Course analysis DM1588 – 2023

0. Author (Name, email)
Course responsible. ciolfi@kth.se

1. Description of the course evaluation process

The students had two representatives that collected feedback during the first half of the course. This feedback was summarised and presented to me in a meeting with the representatives. I then presented it back to the class, and to the board at the *länkmöte*. In addition, during the *länkmöte*, the Study Board representative went through the feedback that they had received on their side, and I took notes. Each student also had the opportunity of writing a non-graded individual reflection about their own experience in the course, as well as filling in the KTH course evaluations. As a course responsible, I reminded them about these different channels during class meetings (first class, mid-term class, and last class).

The individual reflection was set up as an ungraded quiz assignment on Canvas, and one of the requirements to get a grade in PRO1. Students were told, however, that they did not have to answer all the questions if they did not want to, and that there are no right or wrong answers. The questions were complementary to those in the course evaluations: they were mostly about their personal experience while doing the project, their main take-away from the course, as well as any concerns/comments they had about their participation/learning. Responses were submitted by all of the students who took the course (one of the registered students did not take the course). Gender and disability data were not collected because it would not have been anonymous.

The KTH course evaluations were filled in by around 5% of the students (4/76); all Swedish students in years 1-3. The gender distribution is not available in the generated report, but it seems to correspond to 3 men and 1 woman (given that a woman left a comment on the question regarding gender, and that a summary graph was generated for people identified as men, indicating that at least 3 of the 4 respondents were men). This 5% includes students with disabilities, but it is not possible to know how many. One student (woman) left a comment regarding gender: *"I did not feel that gender matters in this co[u]rse. (in a good way)"*.

2. Description of meetings with students
I had a meeting with the two student representatives where they presented a summary of the feedback they got from their classmates (mostly on facing the challenge of translating theoretical knowledge on electricity/electronics into manipulating the hardware for the first time, and wanting as a consequence more introductory material at the start of the course). After analysing the feedback, I presented the main insights in a class meeting to the whole group.

3. Course design
The course has:
- six class meetings consisting primarily of seminars lead by the course responsible (except one with guest lecturers);
- five lab assignments to be done in pairs during five lab sessions where students get support from the course responsible and teachers;
- one mini-lab assignment to be done individually at home;
- two practice quizzes (i.e. ungraded) on the theoretical parts of the course;
- one project where two lab pairs collaborate to create an interactive installation;
- three supervision meetings towards the project;
- two technical assistance sessions towards the project;
- one presentation where students show a demonstration video and engage in Q&A with their peers.

Seminars include interactive lecturing and in-class exercises where students engage with each other and with the lecturer. Attendance is mandatory for seminars (students can miss up to two), and is optional for the other activities. The first week, the groups (self-made) are given a kit with all the material they need to complete the course. The students get extra support from teachers via email; from teachers and peers via the Discussions forum on Canvas; and from MIDDLA studio managers by booking slots with them on campus.

Regarding the constructive alignment, each of the class meetings and lab assignments contribute to one or more intended learning outcomes (ILOs) and building blocks of the project, so that succeeding in the labs equips the students to succeed in the project, where they further acquire team-working and presentation skills. The students receive continuous formative feedback when they submit each lab until they get a "pass", as well as during project supervision. The project's grading criteria is designed to assess that the ILOs have been achieved, and the project is graded only after students have the opportunity of getting peer feedback and improving their final submission.

This year, I further developed the course based on: my own course analysis from 2022 (student feedback, plus *länkmöte's* insights passed on to me by the Study Director, given that I was on partial sick leave at that point in time); last year's teachers / teacher assistants' experiences; and my own notes along the course. Changes implemented to improve the course include:

- Improving the Kurs PM and publishing it before the beginning of the course.
- Repurposing one of the lab support sessions (previously for catching up with labs) to be an extra technical assistance session towards the project.
- Compacting the seminars to be 6 instead of 7, so that students would have more time towards the end of the course to dedicate to the project.
- Updating the inspirational material to incorporate novel technologies from academic research.
- Updating the content of the seminars.
- Purchasing new materials (sensors, actuators, basic electronics, etc.) to provide to the students.
- Defining a process for students to pick up and drop off the hardware, together with the MIDDLA studio manager. This also included more communication with MIDDLA staff so that students could make use of the space, get the 'driver's licence', upcycle materials, get support with soldering, and in general know what is available in MIDDLA and get inspired and motivated to undertake sensor-based projects.
- Creating guidelines for supervisors to continue improving the quality of supervision and ensure they were all on the same page. This was particularly important given that both teachers were new to the course.
- Creating guidelines for lab teachers to continue improving the formative feedback regarding lab submissions. This was particularly important given that both teachers were new to the course.
- Creating a communication channel for teachers to keep each other in the loop regarding the course.
- Improving the description of the lab assignments and project assignment.
- Adding internet communication to a lab assignment (where radio communication became instead optional), as this was highly relevant for the project.

4. Students' workload

The course is 6 credits and the period lasts 10 weeks, which is equivalent to 16 hours a week on average, for a total of 160 hours. The course typically has 4 scheduled hours per week during 9 weeks (the first week that has 6), plus an estimated load of 10 hours per week to dedicate to the project, which starts half-way through the course. The time to complete the labs and preparatory tasks must also be accounted for within the total of 160 hours.

From those who filled in the course evaluations (4), one student perceived that they spent slightly more than what was expected (18-20 hours a week); two estimated spending 12-14 hours; and one 6-8 hours. Only one student commented on this, saying that they spent more time on the project than on the other activities (which is in line with the course design).

5. Students' results on the course
All of the students who followed the course and submitted their work have successfully passed (76/76). One student registered but did not take the course and so they did not pass.

6. Students' answers to open questions
As the 'best aspect' of the course, students highlighted the pedagogical skills of the 'main teacher' (course responsible) (one student); and working in a practical way (two students) while collaborating with peers (one student). Regarding improvements, one student suggested to continue improving the lab descriptions, and one described their group's struggle to give positive feedback to other groups in the final presentation. This student also struggled with mandatory attendance and with getting started to code in Arduino (however it is hard to assess the situation given that this student declared having spent less than half the expected hours to the course).

7. Summary of students' opinions
The course evaluations (although filled by very few students) show that respondents appreciated the course. Most (3/4) said they worked with interesting issues (one was neutral); 2 said that the course was challenging in a stimulating way (2 were neutral); 2 said they got feedback without being graded (while a neutral respondent said they would have liked more feedback from project supervisors); most (3/4) said the assessment was fair an honest (it is worthy to notice, though, that they had not been assessed yet); all declared they had been able to learn by collaborating with others; and most (3/4) that they got support when needed (the fourth student seems to have wanted the teachers to directly solve their programming problems rather than equip them with the tools to solve them on their own).

The personal reflections (filled in by 76 students) show a generalised positive outcome and constructive feedback. The answers show that many students truly enjoyed the course and found it *"fun"*, *"really enjoyable"*, *"interesting"*, *"inspiring"*, etc., and that it *"really fits the programme"*. Personal concerns about participation were few but highlighted: difficulty in relating seminars to labs; struggling with mandatory attendance to in-person class activities (seminars); and wanting to get more variety of sensors and actuators in their hardware bags provided by KTH.

Students listed a range of take-away learnings that align with the ILOs (such as learning to programme with sensors and actuators) but that also go beyond them. Just as in previous years that I have led this course, some mentioned wanting to continue using Arduinos for undertaking larger projects; others reported a newly found interest in designing for physical interaction, and for creating innovative artefacts. Moreover, some mentioned it was one of their favourite courses at KTH so far, or that it was going to be *"very influential for me when it comes to picking courses later"*. They largely appreciated the practical aspect of the course, but especially the ability to apply theoretical knowledge in practical contexts. Students also highlighted the *"freedom"* to conduct their projects, and the rewarding sensation of *"moving something by programming it"*. They declared getting a broader understanding of how software and hardware work; and appreciated collecting experience with rapid prototyping skills and iterative design and development. Besides the specific programming languages they learned to use in the course, students also mentioned acquiring knowledge on *"engineering"* and *"programming"* in general; and on *"how to write reusable and independent code"* and *"navigate [a language] using documentation"* in particular.

Several mentioned acquiring or improving general skills such as: time management, team work, tackling a project larger than what they were used to, creative thinking, problem solving, and English-communication skills. Crucially, and in line with the previous two course instances, students spontaneously reflected upon an increase in their **self-confidence** when it comes to programming and building artefacts using Arduino and electronic components (e.g.: *"one of my main takeaways is that I am capable of learning new languages and becoming comfortable with them. This realization has boosted my confidence in my ability to adapt and grow as a programmer"*). A sense of achievement and pride at the end of the project was, this year again, evident in the reflections. Several students also

highlighted their newly acquired ability of incorporating sensors in technical solutions during their future studies, as well as becoming aware of the pervasiveness of sensors and actuators in daily life. On this regard, one student stated: *"I have a new framework for thinking about hardware and electronics. It is no longer just "magic""*.

The liason with MIDDLA was highly appreciated. For example, one student wrote: *"I appreciated that we, as students, were given access to a conducive environment like MIDDLA, which is abundant in resources and enabled us to construct our project effectively."*
Finally, students praised course organisation, course structure, content selection and delivery, communication (e.g.: *"The communication in this course has been great, one of the best so far during my time at KTH"; "The seminars and labs were well planned out and explained to fit the progress of the course"*), examination (that there is no written exam), and the quality of the teaching.

8. Overall impression
My overall impression is that the course was well received this year again, given students' feedback as well as the quality of their participation. Adding the tutorial on internet communication, as well freeing some time close to the project presentations while offering an extra technical support session worked quite well. Getting all the teachers on the same page regarding formative support (for labs and for supervision) also proved itself important, and generated a nice working environment among teachers (who were quickly helping each other with advice and tips). It also allowed for faster reaction to questions from students in the forum or via email (in spite of this, one respondent of the course evaluations felt the feedback for labs was slow). Counting with support from MIDDLA to coordinate the acquisition, distribution, and use of material was key.

9. Analysis
In the course evaluations, one student commented on gender not mattering in the course, 'in a good way', which I interpret as the student perceiving equal treatment regarding gender. However, for my observations (and as I have already reported before), certain gender stereotypes seem to still be present in the way that some mixed-gender lab groups divided their tasks. I am considering an intervention for next course round where students would agree on their own collaboration terms at the beginning of the course, and revise/discuss the terms as the course progresses. The goal would be to become aware of the types of skills that are acquired when dividing learning tasks in certain ways. Other struggles regarding collaboration appear again in a few individual reflections, such as group dynamics and time management when working in groups, so the intervention could address these other levels too.
Regarding disabilities, one student with dyslexia commented that it is hard for them to learn to code from written material (the student does not comment whether they played the explanatory videos that were available on Canvas, nor about the live, oral support given in the 7 lab support sessions; and, the student doesn't comment either on whether they use text-to-speech tools to consume the material, or whether they rely on reading).
Finally, very few students (5%) completed the course evaluations, which might suggest they felt their feedback had been heard and acted upon during the course. Another possible cause might be that they were busy with other courses towards the end of the term.

10. Prioritized course development
In response to student feedback, a set of improvements will be prioritised as development for next round. The biggest change is that 3 seminars in the middle of the course will be replaced with sequences of short videos that students will watch at home. This will allow them to *not* come to the campus for those sessions that are more content-driven, and acquire the knowledge in more flexible ways, at their own pace. The first lab, where most students code in Arduino for the first time, will have a longer deadline, answering to student's feedback on needing to focus more on coding *"when you are new to it"*. The class on material knowledge and home-made sensors, together with the associated mini-lab will happen earlier in the course as suggested by students, and the mini-lab will have a support session (and a later deadline), given that this year some students struggled with coordinating with their lab mates to use the equipment separately. We will also offer an optional workshop session the first week, for students who want to refresh their practical knowledge of circuits, batteries,

resistors, and other basic electronics components and concepts, which should help them more quickly relate theoretical content on electricity/electronics to the practical side of it. Finally, the labs' description, scope, and order will be further assessed to continue strengthening the matching with seminars and project work; and the in-person seminars will continue being refined to keep engaging students interactively when they are on campus.