School of Computer Science & Engineering

COMP9242 Advanced Operating Systems (AOS)

2021 T2

AOS Course Survey Result
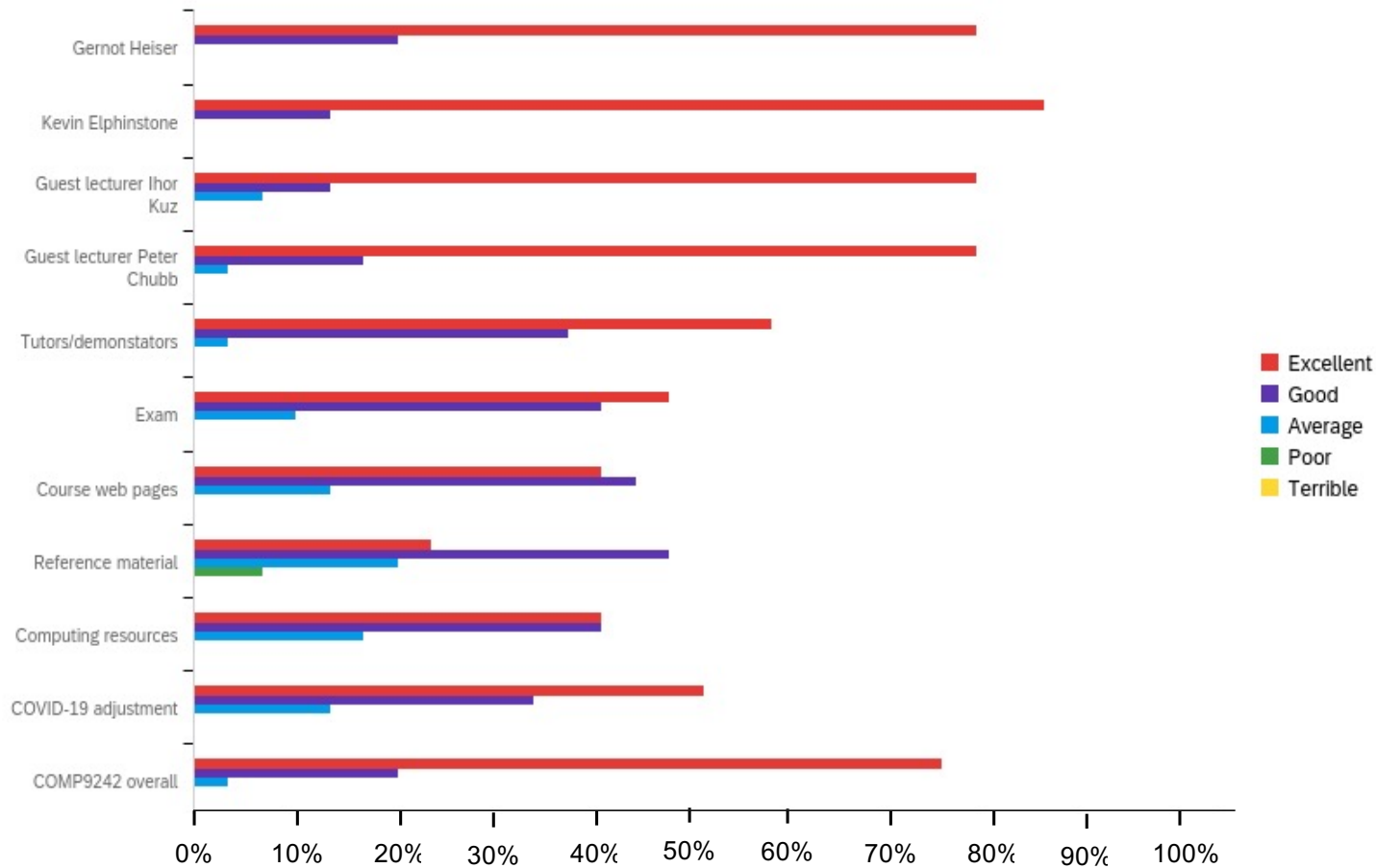
@GernotHeiser

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1: Quick evaluation single answer

1: Quick evaluation (small is good)

Question	Mean	Excellent		Good		Average		Poor		Terrible		Total
Gernot Heiser	1.21	79%	23	21%	6	0%	0	0%	0	0%	0	29
Kevin Elphinstone	1.14	86%	25	14%	4	0%	0	0%	0	0%	0	29
Guest lecturer Ihor Kuz	1.28	79%	23	14%	4	7%	2	0%	0	0%	0	29
Guest lecturer Peter Chubb	1.24	79%	23	17%	5	3%	1	0%	0	0%	0	29
Tutors/demonstators	1.45	59%	17	38%	11	3%	1	0%	0	0%	0	29
Exam	1.62	48%	14	41%	12	10%	3	0%	0	0%	0	29
Course web pages	1.72	41%	12	45%	13	14%	4	0%	0	0%	0	29
Reference material	2.10	24%	7	48%	14	21%	6	7%	2	0%	0	29
Computing resources	1.76	41%	12	41%	12	17%	5	0%	0	0%	0	29
COVID-19 adjustment	1.62	52%	15	34%	10	14%	4	0%	0	0%	0	29
COMP9242 overall	1.28	76%	22	21%	6	3%	1	0%	0	0%	0	29

2a: Your main reasons for taking AOS

#	Answer	%	Count
1	Interest in operating systems as an area of study	70%	21
2	Chance to build a complete system (almost) from scratch	67%	20
3	Chance to get fingers *really* dirty	63%	19
4	Considering doing systems research	17%	5
5	Looking for a challenge	67%	20
6	Looking for an easy course	0%	0
7	Friends told me to do it	17%	5
8	General reputation of the course	73%	22
9	Reputation of the course in industry	37%	11

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2b: Your main reasons for taking AOS

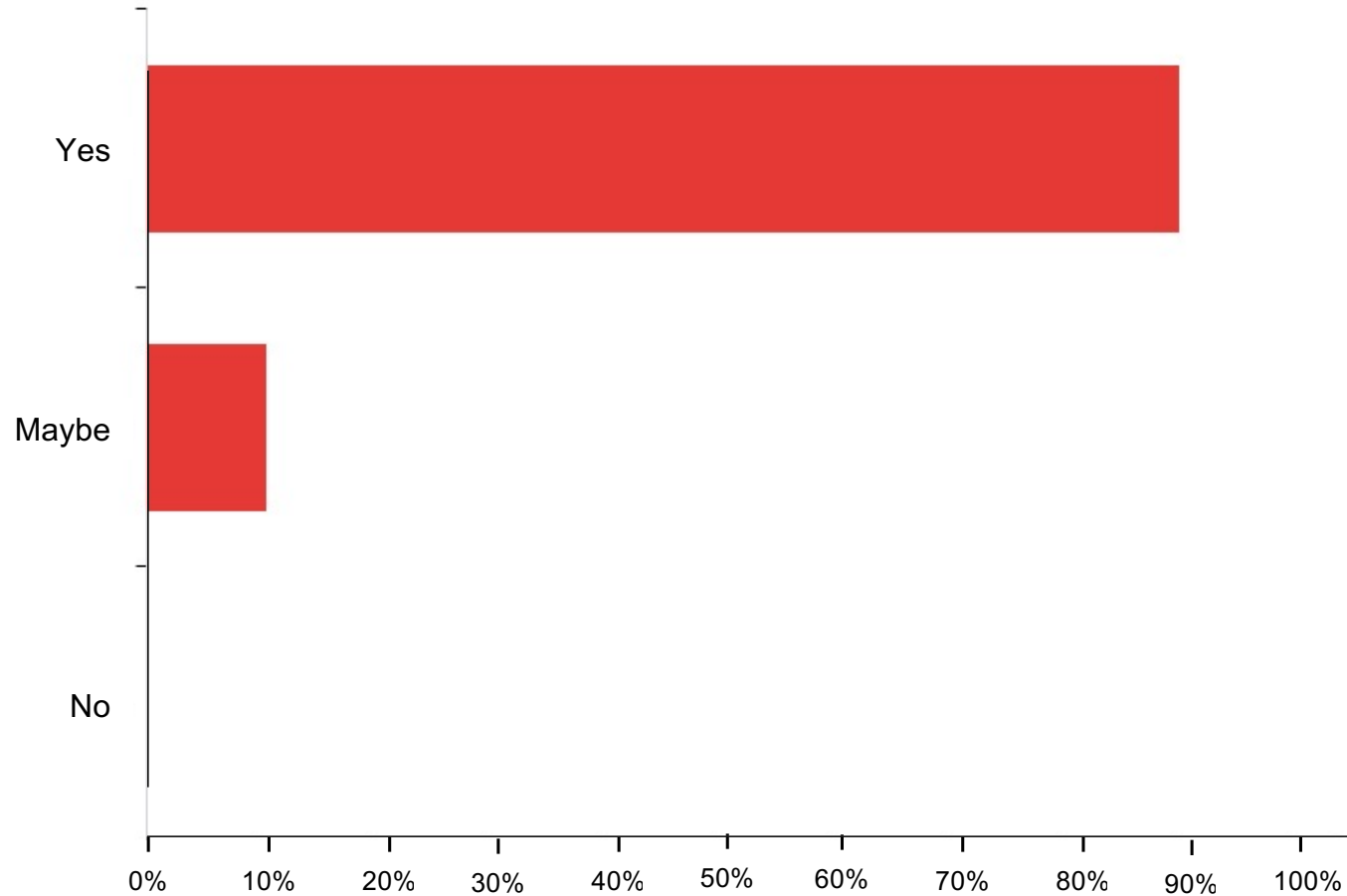| Other factors not mentioned above? |
| --- |
| Possibly trying to understand the nitty gritty details of building a system and maybe making it a basis for doing research ahead |
| A reason to interact with sel4! |
| Embedded systems |
| Boyfriend doing it |
| I really enjoyed the base course and my tutor Shane recommended it as an interesting course. I had no idea of the reputation before starting! |

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3: Enrolment was up but below pre-Covid…

Enrolment in the course was up from last year but still a bit down from previous years (and we had hope getting some students back who gave it a miss last year due to Covid-19). It seems the pandemic was still having an effect, despite things being almost normal at the beginning of the term. We'd be interested in knowing more about students' reasons for not taking the course.
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 of one student who tried it last year but could not adjust to a purely online format, and now no longer has any free electives to attempt the course again.
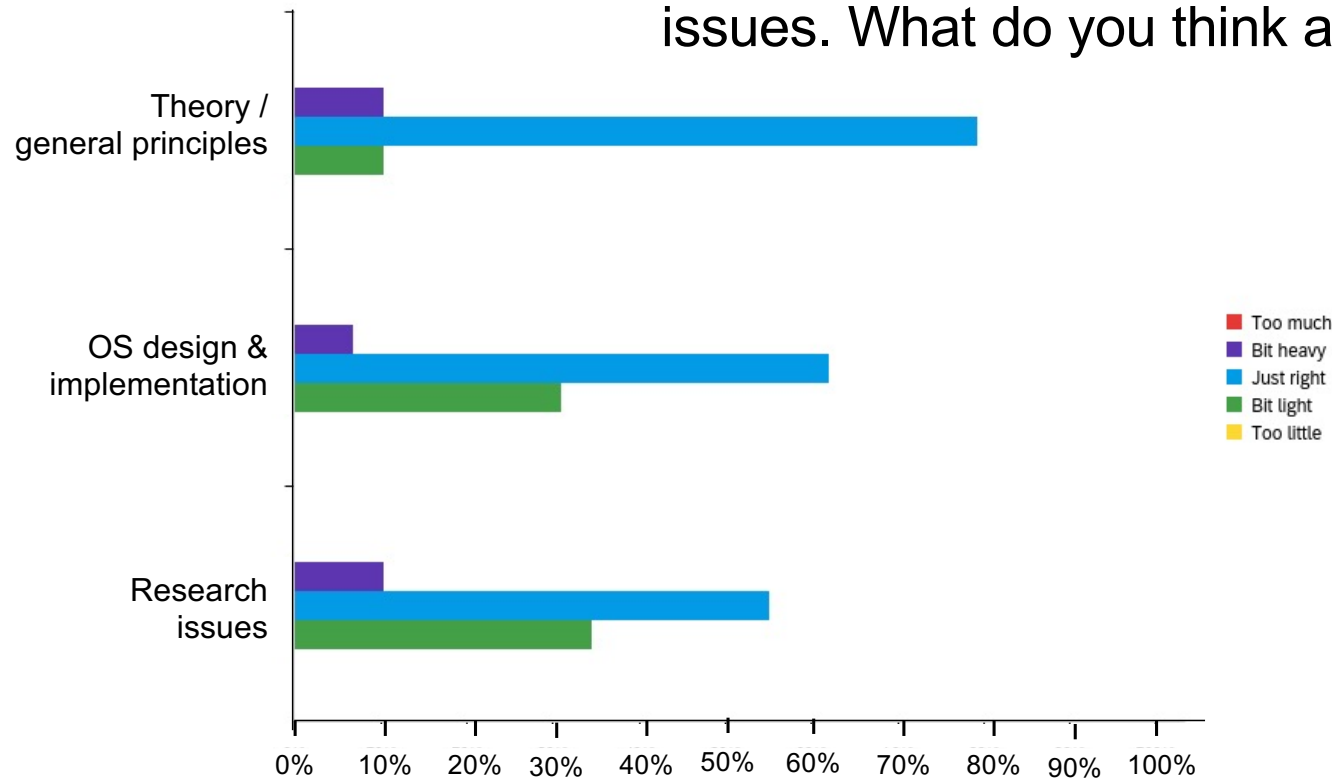
I did hear that some people were keen to take on the course during a non-pandemic year in order to get that more in-person experience. That is something that I do feel would add a little something special to their experience although I did think the pandemic adjustments were all great

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4: Would you recommend COMP9242?

5: OS D&I vs theory vs research issues

AOS is heavy on design and implementation issues. It also tries to remain close to present research issues. What do you think about the content?

6: What were the best things about AOS? 1/4

What were the best things about this course?
The project, of course. The lectures, while not all that relevant to the project, were interesting and motivating. The exam was unique and challenging in a good way.
implement sos
Provided much of an insight into current operating systems focus and research fields. Challenging but satisfyingly achievable course to complete. Unique culture of support amongst peers and between students and course staff.
Awesome lectures, fun project
Getting to develop a complete system from scratch
The exam format Being able to work on the project and see it come to life throughout the term
The project!
Chance to get hands on. Opportunity to learn through experimentation.
Challenging content; good lecturers who really know their stuff.

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6: What were the best things about AOS? 2/4

What were the best things about this course?
The project and the lectures were of a very high quality. The project was a uniquely engaging experience
You get to create your own OS on top of Sel4.
I really enjoyed the relevance of the course to modern research; it was especially satisfying to review and (mostly) understand recent papers in the exam
- Able to (carefully) make my own design decisions for an actual system. - Considerations surrounding security and performance. - I can happily say that I am now quite competent in C. - Get to really understand how operating systems work under the hood. Was able to gain much deeper understanding and the challenges surrounding OS.
Project
Ideas behind slides
The project and lecture topics. These helped develop so many skills which is what made the course great such as great understanding about OS', working with a large code base, and research in the field.
after each milestone, I can understand a lot of the corresponding part of os

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6: What were the best things about AOS? 3/4

What were the best things about this course?
Designing our own OS. Talking to Curtis about the design. Working out all implementation details
Enjoyed actually getting to make most of an OS from scratch. Liked the practical approach. Met interesting people. Beers with Gernot
Lectures covered a wide variety of problems and topics, by people who know what they are talking about. Curtis Millar. He always stayed at the consultations until all our questions were answered. He has so much knowledge and was really helpful throughout the whole term, no other tutor has taught me this much. The project. The lab, while it existed.
The lectures spanned so much interesting content
Incredibly rewarding! Lecturers were all great speakers and i particularly enjoyed the guest lectures.
1. Thinking about and designing systems to solve problems. 2. Learning about what the problems and concerns of the OS world are

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6: What were the best things about AOS? 4/4

What were the best things about this course?
Before the lock down, I really felt like I was in a learning community - much more so than any other course I've taken. Going into the lab and seeing people there and discussing issues with them was really enjoyable and productive. We were given a large amount of autonomy in how we chose to implement our OS. This forced us to think about the advantages and disadvantages of different methods and made us think creatively. The theory side was super interesting and it was insightful to learn from all the lecturers.
Getting to work continuously on a big project, and easy access to great help from tutors!
Being able to design and implement actual systems.
Breadth of content
It was really interesting to learn about microkernels and build our own operating system
Project was very hands on, we learnt how to read systems papers (and how to not write bull**** papers). The project was also very balanced in terms of what we were expected to do. Tutors know about design problems we might face, and help steer us in the right direction.

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

What were the worst things about this course?
Lockdown.
to understand how seL4 work
odroid infrastructure crashing :p If this course is still online next year, online marking experience needs to be improved, maybe setup an appointment system or something. Some parts of earlier project milestones were unnecessarily ambiguous, meaning more of an exercise of guessing/confusion, rather than what seemed to be intended to stimulate brainstorming or idea generation.
Poor introduction to sel4 environment - would love to see 1-2 more lectures dedicated to the ins and outs,
Could have been slightly better on discussing the things on the research front and slightly more space for the assignment submission could have been given and showcasing the failed autotests for the milestone 7 so that an idea of where the system failed could have helped a bit more.
A complete lack of sleep for 10 weeks
Reading documentation. seL4's documentation is actually fairly incomplete unfortunately. I ran across too many published TODOs (in the PDF documentation at least). Additionally, it could have explained some more elements in more details. Fortunately we didn't have to sift through external documentation such as the SOC docs but I found that a pain to read.

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

What were the worst things about this course?
Being given a large codebase where we were expected to look at and change many parts of it was good. However, this is a departure from what I was used to in other comp course. Making it clear early on that we were expected to alter manyof the codebase, and not just specific indicated parts (like in 3231) would have been helpful
Understanding sel4 was a pretty rough journey at the start. A demo of how to code for the assignments especially with capabilities would be awesome.
I think choosing threads. Some of the libraries were not thread-safe (I believe).
Poor communication about how the final OS is tested and marked at the end of the course. Like what kind of programs are run, or the fact that the frametable limit wouldn't be tested with less than 16 frames. The fact that malloc, nfs, pico, etc.. are not thread-safe was not apparent to us in the design phase. Maybe a warning would have been nice in the AOS design guide. The documentation of SOS system calls. They did not describe what should be done in edgecases, like if the string pointer passed in to open() pointed to an invalid region of memory.
Lectures going online (although that was unavoidable :c). Lectures felt maybe a little too disconnected from the project.
It was little difficult to feel part of the community (although I understand this is primarily due to lockdowns). Could not use vs-code to compile and run Odroid (did not work using ssh and vscode)

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

What were the worst things about this course?
The project felt so open-ended, but also not really. i.e. groups might tend towards similar solutions, only because of similar levels of (limited) background knowledge. e.g. our group used continuations, but it was only possible with the use of an external library; we would have very little idea on how to build that library ourselves from scratch.
Not enough lectures about coding with seL4, most part of the project is based on the first two lectures.
Not being able to apply some of the lecture content in a practical way. This made it a more difficult to understand those concepts.
Lack of instructions
The long nights.
The lack of documentation about some of the stuff in seL4 (I realise it is most likely much more documented than many other systems, but I still found it difficult to find info sometimes). Lack of help sessions - mostly a me problem, but I ended up tutoring during most of the consultations apart from the Friday session, which made it hard if we hit a show stopper - perhaps run a session earlier in the week as well?
The project was a bit slow to get started (rip trimesters) Maybe give us more of a coro and threading model to start with?

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7: What were the worst things about AOS? 4/4

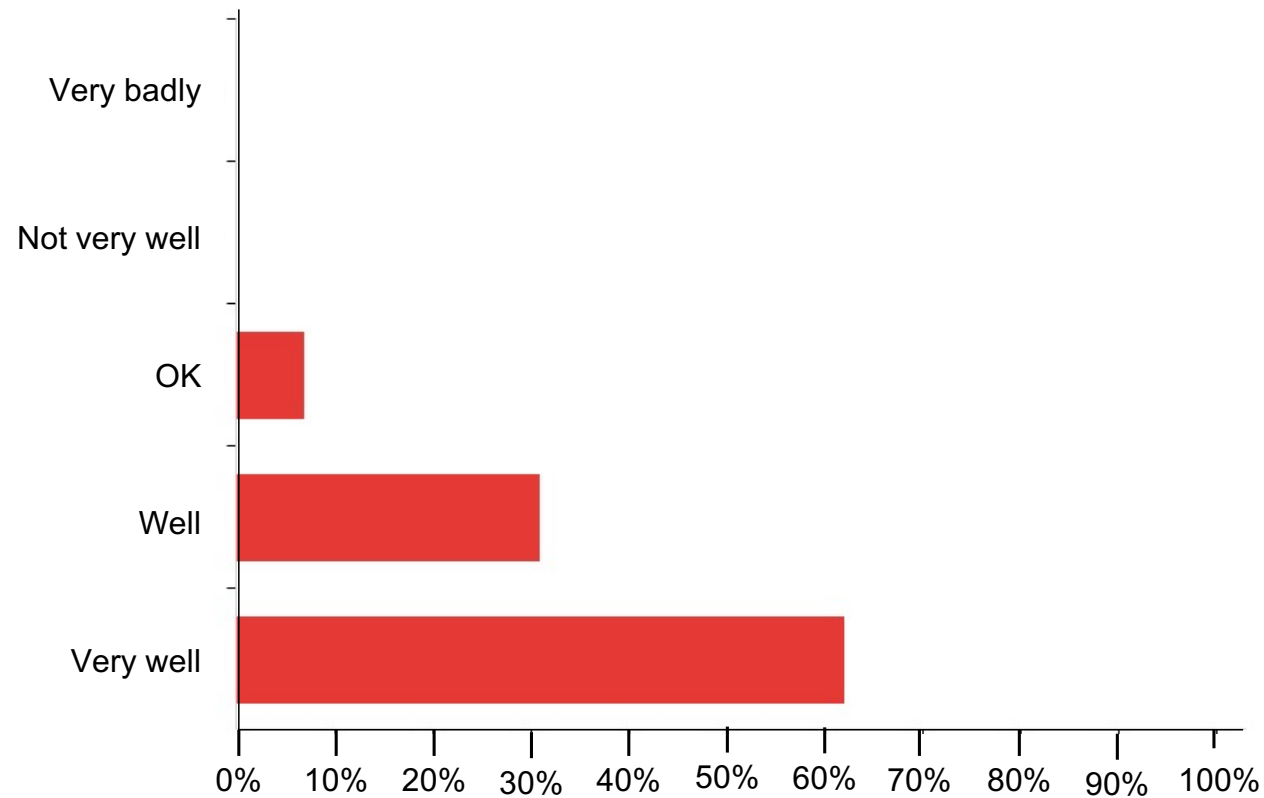| What were the worst things about this course? |
|---|
| N/A |
| There was varying capabilities and understanding of course content from the tutors. Some also had looser marking guidelines than others too. |
| I feel like the format of the exam is too different from the rest of the course to be a good measure of what was learned in the course. It is a good preparation for further academic study in OS, but I didn't really revise any of the lecture material to study for it. |
| Due to the aforementioned freedom provided, it was practically impossible for tutors to help us in any meaningful way. This left us in some situations that felt really hopeless for at least a few days.
It would have been nice to see some final feedback about our projects rather than just the mark. |
| Not being able to go into the lab :(
(I know this was totally unavoidable given the circumstances, but I really missed being in the lab!) |
| Odroid kits dropping just before due time. |
| Some lectures were a little hard to follow |
| The project is tough and ate up a lot of my time |
| seL4 documentation can be improved |

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

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9: What could we have done better… 1/2

8.2: What could we have done better in running the course under pandemic conditions?
Discourse and Blackboard Collaborate don't really do anything to foster an Oud-like atmosphere. A bunch of us used the CSE Discord server's (Discord, not Discourse) COMP9242 channel, which provided a more casual chatroom style environment. So if you have to do this again (hopefully not), you could have an official Discord server for the course.
Make recorded lectures and content easier to find
I feel like more consults would have been better. Even if we have two consults in one day (morning and night) so we can go for feedback, iterate, then come back for some more feedback.
There's not much more
Consistency in lecture deliveries; some were pre-recorded and available on course website, others were on blackboard/echo360 (which has a terrible ui). Would like to see recordings on youtube (as private links if needed) since it's a good interface + accessible
More tutors for the online help/marking sessions. It felt like you had to wait for a long time if you didn't join the hopper queue early.
Make the lectures not at 9am if possible, pandemic conditions tend to mess with people's sleep habits, making it unlikely for people to be up early.

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9: What could we have done better… 2/2

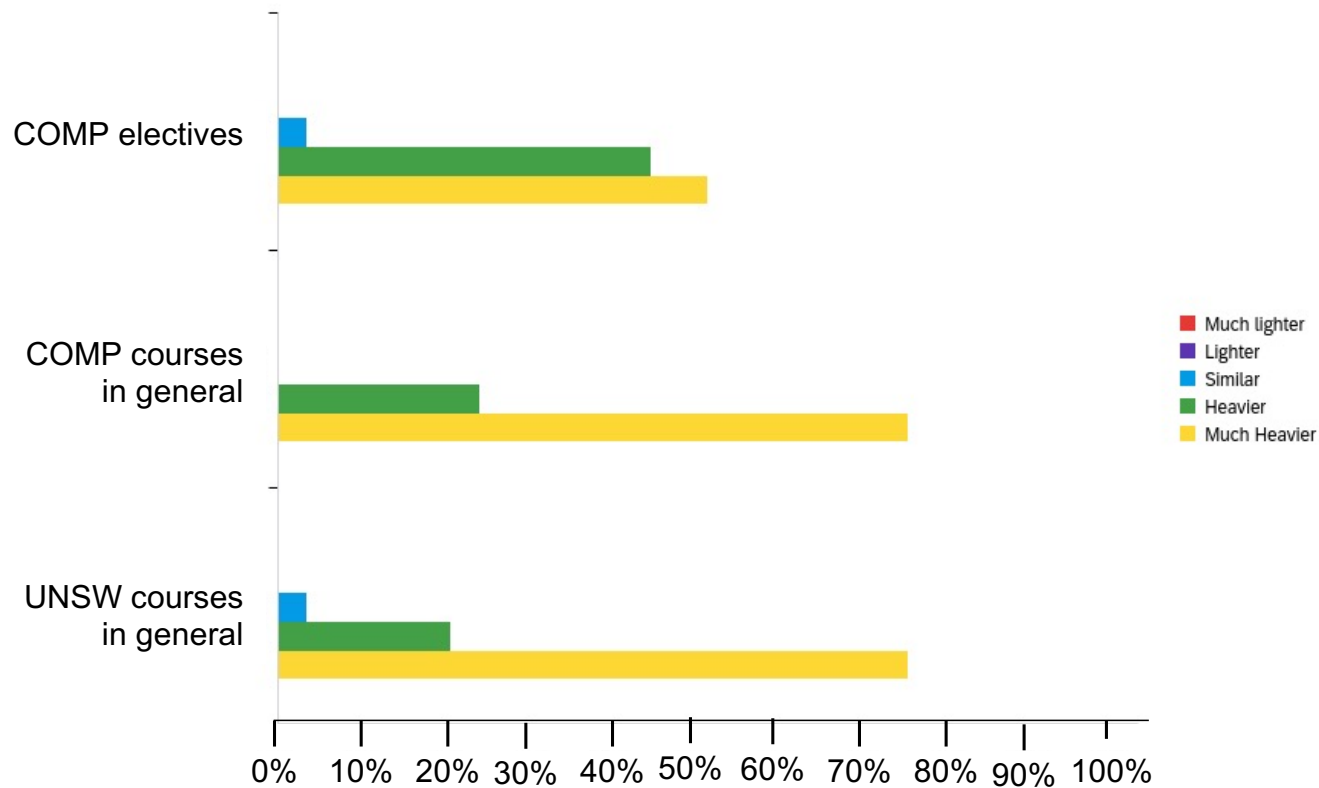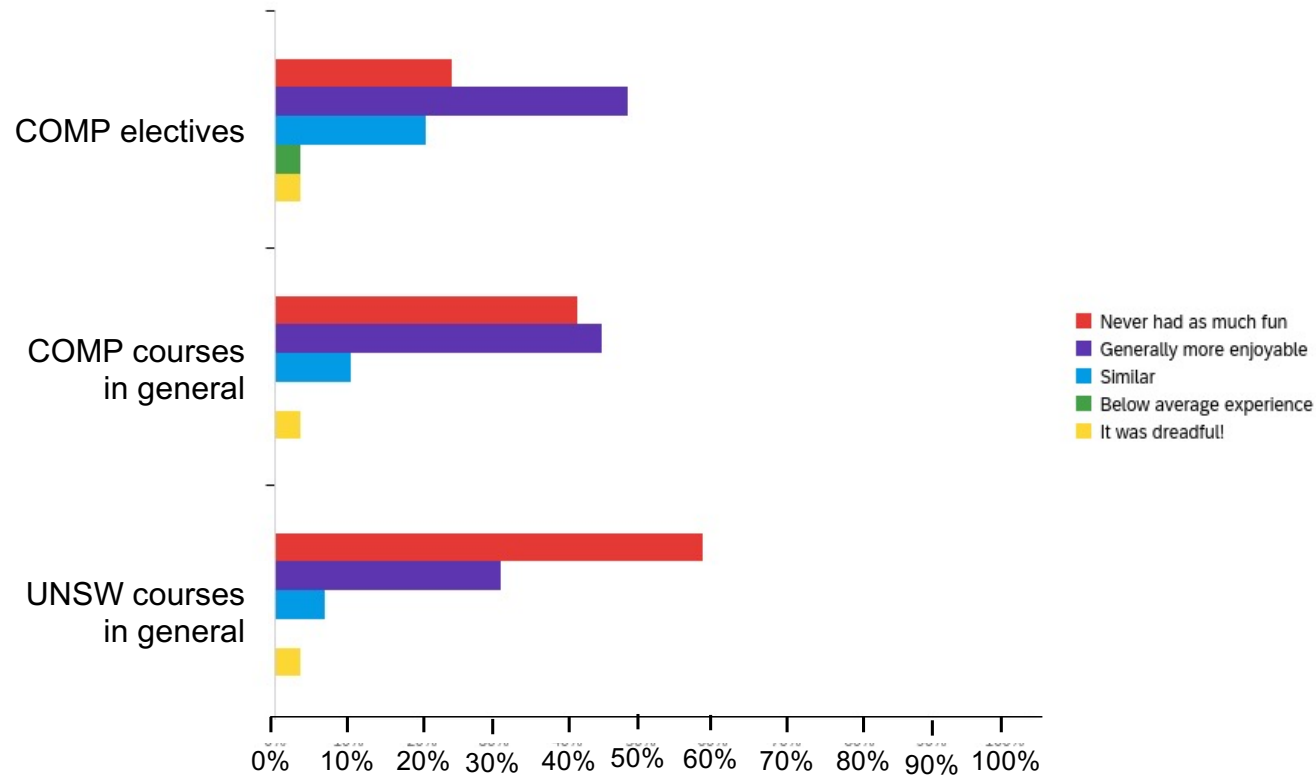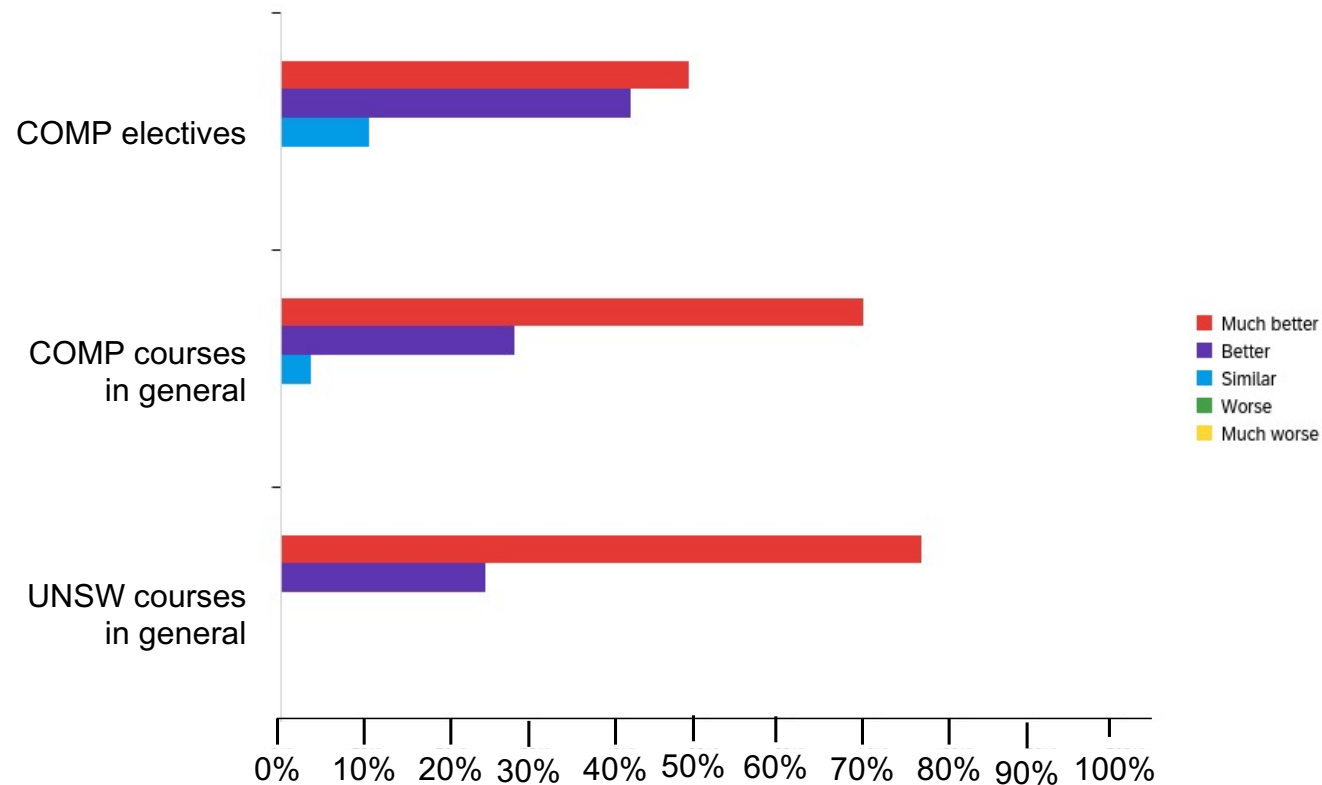| 8.2: What could we have done better in running the course under pandemic conditions? |
|---|
| A couple more consultations would be nice.
You could also probs engage with us in online lectures cause there's only 10-20 of us attending. |
| I think it would have been better to have more consultation hours or fewer but longer sessions. Tutors generally couldn't spend much time on students because they had to go through and mark everyone, which took quite a while per group, meaning that there was barely enough time for questions.

Forum response times were sometimes quite slow. |
| Preparedness for remote delivery (technical issues). This is more of a thing that is solved with experience and prep-time, which we obviously did not have. |
| Seems as if only one tutor (Curtis) responded on the forums, this lead to delayed answers sometimes. |

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10: How does the workload compare to …

11: How did your experience compare to ...

12: How does the quality/value compare to…

13: Missing background knowledge 1/4

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?

Aside from me forgetting some of the content in COMP3231 and forgetting certain ways that function pointers can be used at the beginning, I believe that the COMP3231 as a prereq adequately covers the required knowledge (though some of the extended OS content is certainly useful for this course).
In terms of a grade requirement, I would consider it appropriate to accept students with either a DN WAM or DN grade in COMP3231 (with a recommendation for HD in the latter). While I would personally consider a DN in COMP3231 to be very borderline, students should not be unnecessarily restricted from attempting the course. Furthermore, the early milestone deadlines provide a strong safeguard allowing inadequate students to drop the course before census date.

I think having a distinction wam and distinction score in COMP3231/3891 is an approriate pre-req for the course.

I personally didn't suffer any major issues but C knowledge is a must. There being little "C courses" at UNSW, its hard to say what I would prescribe as a pre-requisite but I think going into this course with limited C knowledge would be extremely challenging. Of course I agree that COMP3231 OS concepts were equally as important.

1. I think I would have benefitted from knowing more about computer architecture.
2. I don't think a sub-distinction WAM should be an impediment to doing this course given that the courses' reputation probably has an automatic selection effect

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13: Missing background knowledge 2/4

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?
I think WAM is a pretty poor indicator of preparedness for AOS both ways (although it's probably the best you could do for this year).
In my opinion, distinction WAM might be enough, although I believe AOS really forced students to understand what any of the concept in COMP3231 REALLY meant. I think motivation to learn and understand embedded systems/OS is more important than the marks received.
Background knowledge: how to actually implement the execution models talked about in the aos lectures. Distinction wam is not harsh.
not much... may be want to learn more about C and seL4 more before. Yes, can be a distinction WAM overall like COMP4128. Not too harsh.
Yes it is too harsh
Probably don't necessarily need a distinction WAM if you are passionate and talented. I probably had an adequate background just from taking COMP3231
You guys ought to have all the data. See what WAM/os marks we all had

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13: Missing background knowledge 3/4

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?
I took this course exactly a year after writing my very first line of code (i'm only in 2nd year) and felt that I personally was lacking experience overall. After only having taken compulsory courses and the base OS course, I was able to keep up but I would not recommend it to 2nd year students from an experience perspective. Distinction WAM was no problem however as many of the COMP courses are quite easy in comparison!
I reckon there are some people not fulfilling the requirements outlined above who could pass the course, but I can't imagine it would be a very pleasant experience for anyone involved. Keeping the requirements as-is is probably a good idea.
I think that a requirement which is based on COMP3231 performance is more suitable than that of a WAM but I can understand why WAM was used because of all the COVID stuff and pass/fail from last year. COMP3231 introduced the base concepts which were used in this course and I did not feel particularly overwhelmed with any of the theory aspects, though they were still challenging and an extension of previous content I had explored.
Distinction would definitely be too harsh especially if the cause of low WAM came from different area of study. Standard OS course would definitely be enough for the preparation.

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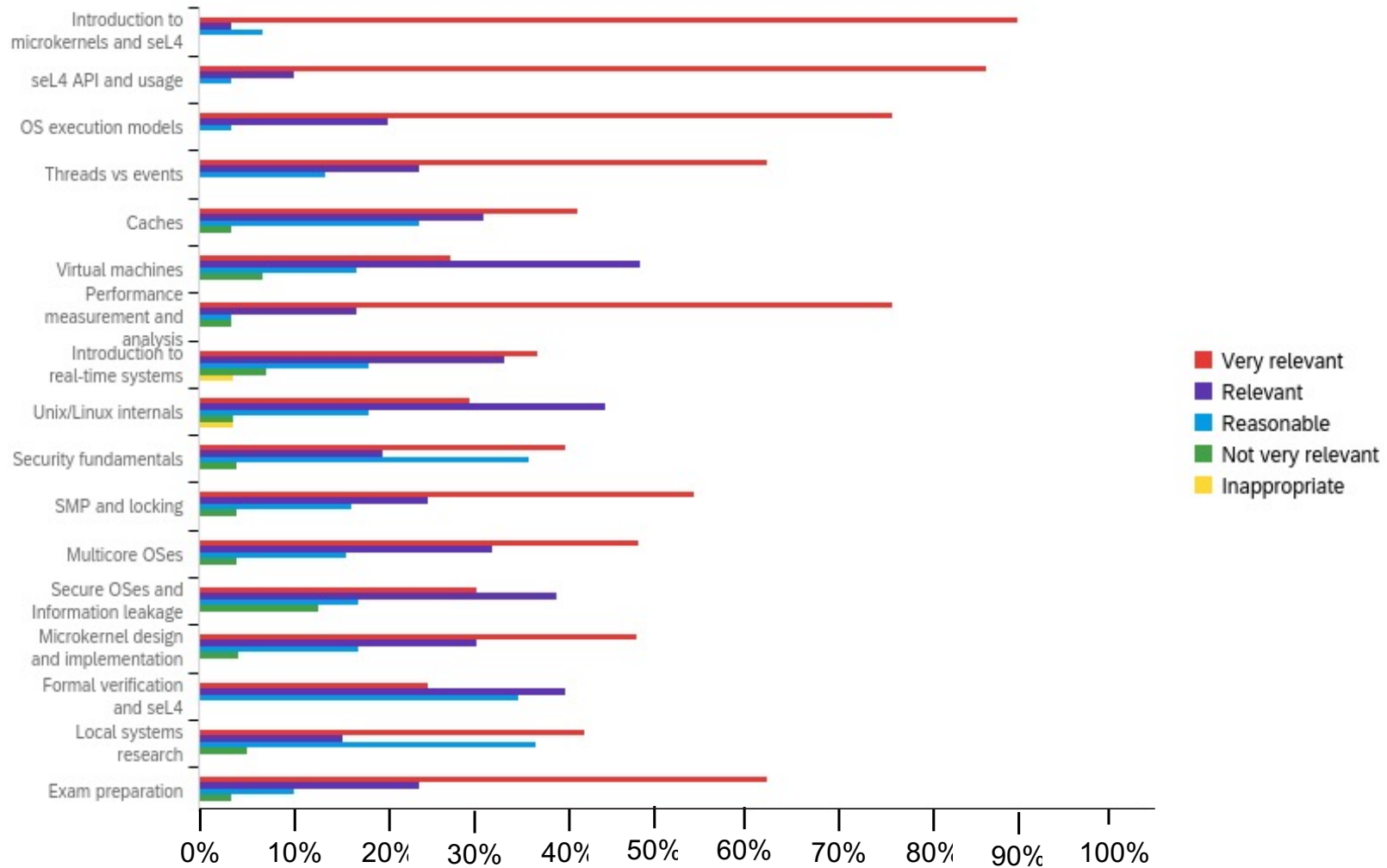# 13: Missing background knowledge 4/4

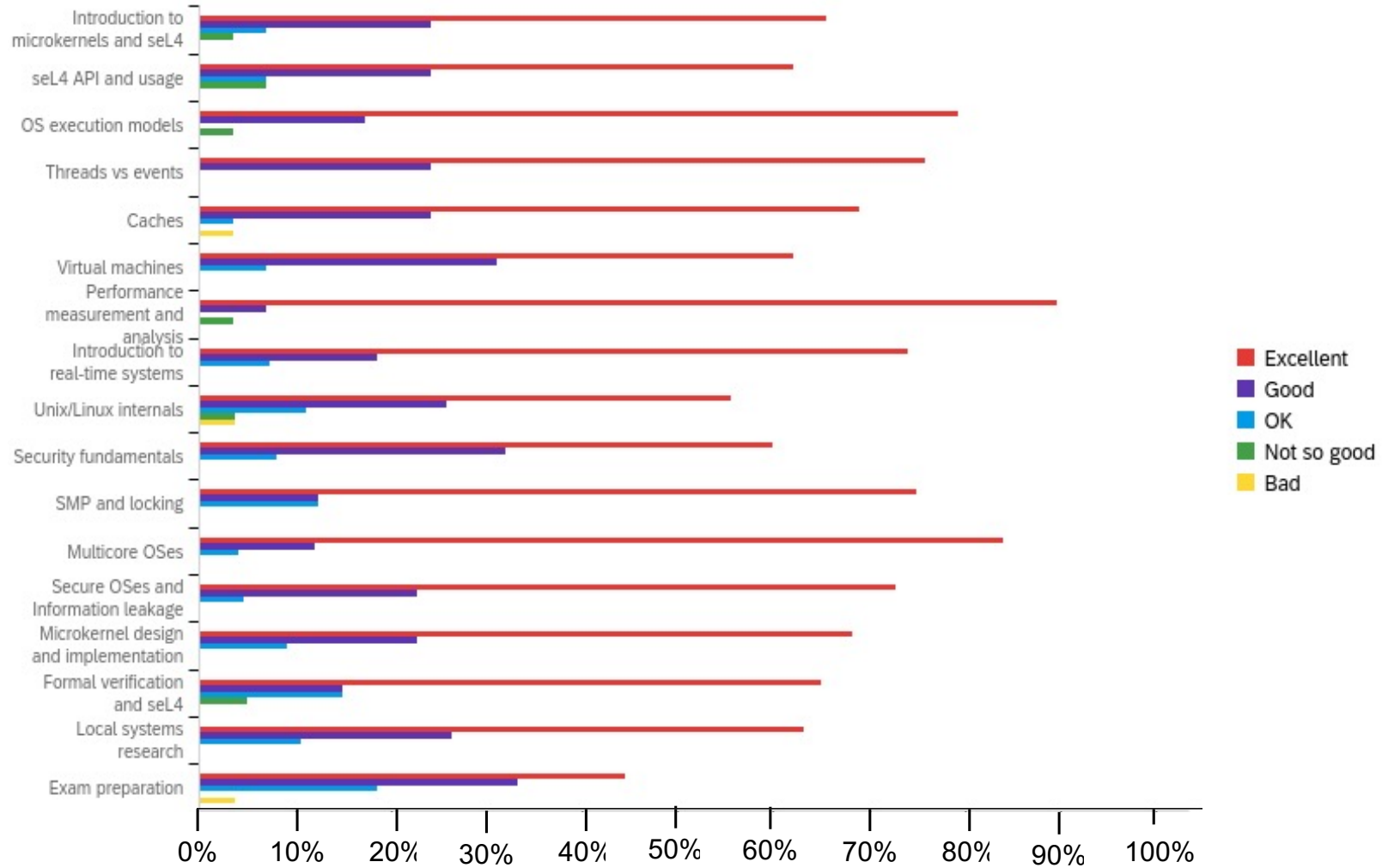| What background knowledge do you think you were missing that would have helped you in this course? Is distinction WAM (used this year in lieu of distinction grade in COMP3231/9201) a suitable preparation? Is it too harsh? |
|---|
| I do not have a distinction WAM (<70 mostly due to a slack attitude in 2nd & 3rd year) but got >90 in both OS and AOS. A distinction WAM is too harsh and not a sensible barrier, while a requirement on OS grade makes perfect sense, given the course is related too and feeds into AOS. |
| Not sure if a high WAM is an accurate predictor for doing well in the course. This course is definitely very tough so it is a fair restriction |
| Suitable for most cases. However, having not learnt much from OS due to the pandemic, the only reason I got into the course was through the WAM barrier, and I suspect there are some students who have a strong interest in OS but might not meet the barrier. |

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14: Relevance of lecture topics

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15: Quality of the lectures

16: What will be useful in the future? 1/3

Which material do you think will be most useful to you in the future?
Performance measurement/analysis, execution models, caches.
Unix/Linux internals, virtual machines
Caching, multiprocessor OS and security
proper benchmarking techniques was a topic i found very interesting and would probably be very useful
all
Experience working on and with large codebases and projects Deep understanding of how things really work in operating systems
All the OS design related materials. Unix internals was fairly interesting.
Threads v Events, Security/Secure OS
Caches!
Multicore operating systems, caches, SMP.

16: What will be useful in the future? 2/3

Which material do you think will be most useful to you in the future?
The security, VM, execution models topics
Ironically I've skipped them, I would find Unix/Linux internals and Multicore OSes both fascinating topics. Performance and analysis taught me how to critically read published papers, which I'm sure will be useful in the future.
virtual machines; caching; execution models.
Security mindset
The lectures more focused on the design considerations in operating systems: the seL4 lectures, execution models.
Project spec
I don't think one particular lecture is the most useful.
Threads v Events, performance and security were probably the most relevant
Caches and performance measurement/analysis is very useful even if I don't do OS development.

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16: What will be useful in the future? 3/3

Which material do you think will be most useful to you in the future?
I hope all of it will be.
Security Fundamentals
All of the things about the design choices and advancements in OSes/micro kernels as well as the factors which affect performance.
I think caches, security, and virtualisation (along with general OS knowledge). But not sure!
Caches, Virtual Machines, Performance measurement, Unix/Linux internals etc
Profiling, RTOS, Unix internals, SMP, multicore
Execution models, virtual machines, performance measurement and analysis, locking
Caches/VMs

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17: What should be added?

Which material, not presently in the course, would you have liked to be covered?
A demo lecture on sel4 programming instead of 2 long monologues in w1 and 2. Or delegate a tute sesh to cover this. especially capabilities.
More about system design/architecture on top of a microkernel (and especially a capability-based microkernel), or case studies on how microkernels are used in various systems.
Processor specific implementations and differences. Microkernel applications in industry.
I think expanding on the actual implementation details around the formal verification of the seL4 kernel would've been very interesting to see - what were the exact challenges, what did the code look like
A bit more about monolithic kernels (e.g. Windows) would be nice
Some more examples on how things were done on OSes like linux, freebsd etc.
Hard to know what I don't know, some more examples would be nice, eg lock free programming, RTOS, or deep-dive debugging As the content is not assessable, you could host lectures in w6 and/or w11 either live or just post recordings as an optional lecture. I'm sure you would get many students still interested and watching/attending

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18: What should be removed?

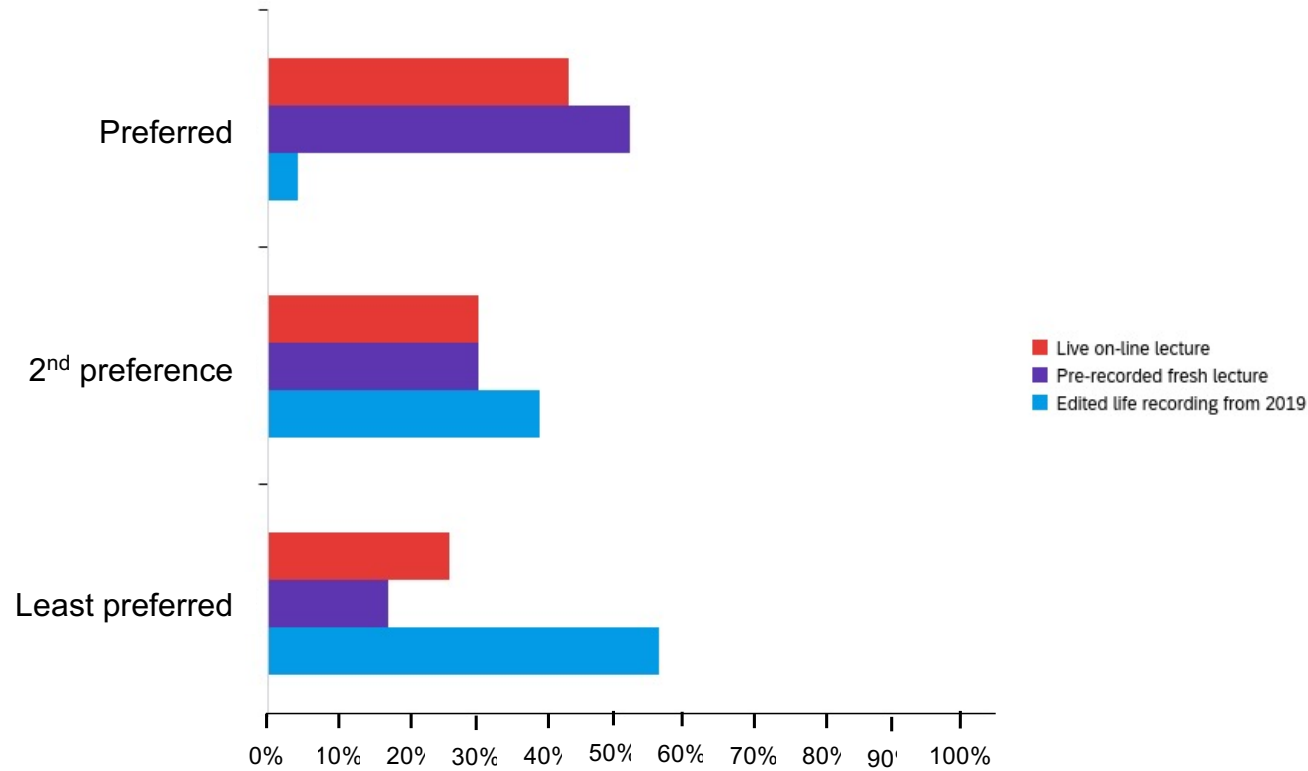| Which material, not presently in the course, would you have liked to be covered? |
|---|
| Probably introduction to real time systems |
| Virtual machines was something I didn't really understand and wasn't applicable to the project so could probs cut down on that |

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19: Why watch/skip the lectures?

17.1: What made you watch the lectures?	%	Count
I had enough spare time	50%	15
The lectures were too good to miss	66%	19
Given the pace and lack of textbook, I could not afford to miss the lectures	41%	12
I expected the material to be required for the exam	38%	11
None – I skipped most of them	7%	2

17.2: What made you skip the lectures	%	Count
Overall workload in this and other courses	83%	24
Lecture notes and references cover the material adequately	7%	2
Lectures are boring	3%	1
Lectures were irrelevant to the project	67%	16
Friends told me the lectures were irrelevant for the exam	7%	2
First half was more interesting than second half	3%	1
None, I watched all of them	28%	8

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20: Live lectures vs recordings

21: Any other comments on virtual lectures? 1/2

Any other comments on the virtual lectures?
Prefer some lectures to be live and others to be recorded, e.g. 1 each per week could be reasonable. Recorded lectures tend to deliver information more succinctly (useful towards end of term with overload from other courses), but live allows slightly more interactions and quicker clarification. (Obviously no replacement for in-person lectures which are naturally much better. For online learning I usually prefer reading articles over lectures for theory, though there are exceptions.)
I had some technical issues (desyncs, poor quality) with live Blackboard lectures
Not much between them
Live lectures online just feel like they're paced weirdly, especially when not many people are actively engaging, more so in the recordings afterwards, so I think pre-recorded videos are better. Also recorded lectures on youtube would be good.
I found it much easier to attend when I knew that they would be live.
I can't remember which ones were pre-recorded fresh lecture, but what's the point of this type of lecture? Doesn't make sense to me
I find it difficult to concentrate in online lectures so I usually just watched the recordings at my own pace. I only went to a couple of live online lectures.

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21: Any other comments on virtual lectures? 2/2

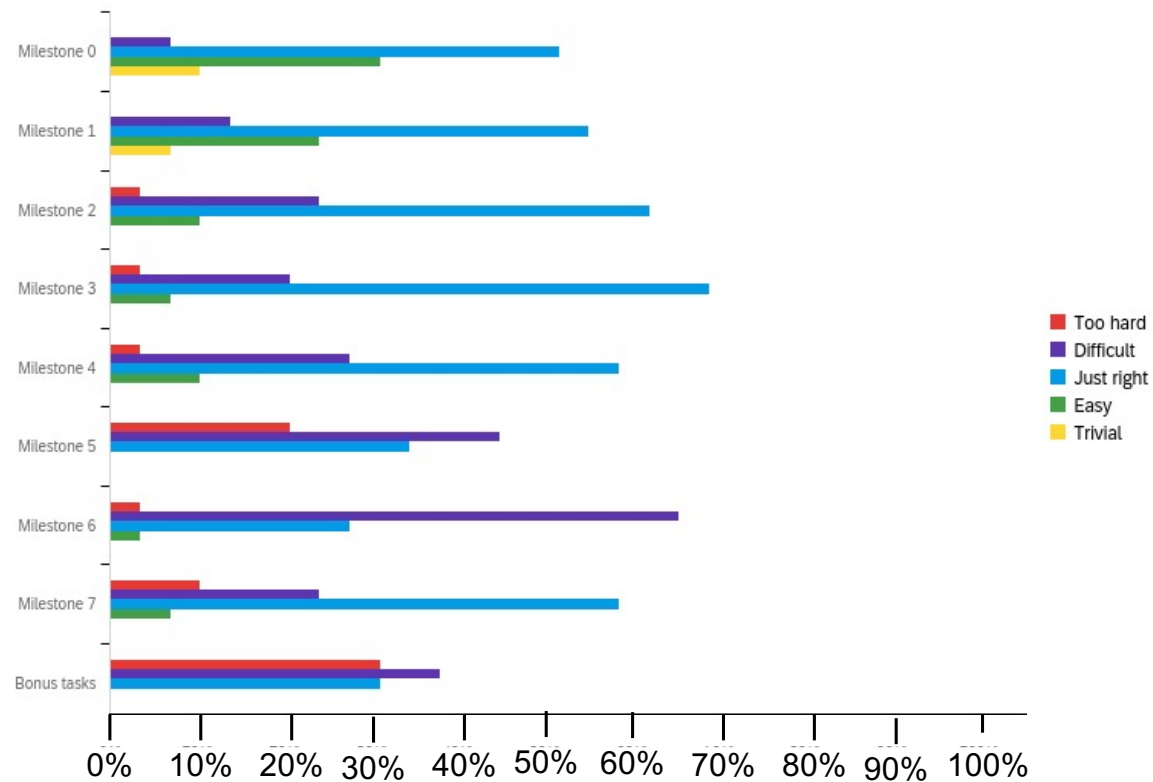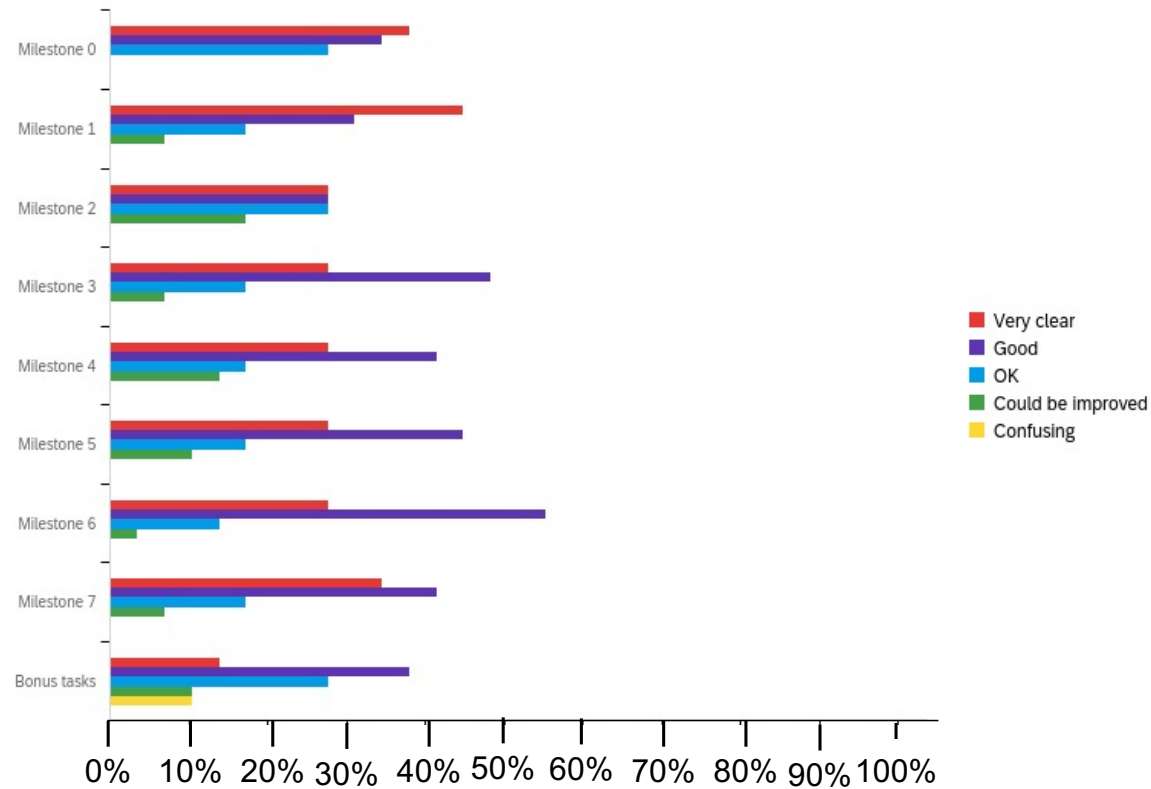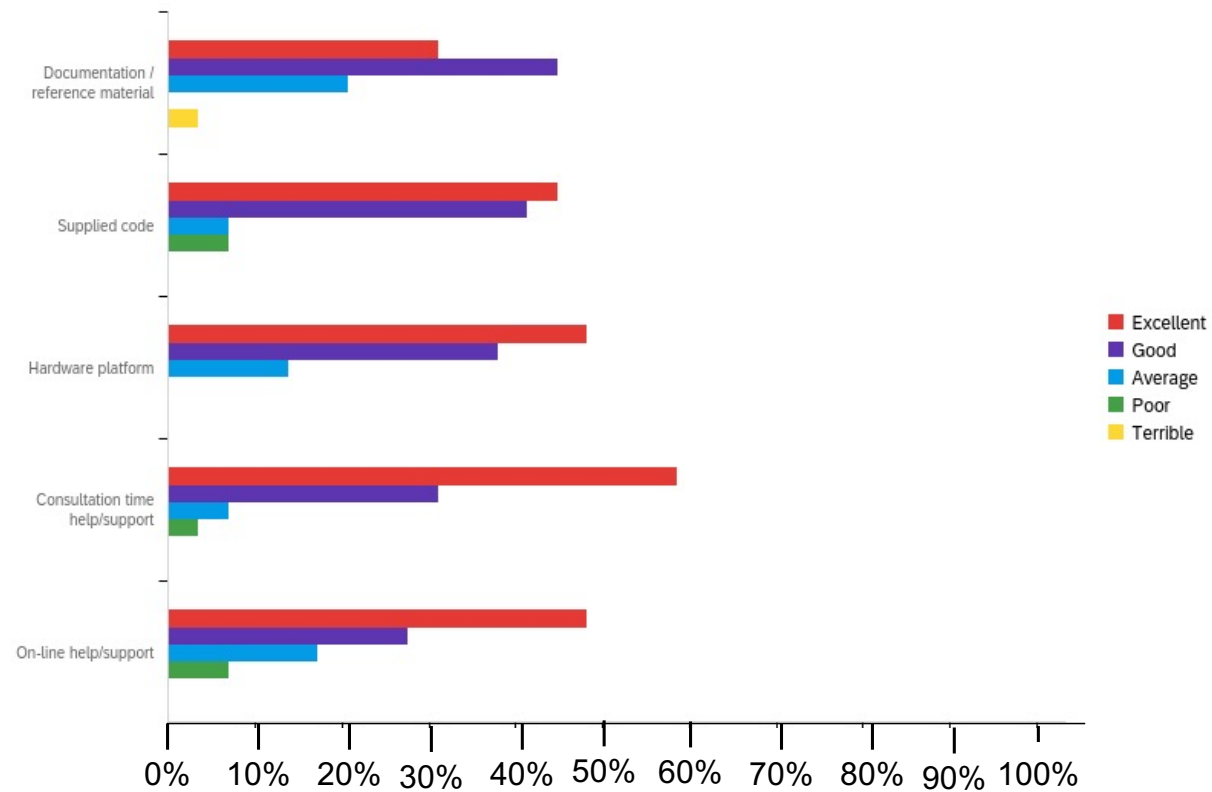| Any other comments on the virtual lectures? |
| --- |
| For Gernot, I think live on-line is best, while for Kevin 2019 recordings worked well (albeit difficult when someone asked a question). I am more likely to watch a live lecture during that week than a pre-recorded lecture, and fell behind when we had a few pre-recorded lectures |
| I didn't realise until the end of week 1 that most lecs were unrelated to the project (but still planned to watch them out of interest [key word: planned]); maybe it's worth mentioning this in wk1 |
| To add more detail re. watching lectures - I often didn't watch them live/in the week they were released, but watched them in batches when I had time. Some of the lectures weren't directly relevant to the project, so I didn't watch those immediately. |
| Some more examples for Gernot's lectures. I don't mind the pace, it is a little fast, but without a clear example to build a mental model, it can be hard to follow.
Kevin gives very clear examples that builds out a mental model that makes it easier to follow. |

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22: Level of difficulty of various project parts

23: How well was the project specified?

24: What was the quality of...

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25: Taste of Research / Summer Internships

The faculty is again offering taste of research (ToR) internships. Tell us about your interest in ToRs

Answer	%	Count
I have applied for a ToR with the TS group	27%	4
I have applied for a ToR, but with a different group	0%	0
I'm planning to apply for a ToR with TS later	27%	4
I'm planning to apply for a ToR later, but not with TS	0%	0
I've got no time for an internship with TS (other internships, paid work, ...)	52%	15
I'm not interested in an internship with TS	31%	9
I'm so glad I survived this course but don't ever want to do anything with operating systems again!	0%	0

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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!	21%	6
Maybe	41%	12
I'm already committed to a thesis outside TS	21%	6
No way – leave me alone!	7%	2
I'm doing a 3-year degree and are not interested in honours	10%	3

Any comments on TS internships or theses?
I'm a postgrad student, I don't know if any of this is relevant although if the opportunity presented itself I would love to

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27: Any final comments? 1/2

Any final comments you would like to make?
Best project ever, favourite course ever! The second half of the project was much harder than the first half, so I think you have some room to make the earlier milestones harder.
excellent course
Thanks Gernot Kevin and Curtis!!! Really well organized.
amazing course, seL4 is awesome
I just want to say thank you. The experience and knowledge gained from this course aren't comparable to any other courses I've taken at UNSW. - a final year MTRN/Comp sci student
More lectures on seL4 coding part, instead of just 2 lectures about it intensively at week1. Week's lecture contain too many information for my little brain.
Great course! Loads of work but learnt a lot.
Was kinda keen to write an OS completely from scratch - a tad disappointed we got given so much starter code. Some show stoppers weren't put on the milestone pages - this was frustrating because we generally got marked the week after on Friday due to availability, giving us effectively only a few hours to fix before the last help session of the week.

27: Any final comments? 2/2

Any final comments you would like to make?
Thank you for the term. I will wear my t-shirt with pride!
Thanks for running this course, it was really fun and rewarding!
Thanks to everyone involved for an awesome course :D
Thanks for taking away my weekends in exchange for excellent project experience.
Thanks for an amazing term and amazing experience!
Thanks for the course!
An idea: have a live leaderboard with fastest FS times in all 3 categories, essentially game-ifying the FS bonus mark for the second half of the term.

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The End