolve them.

The project is obviously the best part of the course. The spec for each milestone is very clear.

Working with a partner was also a lot of fun.

It's nice to see how passionate all the staff are about operating systems.

# 7: What were the worst things in AOS? 1/4

## What were the worst things about this course?

The exploration of the papers felt like 1 lecture wasn't enough

Not a fan of the exam, a matter of taste

nothing stands out

I found it hard to connect with other AOS students. I've heard there is usually a lab where there's often students working on the project, and that was a factor in my original choice to commit to the subject. I chose to remain enrolled when the pandemic hit, but I found it easier to feel completely lost, very behind, or hopeless without much interaction with anyone but my partner. Especially over the weekend when the forum is (understandably and correctly) less actively monitored. I don't have any non-pandemic related criticisms of the course. And I was in the informal Facebook group chat for this course - but it was not very active unfortunately.

The amount of time required to keep up with the milestones. With assignments for other classes also due on Sunday, it wasn't always possible to complete the milestones on time.

The project was quite struggling since there were not documentation resources for seL4 for us to understand the base code or for us to research and experiment with seL4.

trimester is too short

seL4 documentation / course documentation needs updates

# 7: What were the worst things in AOS? 2/4

## What were the worst things about this course?

The only shortcoming of this course I can come up with was that we couldn't get the hardware and had to access it via CSE server which was slow and a bit inconvenient.

Not being able to see other students doing the course at the same time due to covid was kind of rough. Sometimes it felt a little isolating and I felt a bit of burnout towards the end of the course.

Lab specifications are (understandably) vague. If you were not able to complete and demonstrate a milestone by the end of the week (since you are allowed to demo the following week), then you have to hope that your interpretation of the spec aligns with the tutors, otherwise you lose a mark. I found the marking to be ruthless and reworks were required for minor reasons (i.e. you hardcoded your max file descriptors, and the demo required a few more). The effect of a rework is more than just a mark since you have to spend time on the previous milestone rather than working on the next one, so it is easy to be in the same position again the following week.

One suggestion is to set the lab schedule so that the weekend is at the start of the 7 day milestone cycle. Currently for a 1 week milestone, you have 5 days (Mon-Fri) to work on it, with guidance from tutors, and then 2 days (Sat, Sun) without any guidance. I feel if the weekend was at the start of this cycle, then you have 2 days to understand and start work yourself, then you have access to the tutors for the remainder of the time, up to the submission deadline. I feel this would result in better consult utilisation as well.

lack of sleep

# 7: What were the worst things in AOS? 3/4

## What were the worst things about this course?

I feel the theory topics should be integrated with the practical milestones more. For example, having some harder requirements on milestones that show understanding of the caches lecture, or utilising techniques from virtualisation lecture / security.

Nothing comes to mind

Topics related to the project itself could be increased in proportion (for example, we only discussed about seL4 only in 1st week, and we didn't discuss things like interrupt handling and TCB configs). Also, number of minor typos in specs are a little bit too high 😊

The markers could have given more feedback after each demonstration.

trimester is too short  
sel4 documentation / course documentation needs updates

It was very difficult to motivate myself to watch the pre-recorded lectures. I think live (online) lectures would have been more enjoyable. The Q&A that replaced lectures got little use.

It would be nice if the tutors could prepare some material to present and/or discuss in the tutorials, rather than the tutorials being used only for Q&A and marking. The tutors were great though. This is more a comment about the structure of the tutorial. *[continued next page]*

# 7: What were the worst things in AOS? 4/4

## What were the worst things about this course?

*[continued from previous page]*

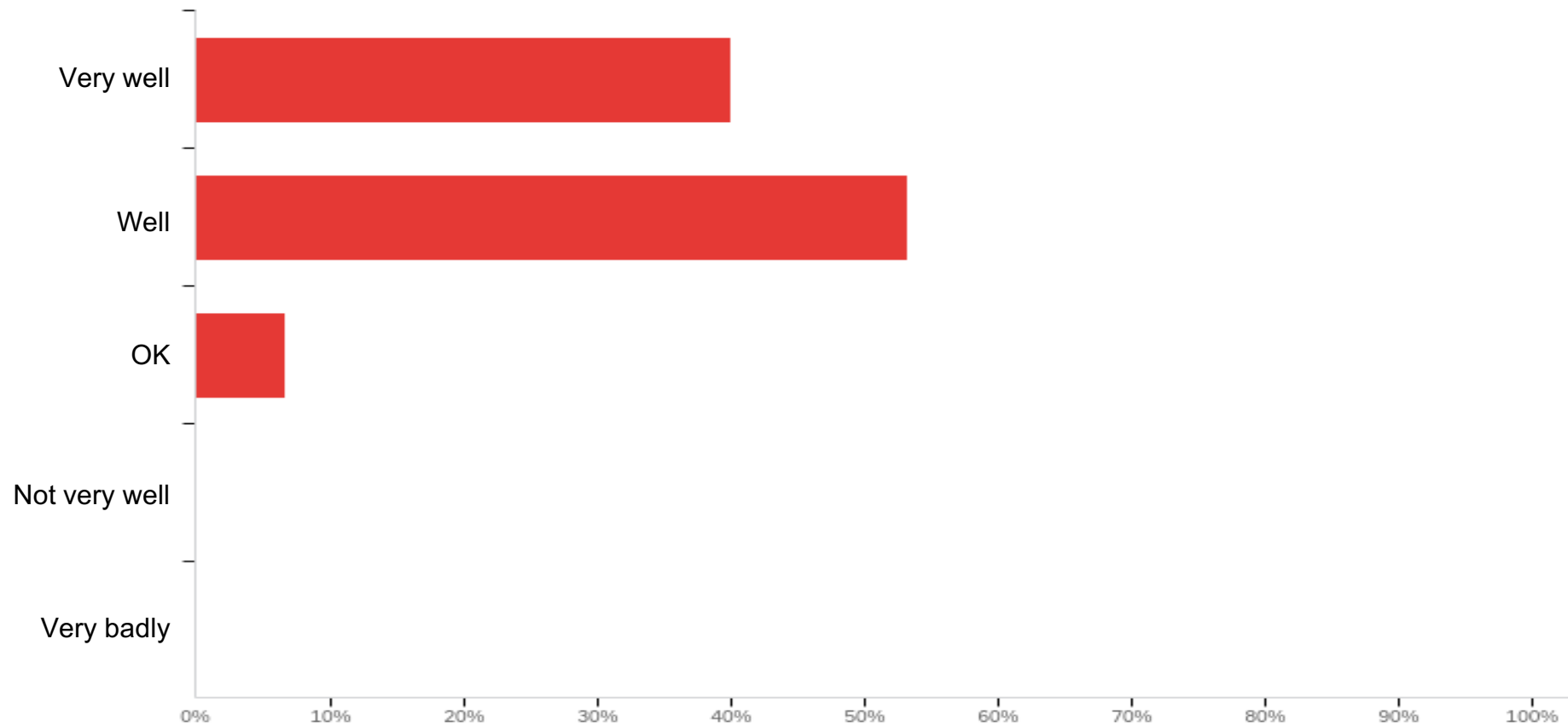
Although I've received my final mark for this course, I haven't received a grade for M7 or the final exam. It would be nice to get some feedback for these assessments.

I found that Gernot sometimes goes through content a little too fast in the (recorded) lectures, or assumes too much knowledge. I'm not sure whether other students felt the same way.

I also sometimes felt intimidated to ask questions, for fear of sounding stupid. I suspect that some other students felt the same way about this. One example that I can remember that made me more reluctant to ask questions is this; in one of the (recorded) lectures (I think the performance measurement lecture), Gernot was talking about some benchmarking crimes and made a comment to the effect of "this benchmarking crime is either a result of incompetence, or dishonesty, and they're both just as bad". After hearing this, I was worried that if I asked a question, and the question was seen as a 'dumb' question, I'd be seen as incompetent, which is as bad as dishonest, and I definitely don't want to be as bad as dishonest. This is a little bit of an exaggeration, but I think it gets my point across. Doesn't everyone start out as incompetent? And then (hopefully) improves over time? I'm not sure exactly what else can be done to help students feel less intimidated to ask questions.

Overall though, the course and all of the staff were awesome. Gernot and Kevin are super knowledgeable and passionate about operating systems. The tutors were always helpful. The material is very interesting, and the project is extremely challenging and rewarding. Best course I've taken at UNSW so keep up the good work :-).

# 8.1: How did the teaching team adapt to the restrictions imposed by the pandemic?





## 8.2: What could we have done better...

### 8.2: What could we have done better in running the course under pandemic conditions?

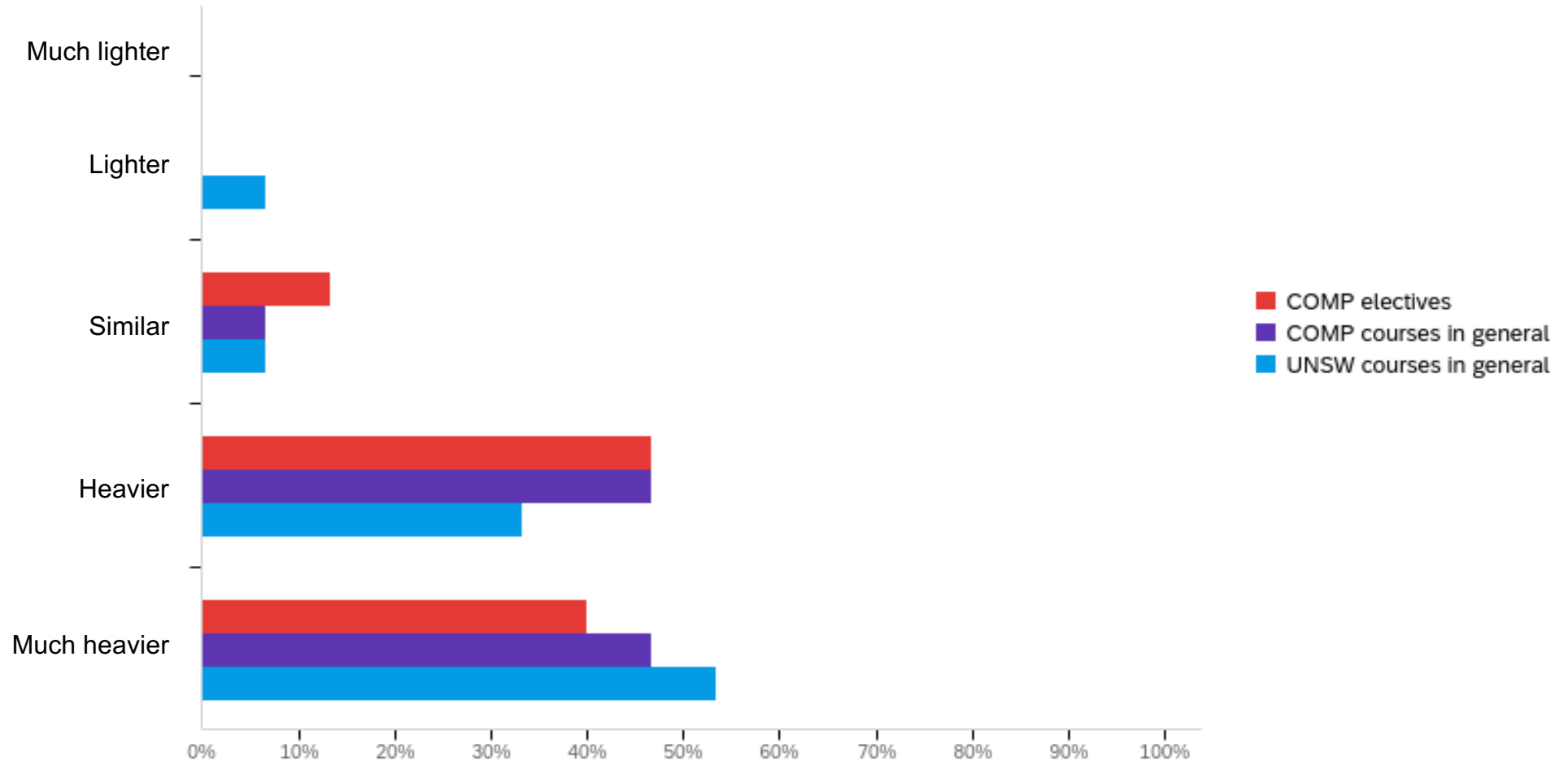
I think it would be better if the lab kits would be distributed as before instead of accessing it via CSE server.

If it is possible, putting up lectures earlier would be great, especially towards the end of the term when things become a bit more hectic or put the q and a sessions slightly later in the week as there were weeks where lectures were posted online on sunday and I didn't get a chance to watch them before the monday q and a session (due to me staying up late on sunday nights to finish off milestones and not being able to wake up earlier on monday mornings...).

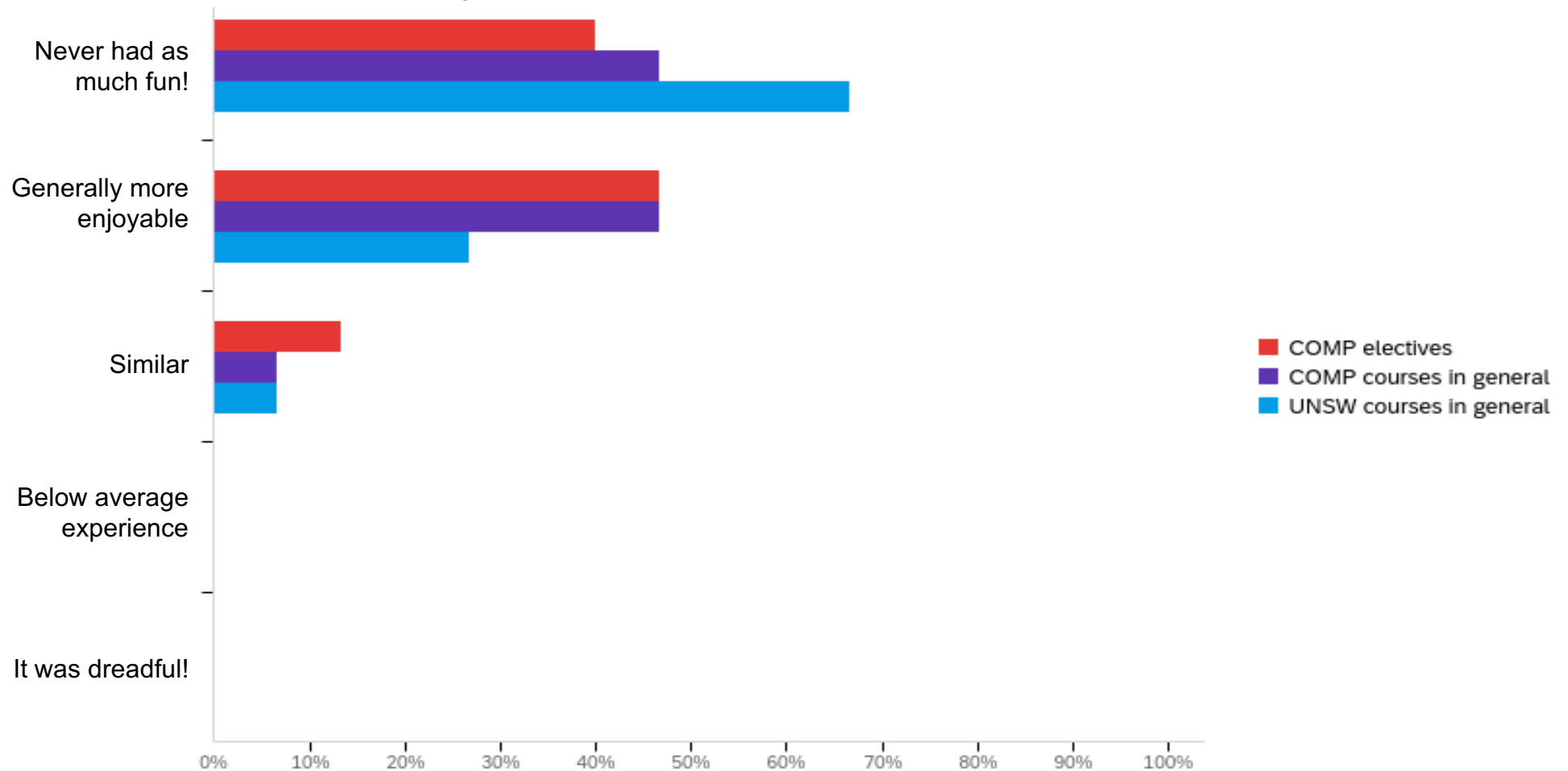
Allow students to take the kits home! Yes, working online is nice as we don't have to carry and baby the AArch board, but if we played around with the kernel and managed to mess it, there is nothing we can really do to reboot the board other than posting to Piazza.

Live lectures rather than lecture Q&A

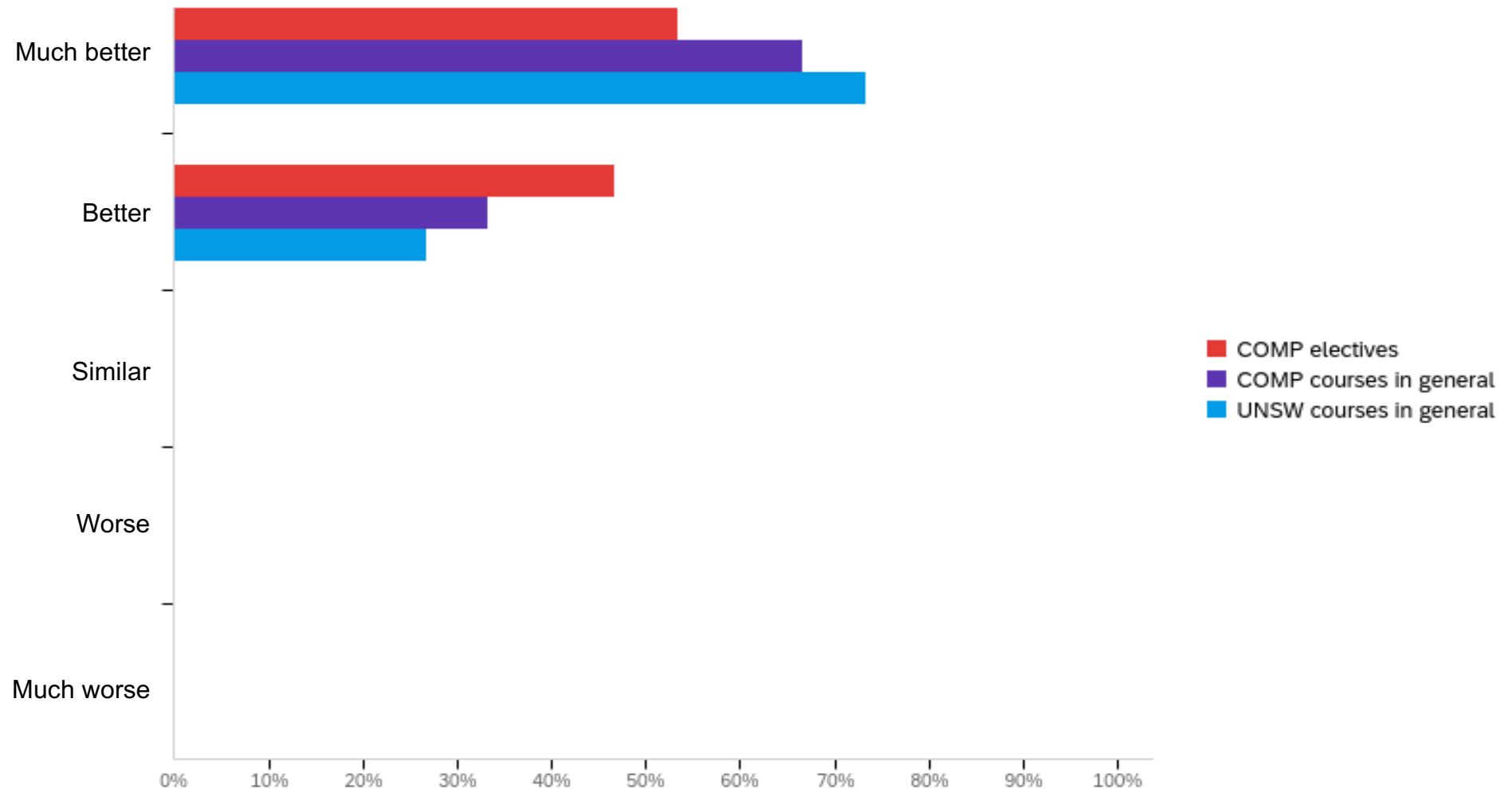
# 9: How does the workload compare to ...



# 10: How did your experience compare to ...



# 11: How does the overall quality/value compare to...



# 12: Missing background knowledge 1/2

What background knowledge do you think you were missing that would have helped you in this course? Is distinction WAM (used this year in lieu of distinction grade in COMP3231/9201) a suitable preparation? Is it too harsh?

The first two threshold milestones of the project would be enough to indicate competency in the project, but I don't know if DN wam is enough to prepare for the type of answers the final wants

Just the knowledge that some of the course content is available before the term starts would've been nice to prepare for the term, the restriction is fine

I think distinction WAM is too broad a measure. Students such as myself may have a non-technical second degree they aren't as good at, or maths subjects dragging down their WAM but be otherwise capable. I don't have a distinction WAM, but I think I was suitably prepared.

DN in OS is a reasonable requirement for AOS since a lot of background from OS helps me to understand and start with AOS, and it still seems like I am not prepared enough. Some knowledge of concurrency models would help me better in the project since I spent quite some time researching and understanding that, and tried to implement my decision in a sane manner.

# 12: Missing background knowledge 2/2

What background knowledge do you think you were missing that would have helped you in this course? Is distinction WAM (used this year in lieu of distinction grade in COMP3231/9201) a suitable preparation? Is it too harsh?

Distinction WAM is good preparation. I did it the year after I did EOS, and found that even though I forgot a lot of things, there's plenty of time to regain the knowledge with your project.

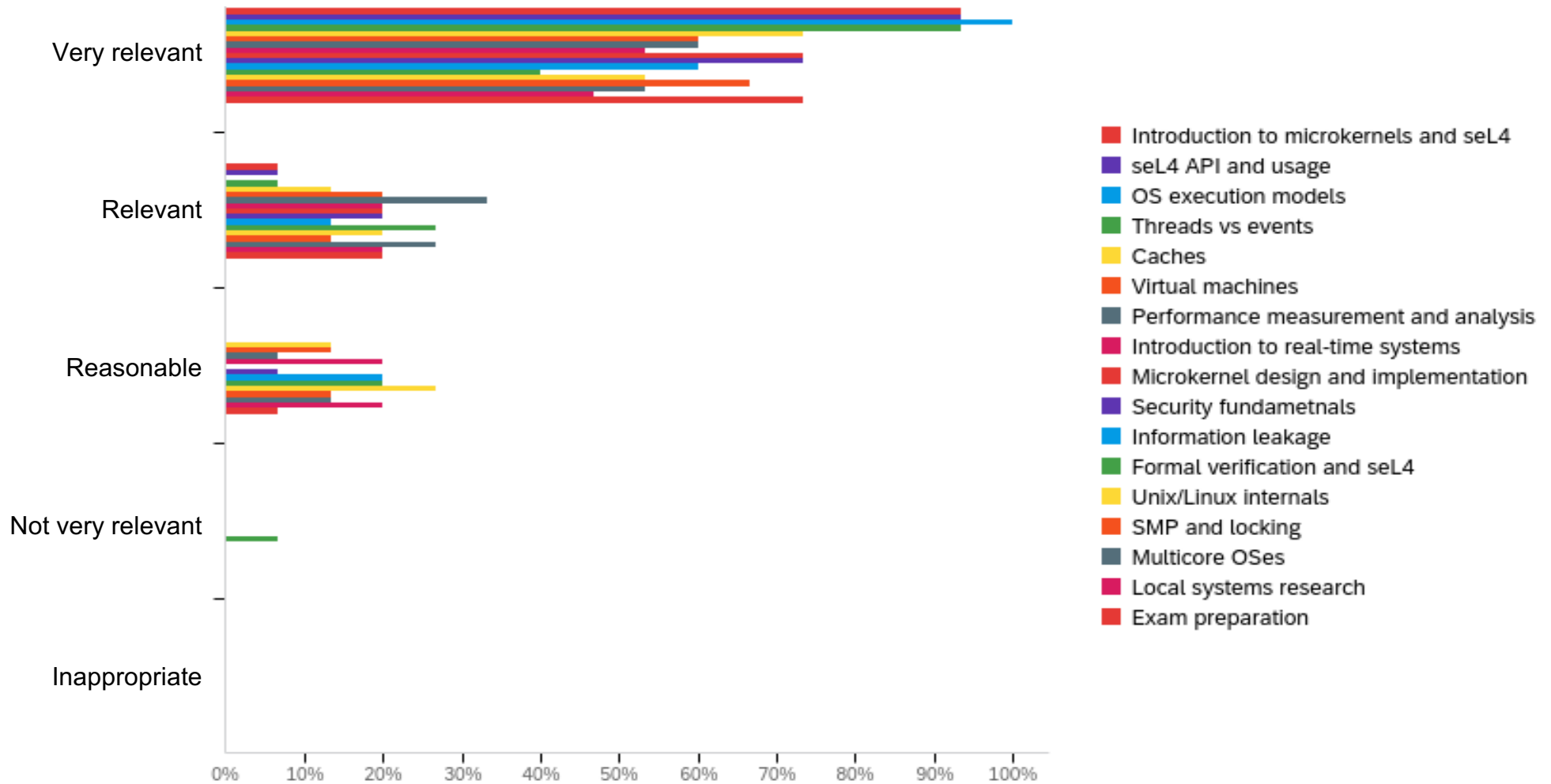
I think this year's restrictions make sense given the situation, but requiring distinction in OS is probably better, WAM is bit too general

I had a background knowledge in playing with Android custom ROMs so I know a little bit about devicetree, which allowed me to port the supplied seL4 and SOS skeleton to QEMU, which helps our team to debug our project by a lot.

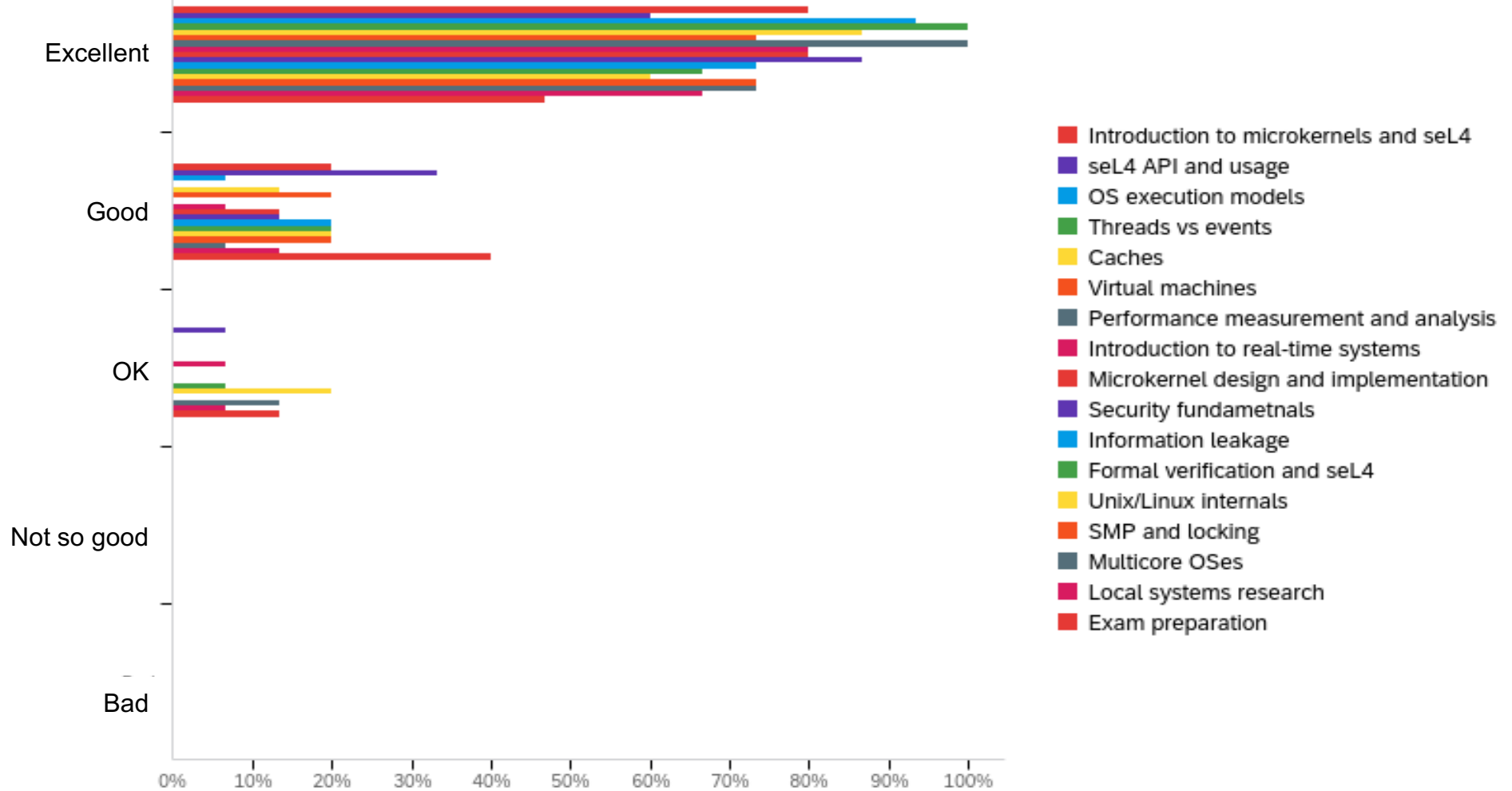
However, I'd imagine my other classmates would be struggling to debug their projects if they didn't know about this beforehand.

I think a DN in OS is a good prereq.

# 13: Relevance of lecture topics



# 14: Quality of the lectures





# 15: What will be useful in the future? 1/2

## Which material do you think will be most useful to you in the future?

Reading papers, and probably threads/events, caches, performance analysis

Caches

lectures on concurrency models and SMP

caches, virtual machines, security, Unix internals, SMP and locking, multicore OSes

SMP, Security, Unix/Linux internals

threads and events

I think all the lecture notes, recordings as well as the resources of seL4 will be very useful for me ;D.

Virtual machines, security, threads vs events.

Caches + Virtualisation

All, I am not sure how big this field is, but I feel this course covers a huge range of topics that provide a strong foundation for systems work.

# 15: What will be useful in the future? 2/2

## Which material do you think will be most useful to you in the future?

I think learning about caches and SMP / locking is most likely to be useful, since this is something which is relevant even outside of systems programming.

SMP/multicore, perf. analysis, caches, real-time systems, virtual machines.

The introduction to caches and the guidelines on benchmarking.

I think the seL4 API, execution models, thread vs events lectures were most useful for the project.

It's tough to say what will be most useful for the future. I'm hoping that all of them will be useful in one way or another. It was nice to learn about general OS topics as well as microkernel and seL4-specific topics.

caches, vms, benchmarks

some

# 16: Material to add/remove

## 17.1: Which material, not presently in the course, would you have liked to be covered?

Maybe some more content about Linux kernel development? Sometimes the course felt a little too focused on microkernels or even seL4 specifically.

## 17.2: Which of the current material would you like to see scaled back or excluded?

If you're looking to save time, the details about verifying seL4 can probably be shortened and worked into the other seL4 lectures

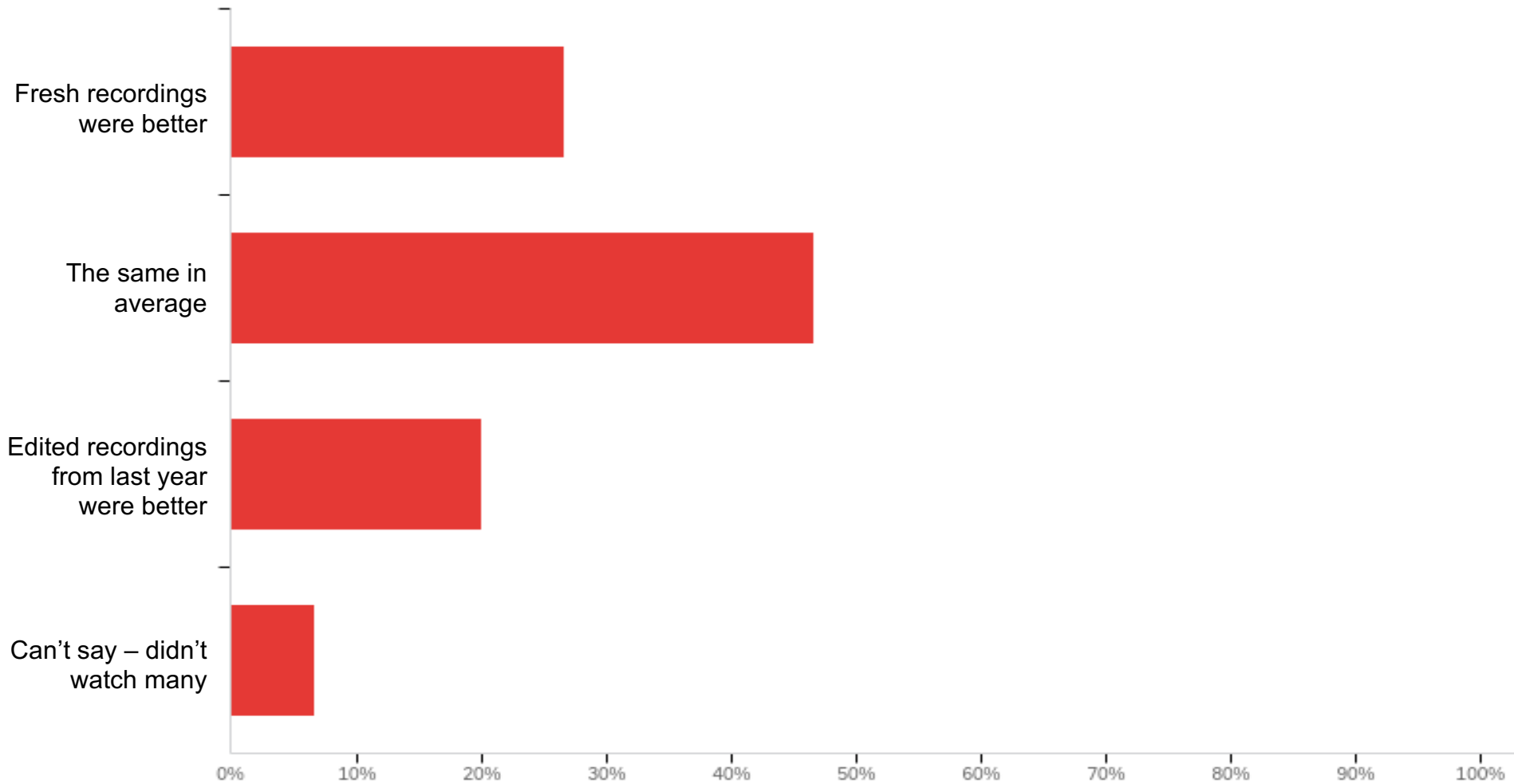
Less detail about formal verification.

# 17: Why watch/skip the lectures?

17.1: What made you watch the lectures?	%	Count
I had enough spare time	53%	8
The lectures were too good to miss	53%	8
Given the pace and lack of textbook, I could not afford to miss the lectures	47%	7
I expected the material to be required for the exam	60%	9
None – I skipped most of them	7%	1

17.2: What made you skip the lectures	%	Count
Overall workload in this and other courses	53%	8
Lecture notes and references cover the material adequately	0%	0
Lectures are boring	0%	0
Lectures were irrelevant to the project	20%	3
Friends told me the lectures were irrelevant for the exam	7%	1
First half was more interesting than second half	7%	1
None, I watched all of them	53%	8

# 18.1: Fresh recordings vs edited live recordings



# 18.2: Any other comments on recordings?

## Any other comments on the recordings?

It's good that student questions were included, but then it kinda reduces the amount of questions that could be ask during BBC

The questions that were edited in were really good for active watching!

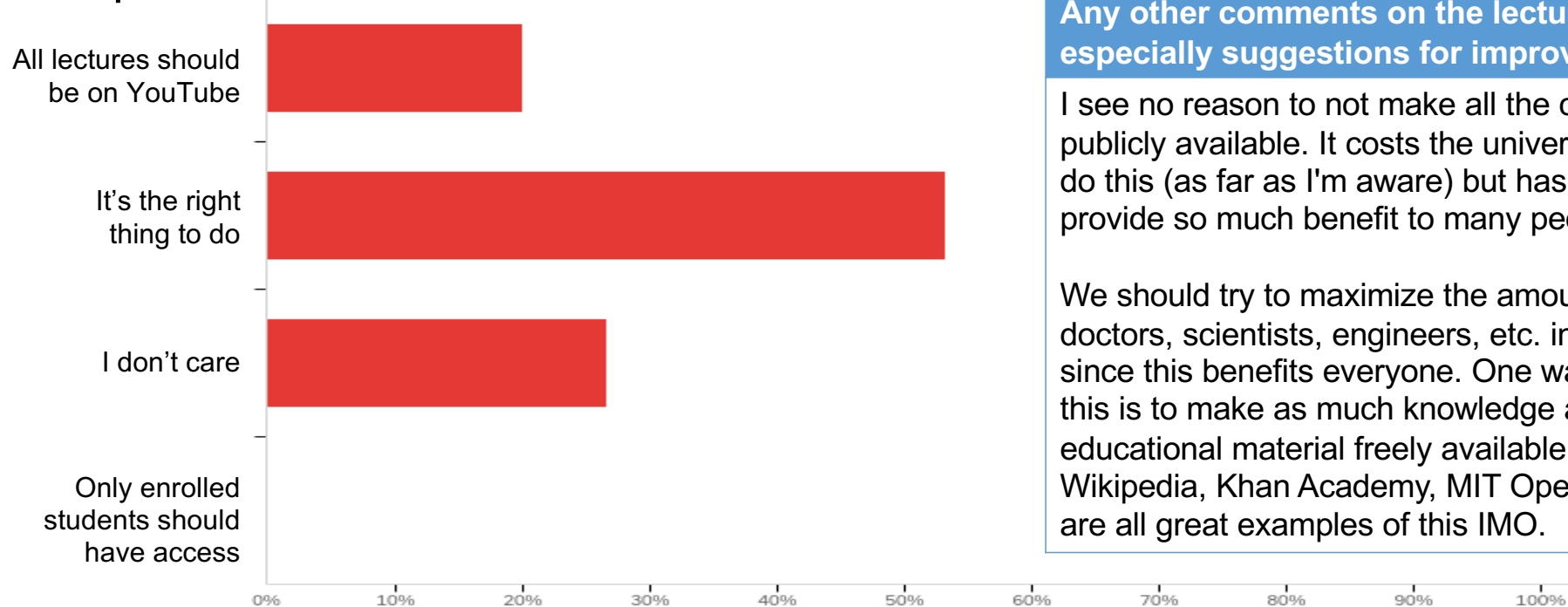
The fresh recordings from Prof. Gernot have very bad audio quality. I am pretty sure he must be using the new MacBook Pro 16", as my other lecturers using the similar device share same traits in regards to audio quality (heavy high frequency artifacts presumably due to noise reduction algorithm). Other than this I am indifferent to edited life recordings vs fresh recordings.

The audio quality is pretty bad.

in edited life recordings, occasionally the lecturer uses the mouse cursor to refer to something on the slides, but the cursor is not recorded. this is really confusing

# 19: Lectures on YouTube

The course had for a long time all material freely available, except for the lecture recordings. This year we made all the seL4-related lectures, as well as the performance lecture, freely available on YouTube. What is your opinion on this?

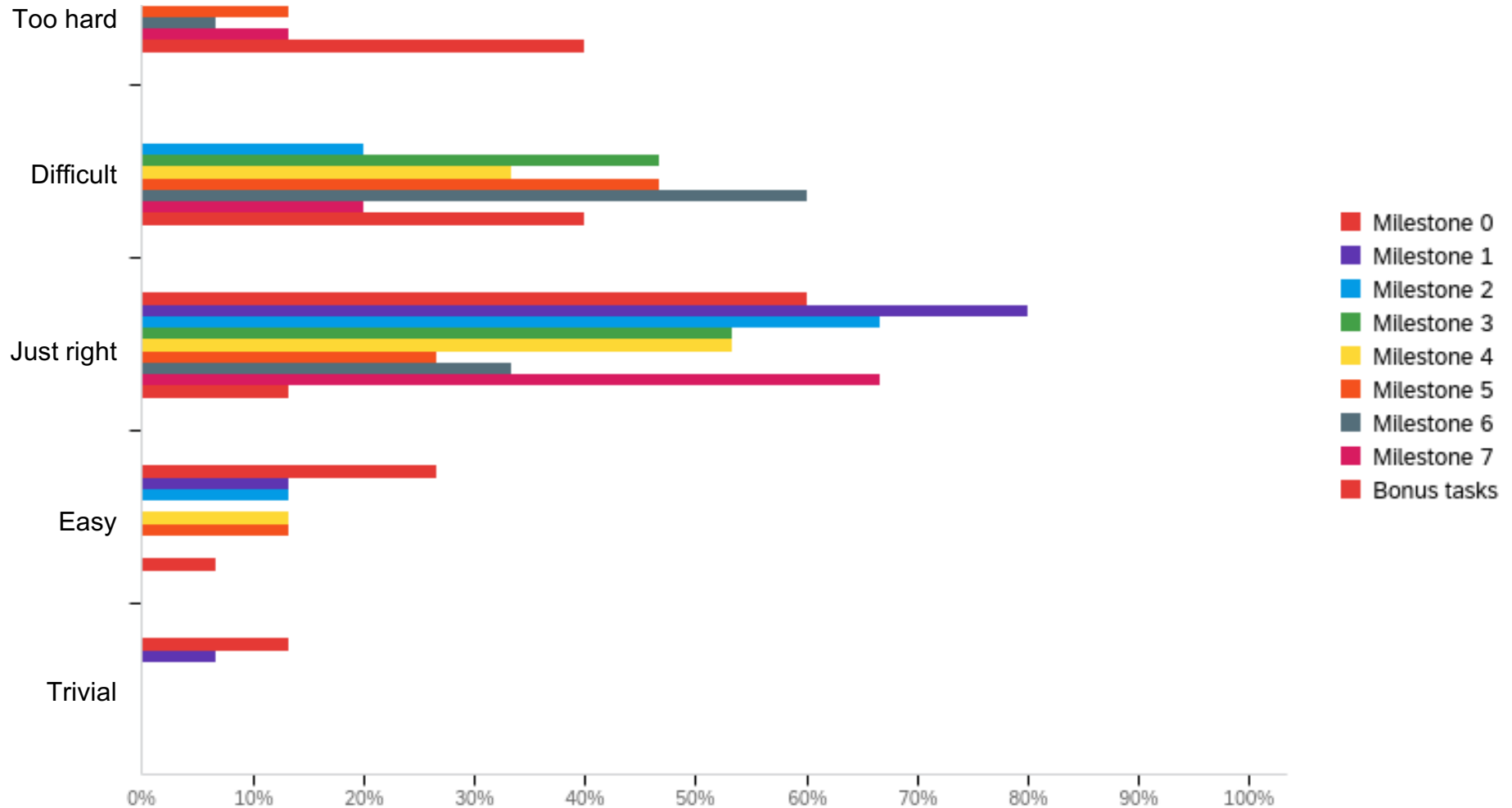


## Any other comments on the lectures, especially suggestions for improving them?

I see no reason to not make all the course content publicly available. It costs the university nothing to do this (as far as I'm aware) but has potential to provide so much benefit to many people.

We should try to maximize the amount of great doctors, scientists, engineers, etc. in the world, since this benefits everyone. One way to try do this is to make as much knowledge and educational material freely available as we can. Wikipedia, Khan Academy, MIT OpenCourseWare are all great examples of this IMO.

# 20: Level of difficulty of various project parts

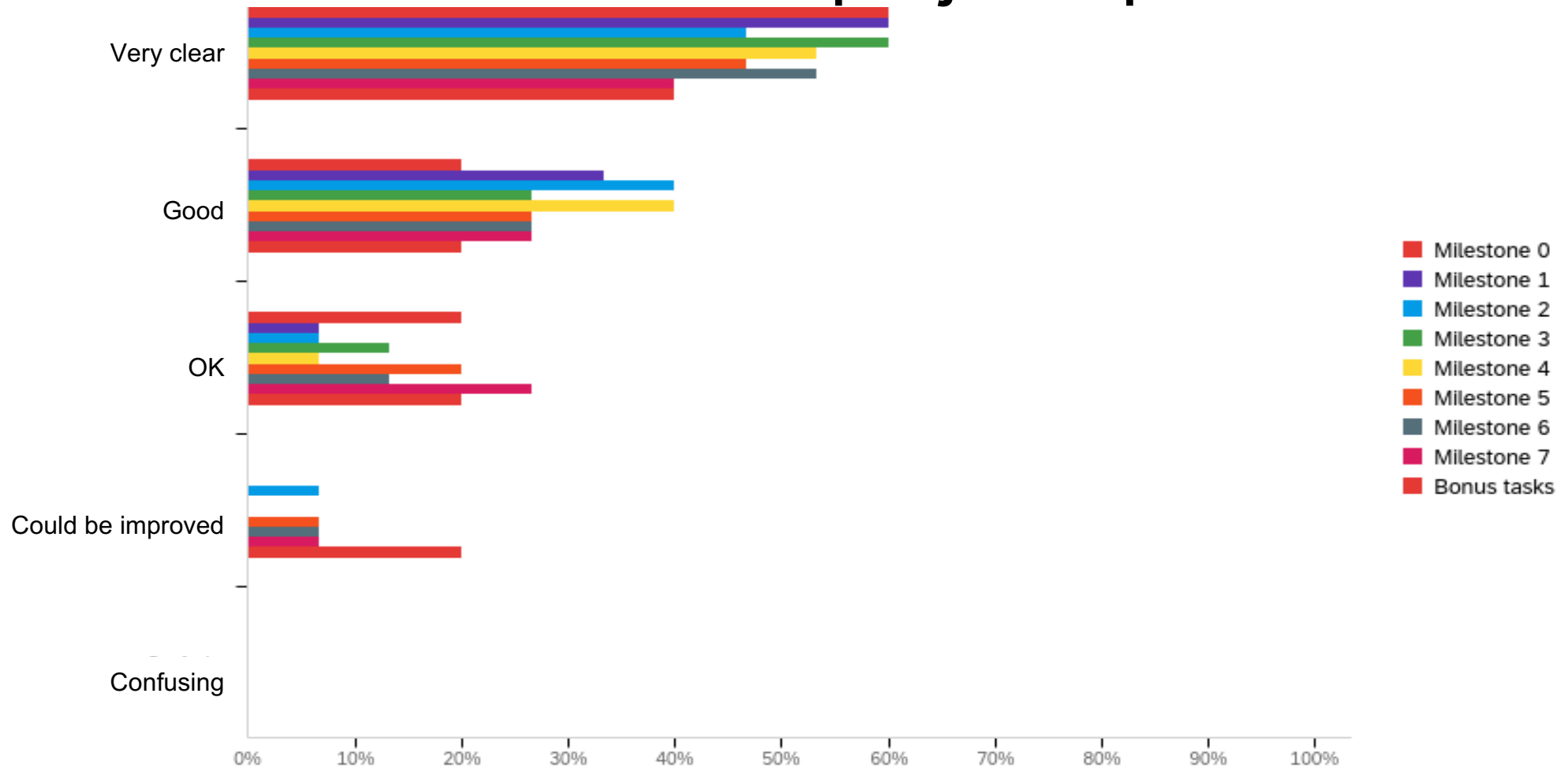




## 20: Level of difficulty of various project parts

Milestone	Too hard		Difficult		Just right		Easy		Trivial		Total
0	0%	0	0%	0	60%	9	27%	4	13%	2	15
1	0%	0	0%	0	80%	12	13%	2	7%	1	15
2	0%	0	20%	3	67%	10	13%	2	0%	0	15
3	0%	0	47%	7	53%	8	0%	0	0%	0	15
4	0%	0	33%	5	53%	8	13%	2	0%	0	15
5	13%	2	47%	7	27%	4	13%	2	0%	0	15
6	7%	1	60%	9	33%	5	0%	0	0%	0	15
7	13%	2	20%	3	67%	10	0%	0	0%	0	15
Bonus	40%	6	40%	6	13%	2	7%	1	0%	0	15

# 21: How well was the project specified?



# 21: How well was the project specified?

Milest	Very clear		Good		OK		Could be improved		Confusing		Total
0	60%	9	20%	3	20%	3	0%	0	0%	0	15
1	60%	9	33%	5	7%	1	0%	0	0%	0	15
2	47%	7	40%	6	7%	1	7%	1	0%	0	15
3	60%	9	27%	4	13%	2	0%	0	0%	0	15
4	53%	8	40%	6	7%	1	0%	0	0%	0	15
5	47%	7	27%	4	20%	3	7%	1	0%	0	15
6	53%	8	27%	4	13%	2	7%	1	0%	0	15
7	40%	6	27%	4	27%	4	7%	1	0%	0	15
Bonus	40%	6	20%	3	20%	3	20%	3	0%	0	15

## 22: MCS kernel

This year we transitioned lectures and project to the new MCS model, which represents the future of seL4. What do you think about the use of the MCS variant?

Answer	%	#
Overdue	0%	0
OK	87%	13
Premature	0%	0
I don't care	13%	2

### Any other comments regarding the MCS kernel?

Would be great to have some good documentation for this, or some notes comparing MCS and the old (previous) model

I am not sure what baseline to compare against as this is my first experience doing such work.

Something I kept forgetting to mention during the term is that the seL4 documentation linked on the course page doesn't include the MCS updates. It was easy enough to find the latest version on the seL4 website though.

Just need more documentations. I have to refer to either the supplied non MCS config version 11 manual, or version 10 MCS manual.

some docs need updates

## 23.1: ODroid access

Another novelty this year, triggered by the pandemic, was that we made the ODroid kits available remotely online instead of issuing them directly to students. If you were to do the course normally (i.e. without COVID-19 related restrictions), what would your preference be?

Answer	%	Count
Keep accessing the kits remotely	47%	7
Revert to issuing the kits to students	40%	6
I don't care	13%	2

## 23.2: Reasons for your preference? 1/2

Please let us know the reasons for your preference (unless you don't care).

It was easier to start programming immediately for the milestone instead of worrying about if the offline setup is wrong.

It provided an easy way for both of us to test what we were doing without either always working in the same room or having the Odroid frequently change hands

Doesn't require complex local setup, easier to work from anywhere without carrying a kit around

It helped focus our debugging time on actual SOS issues rather than odroid issues, and it gave the freedom to work on the project from different computers more easily (specifically a MacBook which has abysmal battery life running linux but also has issues installing the dependencies to interface with an odroid). The supplied odroid scripts were also great.

It was easier not having to carry the kits around and also it allowed leaving programs running for a long period of time.

Get to play around with the hardware (feel like a true engineer)

To do the project requires to upload the image frequently, but uploading via the sever was very slow from my home, and sometimes it crashed due to frequent uploading.

## 23.2: Reasons for your preference? 2/2

Please let us know the reasons for your preference (unless you don't care).

Very often, uploading onto the odroid remotely would timeout which was frustrating at times as well as not being able to physically reset the odroid meant that when it did crash and if you typed the wrong commands in, emails had to be sent in order to get it fixed which delayed the process of being able to work on the project.

Quick build time and no need to worry about hardware, just do some terminal magic and you've got your environment setup!

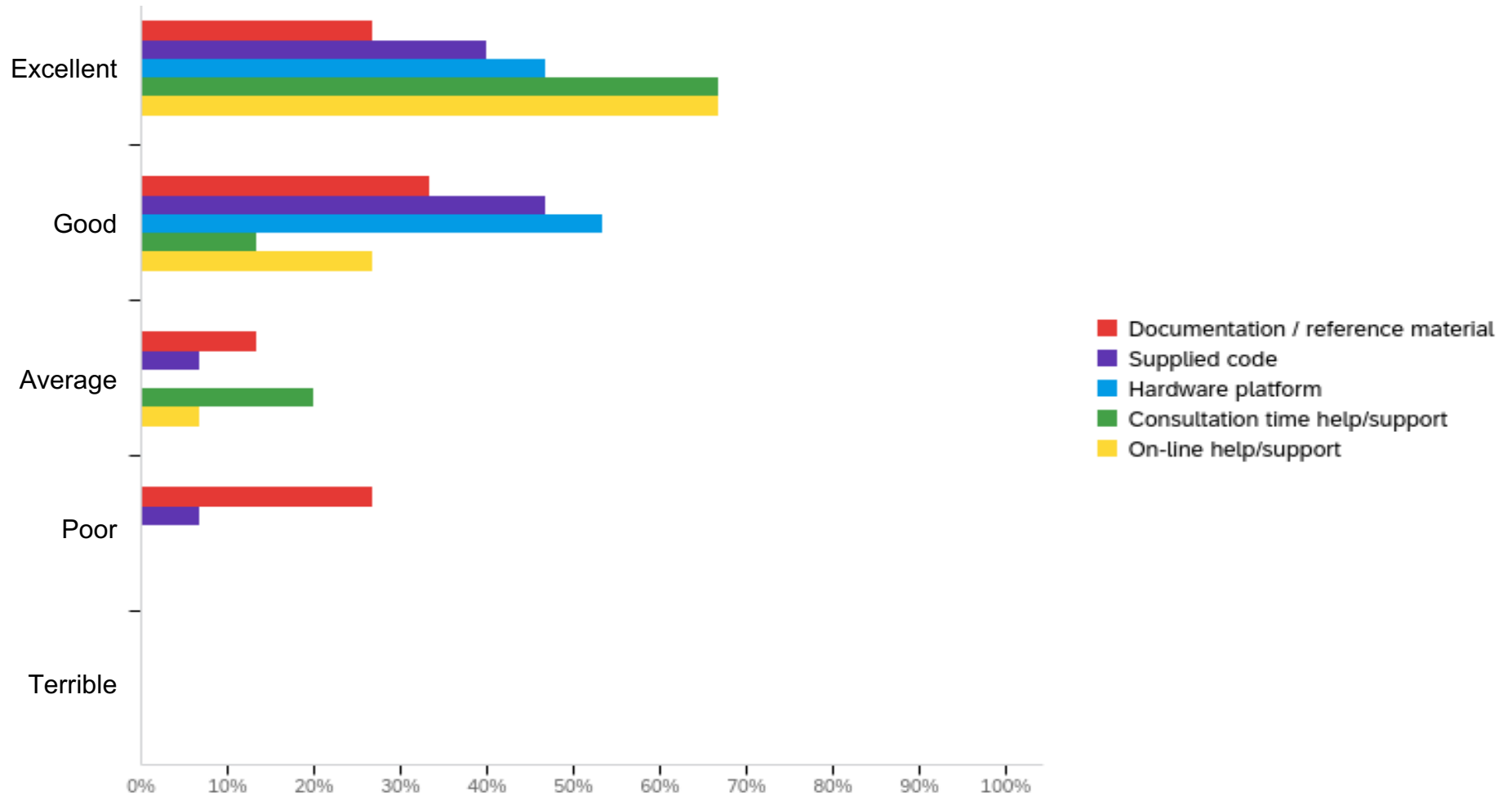
The process of accessing the kits remotely was very smooth, and the one time I did accidentally brick my ODroid it would've been a lot more inconvenient to go into uni to request another one compared to just asking on Piazza then reallocating.

- Latency. I can't work from home quickly as the VDSL line in my area does not have a powerful reverse link.
- The inflexibility to play around with the kernel.
- Limited debugging ability (for example, the ability to capture raw packets would be nice if the device were sitting on my desk besides my trusty PC)

It's an opportunity to learn a tiny bit about the hardware.

Fun to be able to touch hardware.

# 24: What was the quality of...





# 25: Taste of Research / Summer Internships

The faculty is presently not offering taste of research (ToR) internship, so you obviously couldn't apply, although a number of CSIRO internships are available for work with the Trustworthy Systems (TS) group. Furthermore, it looks like the faculty will soon resurrect the ToR program in somewhat modified form. What do you think about this?

Answer	%	Count
I'm annoyed there was no ToR available, I would have applied	27%	4
I'll apply if the ToR runs again	40%	6
I'm annoyed that you didn't advertise the CSIRO summer internships, I would have applied	40%	6
I did apply for the CSIRO internships with TS	0%	0
I've got no time for an internship with TS (other internships, paid work, ...)	47%	7
I'm not interested in an internship with TS	20%	3
I'm so glad I survived this course but don't ever want to do anything with operating systems again!	0%	0

## 26: Thesis

There are a number of seL4-related and other systems and verification thesis topics available in TS. Would you be interested in doing a thesis?

Answer	%	Count
Yes, totally!	47%	7
Maybe	47%	7
I'm already committed to a thesis outside TS	7%	1
No way – leave me alone!	0%	0
I'm doing a 3-year degree and are not interested in honours	0%	0

### Any comments on TS internships or theses?

Would be great to give us access to information for these opportunities, as well as requirements, what we would do (expectation), how relevant these work compared to current research or course work

# 27: Any final comments?

## Any final comments you would like to make?

Fun, rewarding, difficult study

I'm actually disappointed that I took this course with other demanding courses. The course is harder than most, but it is also the most rewarding time investment I've experienced, I wish I could've devoted more of my time to it

This was a very fulfilling class and I think it was well managed despite having to overcome many challenges presented by COVID-19.

Love the course!

I really enjoyed this course and I'm grateful to everyone who provided such a fantastic course! Thanks for all the work!

Overall the course was great, big thanks to everyone (lecturers and tutors) who made it a great course despite of covid restrictions.

Thank You :)

Thanks for the course :)

Thanks for the course.

Thanks again for an awesome term to Gernot, Kevin, Curtis, and all of the other lecturers and tutors!