ABSTRACT: We report on a case study of teaching a first semester physics course to 700 students in the Autumn semester of 2014. We discuss specific issues for future consideration related to the efficient use of resources, managing and training of student assistants, the learning process for the students, the logistics of teaching such large groups, and the relations between students, assistants and lecturer.

1 BACKGROUND

1.1 Course setup

The University of Stavanger provides a broad range of engineering and natural science degrees, spanning chemistry, physics, mathematics and building, machine, electronics and, perhaps most famously, petroleum engineering. All of these bachelor’s programmes share the first semester physics and mathematics courses, which therefore comprise up to 800 students, most fresh from high school, many from outside the Stavanger region.

The physics course FYS100: Fysikk had in the Autumn 2014 semester 692 students signed up; of these 534 (77%) took the written exam; of these 371 (69%) passed (grade E or better). 139 are signed up for the re-exam (pending).

The format of the course is three weekly lectures of 2 x 45 mins each. In addition, problem sessions are available to the students once a week for 2 x 45 mins, under supervision by student assistants. The lectures are streamed online live and for later viewing; and the admission to the exam is subject to the completion of four hand-in problem sets. The course covers 13 chapters of a standard “mechanics for engineers” textbook, roughly one chapter per week. There were 22 student assistants attached to the course.

1.2 Aim of case study

Having taught the course in 2013 using the pre-existing setup, the lecturer introduced a number of changes, including:

- An extended exposition and motivation of the course setup to the students at the beginning of the course. Would the students be able to grasp and accept the framework of the course, their own roles and responsibilities in it and be able to reflect and adapt their prior expectations in relation to it?

- A training session for student assistants with a similar exposition, but also a behind-the-scenes insight into the didactic choices of the lecturer. Would this help for the assistants to find their own place in the teaching and learning process?

- The use of problem sessions as actual classroom teaching with a structure, two assistants per classroom, and a focus on participation at the group (table group setup) and class level (blackboard presentation). Would the students be willing to participate? Would the assistants be able to motivate the students?

- The introduction of a head assistant, to answer day-to-day requests and queries from the students, and to manage the student assistants. With this, a somewhat more strict approach to granting individual requests for extra material, extra tuition, individual attention. Would the students accept such an in-between as authority? Would the student assistants?

The new initiatives were mainly aimed at strengthening problems sessions as teaching and learning environments. Through better organising and training of student assistants, and a more precise set of expectations to the structure of the sessions, priority was given to the students that attended regularly. This in contrast to previous years, where problems sessions were more akin to Q&A sessions, and students would come and go.
1.3 Data

The discussion below is in part based on a student evaluation questionnaire [1], deployed after the last lecture. Just short of 250 students responded, and results will be referred to below by “SE”. Given that less than half of the students taking the exam responded, one should expect a significant bias on the population. Experience shows that it is the very negative and to a lesser extent the very positive students that respond, and so the results must therefore be interpreted with care. Still, given the size of the population, some statistical significance must be expected, in particular for questions that are not explicitly “pro” or “contra” something or somebody. In addition, a questionnaire was sent out to the student assistants [2], referred to as “SAE”. Here the population is much smaller, with 10 respondents out of 22. Finally, the discussion will be based on various factual numbers (exam results, hand-in results) and private observations by the lecturer, as well as a number of external facts referred to individually.

1.4 Disclaimer

The author (who is also the lecturer) has no background in didactics other than several years of teaching experience at various levels, in various topics, in a number of European countries. This will go a way towards explaining the un-orthodox terminology used, as well as the absence of reference to scientific literature in this field. Hopefully, some of the issues raised here will be seen as sufficiently interesting to become subject to proper professional scrutiny.

Finally, it should be emphasized that the present study is not part of the general discussion about whether it is sensible to teach such large student groups in the first place. Rather, it is an attempt to highlight what specific problems must be faced, if one does choose to do so.

2 LEARNING, EXPECTATIONS AND ROLES

2.1 What we think we need; what we do need; and what we can in fact have.

Consider Fig.1 as a simple-minded illustration of the relations between Lecturer, Student and Institution. We will assume that there is an objective number of things (material, practical, logistical) that the student needs to learn the subject matter well. This is the blue circle. The green circle represents what the lecturer believes the student needs, the orange what the student herself believes she needs (we will ignore the further complication that different students may have different orange circles). This splits the world up into 8 different regions, including things outside all the circles (8). In an ideal world, the three circles would coincide, and student and lecturer merrily proceed in complete accordance. In this same ideal world, the resources provided by the institution will also precisely match the common circle. This is rarely the case. Indeed, the reason to teach in such large groups is to a large extent to save resources (money, lecturer time, infrastructure capacity) and use these for more specialist courses, later in the degree trajectory. Or to use the resources available for other aspects of student life particularly relevant when arriving at University, induction weeks, student mentors, help with housing, private issues.

2.2 Student role and relations

The student arrives to the first semester with certain expectations, which no doubt have significant overlap with the blue circle (3+1). It is fine to also provide elements of 5 and 7 as long as 1-4 is covered, and indeed an incorrect subjective expectation may turn into an objective need, if strong enough (the availability of coffee, for instance).

A common expectation carried over from high-school seems to be individual attention from the lecturer. Fairly soon, it becomes clear to the majority that this is something that the lecturer does not have the resources to provide for these very large groups. But there is a small subgroup of students who require, request and sometimes obtain individual attention. This may be due to uncertainty on their part, a need for reassurance, lack of confidence in the student assistants or simply personal issues that need to be addressed by the lecturer.
Many students believe that they have a well-developed learning strategy, which they expect will carry them through their education. For most, this is true, and the majority perform well and remain largely anonymous to the lecturer. These strategies impact on the level of attendance at lectures, at problem sessions, the extent to which they use the textbook, and look for complementary or even alternative teaching material (other books, other problems, old exams, old hand-ins).

Most students view the lecturer as an authority that one may challenge, but also respect. This seems to be a quite impersonal relationship, the lecturer is simply a character in the life of the student, with a particular function (lecturing, setting the problems, correcting the exam). A student would be unlikely to challenge and rarely acknowledges the lecturer in a “real life” situation. Students seem to be ambivalent towards student assistants. On one hand they appreciate the help, and respect the job that the assistants are doing. On the other, the assistants are their fellow students, and are therefore more prone to criticism and pressure to give extra help, special favours, even solutions to problems.

### 2.3 Lecturer role and relations

The lecturer is typically also the course administrator, and is responsible for formatting the course, choosing the textbook and curriculum, preparing and delivering the lectures, setting the hand-in problems and setting and correcting the exam. For large groups, the added responsibilities include hiring and supervising the student assistants, as well as a significant email correspondence with students on a variety of topics (on the average 1-2 per student over the semester, or 10-15 per day). This may result in a mismatch between the perceived available resource (the lecturers time) and the actual resource (the lecturers time per student). Individual requests for attention and tutoring will often be declined, prompting a sense of distance and perhaps even arrogance from the student’s perspective. A prime role of the lecturer is therefore to decide on the rules and standards of interaction, and to set these out clearly to the students early in the course.

Traditionally, much attention has been given to the lecturer as a teacher. For large groups, interaction with the individual students during lectures is not an option. And so to a high degree, lectures are exposition of the curriculum, aimed at explaining key points and to motivate self-study and problem solving either privately or in the context of the supervised problem sessions.

### 2.4 Student assistant role and relations

The role of the student assistant is on one hand to help the students solve weekly assigned problems and to some extent the hand-in problem sets; on the other hand to help implement the teaching framework defined by the lecturer. This may leave the individual student assistant with a split loyalty: is he there to help the students or to help the lecturer? Should he provide the orange circle or the green circle? Being employed by the lecturer on behalf of the University, the answer is in principle clear. But in practice, co-students (some of whom may be acquaintances or even friends of the student assistant) may push more or less explicitly for extra help, disproportionate attention or even access to the solutions that the student assistant has been provided with.

It is crucial for the student assistant to be made aware of his role as a de facto teacher, and a representative of the lecturer and his teaching philosophy. This requires that the student assistant is given insight into why the lecturer makes the didactic choices he makes; and the student assistant should be able to influence how these are to be implemented. Clearly, trust is an essential part of the relationship between student assistant and lecturer.

### 2.5 The institution and its relations

Universities are to a largely funded based on student ECTS production. A sizable fraction of students signed up at Universities never complete their degree, but drop out after the first or second semester, because of lack of interest, emergence of alternative options, perceived or actual lack of ability, changes in the private sphere or for economic reasons. Institutions therefore have an incentive to sign up significantly more students than the study programme has resources for further down the line, in the anticipation that the group by then will reduce and refine. Referring again to Fig. 1, the institution represents what one may in fact have, which ideally should encompass the blue circle. Typically, the institution will attempt to provide 1 and 5, since that will be requested by students and lecturer. Conflict may arise when 2 and 6 are provided, but not 3 and 7 (or vice versa). Sometimes, the institution will provide something from 8, which is deemed to be in 4.
Institutions have limited resources, and often even 1-3 and 5 are provided to a reduced extent. This is typically a too small lecture room (in FYS100, a second streaming room is provided); an insufficient number of problem session rooms; not enough student assistants; not enough study places/group rooms. Compensating initiatives may be provided such as various on-line resources and live and stored streaming of lectures. This in an attempt to shift the dynamics of the teaching setup so that what was in 4 and is not available may be replaced by something that originally is in 8, and is available (and perhaps more economical). Typical examples are inverted classrooms, home-study through streaming, on-line tests and feedback software. The obvious question is whether this new teaching setup provides better learning, or simply upholds the same level of learning using less resources.

2.6 The rest of the World

In particular when first embarking on University life, many outside factors influence the student and aware of and navigate, rather than specifically address case by case.

Learning is often (correctly or not) firmly associated with the direct interaction between teacher and student. Since for large groups this is not an option, a central question is where the student feels the learning takes place. This was a question in the student evaluation with the following outcome (see Fig. 2) [1]: two thirds of students find that learning takes place during problem solving. Just over half find that they learn during lectures, with an equal number identifying learning in discussion with their co-students. Reading the book is somewhat useful after the lecture, but discussions with student assistants and watching a repeat of lectures does not seem to engage the learning process. Even taking into account sources of bias (perhaps the students streaming from home are less likely to participate in the survey?), it seems that what happens outside the lecture room is at least as important, and likely even more important, than what happens inside. And that students are aware that tuning their understanding and skills through problem solving is essential.

3 OUTCOME AND EVALUATION

3.1 Student evaluation of course

The course setup in terms of relevance, book, curriculum and structure is well tested, and the SE supported this through largely positive feedback. Specific points to mention include that [1]:

- Students did not typically prepare prior to the lectures.
- The course is deemed to be harder than the other courses on the same semester. This included the level of the hand-in problem sets.
- Students prioritized weekly and hand-in problems when preparing for the exam. Streaming the lectures again and consulting the lecture notes was much less popular.
- The lecturer was popular, but his handwriting (and hence the lecture notes written during lectures) poor. Still, 71% preferred to continue using document camera rather than alternative media (Powerpoint, Smartboard, Blackboard, online media). It is unclear whether the students have a basis for comparison.
- A third of respondents used streaming regularly instead of attending lectures. This may reflect a bias in the respondents. Few chose to see lectures (live or streamed) more than once.
- About half the respondents used the problem sessions, and were largely positive.
- Teaching in English was acceptable (previous surveys [4] at beginning and halfway through the course showed 7% favouring Danish; 74% favouring English; 16% happy with either).
- In the “additional remarks” part of the survey, negative comments outnumber the positive by a factor of 2. Many are concerned with the poor writing of the lecturer, some expressed a wish
for teaching in Norwegian. Conversely, students seemed to acknowledge that the lectures had entertainment value.

3.2 Student assistant evaluation of course setup relative to previous years

The feedback from the student assistants is fairly coherent [2]. FYS100 is again considered slightly harder than the other courses on the semester. Mandatory hand-in problems are considered hard but a necessary evil to force students to do problems. This however makes many students focus exclusively on the hand-ins, rather than optional weekly problems, reading the book, or following the lectures carefully.

One new problem session initiative was to place tables in squares with students seated around. This was evaluated favourably by assistants to promote students-student interaction and allowing assistants to assist a whole group of students in one go. A second initiative was to try and force students to present solutions on the blackboard. This was unfavourably received by the students, although the assistants seem to be largely positive.

The general stricter classroom setup was also evaluated favourably by the assistants, in part because the free setup the year before contributed to noise and unpredictable availability of help. It was however clearly remarked, that the stricter setup appeals only to a certain group of students, and resulted in a lower attendance at the problem sessions than previously.

The student assistant group was composed more or less evenly between older students (having taken the course themselves 3-4 years ago, with a different lecturer) and younger students (having taken the course themselves the previous year, with the same lecturer). Some of the assistants remark that they themselves never attended problem sessions.

4 DISCUSSION AND OUTLOOK

Teaching groups of several hundred first semester students in natural sciences throws up a series of specific problems. The obvious question to ask is: Does it work? Can it work better? What defines “better”?

The initiatives presented here targeted the students who choose to attend the problem sessions. The method was giving the student assistants new tools to use their time more effectively, and make them perform actual classroom teaching. This turned out to only appeal to a particular group of students. These are not the very strong students, but the students likely to pass the exam, who through structured guidance may be taken to a higher level (and a higher grade).

Statistics show that over several years, with different lecturers and a number of different initiatives, the fail rate is stable around 25%; after re-exam 20% [3]. From correcting the exam papers, it is clear that as significant fraction of these are students who for various reasons lack the motivation, the interest and perhaps the skill to complete this particular education. The fail rate in the parallel mathematics course is similar or slightly lower.

The case study has to our mind provided a number of questions to be addressed when teaching large groups: What resources are in fact needed (blue circle)? Who should decide how to prioritize limited resources (lecturer, students, institution)? Should the emphasis be on getting more students through the course, or making the students that do come through, better? To what extent should electronic media be introduced, and should they be aimed at providing better learning results; or the same learning results using fewer resources? How should the relative emphasis be between lectures and problem sessions? How should one educate and motivate student assistants? How structured should the problem session be? Which groups of students does one engage, and which type of study behaviour does one promote by having more or less structured problem sessions? Does it even make sense to promote one particular study behaviour (typically defined by the green circle) with such large and diverse groups; or should one cater equally to all study behaviours (many different orange circles); or not at all? Are happy students also successful students?

REFERENCES

[3] Data from exam office, TN, University of Stavanger.